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EMOTIONAL TRAUMA AND CHILDREN'S EXECUTIVE FUNCTIONING: IS THERE A CONNECTION?

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Dedication

This work is dedicated to my family. In particular it has been my parents' unwavering support, both personally and professionally, that has made all my achievements possible. I would also like to again make a dedication to William James Holder, for all your deep psychological thoughts.

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Emotional Trauma and Children's Executive Functioning: Is there a connection?

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The purpose of this dissertation was to examine the connection between emotional trauma and executive function ability in children and adolescents. Trauma is defined as an overwhelming event that is beyond the realm of what might be an expectable occurrence for the average person. A serious outcome, occurring in around 14% of those children who experience trauma, is the development of Post Traumatic Stress Disorder, which is classified as an anxiety disorder occurring after exposure to a traumatic event, in which symptoms of re-experiencing, avoidance, and arousal are present. In addition to the numerous physical, emotional, and social effects of trauma, neuropsychological and imaging research has confirmed that children's neuroanatomy and cognitive functioning are often affected. It has been proposed that intrusive thoughts occurring immediately after the trauma event may modify the neural network function, setting the stage for neurobiological dysregulation. One of the most common neural anatomic areas of concern following trauma is the prefrontal cortex, a structure that continues to develop until the third decade of life, and that has been implicated as the home of executive function, an idea conceptualized in a number of ways, but that is most often considered an umbrella term describing essential functions of the mind, such as planning, inhibition, attention, and working memory. The scope of literature addressing

the effect of trauma on executive function is minimal. It is the hypothesis of this study that early trauma may disrupt the normal development of the PFC and subsequently result in decreased executive functioning abilities. In order to explore this hypothesis, a set of neuropsychological measures were selected as representative of executive functioning, based on previous research. An initial factor analysis was conducted in order to determine if, as suspected, all subtests chosen load on a common factor of executive function. Multiple linear regression was used to determine whether children who experienced trauma have impaired executive functioning abilities, if there was a significant gender difference, and what, if any, differences there were between children who developed PTSD and children who did not.

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Chapter 1: Introduction

Childhood trauma is a terrifying experience for the child and for the adults who care for that child. Children and adolescents in every country experience traumatic stress from natural disasters, accidents, war, poverty of care by those around them, and direct aggression from others (Hutchison, 2005). In the United States, the most frequent type of trauma experienced by children is maltreatment, a term that describes the physical abuse, sexual abuse, emotional abuse, and physical and emotional neglect of a child (Shipman & Taussig, 2009). Children's attachment, identity development, sense of self, and connection to the world around them are often seriously compromised by maltreatment. Much of maltreatment is considered a Type II trauma, meaning that it happens repeatedly, over a prolonged period of time (McDermott, 2004). Although most children will recover from traumatic stress (80-90%), others develop significant psychosocial or neurological symptoms (Ford, 2009; McFarlane, 1997; McDermott, 2004). Fortunately, there are number of empirically supported interventions for the psychosocial effects of trauma (Ford, 2009; Hutchison, 2005; Lohr, Hooke, Gist, & Tolin, 2003).

One of the most concerning outcomes is the clinical diagnosis of Posttraumatic Stress Disorder – PTSD. PTSD is characterized by re-experiencing of the event, avoidance, and emotional numbing after a traumatic event (American Psychiatric Association [APA], 2000). Neurologically, traumatic stress has been shown to affect the hypothalamic-pituitary-adrenal axis, the amygdala, and the frontal lobes (De Bellis, Hooper, & Sapia, 2005). Catecholamine neurotransmitters are also disrupted, and the

combined dysregulation of these systems has a serious impact on brain functioning (Yehuda, 1997).

The prefrontal cortex, one of the structures affected by traumatic stress, is also linked to the performance of executive functioning. The frontal lobes, specifically the prefrontal cortex, are an essential part of the human brain, allowing for many of the activities that have furthered civilization (Goldberg, 2009). Executive functions are believed to be coordinated by the frontal lobes, in conjunction with other brain areas. Although there is much debate on the best definition, it is largely thought today that executive functioning is an umbrella term that encompasses processes such as working memory, attention, inhibition, planning, and shifting (P. Anderson, 2008; De Luca & Levener; 2008; Goldberg, 2009; Marcovitch & Zelazo, 2009; Martin & Failows, 2010). Developmentally, the prefrontal cortex does not finish myelination and other development tasks until well into adulthood, possibly as late as the third decade of life (Dennis, 2006; Goldberg, 2009; Reynolds & Horton, 2008). Executive functions can first be observed during the second and third year of life, but are immature and concrete, and during childhood begin to develop at a much quicker pace (De Luca & Leventer, 2008). Assessment of executive functioning has been a task with uneven development, largely because of the controversies surrounding a solid definition of the construct (Baron, 2004; Burgess, 1997; Martin & Failows, 2010; Rabbitt, 1997). Interventions are few and far between, and largely focus on compensation strategies rather than treatment (Ylvisaker & Feeney, 2008).

Some authors have made the logical assumption that because trauma affects the same brain structures and neurotransmitter systems that seem associated with executive functioning, trauma itself may hamper executive functioning (Teicher, et al., 1997). The prefrontal cortex, which is not fully developed during childhood, may be especially susceptible to early insult. Some research on select populations (i.e., sexually abused, neglected, exposed to domestic violence), or with a certain aspect of executive function (e.g., attention), has supported the idea that traumatized or maltreated children may have impaired executive skills (Calkins & Marcovitch, 2010). To date however, there has been relatively little research on this possibility.

The purpose of this study was to determine whether the experience of maltreatment or maltreatment, resulting in the diagnosis of pediatric PTSD, has a significant impact on executive functioning skills. Specifically, the questions addressed were the following: a) does trauma decrease executive function abilities, b) do girls who have experienced trauma have more impaired executive functioning skills than boys, and c) do children who developed PTSD after trauma have significantly more impairments than those who did not develop PTSD. The following chapter will present a review of the literature on executive functioning and childhood trauma. Subsequently, a study is described that had the goal of advancing knowledge about the outcomes of early trauma with regards to how it may affect the development of executive function ability. This information is important because the prefrontal cortex is intricately connected with many areas of the brain, and its major role, executive functioning, is essential for competent performance in most areas of academic, social, and emotional abilities. Better

understanding of the effect that trauma has in this area would not only provide researchers more information, but had the potential of providing a starting point for clinicians to develop more effective interventions. Chapters 3, 4, and 5 present the study methods followed, results obtained, and a discussion of the results provided.

Chapter 2: Review of the Literature

A critical analysis of the current research base in the areas of executive functioning and trauma was meant to establish a foundation for conducting the present study. The first section presents a detailed discussion of the conceptualization of executive functioning, the development of neuroanatomy and cognitive components of executive function, models and evaluation of the construct, and interventions for executive functioning deficits. Next, an overview of trauma and maltreatment research in children, the impact of trauma on development and outcomes, assessment and intervention strategies, and cultural and gender considerations when working with trauma victims, will be presented. Finally, the current literature linking these two fields will be discussed, and suggestions from the literature concerning why this area is underdeveloped and how it could be improved upon will be presented.

EXECUTIVE FUNCTION

Early in the 1990's the National Institutes of Health (NIH) declared that it was to be the decade of the brain. Interestingly, their language echoed a much earlier statement by the neurologist Tilney, who in 1928 wrote that all of human evolution should be considered the age of the frontal lobe (Goldberg, 2009; Tilney, 1928). Early neurology textbooks made mention of the frontal lobes in order to instruct students that the area was an ornamental addition to the brain with only minor involvement. This attitude was reevaluated when the case of Phineas Gage came to the attention of researchers (Dennis, 2006). In particular, Gage's case sparked interest in the prefrontal cortex (PFC) and how

it might contribute to the personality of a human being. In fact, the ensuing years have revealed that the PFC is the anatomical seat of human intention, planning, and foresight – in essence the aspects of cognition that make us distinctly human (Goldberg, 2009; Risberg, 2006; Sullivan, Riccio, & Castillo, 2009). Without the PFC and cognitions that are often called *executive functions*, the mind is "bez tsarya v golovye," a Russian expression roughly translating to "a head without a czar inside." These executive functions, a kind of internal conductor or leading executive (P. Anderson, 2008), were posited by Julian Jaynes (1990), to be a possible reason for the creation of religion. Jaynes hypothesized that executive commands of the brain were mistaken by early humans as voices of the gods, and though this may be a bit far-fetched, it does seem in line with the prevailing conceptualization of executive function as the unique ability that has led to the human development of civilization. The most striking coincidence found in history is the Sistine Chapel fresco by Michelangelo, *The Creation of Adam* (Appendix). The robe of God is billowing out in the shape of a brain, God's feet are on the brain stem, his head is situated in the frontal lobes, and his finger, touching Adam to make him human, is coming out of the PFC. Art historians have noted this strange configuration by Michelangelo, and often debated if it was in fact a coincidence (Goldberg, 2009). This section will explore the various definitions and conceptualizations of executive functions; discuss the neuroanatomy and cognitive components of executive function and their development; and discuss models of executive function and current evaluation of, and intervention for, executive function skills. Throughout the discussion, controversies will be explored that still beset this elusive but integral part of human existence.

What is Executive Function?

Gertrude Stein, in response to the question "What is the answer," once famously retorted to her partner Alice Toklas, "What is the question?" That is perhaps the best way to approach the question presented as the title of this section. Each book, chapter, and article presents a different definition of *executive function*, some similar to one another and some radically different, but each trying to answer this question. Much of the discord comes from the different conceptualizations of what *executive function* might be. To some, it is a unitary concept that acts as an executive for the rest of the brain (P. Anderson, 2008; De Luca & Levener, 2008; Goldberg, 2009), to some, a representation of conscious control over actions (Dick & Overton, 2010) in a goal-directed manner (Marcovitch & Zelazo, 2009; Stollstroff, et al., 2010). It has been called an umbrella term (e.g., Martin & Failows, 2010; Mulder, Pitchford, Hagger, & Marlow, 2009; Polderman, et al., 2007), encompassing multiple, distinct psychological processes (P. Anderson, 2008) that function reciprocally with biology (Dick & Overton, 2010). It has also been said that all of these definitions are flawed because they are no more than vague, ambiguous references (Dick & Overton, 2010). It is the aim of this discussion of literature on executive functioning to offer a working definition, used for the later study.

Neuroanatomy of Executive Functioning

It seems to be firmly established that the frontal lobes, more specifically the PFC, play an integral role in executive functioning, and that the PFC is largely responsible for the direction and implementation of these functions. It has been suggested that intricate

pathways between the PFC and more posterior structures may in fact be where executive functions are originating, though this hypothesis is still in the infancy of development (Tamnes, et al., 2010). The neuroanatomy of the entire brain and its connections to the frontal lobes could be explored, but that is beyond the scope of this discussion, and so focus will be maintained only on those structures most relevant to executive functioning.

From an evolutionary perspective, the PFC was one of the last structures in the human brain to evolve into what we know today (Carlson, 2007; Goldberg, 2009). The basal ganglia were, with the thalamus, central to the more primitive, or subcortical, brain. Composed of the caudate nuclei, putamen, and globus pallidus, the basal ganglia were responsible for initiating and controlling movement (Carlson, 2007). A corollary structure to the basal ganglia is the amygdala, which is believed to have always regulated functions that are essential for the survival of the species (e.g., reproduction, fight or flight), much as it does in the modern brain. The cerebellum, located dorsally to the brain stem was long thought to be responsible only for movement coordination (Carlson, 2007), a notion which now seems preposterous given that the total neurons of the cerebellum (approximately 50 billion) make up half of those present in the whole brain (Goldberg, 2009).

As the human brain continued its evolutionary march, the cortex came into being and with it the hippocampi. Singularly known as *hippocampus*, a Greek work for seahorse, each is a long structure found in the right and left temporal lobe (Carlson, 2007). Ironically, the hippocampus does not resemble a seahorse in the least, but has been linked to the formation and storage of memories (Carlson, 2007; Grafman, 2006). The

exact role of the hippocampus in memory, however, is still a topic of hot debate. The hippocampus together with the cingulate cortex forms the cortex that is considered by some to be part of the greater frontal lobes (Goldberg, 2009; Grafman, 2006).

The development of the neocortex (literally "new cortex") is what brought about the distinct division of the lobes – frontal, temporal, parietal, and occipital. The prefrontal cortex is the most frontally situated area of the neocortex, and is delineated in several ways (Goldberg, 2009), though the most useful is a pictorial representation. In terms of the Brodmann areas (Appendix), the PFC encompasses areas 8, 9, 10, 11, 12, 13, 44, 45, 46, and 47 (Dennis, 2006). It is often divided functionally into the orbitofrontal, ventromedial, and dorsolateral regions (Damasio & Anderson, 2003; Grafman, 2006). The orbitofrontal PFC shares a connection with the amygdala, which regulates emotional processing of the essential survival functions, the hippocampus, and the temporal visual areas (Grafman, 2006). The dorsolateral PFC maintains ties to the basal ganglia, which seems to function in conjunction with and under the control of the frontal lobes, the motor cortices, association areas, and parietal cortex. Additionally, it has been shown that the part of the cerebellum that connects to the dorsolateral PFC has grown exponentially over time, evolving in sync, and indicating a reciprocal relationship between the two (Goldberg, 2009).

Though no exclusivity is implied for the relationship between the PFC and the dopaminergic system, they do often appear together in research, and dopamine seems to be one of the most relevant neuromodulators involved in the functioning of the PFC and more specifically for performing executive functions. Neuromodulators, which are

similar to and often referred to as neurotransmitters, are slower acting than neurotransmitters and typically communicate via long axons (Goldberg, 2009). A concise review of dopamine's production and transmission in the brain can be found in Carlson (2007, pp. 118-122). Dopamine has been associated with each of the skills believed to comprise executive functions. At optimal levels, dopamine ensures the normal functioning of executive tasks for an individual. Higher and lower levels of dopamine than is normal have been linked to impaired working memory function; the more extreme the differentiation the worse the performance seems (McNamara & Albert, 2003). Forebrain dopamine is involved in attentional switching and appears to be a necessary factor in forming the association between a stimulus and response, which is the predominant reason for shifting or maintaining attention (McNamara & Albert, 2003). There has also been a genetic component to executive functioning identified. When a genetically inherited dopamine transmitter (i.e., DAT1) is functionally altered, ability to maintain attention is decreased (Stollstorff, et al., 2010).

Putting the Function in Executive Functions

To Luria (1966), the structures of the PFC were not the pièce de résistance, but rather their importance was inherent in the functions they facilitate, which are defined by the outcomes they produce. A pitfall in the consideration and discussion of executive function is to assume that these outcomes are explanatory. In fact, they are simply an outcome and often the explanation behind them, and behind executive functioning, is still beyond the firm grasp of scientific understanding (Dick & Overton, 2010; Zelazo &

Müller, 2002). Martin and Failows (2010) cited a number of executive function descriptions that purport to include inhibition, strategy development, persistence, and flexibility of action; or planning, decision-making, judgment, and self-perception; or planning, inhibitory control, attentional flexibility, and working memory. Eslinger (1996) reportedly identified 33 separate functions, whereas Booth, Boyle, and Kelly (2010) identified 21 in their meta-analyses. The most commonly reported executive functions seem to be working memory, shifting, inhibition, planning, and attention. Lezak (1995) identified four broad domains – volition, planning, purposive action, and effective performance – that seem to encompass the many separate constructs put forward as representing the functions associated with executive functions. At this juncture, though there are many frequently recognized and researched aspects to executive functioning, no consensus has been reached as to definite components for inclusion. This is based in large part on methodological issues that arise in the measurement of executive function, and that will be examined in more depth in later discussion.

In the last decade, executive functions have begun to be envisaged as being either *hot* or *cool*. It stands to reason that processes that are often considered the highest levels of human functioning (P. Anderson, 2008) would not be exempt from the effect of emotion. As such, cool executive functions are those elicited by relatively abstract, non-contextual tasks (P. Anderson, 2008; Zelazo, Qu, & Kesek, 2010). The most common measures of executive function (e.g., card sorting tasks, trail-making tasks) are measuring cool executive functioning. Hot aspects of executive functioning are those that evoke emotions and motivation (P. Anderson, 2008; Zelazo, et al. 2010), typically through the

use of reward and punishment. Gambling tasks are the most relevant example of measures of hot executive functions, as this is an area not yet fully explored, and few measures have been developed to elicit these behaviors.

A paramount issue in the study of executive functioning that must always be considered is the importance of novelty. Executive function is in essence, the manipulation of novel information, because once information or action has become routine, it is subsumed by other areas of the brain in order to free up the PFC for continued fielding of new information that comes its way daily (Goldberg, 2009; Strauss, Sherman, & Spreen, 2006). This issue will be touched on more thoroughly in the later sections discussing evaluation of executive function.

Working Memory

At its most basic, working memory is the process that stores information temporarily, keeping it handy for quick retrieval and use (Dennis, 2006). Believed to be linked to the dorsolateral PFC, the most popular model for understanding working memory is that of Baddeley (2000) who outlined the components of the central executive, phonological loop, visuo-spatial sketchpad, and the episodic buffer. According to the Baddeley model, the central executive acts as the supervisor and mediator for each of the other units. The phonological loop and visuo-spatial sketchpad serve to hold on to and manipulate verbal and visual information respectively. The episodic buffer, an update from Baddeley's 1996 model, serves to combine the representations of the working memory and information stored in long-term memory into one consolidated episodic

event (Agostino, Johnson, & Pascual-Leone, 2010; P. Anderson, 2008). This episodic buffer may in fact be the most integral part of the model, in that it defines the connection between the working memory of the PFC and the more stable, long-term memory system.

Attention

At its core, attention as an executive function is the ability to attend to and maintain focus on a given stimulus while filtering out or ignoring the input being offered by background distractions (V. Anderson, 2008). Posner, a leading name in frontal lobe research, advocates a view that names attention and self-regulation as the predominant uses of the PFC (see discussion in McCloskey, Perkins, & Divner, 2009). It is also the PFC executive function most implicated in hot, emotion-laden processes. Deater-Deckard and Mullineaux (2010) proposed that the attentional system is what allows cognitive control of negative responses to feelings such as anger and fear, and allows for attentional engagement and disengagement at appropriate times in order to control these emotions (Calkins & Marcovitch, 2010).

Attention is one of, if not the, most prominent concerns for children by parents and teachers, due to the effect that impaired attention can have on home and academic situations for children. Attention-Deficit/Hyperactivity Disorder (ADHD) is currently a common diagnosis for this age group. An interesting side note on attentional capacities comes from theories of evolution. It is believed by some that poor attentional control, specifically that resulting in the symptoms of ADHD, may be remnants of survival instincts in humans who lived in pre-agricultural times, as the traits of impulsiveness,

aggression, and distractibility were useful in hunting; or that symptoms of ADHD may have helped early infants get more attention from their mothers in hostile environments (Risberg, 2006).

Inhibition, Shifting, and Planning

These final three concepts – inhibition, shifting, and planning – have been singled out for definition because of their common occurrence in executive function literature. Inhibition is a person's ability to stop or change action that is ongoing (Dennis, 2006) or that may be a dominant or impulsive response that should be restrained (V. Anderson, 2008). The growing ability of a young child to follow rules by controlling his or her actions is an early hallmark of inhibitory control (Calkins & Marcovitch, 2010). Further, inhibition is also involved in error monitoring and correction (Bell, Greene, & Wolfe, 2010). Shifting is an important function that allows a person to move attention from one stimulus to another in a seamless and efficient manner (V. Anderson, 2008), and is an integral part of the larger attention and working memory systems. Finally, planning is, in essence, the path to goal-directed behavior, which is the common definition and cornerstone of executive functioning (Calkins & Marcovitch, 2010).

Developing the Capacity for Executive Functioning

From an evolutionary perspective, developing a larger brain with more cortical volume devoted to the prefrontal cortex, as seen in the current *Homo Sapiens Sapiens* brain, has allowed for advances in technology and creativity (Risberg, 2006). Initially, as executive functions were explored, it was believed by many pioneers including

Alexander Luria, that executive functioning was absent in childhood. This corresponded nicely with Piaget's stage transition from concrete operational to formal operational thinking, occurring around age 12. Research since this time has found that, though immature, executive function is present in childhood and can be easily discerned with age appropriate measures (De Luca & Leventer, 2008). The Cognitive Complexity and Control model of executive function development (Zelazo & Müller, 2002) is based on the idea that changes in functioning can be characterized by the complexity of problems that children can solve. Children have the capacity for executive functioning but can only utilize it at a rudimentary level. The ability to apply these functions to more difficult problems progresses with development of the child. The PFC, established to play a dominant role in executive functioning, begins developing in utero with the rest of the brain. However, it is the last structure to become fully myelinated, continuing to form connections with the frontal lobes and other brain structures well into adulthood – possibly as late as the third decade of life (Reynolds & Horton, Jr., 2008).

At birth, the brain has not yet started to myelinate, but in the first eight months of life synaptogenesis and myelination begin, and the ability to detect goals and distinguish between animate and inanimate objects develops, as well as the early signs of a working memory and inhibition system. By 12 months, synaptogenesis and myelination are well underway, and joint attention abilities have begun to show. Fourteen months typically brings the beginnings of social referencing, and by two years the brain has developed 80% of its weight. At this stage, improvements in inhibition and working memory have been documented, along with the understanding of pretense. By three years of age, there

is proven increased gray matter (made of nerve cells and nerve bodies) and white matter (made of axons and tracts) volume, as well as increased metabolism. With these developments come improved inhibitory control and sustained attention as well as effective decision making. Age four sees further gray and white matter volume increases, plus better cognitive flexibility and success at understanding false-belief tasks. Children around five years of age experience even further increases in gray and white matter and metabolism, as well as gains in strategy formation and working memory. This is in addition to awareness that one can hold a belief about others' beliefs. Through ages six and seven, metabolism will continue to increase, and bring about a more adult-like theory of mind and understanding of conflicting mental states (Blakemore & Choudhury, 2006; De Luca & Leventer, 2008; Fadem & Monaco, 2008; Wood & Smith, 2008).

Between ages 13-14, structural imaging of the brain shows white matter increases in the frontal areas, while gray matter decreases. This suggests a reduced synaptic density – an important element in the development of the human brain and PFC. Improvements in affective decision making ability should begin and continue till maturity. Between ages 15-19, as gray and white matter continue to change, there is typically improved attentional control, increased processing speed, more mature inhibition, and gains in working memory, strategic planning, and problem solving (Blakemore & Choudhury, 2006; De Luca & Leventer, 2008; Fadem & Monaco, 2008; Wood & Smith, 2008).

Current empirical studies concerning the development of executive functioning

A recent spate of studies on the development of executive functioning has been enhancing our understanding of these abilities. Tames et al. (2010) evaluated children and adolescents ages 8-19 on their updating, inhibiting, and shifting abilities, and compared these findings to magnetic resonance imaging (MRI) of cortical thickness. In addition to showing that these executive functions are present in children as young as eight, the study also found that ability to update was associated with thinner cortices bilaterally, in both the parietal and frontal regions, while inhibition abilities were associated with thinner orbital and temporal cortices. These findings offer interesting insight into the possibility that posterior regions of the brain are more integral to executive functioning than previously believed, and call for more study of the possibility.

When evaluating the difference in executive functioning abilities for 8 and 11-year-olds, Ang and Lee (2010) tested children at both ages by giving them a visual recall task, introducing a distraction task that suppressed executive function, and then conducting visual recall again. Eight year olds did not do as well initially on the visual recall, but the distraction task did not seem to have any effect on their performance on the second task. Conversely, the eleven year olds did much better on the visual working memory task, but were greatly impaired by the suppression condition and so performed much worse on the delayed recall. It is suggested by the authors that because the 8-year-olds have not developed many executive function skills, they are less affected by an executive function suppression task. This study provides further insight into how the progression of developing executive functioning may occur. Genetics may also play a

role in the development and stability of executive functions over time. A twin study conducted with children at age 5 years and again at 12 years found that correlations of processing speed were all significantly high within the twin sets (Polderman, et al. 2007). This theory of genetic transmission was also supported by a 2009 study conducted by Jester et al., which found that parental executive function abilities are positively associated with child executive functioning, controlling for IQ.

It has been well documented that pre-term births carry a number of risk factors for later developmental delays, and the effects of pre-term birth on executive function have been under investigation of late. Nostari and colleagues (2007) have shown that young adults who were born at less than 33 weeks gestation are impaired on inhibition and mental flexibility measures, even when free of other disabilities. Mulder et al. (2009), found in a meta-analysis that although executive functioning abilities are often a problem for children born preterm, the extent to which they are impaired is influenced by their gestational age, the age at which they are tested (presumably affecting how much time they have had to catch up), and the particular skill under investigation. When the gestational age is greater than 26 weeks, Mulder and colleagues (2009) found that children are able to catch up in attentional skills, but will seemingly indefinitely lag behind other children in phonemic and shifting skills.

Obesity, an alarming condition in western children, was recently the subject of a pilot study on executive functioning (Lokken, Boeka, Austin, Gunstad, & Harmon, 2009). Adolescents categorized as extremely obese (Body Mass Index greater than 99%) were found to have severe deficits in executive function, particularly in attention, when

compared to normative data. Although this study raises concerns that many pilot studies do, it is an intriguing avenue of research for the development of executive functioning, and the question of how development is affected by health conditions such as obesity. School is, at its most basic level, a place for children to develop. Burrage and colleagues (2008) conducted an investigation to determine if school had any effect on the development of executive functions, specifically working memory and inhibition. Children within a four month age range, who were either in Prekindergarten or Kindergarten, dependent on the birth-day cutoff for school enrollment, were evaluated at the beginning and end of the school year. Both grades showed improvement in overall functioning, but those in the kindergarten class made significantly larger gains. Although this seems to support the idea that there are school-related effects on executive function development, it is also interesting to consider the possible social implications. Presumably, there were older and younger students respectively in the Pre-K and Kindergarten classes, so one must wonder if the social interactions with other students had any effect on the development of the participants in the study.

Toward a Model of Executive Functioning

According to Gioia, Isquith, and Guy (2001), a good model is theoretically valid, integrates all aspects of the construct, accounts for possible impairments, proposes specific brain-behavior relationships, and translates into appropriate assessment techniques. This description brings to mind the saying that it is hard to be all things to all people.

Norman and Shallice (1986) attempted to do this with their model of the Supervisory Attentional System, which frames executive function in the light of attentional abilities. Baddeley (2000) had the Working Memory model (see above), and Barkley (1997) proposed a model based on inhibition. Zelazo and colleagues (2002) proposed a Problem-Solving Framework of executive functioning, Miller and Cohen a Guided Activation Theory; Duncan stressed that all executive functioning is temporary, whereas Damasio proposed that executive functioning was more about the emotional markers (see P. Anderson, 2008, and Grafman, 2006 for a detailed discussion of the above).

All of the preceding models seem to be lacking or even outdated at times. In the absence of a wholly satisfactory model to present in this literature integration, a new model began to take shape. It should be noted that the model presented in the Appendix and discussed below is a clinical model and not a product of statistical research. It is formulated from a synthesis of the models mentioned above, other reading on executive functioning, and personal observations. It is indeed difficult to be all things to all people, and so this model is not presented as the definitive explanation of executive functioning, but rather a working model toward a more complete understanding of the concept for the purpose of this investigation.

A Working Model of Executive Function

This model is founded on the assumption that without executive function, a stimulus would produce an immediate behavioral reaction. Inhibition, conceptualized as

the gateway to executive function, is represented by an open door in the circle of executive function. Inhibition breaks the connection between the immediate reaction and the enactment of behavior, providing a delay, during which executive processes can begin. Inhibition, more specifically, allows for the enactment of attention to the stimulus. Attention must be maintained in order for enough information about the stimulus to be gathered into the working memory.

In this proposed model, the most influential and closely followed work is Baddeley's model of working memory (2000), which has shown great validity with regard to that construct. In this model, the working memory is a composite of the phonological loop that processes verbal information, and the visuo-spatial sketchpad that processes visual information. The episodic buffer is the go-between, incorporating information from the memory engine, a concept representing all memory beyond short-term working memory. Note that in this model there is no reciprocal relationship between the episodic buffer and the memory engine, and that the memory engine is outside the larger model. This is because this model does not endeavor to explain the larger processes of memory or how short-term working memory translates into long-term storage. It does however recognize that the processing of memory is inherent to almost all brain functions, though not addressed here.

The process of working memory allows for another executive function – shifting. Working memory allows a person to shift between thoughts while maintaining the set, and these shifts are fed back into working memory, thus the reciprocal relationship. The result born of working memory and shifting is the ability to plan for an outcome, which is

part and parcel of the ability to set goals – a cornerstone of executive functioning. Once a behavior is planned and goal set, executive functions may continue to inhibit, but will eventually allow for the enactment of a behavioral commission or omission.

In the model, these executive function processes are set within a gray circle. The gray is a representation of the fact that each of these processes, in fact, float in a sea of emotion. Theory of mind (Fernyhough, 2010), a construct that represents social intelligence, or the ability to understand others' emotions and respond appropriately, and emotion are so integrally linked with executive functions that it can be said one does not happen without the other. The barrier encasing the executive processes is diffuse, because the entire executive function process is temporary and may happen in only a matter of seconds. Finally, this model shows a barrage of arrows from historical, cultural, and social influences toward the executive processes. As with all things, executive functions are not trapped within us, but are acted on by what is around us, our context of life. An important aspect of this model that must be noted is that although the model is named executive function, this does not imply an explanation or singular unit. Executive function is merely, in this model, a name for a set of interrelated processes that work together despite their diversity.

Assessing Executive Function: A Tricky Business

The evaluation of executive functioning is, without question, the most controversial aspect of the construct. Definitions and models may differ, but all essentially provide different means to the same end. The task of evaluation, however, is

greatly criticized and contributes exponentially to confusion found in the literature. This section will review the most prevalent ways of measuring executive functioning and touch on why assessment of executive functioning has become a point of contention. Unfortunately, this author is not able to offer a solution to the quagmire that executive functioning evaluation has become.

Ways to Measure the Construct

The current stable of assessment techniques used to measure executive function include: performance measures believed to tap the various functions under the executive umbrella, behavioral ratings of executive functioning, several commercially available batteries, and more fluid (experimental) techniques. Performance measures are often recommended because they allow the testing of responses under novel circumstances (Baron, 2004), and performance in novel situations is believed to be the hallmark of executive function (Goldberg, 2009). Additionally, using a variety of these measures is recommended because of the heterogeneity of functions which make up the broader idea of *executive functioning* (Strauss, et al., 2006). To examine the areas of planning, organizing, reasoning, and shifting, tests such as the Halstead Category Test (CT) and Wisconsin Card Sort Test (WCST) are frequently used. These both utilize feedback to the participant in order to elicit shifting behaviors and uncover the presence of perseveration difficulties (Baron, 2004; Strauss, et al., 2006). Studies have shown that the WCST is especially sensitive to age, with younger children having more difficulty shifting sets and

showing an inability to complete as many categories as older children (Bujoreanu and Willis, 2008).

Other tasks such as the Tower of Hanoi and Tower of London require planning and execution toward a goal. Inhibition is often assessed with tasks such as the Stroop color-word test, which requires one to inhibit a natural response and provide something different, as well as Go-No-Go tasks and Stop Signal tasks, which require behavioral inhibition based on an examiner signal (Strauss, et al., 2006). Fluency is assessed with a number of measures, including tests for verbal fluency, design fluency, semantic fluency, and fluency for letters (such as with the popular Controlled Oral Word Test (COWAT) or "FAS" task, where a participant names as many words as they can which begin with a stated letter) (Baron, 2004). An important point in the consideration of all these measures is how highly they correlate with IQ. A 2007 study by Arffa found that Full Scale IQ is highly correlated to performance on the WCST, Stroop tasks, and fluency tasks.

Strauss, Sherman, and Spreen (2006) find one disadvantage to measuring executive function with performance tasks is that the examination format does not allow enough flexibility for a person to show their true potential. As such, behavioral measures are thought to be a way in which information can be gathered concerning everyday actions of the client, and may give a broader view of actual abilities. Current measures include self-, parent-, and teacher-report measures for children ages 2-18, which take a developmental orientation in order to provide life span information (Gioia, Isquith, & Kenealy; 2008). The Behavior Rating Inventory of Executive Function (BRIEF) is one such measure that is frequently used. The BRIEF is a parent, teacher, and self-report

measure that has normative data for children ages 5-18 years. It is divided into indexes which provide information on different aspects of executive functioning (Baron, 2004). Empirical research on the BRIEF has found that while scores correlate highly with other rating scales (e.g. Child Behavior Checklist [CBCL], Conner's), there are no significant similarities with performance measures of executive function (McCauley, Chen, Goos, Schachar, & Crosbie, 2010). Another study with the CBCL, Conner's and Children's Executive Function Scale (CEFS) found that none of these scores seem to provide information about executive functioning which is reliable or correspondent to other, non-report measures (Gouldon & Silver, 2009).

There are several batteries available that measure a variety of executive function skills, and to their advantage, they are able to provide an overall score of executive functioning which is derived from the different abilities tested. These include the Delis-Kaplan Executive Function System (D-KEFS), the Behavioral Assessment of the Dysexecutive Syndrome (BADS), the Cambridge Neuropsychological Test Automated Batteries (CANTAB), and the NEPSY-II (for an overview of these measures see Strauss, et al., 2006). The D-KEFS and NEPSY-II, in particular, are beginning to be used as the standard with children. Espy, Bull, Kaiser, Martin, and Banet (2008) contend that the NEPSY-II is the only psychometrically sound, norm-referenced measure of executive functioning currently available which can accurately appraise Prekindergarten aged children's abilities, though it too has critics. A final assessment technique often seen in the literature is "Experimental measures," which are designed by the researchers for the study at hand and, though results are written they provide no basis for comparison across

the literature. Goldberg (2009) refers to these as fluid measures and reports that Luria himself used a non-standardized, fluid battery when doing his seminal work on executive functioning. Without a way to compare results from these studies however, they do not offer empirical insight into the construct.

Criticism of the Measurement Endeavor

If, at their core, executive functions serve to process novel information, then by definition, a test of executive function will have no test-retest reliability. This is in fact a frequent criticism of all measures of executive function (Burgess, 1997; Martin & Failows, 2010; Rabbitt, 1997; Strauss, et al., 2006). Rabbitt insists that *any* task performed more than *once* ceases to measure executive function. One has to wonder if this hard-line is in fact a bit zealous. It does seem that the more one performs a task the less novel it becomes, but is a solitary performance of a task all it takes to become automatic? Whether or not Rabbitt is overambitious in his views, it is true that low test-retest reliability limits diagnostic usefulness and must be taken into account (Strauss, et al., 2006). Other purported difficulties with measuring executive function include differing opinions on the construct validity of various skills (Goldberg, 2009; Rabbitt, 1997), contentions that tests which should measure the same executive skill (i.e. WCST and Category Tests) actually measure different aspects of that solitary construct (Rabbitt, 1997; Strauss, et al., 2006), and that executive function tasks as a whole have poor task purity because all the skills encompassed call on other cognitive skills and functions. Burgess (1997) goes so far as to call executive functioning the Cinderella area of

neuropsychology. It is possible that all psychometric tests lack task purity to some degree because of the complicated system connections of the brain. In fact this may be an acceptable and reasonable problem in measurement, since it provides a more accurate representation of how we utilize these skills in day-to-day life is presented.

Interventions for Executive Function Deficits

The idea of intervening with executive functioning deficits is interesting when one takes into consideration what we know about executive function. How do you intervene in a process that involves a construct that is so varied and is composed of so many skills? Ylvisaker and Feeney (2008) suggest the idea of scripts that a child or adolescent would practice – a kind of self talk to take the place of the self talk usually performed naturally by the PFC. A general script might include asking oneself: What is my goal?, What might get in my way?, What can the plan be?, Let's do it, and finally How did that work? (Ylvisaker & Feeney, 2008). The authors also offer scripts for other scenarios, such as Big Deal/ Little Deal and Scary/ Not Scary. They further suggest working with people who have executive function deficits by offering training in organization skills, compensatory academic strategies, and using positive behavior supports. These suggestions are all easily applied in school or home settings and are accessible enough to be conducted by parents or teachers.

Mindfulness, a popular construct in positive psychology, originated from ideas behind classic Buddhist teachings. Flook, et al. (2010) proposed a study where mindfulness training programs, incorporating yoga, were given to second and third

graders. They found that, based on behavior rating scales of executive functioning, children who had low executive functioning before the intervention had significant increases when compared to the control group in overall executive skills. Although this study was conducted on a small scale it raises interesting possibilities. A reasonable and helpful follow-up study would include performance measures when evaluating the children before and after training. Similar studies have looked at children's executive functioning and exercise, and found that as children increased the amount of time spent in physical activity, their executive skills also increased (Buck, Hillman, & Castelli, 2007; Tomporowski, Davis, Miller, & Naglieri, 2007). Taken together, one must wonder if more general life skills that are considered good for overall well-being (e.g. mindfulness, exercise, good nutrition) have positive effects on the ability to participate in more goal-directed behavior as well.

There are psychopharmacologic treatments for deficits of executive cognitive functions. Studies with schizophrenic patients and Parkinsonian patients are where most of the information concerning pharmacologic treatments comes from, as dopamine has been heavily implicated in both conditions. Risperidone and clozapine, two atypical neuroleptic drugs, have shown success in antagonizing dopamine receptors and are associated with increased executive functioning abilities. Levodopa, a dopaminergic drug, has also been associated with upswings in these abilities. As discussed previously, both the under-activation and the over-activation of dopamine receptors can be detrimental to PFC functioning. Long-term uses of clozapine and levodopa have both been linked to an over-activation of receptors and a build-up of dopamine in the PFC

which can lead to further impairment in executive skills (McNamara & Albert, 2003). In fact, in the schizophrenia and Parkinson's literature, many severe side-effects of these drugs have been noted. It may be that the implications of pharmacological treatments are too grave to warrant their use for a deficit which does not lead to death or serious illness.

The Academic and Linguistic Applications of Executive Function

Unfortunately, there has been very little sound empirical research on cultural and gender differences in executive functioning. Nevertheless, there have been studies looking at how executive functioning is related to academic skills and deficits, and how bilingual abilities may interact with executive skills. A meta-analysis by Booth, Boyle, and Kelly (2010) found that children who have reading disabilities also have executive function impairments, but that the effect sizes varied greatly across studies and that task modality had a large moderating effect on the outcome. When considering mathematical abilities, multi-step problem-solving skills are most predictive of executive functioning, especially for the attention, inhibition, and updating skills (Agostino, et al., 2010). Conversely, it has been shown through a longitudinal study of children attending Head Start programs that early working memory and attentional control are the best predictors of growth in literacy and numeracy skills (Welsch, Nix, Blair, Bierman, & Nelson, 2010).

Studies have long shown that bilingualism is predictive of a number of advanced cognitive skills. With regard to this, bilingual children seem to have comparable performance to monolingual children on measures of vocabulary fluency and working memory, but are able to complete the tasks much more rapidly than their monolingual

counterparts (Bialystok, 2010). In a study of children in India and Canada, bilingual children performed significantly better than monolingual children on tasks of inhibitory control and cognitive flexibility, but not on response suppression (Bialystok & Viswanathan, 2009). This area of study with executive functioning, which is still in its infancy, may be a precursor to further cross-cultural work in the field.

CHILDHOOD TRAUMA

> Thus ebbs and flows the current of her sorrow,
> And time doth weary time with her complaining.
> She looks for night, and then she longs for morrow,
> And both she thinks too long remaining;
> Sort time seems long in sorrow's sharp sustaining:
> Though woe be heavy, yet it seldom sleeps;
> And they that watch see time how slow it creeps. (Shakespeare, 1954/1994, ll. 1569-1575)

The suffering of and recovery from trauma is a grave part of the human condition, which has been documented to haunt mankind since the earliest times. Often seated in sorrow, "Seven days and nights I sat beside the body, weeping for Enkidu…I roam the wilderness because of the fear. Enkidu…who I loved, is dirt…Must I die too?" (Ferry, trans. 1993, tablet X.i), tales of trauma from the death of others were told from the earliest written work – the *Epic of Gilgamesh* – to the Greek tales of Achilles, whose traumatic rage over the death of his cousin led to the downfall of Troy. Tales of trauma were often brought on by the evil deeds of others, such as the above quote from Shakespeare's poem, *The Rape of Lucrere,* or as seen in Macbeth's psychotic break after the murder of King Duncan. In Bram Stoker's *Dracula* (1897/1989), Jonathan Harker

was held captive and tortured, after which descriptions indicate he was suffering from traumatic stress – "He has had some fearful shock – so says our doctor – and in his delirium his ravings have been of wolves and poison and blood; of ghosts and demons…" (p. 96). All tales of trauma are ultimately seated in fear; fear of meeting the same fate as that of ones we love, fear of never holding someone again, or fear of the evil in other humans' hearts. "That suggests that what you fear most of all is – fear. Very wise, Harry" (Rowling, 1999, p. 155).

Though never as elegantly rendered as in classic works, trauma is nonetheless still an omnipresent part of our society. *Trauma* comes from the Greek word for wound, "*traûma"* (Ford, 2009), and children are the most tragic victims of this experience because their trauma is often caused by adults who should protect them. Children can be witness to or victims of staggering events such as vehicular accidents, fire, and natural disasters, or acts such as homicide, suicide, terrorism, times of war and armed conflict, sexual exploitation, or gender-based violence (Hutchison, 2005).

Posttraumatic Stress Disorder (PTSD) is perhaps the most clinically impactful development of a person experiencing trauma. Classified by the *Diagnostic and Statistical Manual of Mental Disorders* (American Psychiatric Association [DSM-IV-TR], 2000) as an anxiety disorder, PTSD is the only anxiety disorder that must be predated by a traumatic event involving the experience or risk of serious injury or death to self or a close other that then causes an intense negative emotional response. Once it has developed, PTSD is characterized by persistent re-experiencing of the event, persistent avoidance and emotional numbing, increased arousal, and significant

impairment to functioning (DSM-IV-TR, 2000). PTSD may be especially harmful to children, who have yet to fully develop and must cope with experiences for the remainder of their lives.

In the United States, maltreatment is the most common form of trauma that children experience (Gabbay, Oatis, Silva, & Hirsch, 2004; Greenwald, 2005; Perkonigg and Wittchen, 1999). Though there are many excellent works on the forms of trauma children are often exposed to in other countries (e.g. Kaplan, 2008), this review will hence forth focus on maltreatment research, the impact of trauma on development, outcomes, assessment and intervention strategies, and finally gender and cultural considerations for traumatized children.

An Awareness of Trauma and Maltreatment

A 2009 paper by the U.S. Department of Health and Human Services indicated that in 2007 legal reports were filed in abuse and neglect cases for around 794,000 children, about 10.6 in 1,000 kids, and 1,760 of those cases followed the death of the child. Statistics from protective service agencies indicate that in 2006, 3.6 million reports of abuse and neglect were investigated and one quarter of those investigations resulted in intervention (about 905,000 children). Of those 64.1% involved neglect, 16% and 8.8% of those were physical and sexual abuse respectively, and 15.1% were cases of mixed modalities of neglect and abuse (Shipman and Taussig, 2009). In these cases there was an equal gender distribution, it was found that younger children are mistreated more frequently than older children, and African-American and Alaskan Native/Native

American children are overrepresented in all maltreatment statistics. These numbers are believed to represent only a fraction of childhood maltreatment that occurs in the United States, as the majority of interfamilial abuse and neglect goes unreported.

Although we all experience life stress, trauma is definitively different. Life stresses are those which are expected in the course of an ordinary lifetime, while trauma is an overwhelming experience that one should not be expected to deal with (Greenwald, 2005; Hutchison, 2005). Trauma is classified as either Type I, meaning that it is a result of a single incident, or Type II, which is the result of prolonged or repeated exposure to a stressor (Marold, 1998). While Type I trauma more often results in symbolic reenactment and recurrent visualizations of the event, Type II trauma has stronger associations with symptoms of denial, numbing, and aggressive acts (Terr, 1991). Greenwald reports that experiencing trauma during childhood or adolescence has become a norm for many children. While the definitions of abuse and neglect vary slightly from state to state, Goodman, Quas, and Ogle (2009) provide a comprehensive definition of child maltreatment – acts of commission or omission that result in physical, sexual, or psychological abuse, or the neglect of a child.

Physical Abuse and Neglect

The neglect and physical abuse of children are often reported simultaneously, and risk factors for both conditions are similar. Significant factors found for children who are neglected or physically abused are poverty and low maternal education (Masten and Wright, 1998). These factors also describe many families in which neglect and physical

abuse do not occur, and so should be interpreted with care. Neglect can result in underweight, malnourished, medically ill or unhygienic children. Physical abuse is often caused by blunt force or shaking, and abusive head trauma is common, such as battered child syndrome, whiplash, shaken infant syndrome, and retinal hemorrhages (Chiesa and Dunhaime, 2009; Levin, 2009). Common signs noted by physicians treating abused children are that the child was brought to the doctor only after a delay, that the report given is inconsistent with the injury and further questioning leads to changes in the story, that injuries are often reported to be self-inflicted or from a sibling, that parents appear defensive and lack appropriate concern, and that scalds and burns are often present (Jacobi, Dettmeyer, Banaschak, Brosig, and Herrmann, 2010).

Sexual Abuse

Sexual abuse is a form of maltreatment that receives a great deal of attention in the media and in literature. This may be due to the uniquely personal nature of the abuse, or that most childhood sexual abuse is incestuous. Teegen (1999) defines sexual abuse as occurring when children and youths are engaged in sexual activities to which they could not responsibly give consent due to their developmental phase. Internationally, it is estimated that 7-36% of females and 3-29% of males experience sexual abuse during childhood (Teegen, 1999). Studies in the U.S. have found that between 26-60 percent of people (male and female) do not ever report their experiences of sexual abuse, and of those who do, 48-80% will wait a significant amount of time before disclosure (Lyon, 2009). An important point is that while delay in reporting is common, recantation and

denial are highly unusual (London, Bruck, Wright, and Ceci, 2008). Risk factors significantly associated with childhood sexual abuse are social isolation of the child, a household where the mother is dominated or abused by the father, the experience of parental job loss, marital deterioration, or excessive household drug and alcohol abuse (Masten and Wright, 1998). The long-term sequelae associated with sexual abuse specifically are mistrust of others, social isolation as an adult, avoidance of either emotional or sexual intimacy, negative self-concept, and the continuation of dependent relationships (Teegen, 1999).

PTSD

The condition of posttraumatic stress disorder was added to the DSM in 1980, however the acknowledgement of the symptoms now associated with this disorder have long been documented in various forms. As recently as World War I it was believed that the symptoms were only seen in combat veterans (Hutchison, 2005). Since the time of formal acknowledgement of PTSD, four countries have opened national centers devoted to studying the disorder, private hospitals have established inpatient units with the sole aim of treating PTSD, international centers attempt to provide assistance to refugees and asylum seekers suffering from PTSD, and even the U.S. military has been forced to address the growing epidemic of PTSD in their veterans (Wilson, 2004). In fact, in 2009 PTSD was the second most costly medical condition in the United States with associated costs totaling around 72 billion dollars (Ford, 2009). Despite this growth in the recognition and treatment of the disorder, it is essential to point out that the development

of PTSD is the exception, rather than the rule for those who suffer a traumatic event; between 80-90% of trauma sufferers never develop the disorder (Ford, 2009; McFarlane, 1997). For some, trauma may be a source of motivation and strength in marveling at one's survival, but for others PTSD may manifest in a variety of forms: acute, delayed, chronic, intermittent, residual, and reactivated PTSD (McFarlane, 1997). While some studies with veterans suggest that there may be premorbid factors that put one at risk for developing PTSD (e.g. Putman, 1998), the disorder has largely been accepted as a reaction to a traumatic event. Children who suffer maltreatment are especially prone to developing PTSD, as they have seldom had time to develop coping strategies which may be utilized during a time of trauma.

The Impact of Trauma on Childhood Development

Childhood is a perpetual whirlwind of learning and changing. A well cared for and loved child will develop secure attachments and positive self-concepts. Children exposed to trauma, specifically to maltreatment, will face developmental roadblocks on the way to adulthood. Their attachment abilities, psychosocial development, memory, and neurobiology will all be affected by these experiences.

Neurobiological Development

Trauma changes brain function at a very rudimentary level. The brain, which is typically formatted to learn, is reprogrammed for a focus on survival (Ford, 2009). Survival focus requires the brain to anticipate, prevent and protect against damage. It is driven and then reinforced for identifying threats and maintaining vigilance. In the

current literature, the majority of studies on the neurobiological effects of trauma and PTSD are conducted with adults. Children and adolescents pose unique problems when attempting empirical research. Their neurobiology is inherently different at every developmental stage, which makes comparing studies difficult. Children seem to develop problems more readily after trauma than adults, and their neurobiology is further impacted by their current state – whether they are still exposed to the trauma or have moved into a safe and supportive environment (Kowalik, 2004).

Neuroimaging studies have provided a picture of how the brain structures of a child exposed to trauma, or one who has developed PTSD typically differ from a normally developed child. The overall cerebral volumes of children are smaller (De Bellis, et al., 2005; Jackowski, de Araújo, de Lacerda, Mari, and Kaufman, 2009; Kaufman, Aikins, and Krystal, 2004; Shin, Rauch, and Pitman, 2005), as are the corpus callosum (De Bellis, et al., 2005; Kaufman, et al., 2004), amygdala (Ford, 2009), and prefrontal cortex (PFC) (Ford, 2009; Kaufman, et al, 2004; Shin, et al., 2005). Lateral ventricles tend to be larger in those with PTSD and right cerebral blood flow is decreased to the PFC and hippocampus, but increased to the amygdala (Kaufman, et al., 2004). Studies of the hippocampus in people with PTSD have produced interesting results. Adults who have suffered trauma almost always have smaller hippocampi bilaterally (Ford, 2009; Greenhoot and Bunnell, 2009; Shin, et al., 2005), however studies with children have produced different results. Although expected to also have smaller hippocampal structures, studies seem to have found that the hippocampus of children with PTSD is unchanged in size (De Bellis, et al., 2005; Ford, 2009; Jackowski, et al.,

2009; Shin, et al., 2005). De Bellis and colleges suggest that the condition of PTSD may exert a *gradual* aversive effect on the hippocampus, which has not yet manifested in the developing brain. Studies with maltreated children (Kaufman, et al., 2004) and adults who were maltreated as children show that cerebral volumes are smaller based on 3 conditions: age of onset of abuse, length of duration of abuse, and the severity of PTSD symptoms.

The hypothalamic-pituitary-adrenal (HPA) axis is the coordinator of stress reactions. Typically, stress stimulates the release of corticotrophin-releasing factor (CRF), which in turn initiates the release of adrenocorticotrophic hormone (ACTH) from the pituitary gland and cortisol from the adrenal gland (Southwick, Rasmusson, Barron, and Arnsten, 2005; Yehuda, 1997). Norepinephrine (NE) and dopamine (catecholamines) are inhibitory agents which help calm down the neural system once the threat has passed (Southwick, et al., 2005). The amygdala, which is primarily responsible for detecting threat and controlling defensive responses, releases catecholamines in response to stress (Southwick, et al., 2005) The catecholamines (NE, epinephrine, and dopamine) and cortisol aid the amygdala in the encoding and consolidation of fear and emotionally relevant memories (Southwick et al., 2005). The catecholamines and cortisol affect the PFC and hippocampus, causing arousal for threat, and then calming once the threat has passed so that a baseline is again reached (Ford, 2009; Southwick et al., 2005) Serotonin, a neurotransmitter which is both excitatory and inhibitory, is also active during the stress reaction.

Indices of neuroendocrinology taken in people who suffer trauma, and those who develop PTSD, differ significantly from the typical population and from the neural reaction to everyday stressors (Yehuda, 1997). On a broad level, the brain functions in conjunction with the autonomic nervous system (ANS). The ANS is composed of sympathetic (fight vs. flight) and parasympathetic (the brakes) factors (Ford, 2009). Together, these systems help the body regulate reactions to fear stimuli.

Studies have found that trauma, especially in those who develop PTSD, causes a number of changes to this system. Catecholamines, CRF, and serotonin are released at increased levels (Bevans, Cerbone, and Overstreet, 2005; De Bellis, et al., 2005; Ford, 2009; Kowalick, 2004; Yehuda, 1997). Most studies show that children who have been maltreated have lower than normal levels of cortisol (Kowalik, 2004), as do adult suffers of PTSD, although there are some studies which contradict these findings (Ford, 2009). Yehuda (1997) states that an issue with cortisol measurement is how the sample is collected. Cortisol measured from blood samples may be inflated due to a transient spike in the hormone during the anticipation of the needle prick. It may be that urine samples provide a much more accurate measurement, and Yehuda argues that studies using this type of sample are likely to have greater validity.

When an excess of catecholamines are produced and the circulation of cortisol is increased, the abilities of the PFC (particularly working memory) are reduced, essentially taking it "off-line" (Bevans, et al., 2005; Southwick, et al., 2005). While this should typically be leveled out by the effect of dopamine, in the traumatized brain dopamine is present in too high a concentration to be effective. Additionally, there is nothing to

appropriately inhibit the amygdala, so fear responses continue to increase (Southwick, et al., 2005). The amygdala, hippocampus, and PFC are flooded with NE (Ford, 2009), and the trauma causes a hyperarousal of the stress system which prevents the system from returning to baseline and can cause permanent damage (Wilson, 2004; Yehuda, 1997). Research has found that elevated levels of catecholamines and cortisol will result in a quickened loss of neurons, delayed myelination of axons, abnormal pruning of synapses, and inhibited neurogenesis. Prolonged and early exposure to stress (such as that suffered by maltreated children) will lead to sustained high levels of catecholamines and cortisol (Southwick, et al., 2005). Increased serotonin, often present in people diagnosed with PTSD, has been found to cause panic attacks (Kowalik, 2004), and is often related to increased hostility, irritability, aggression, and an increased risk of depression (Ford, 2009; Southwick, et al., 2005). Studies of adults and children immediately post-trauma have found that in children, high levels of sympathetic autonomic nervous system activity and increased cortisol put one more at risk for developing PTSD, while in adults low cortisol levels are linked to the disorder (Ford, 2009).

Psychological Development

One of the earliest tasks of infancy is the work done to form human bonds, a task which will continue throughout life as humans attempt to form social relationships (Bowlby, 1958). The theory of attachment is closely linked to the impact of trauma on development, as an early trauma to a child can affect her or his ability to form secure attachments throughout life. Erikson's stages of psychosocial development (1950) further

elaborate on childhood development. During the first year of life, infants learn to trust their parents to meet their needs, which in turn, translate into a trust of their environment. If this need is not met, children will become fearful and view their environment with mistrust. The following two years of development involve gaining a sense of autonomy within one's environment. Children physically are more able to explore and do things on their own, and from these explorations will develop a sense of self-reliance. Children who are not supported during this stage learn to be fearful, and feel shame and doubt about their own abilities. From approximately ages three to six (the preschool stage), children will start to develop initiative. Initiative allows them to be purposeful and goal-directed in their actions. If not supported, children will instead learn guilt or feel they are *bad* for their initiative. The remainder of childhood is spent in a stage which was deemed critical by Erikson for self-confidence, learning industry. Industry allows children to follow plans through to completion and to function appropriately in their social realms. Completing tasks give kids a sense of being successful. If this stage of development is not completed successfully, children learn feelings of worthlessness. The final childhood stage of psychosocial development happens largely during adolescence, and is a stage of identity development. Children begin to define for themselves who they are and what they want. They learn to set their own boundaries in life and make decisions for themselves which provide a sense of self. When children have not developed appropriately and are not supported in this stage, they instead find themselves in a stage of role confusion because they lack the confidence or support to define themselves.

Maltreatment of children or another significant trauma will affect a child at every one of the aforementioned stages. A maltreated child will mistrust the world, become fearful, learn guilt, feel inferior, and fail to define a self-role in their world. McDermott (2004) discussed the overarching impact of trauma. Type I trauma represents a developmental discontinuity, which will affect the developmental stage the child is in at the time of the trauma. Type II trauma is by definition repetitive, and this repetitiveness ensures that the developmental trajectory will never return to normal without support or intervention. In fact, it actually represents a developmental continuity, albeit a negative one. As an adult it is sometimes hard to imagine that children, who cannot understand the long-term consequences and nuances of trauma, may suffer as much as an adult does. Hutchison (2005) argues that even in infancy, children can experience emotional pain and horror on the same level as an adult, even without the advanced cognitive understanding. Studies have firmly established the reactions that children of different ages have to trauma and maltreatment (see review in Hutchison, 2005). Infants and toddlers react with fear, hyperarousal, aggression, sleep difficulties, clinging behavior, whining, irritability, and become easily frustrated. Between ages three and six children begin to reenact their trauma, experience behavioral regression, are insecure and cling, throw temper tantrums, exhibit extreme anger, and continue to have disturbed sleep. Reenactment of trauma through play and clinging continue in children ages six to twelve, in addition to separation anxiety, guilt, and decreased interest in activities normal for children their age.

Harter (1998) describes personality as being a combination of an *I-self* and *Me-self.* The I-self is the observer and knower of the self's actions. It sees the self as an active

participant and leads the organization and interpretation of experiences. The Me-self conversely, sees the self as an object, the aggregate of all that is known about the self (self-concept). As these two selves are two separate sides of a coin, so they are affected differently by persistent maltreatment. When children are abused or neglected, the I-self becomes less self-aware and is less capable of introspection, which leads to an impairment in emotion. The I-self no longer feels continuity of being the same person over time, or the coherence that there is a unified self. With these impairments comes a loss in a child's sense of agency and volition. The Me-self suffers differently, developing a low global self-esteem, and a sense of inner self badness. A large discrepancy develops between the ideal and real self as a result, and children engage in grossly excessive self-blame (Harter, 1998).

Trauma impacts other areas of development and functioning beyond the psychosocial self. Maltreated children are prone to delayed language development, particularly the development of lexical and grammatical skills (Eigsti, 2006). These children are more affectively labile and less likely to engage in positive and appropriate emotion-regulation due to their negative reactions to emotional situations. Their lack of trust makes intervention efforts more difficult due to the difficulty of establishing a positive relationship (Goodman, et al., 2009). Children in the foster system, who in the majority have experienced multiple kinds of maltreatment, have more attentional and social difficulties. They typically show more delinquent and aggressive behaviors, as well as somatic problems and anxious/depressive symptoms. Fourteen percent of foster children suffer from PTSD (Oswald, Heil, & Goldbeck, 2010). Not all maltreated

children are doomed to suffer these impairments. Resilience has been shown to be an effective protective factor, which may buffer against some of the more long-term sequelae associated with maltreatment.

Memory is perhaps the most controversial developmental issue associated with maltreatment in particular, because of the impact that memory validity can have in legal settings (Mongetta, Salerno, Najdowski, Bottoms, & Goodman, 2009). In their 2009 work, Greenhoot and Bunnell provide a succinct review of the history and issues surrounding memory development in maltreated children. There was a longstanding belief in the literature that trauma was often pushed out of a person's awareness because of defense mechanisms such as dissociation and repression. More recent studies have shown that in fact, one-time traumatic events are remembered more vividly than other memories, and the accuracy of the memory is retained over significant delays in time. Generally, repetitive events are remembered better than single events but are combined into generic memories where *details* are difficult to recall. It would seem logical that repetitive maltreatment memories would be formed the same way, and recent studies have suggested that coping defenses, instead of burying memories, may just help push away details of the encounters (de Decker, Hermans, Raes, & Eelen, 2003; Greenhoot & Bunnell, 2009). It is clear when reviewing the literature of development of memories for traumatic events, that conclusions are difficult to draw due to small sample sizes and lack of controls.

“What doesn’t kill you makes you stronger” (but does it always?)

Ideally, those who suffer trauma would receive immediate intervention (see below) and continued support so that they would be protected from some of the long-term hardships associated with being subjected to trauma. As with most things, the ideal is seldom the reality, and longitudinal studies of those who have experienced traumatic events offer some insight into the dangers of trauma and PTSD for personal outcomes. A number of longitudinal studies have tracked veterans from World War II and the Vietnam Conflict. In studies of soldiers who were exposed to heavy combat and survived, 56% were dead or chronically ill by the age of 65, independent of the effects of PTSD. High mortality rates at a young age have also been identified in young survivors of concentration camps, who suffered and died from coronary arterial disease, lung cancer, and violent death above rates proportional to the normal population. These same results were noted in merchant seaman from World War II who worked the North Atlantic convoys (see review in McFarlane, 1997). Other outcomes for veterans who did develop PTSD include a long-term increase in the comorbidity of alcoholism (64-76%), antisocial personality disorder (48-64%), and schizophrenia (35%) (Keane & Kaloupek, 1997). Sadly, child abuse is believed to be a causal factor for developing schizophrenia and psychosis, particularly auditory commentary and command hallucinations (Read, van Os, Morrison, & Ross, 2005). Read et al. suggest that this might be due to the overactivation of dopamine in trauma patients (see above), a condition also frequently found in patients with schizophrenia.

Research by Anda and colleagues (2006) asked a national sample of patients who belonged to a Health Maintenance Organization (HMO) to complete a trauma measure. When comparing these results to the patients' documented conditions it was discovered that higher scores on trauma were associated with more problems in affective, somatic, memory, sexual, aggressive, and substance abuse domains. Longitudinal studies of sexually abused children have discovered that the severity of the abuse act, the duration and frequency of the abuse, the use of force or violence in the abuse, the relationship the abuser has to the abused, and the age abuse started are all directly correlated to the severity of outcomes, which include depression, self-mutilation, somatization, sexual behavior problems, dissociative identity disorder, borderline personality disorder, substance abuse, and PTSD (Putnam & Trickett, 1997).

Putnam (1998) proposes that PTSD should be thought of as a dimensional outcome rather than a categorical, all-or-none, situation. His argument is that many maltreated children develop partial forms of PTSD which do not meet the DSM criteria. Children who have suffered maltreatment are more likely to manifest re-experiencing and avoidant symptoms, but not hyperarousal. Females who have been sexually abused however tend to have elevated catecholamine levels, indicating hyperarousal, rather than avoidant symptomatology. In a study of abused children, 64% met the DSM-IV-TR (2000) criteria for avoidant symptoms, 80% for re-experiencing events, and 66% for hyperarousal, but only 48% of the children met the full criteria for a diagnosis of PTSD (see review in Putnam). Despite the lack of a formal PTSD diagnosis, the symptoms experienced by maltreated children are still serious and no less worthy of intervention. In

fact, Putnam argues that the symptoms diagnosable as PTSD do not even address the most troubling experiences which maltreated children have – hypersexuality, depression, suicide, self-mutilation, dissociation, difficulty with affect regulation, somatization, impulsivity, low self esteem, disturbances of self-image, and hyperactivity/attention difficulties.

The most common outcomes for maltreated children and those who suffer other traumas are much more encouraging. Ford (2009) defines these outcomes as the three R's: Resistance, Resilience, and Recovery. Resistance allows the child to successfully cope with the acute stress reactions they experience, so that there is only a brief interference with health, work and relationships. Resilience is seen in children who are able to successfully cope with the more severe acute reactions following trauma so that, despite having distinct PTSD symptoms, they are able to quickly return to healthy functioning. Recovery is possible for those who experience severe PTSD symptoms, but are able to return to healthy functioning despite the trauma of their experience. In fact, studies have shown that resilience is a quantifiable characteristic which helps buffer children against long-term harm (Goodman, et al., 2009). There is a fourth trajectory beyond the three R's which is less common (or perhaps not as recognized) and a very encouraging thought. For some, posttraumatic growth is possible, and involves developing new knowledge, abilities, relationships, or hope during the period one is recovering successfully from acute stress reactions (Clay, Knibbs, & Joseph, 2009; Ford, 2009).

Assessing Trauma

In order to plan the most useful intervention, a person who has experienced trauma must be assessed in a systematic way and screened for the potential of PTSD symptoms. Extreme caution should be used with children in order to avoid a re-traumatization, although careful and deliberate planning and implementation of assessment should avoid these difficulties (Ford, 2009). Unfortunately, there are far fewer measures for understanding a child's experience of trauma than there are for adults, an issue which is associated with the dearth of trauma research with children, compared to military and other adult populations (Hawkins & Radcliffe, 2006). Another issue in pediatric assessment of trauma is that young children are particularly difficult to assess because of their undeveloped verbal abilities (Stover & Berkowitz, 2005). In studies with violence-exposed children Stover and Berkowitz found that parents are often unaware of the traumatic event their child has witnessed, or underestimate the impact the event had on their child. Additionally, if the parent was exposed to the same event, assessment can be even more complicated because high correlations have been found between child and parent symptoms of PTSD (Stover & Berkowitz, 2005).

Children who have been maltreated are a critical population to assess for effect of trauma and PTSD symptoms. These assessments typically take place in the social context which the abuse occurred in, due to state and local government efforts to rehabilitate parents in order to keep families together. With this in mind, Culbertson and Willis (1998) offer a systematic approach to assessing maltreated children. First the specifics of the abuse situation must be assessed by obtaining an objective history of the situation

through casework interviews and reviews of medical and child protective services records. The family environment and the parent-child relationship must then be assessed. Culbertson and Willis (1998) suggest using clinical interviews of the caregiver and observations of parent-child interactions, as well as administering the Parenting Stress Index and an adult attachment interview. Finally, and most importantly, it is essential to assess the impact of the abuse or maltreatment on the child. This is often best accomplished through naturalistic observation, play interviews, and administration of standardized testing measures.

Self-report scales are perhaps the most widely used measures of assessment for trauma and PTSD symptoms. Trauma questionnaires have been developed for use with adults (Norris & Hamblen, 2004), children (Nader, 2004), and military trauma specific measures (Keane, Street, & Stafford, 2004). It is important to assess the impact of trauma both as an independent factor, and because these measures can satisfy criteria A (exposure to a traumatic event) of a PTSD diagnosis from the DSM-IV-TR (2000). The *Impact of Events Scale*, a dominant measure in adult assessment, has been revised several times for children, with the most recent incarnation being the *Child's Reaction to Traumatic Events Scale-Revised (CRTES-R)*. It is a 23-item, Likert-type scale which seeks to understand how the child sees herself/himself reacting to a traumatic event. There are multiple other self-reports of trauma events for children which also gauge symptoms associated with the other PTSD criteria, such as *When Bad Things Happen*, a questionnaire from the Massachusetts Medical Center, as well as assessment techniques such as the *My Worst Experience Survey* (a structured interview and questionnaire),

Angie/Andy Cartoon Trauma Scales, and trauma symptom checklists (Nader, 2004). A widely used measure with adults who suffered maltreatment as children is the 70-item *Childhood Trauma Questionnaire (CTQ)*, which consists of 5 scales: physical abuse, sexual abuse, emotional abuse, physical neglect, and emotional neglect (Bernstein, et al. 1994). Although it has been used extensively in research, a recent meta-analysis urges caution, in that the measure is often administered in non-standardized ways, and most studies do not utilize all five scales, making the overall results less robust (Baker & Maiorino, 2010). There are also a number of measures which specifically gauge comorbidity between PTSD and dissociation symptoms (Steinberg, 2004).

A frequent and well-supported argument in the field of trauma research is that a trauma experience is often unique from all others, and therefore interventions need to be tailored to fit the specific needs of the individual. This in turn, means that assessment measures must be able to identify what those individual needs are. One assessment tool which has long been used to understand not what a person has gone through, but how they experience these events and how those experiences color the way they view the world is the Rorschach Inkblot Test (Exner, Jr., 2001). The Rorschach can offer insight into a number of different issues surrounding trauma. The projective test can be used to assess the impact of trauma that a client does not feel is impacting his or her life or is not willing to discuss; it can detect possible malingering or exaggeration of trauma experiences; it can help identify a constellation of trauma emotionality symptoms; it can detect the level to which trauma has impacted how a patient views the world; and can help understand how trauma may be most effectively treated with a particular individual

(Luxenberg & Levin, 2004). Based on earlier assertions that trauma may be especially difficult to assess in young children, this author would also suggest the utilization of other projective measures, such as family kinetic drawings, and the Robert's Apperception Test.

A growing movement in psychology is the idea of *positive psychology,* that purports well-being is more than just the absence of deficit, but is a state in and to itself (Seligman, 1995). This theoretical alignment has the ability to affect the assessment and treatment of trauma in children, with the potential of helping more children reach the stage of growth through trauma (see discussion above). Instruments have been developed to measure not only the impact of trauma, but how much posttraumatic growth is experienced. There are currently two adaptations of this instrument for minors. They are the *Posttraumatic Growth Inventory* for use with adolescents and the *Posttraumatic Growth Inventory for Children* (Clay, et al., 2009). Though there have been few studies to date with these measures, the area is well-worth future investigation for the possibility of the positive benefit maltreated children and adolescents might receive.

Interceding in the Aftermath of Trauma

As the ability to prevent all trauma from occurring is beyond the scope of what psychology will likely achieve, focus must be turned to the best interventions to offer children who have suffered maltreatment and other forms of trauma. Hutchison (2005) stressed that while pain cannot be eradicated after trauma, it can be alleviated. There are several important principles to consider in the intervention literature. The acute phase of

trauma is the most impactful time to deliver an intervention as this may reduce the chance of long-term negative impact (Hutchison, 2005). Maltreated children may be especially difficult to form therapeutic alliances with because they have learned not to trust others, and in order for treatment to be effective a sense of trust and hope must be established, as well as a sense of autonomy, mastery, encouragement of initiative, and assistance with individualization (Marold, 1998) – in essence, the successful intervention will help children reach their psychosocial milestones that trauma prevented.

Intervention techniques which have been most rigorously studied for treatment of trauma include various cognitive-behavioral interventions (Ford, 2009; Hutchison, 2005; Lohr, et al., 2003). *Abuse-focused CBT* is a technique used with physically abusive parents and their children and focuses on psychoeducation, engagement in the treatment, individual and family skills training, and family application of skills (Shipman & Taussig, 2009). *Trauma-focused CBT* was an intervention initially developed for children who had been sexually abused, but has since been used successfully with all types of maltreatment; it works using individual therapy with the child that is focused on psychoeducation about trauma, teaching strategies for managing distressing feelings, thoughts, and behaviors, exposure and processing of trauma memories, and building a trauma narrative (Cohen & Mannarino, 2008; Ford, 2009; Shipman & Taussig, 2009).

Other empirically based treatments for child maltreatment include programs such as *Parent-Child Interaction Therapy,* which focuses on enhancing the quality of the parent-child relationship and teaching appropriate behavior management techniques and *Child-Parent Psychotherapy*, which is an attachment-based intervention for children ages

0-6, targeting feelings of safety, affect regulation, quality of the parent-child relationship, and joint parent-child processing of child trauma experiences (Shipman & Taussig, 2009). Children who have been removed from their homes and placed in another situation, typically foster care, often need specialized treatments. Programs suggested for these children include *Multidimensional Treatment Foster Care,* which is a structured parenting group for foster parents who are currently working with foster children; *Early Intervention Foster Care,* a modified version of the aforementioned for children ages 3-6, which trains foster parents before the children come to them and incorporates a therapeutic play group for the children after their incorporation to the homes; *Attachment and Bio-behavioral Catch-up (ABC),* a 10-week intervention program for enhancing the regulatory skills of infants and toddlers, teaching foster parents to follow the children's lead, enhancing the use of positive physical touching, and teaching foster parents how to allow children to express their emotions; and finally the *Incredible Years Adaptation,* a parenting program for foster care givers who have children ages 3-10 who are at risk for developing conduct disorders (Shipman & Taussig, 2009).

Sound recommendations for treatment include interpersonal and psychodynamic therapies, play therapy, creative arts therapy, group therapy, and family systems therapy (Hutchison, 2005). The treatment of disordered attachment relationships with individual and family interpersonal therapy are often supported in the literature (Culbertson & Willis, 1998; Ford, 2009; Hutchison, 2005). A more recent, but well supported treatment for trauma is *Critical Incident Stress Debriefing.* When an event occurs that is believed to be traumatic to almost anyone who might experience it (e.g. natural disaster, fire, school

shooting), the trauma is immediately processed within 24-72 hours in a group format, with the hope than quickly addressing the trauma will prevent long-term psychological difficulties (Lohr, et al., 2003).

There are two other novel treatments mentioned frequently in the literature. *Eye Movement Desensitization and Reprocessing* (EMDR) is a technique which addresses trauma through typical clinical measures such as history taking and verbal discussion of the trauma. Through these techniques EMDR therapists ask a patient to construct and maintain mental representations of the traumatic event and the physical sensations associated with that event. The therapist then asks the patient to make a series of side-to-side eye movements directed by the therapist, and then express negative cognitions which accompany affective distress and finally generate a more positive image (Lohr, et al., 2003). Although still disputed as an empirical intervention due to the dearth of methodologically sound empirical research (Adler-Nevo & Manassis, 2005), there is some support which could show promise for the technique (Ford, 2009). Another non-validated technique for treating trauma is *Thought Field Therapy*. This treatment is based on the idea that thought fields are both the locus of psychopathology and the vehicle for therapeutic change. A series of algorithms are performed to attune the therapist to the correct body field for modification. The patient is asked to think about a distressing problem and the therapist then taps key points of the body to eliminate psychological distress (Lohr, et al., 2003). This therapy seems much akin to dianetics in Scientology (Reitman, 2006); although, of course, Scientology does not recognize psychotherapy.

Pharmacological treatments are often used for patients who are experiencing PTSD symptoms (Ford, 2009). Studies with selective serotonin reuptake inhibitors (SSRI), monoamine oxidase inhibitors (MAOI), brofaromine (a combination SSRI and MAOI), tricyclic antidepressants, benzodiazepines, antiadrenergic agents, and anticonvulsants have all produced positive results (Friedman, 1997). It should be noted that researchers still remain unclear on how many psychopharmaceuticals function in the treatment of mental disorders, particularly in children, and so they should be used with caution (Whitaker, 2010).

Several studies have offered comparisons of the efficacy of these treatments. In a review of trials offering trauma patients psychopharmacologic intervention (SSRI), prolonged CBT, or a combination of the two, data did not show a significant difference between the three interventions (Hetrick, Purcell, Garner, & Parslow, 2010). Both CBT and SSRI treatment were found to be effective interventions for people who are victims of sexual abuse and Type I trauma (Adler-Nevo & Manassis, 2005; Pine & Cohen, 2002). A 2008 meta-analysis by Wethington and colleagues found that in studies of individual CBT, group CBT, play therapy, art therapy, psychodynamic therapy, and pharmacotherapy for immediate post-trauma intervention, individual and group CBT reduced psychological harm following the trauma, but insufficient data was available to determine the efficacy of other forms of immediate intervention. The only study reporting a significant effect size for EMDR therapy (medium size), was in comparison to no-treatment groups, and when CBT was introduced the effect size was significantly diminished to no effect (Rodenburg, Benjamin, Roos, Meijer, & Stams, 2009).

Culture and Gender Considerations in Trauma and PTSD

As with all mental health issues, a clinician attempting to work with patients exposed to trauma would be remiss to not consider the culture and gender of her or his client. These pieces of a person's whole are not something that can be left at the door, and since the roots of psychology are in the European male, the accommodations for cultures that differ from these roots are an essential aspect of treatment planning.

The African-American community has a unique past in the United-States – there is a history of slavery and the effects of past and present racism, which in turn are associated with current and ongoing issues such as more chronic health difficulties, higher rates of poverty and unemployment, and more violent deaths among adolescent boys and pregnancies among adolescent girls. These issues are not found at such high rates in European-American communities. Consequently, African-Americans have a significantly higher likelihood of developing PTSD than do European-Americans (Cash, 2006). It is important to point out that a therapist should not assume that an African-American client will exhibit PTSD symptoms as a result of any of these causes, as each person's trauma is unique, and many African-Americans do not consider themselves traumatized despite these pervasive issues in their communities.

There are, generally speaking, two kinds of issues that Hispanic people living in the United States face. Recent immigrants from Latin American have often experienced high rates of political oppression in their country of origin, and, after immigrating, face all the typical stressors associated with immigration to an unfamiliar place. Hispanic-Americans tend to live in more disadvantaged communities with higher rates of crime,

face prejudice, discrimination, and hot political issues such as immigration rights, and have less access to social resources. There are high rates of PTSD in the Hispanic community, and a lack of trust in dominant culture health services. The historically strong focus on family and social support in these communities can serve as a buffer against many of the effects trauma might impose (Cash, 2006; de Arellano & Danielson, 2008).

The current clinical understanding of PTSD was shaped by gender studies. Early research of PTSD symptoms was often conducted with male combat veterans or female rape survivors (Kimerling, Prins, Westrup, & Lee, 2003). Although men are more likely to experience traumatic events; women are two times as likely to develop PTSD and are often subject to more chronic and elaborated forms of PTSD (Kimerling, et al., 2003; Tolin & Foa, 2006), possibly because men are more frequently exposed to combat, while women are often the victims of sexual trauma and disempowerment. Historically, the condition of gender as an issue in therapeutic assessment and services was ignored by psychology. In fact, perhaps the biggest oversight occurred with psychology's most recognizable figure, Sigmund Freud. Critics have argued, from logical evidence, that Freud's Oedipal complex was in fact his incorrect interpretation of his female patients' reports of sexual encounters with their fathers, when in fact these were actually reports of sexual assault. Freud's more vicious critics go so far as to argue that the Oedipal complex was actually a cover-up to hide the reports of assault, as many of his patients' fathers were his own colleagues and members of the upper Viennese society (Cash, 2006).

Appropriate assessment and treatment of women would give consideration to these gender specific issues.

Cross-cultural research offers insight to a number of issues faced in other countries. A report by Nagao and Maeno (2006) discusses an epidemic in Japanese society of lack of concern for child welfare. They present five recent case studies of child death from abuse or neglect where the maltreatment was well-known to the community but went unreported. Reports from South Africa indicate that indigenous children's exposure rate to trauma is believed to be between 40-100%, and that 6-22% of children there will develop PTSD (Suliman, Kaminer, & Seedat, 2005). Although sexual assault of girls in armed conflict is often treated by governments as though it were perpetrated by rogue soldiers, Denov (2006) presents convincing evidence from conflicts in Yugoslavia, Rwanda, and Sierra Leone which indicates that this abuse is actually much more pervasive and sanctioned by the military leadership. Incidents of child maltreatment and trauma could be told from the world over and these studies are a small sampling of the types of trauma faced by children worldwide.

In a 2008 paper, de Arellano and Danielson make suggestions for culturally informed assessment of trauma. Before beginning an assessment or intervention plan, the clinician should investigate the target population, including both stressors and support factors in the community. Based on this investigation, new ways of delivering services should be attempted, such as providing transportation or in-community services, or offering culturally relevant material to patients. A therapist should try to understand the relevance of family and community relations to the patient, and make an effort to involve

extended family and other collaterals as needed. Both the type of trauma assessed and long-term sequelae measured should be expanded to include those that are culturally relevant. Finally, the assessment should be evaluated in order to continue improving the model for future clients from the same community.

A final issue to consider in cross-cultural work with trauma patients is the way that a particular culture conceptualizes trauma and intervention. For instance, some eastern religions teach followers that there is no control over fate, so it may seem out of place for a person who practices one of these religions to seek treatment for something that is out of their hands (Hutchison, 2005). Due to the convergence of many different cultures in the United States, an important consideration is cultural or indigenous forms of intervention. For many immigrants and refugees, healers or spiritualists are often a first choice for help, and this is often also true for people who lived in the United States indigenously (Native Americans or those who are considered Mexican) for several generations. Practices such as Santeria, Espiritismo, and seeking healing from a Curandero are used by many minority groups in the United States. There are a number of different indigenous practices that should be investigated based on the population a therapist will work with. It is important to both be respectful of the symptom alleviation that can be found through indigenous means, and if possible to work with the cultural healers to better engage the community.

What is Known About the Effects of Trauma on Executive Functioning

Although much is believed to be known about the role trauma and PTSD play on brain development, and much is believed to be known about what brain structures are involved in executive functioning, there has been surprisingly little work to investigate how experiencing trauma may affect a child's ability to carry out executive functions. In 1997, Teicher, et al. theorized in their writing that the experience of trauma in a child may arrest the development of the prefrontal cortex region, preventing it from reaching a full adult capacity, and that in turn it would be conceivable that functions associated with the prefrontal cortex would also not appropriately develop. The development of executive functions has been shown to be environmentally dependent, intimately linked with limbic functioning (Fishbein, et al., 2009), and it is known that trauma affects the limbic area (see above) and that maltreatment makes for a poor developmental environment. In PTSD, Fishbein and colleagues argue it is difficult to make assumptions about children, because so much of the PTSD literature is based on adult studies; however, this adult literature does show that people who have PTSD seem to have lower attention and abstract reasoning skills.

There have been several empirical studies in recent years from which conclusions about the effects of trauma on children's executive functioning may be drawn. Generally, it has been learned that children who report higher levels of fear also have lower working memory span, impaired motor speed, and an increase in somatic complaints (Kushnir & Sadeah, 2010). In a sample of sexually abused children, performance on the Test of Memory and Learning (TOMAL) suggested that while attention and concentration tasks

were significantly impaired, there was not a deficit effect on working memory tasks (Goodman, et al., 2009). When neglected but medically healthy children were divided into 2 groups (with PTSD and without) and compared to a control group, it was found that on NEPSY tasks, both groups of neglected children had lower executive functioning scores than the control group (De Bellis, Hooper, Spratt, & Woolley, 2009). DePrince, Wienzierl, and Combs (2009) hypothesized that children who are exposed to familial trauma will perform worse on executive functioning measures than children exposed to other types of trauma, or a control group. They found that there was in fact a significant, medium effect size between familial trauma and executive functioning, but no difference between the non-familial trauma group and the control group. Along a similar vein, it was found that children who were exposed to domestic violence of any type, and subsequently developed PTSD, had slower and less effective learning strategies and an impaired effect of rehearsal on memory acquisition, and both children exposed to domestic violence with and without PTSD had below average executive functioning, attention, and intellectual ability (Samuelson, Krueger, Burnett, & Wilson, 2010).

In a study of foster children who were given NEPSY tasks, and whose foster parents were asked to complete parent rating scales of dissociation, it was discovered that higher levels of childhood dissociation were associated with poorer performance in inhibition tasks, but not with tasks requiring primary planning, strategy, or multiple rule sets (Cromer, Stevens, DePrince, & Pears, 2006). DePrince, Wienzierl, and Combs (2008), suggested from these results that people who experience dissociation after trauma may do better in divided attention situations. They tested this theory by giving

traumatized children the STROOP tasks and a measure of dissociation. Children who reported higher dissociation had less interference on the divided attention tasks than the control group. Children in Romanian orphanages are largely believed to suffer a great deal of trauma early in life. Studies with these children have found that those orphans adopted before six months, when compared to orphans adopted from United Kingdom orphanages (which indicates they lacked a nuclear family also), had severe deficits in executive functioning (Colvert, et al., 2008). Additionally, when comparing the Romanian orphans who remained in the orphanages to those who were moved out into foster care settings, it was found that those who stayed in the orphanages also had much more severe deficits than those who were placed into other care settings (Bos, Fox, Zeanah, & Nelson, III, 2009). An interesting study in 2004 (Twamley, Hami, & Stein, 2004) tested college students who had either had experienced trauma with PTSD, experienced trauma without PTSD, or reported no trauma at all. It was found that subjects from the three groups did not differ significantly on any measures of executive functioning. A serious methodological issue with the sample was completely overlooked by the authors of this study, as the fact that, despite trauma with or without PTSD, the subjects have enrolled in college and managed enough academic success to continue. This level of functioning in itself suggests an inherent resilience that does not necessarily generalize to the population at large.

An important issue to consider when interpreting results of all the above studies is that none used a comprehensive sample of trauma victims or defined and measured executive functioning in the same terms. The majority of these studies examined only one

or two of the functions under the executive umbrella. Calkins and Marcovitch (2010) argue that, to date, there has been no comprehensive study of how the different processes that go into executive functioning are related, or become integrated over the course of early childhood. Dalgleish, Meiser-Stedman, and Smith (2005) wrote an informative piece concerning the dearth of solid empirical research in this area, and made suggestions on how future studies could improve on the current work. The authors maintained that research which had been conducted to that point supported the need for further exploration of the cognitive effects of traumatic stress on children. They proposed that researchers should recruit subjects who are survivors of different types of traumatic events, have appropriate power to reasonably reject hull hypotheses, include sample sizes of at least 100 participants so that age and IQ may be appropriately controlled for, and shift away from self-report measures to more widely agreed upon, standardized measures of executive functioning.

It is possible that one difficulty facing the quick growth of trauma research in children is access to appropriate samples. As Dalgleish and colleagues (2005) suggest, a sample needs to be of an appropriate size, but for many researchers it is difficult to gather data about this population in sufficient numbers. Research must also be conducted in such a way that the children are not asked to relive their trauma, which in effect could re-traumatize them. Since the current literature on executive functioning suggests that most now consider it to be an umbrella term encompassing many different functions, it is also important that future research include a variety of skill measures to try addressing as many of these as possible.

Chapter 3: Problem, Purpose, and Method

Statement of the Problem

Trauma in childhood, especially trauma resulting from child maltreatment, is both a distressing social issue and a developmental concern for children. Trauma and one of its clinical outcomes, PTSD, have been clearly documented to hinder the psychosocial and cognitive development of children. Language and memory deficits are reliably shown in children who have experienced traumatic stress, as are neurobiological changes. The amygdala, HPA axis, and prefrontal cortex are all affected, as are key neurotransmitters. Executive function, which is defined for the purposes of this study as a term encompassing a set of interrelated, yet distinct skills, is heavily dependent upon PFC functioning, as well as the same neurotransmitter functions found to be dysregulated in traumatic stress and PTSD. The PFC is the last brain structure to develop fully, with growth and myelination continuing into adulthood. What is currently unclear from the literature is how being exposed to trauma at an age when the PFC is still developing may impact the executive function skills that are dependent on the PFC. Recent studies have suggested that there may be a disruption of functioning after traumatic stress, but to date the studies have used small sample sizes or narrow definitions of executive functioning.

Statement of the Purpose

The purpose of this study was to expand the research base concerning the effects of trauma on pediatric executive functioning. Specifically, this study investigated

performance of children who have been maltreated or developed PTSD on various psychometric measures purported to measure executive skills. Although some research has been undertaken concerning skills such as working memory or attention in children with specific trauma experiences (e.g., domestic violence or sexual abuse), little research exists specifically looking at global executive functioning in a group of children who have suffered trauma from different sources. Therefore, this study aimed to examine these constructs on a more holistic level to help researchers and practitioners become more informed of the potential effects trauma may have on a pediatric population, in order to better plan treatment options.

In the first stage of this study the concept of executive functioning, which is believed to be a set of disparate but related skills, were examined. Several measures were chosen as representative of executive functioning skills. These measures (see below) were chosen because they are commonly used in the current literature as measures of executive function (i.e., COWAT, TMT, WCST), or because in the practical experience of some practitioners including the individual who collected the data used in this study, they appear to require the engagement of executive skills (i.e., MR, AVM). It was expected that the five instruments chosen would all load on a single factor, and therefore be appropriate to combine as an overall executive function score.

The second stage of the study was concerned with the effect that traumatic stress has on the developing pediatric brain and its ability to perform necessary executive functions adequately. The hypothesis tested was that children who have been maltreated (the most common form of trauma among children in the United States) or who have

developed PTSD, would have significant impairment on executive functioning skills. Additionally, as the literature has shown girls and women to be more susceptible to the development of more chronic and severe forms of PTSD, female subjects in the study were expected to have more executive functioning deficits than male participants. Finally, the between group differences of the PTSD group and the non-PTSD group were examined for any significance that executive functioning abilities may have on the difference between children who had suffered trauma and developed the clinical diagnosis of posttraumatic stress disorder and those who had not.

METHOD

Participants

Participants were male and female children and adolescents ages 6-18 who were admitted to a residential treatment center (RTC) from 2000-2009, due to a history of severe emotional or behavioral disturbance. The treatment center provides neurobehavioral services for children with a combination of complex medical, behavioral, social, and learning difficulties with the goal of discharge to a less restrictive setting. Patients were referred to the treatment center from a nationwide pool. Of those admitted, children who received a DSM-IV-TR (2000) Axis I diagnosis of Posttraumatic Stress Disorder (309.81) or child maltreatment (995.5x; 2-neglect, 3-sexual abuse, 4-physical abuse), with diagnosis certified by a Licensed Psychologist and a board certified child and adolescent psychiatrist, were included in the current analysis. Ethnicities included, but were not limited to, African-American, Caucasian, Hispanic, Native

American/Alaskan Native, and multiracial. After a preliminary inspection of descriptive statistics, there were 286 participants who meet inclusion criteria for this study.

Instrumentation

Controlled Oral Word Association Test (COWAT)

The Controlled Oral Word Association Test (COWAT) is a measure of phonemic fluency, which gauges a participant's ability to produce individual words under restricted search conditions within a limited amount of time (Strauss, et al., 2006). Although the search conditions can be varied, the most common, and those used in this administration are words starting with the letters "F," "A," and "S." Scoring is based on the total correct admissible words given within the time limit. Inadmissible words include proper names, wrong words, variations, and repetitions. The original norms, called CL-COWA, were first gathered in the 1960's and last updated in 1996. These norms are stratified for individuals between the ages of 16 and 70, and educational years 0-21. Normative data for school-aged children were last updated in 1997, and are valid for children ages 7-15. It should be noted that although this is the normative data being used in this study, it did differ from that gathered by Delis, Kaplan, and Kramer (2001), and reports higher means than the Delis norms. Studies of the COWAT using the F, A, and S conditions have found internal reliability of .83 and a high correlations with other fluency tests (.85-.94). Correlations between phonemic fluency and verbal IQ have been reported between .44 and .87 (Strauss, et al.).

Wisconsin Card Sort Test (WCST)

The Wisconsin Card Sort Test (WCST) is considered an executive function test that was originally designed to assess abstraction ability and ability to shift cognitive strategies in response to changing contingencies (Heaton, Chelune, Talley, Kay, & Curtis, 1993). It requires strategic planning, organized searching, the ability to use environmental feedback, goal-oriented behavior, and the ability to inhibit responses. The test consists of four stimulus cards placed in front of the subject. The participant is given response cards that have similar designs to those on the stimulus cards, and asked to match the cards to the stimulus cards. Feedback is given each time concerning the correctness of the response, with the correctness response pattern changing during the test without warning provided to the subject. The WCST manual provides normative data for children ages 6 to 17 years old. Due to the nature of the WCST, test-retest reliability ranges for .37 to .72 (Strauss, et al., 2006). Retesting a child on the WCST will produce large variability in scores due to a learning effect. Although the WCST provides a number of scores based on the test results, only the perseverate error score will be used for this analysis. Preservative errors are those made when the child tries to maintain an incorrect set.

Trail Making Test (TMT)

The Trail Making Test (TMT) is a measure of attention, processing speed, and mental flexibility. The age range for the TMT is 9-14 years and consists of two parts. Part A consists of 25 circled numbers, arranged randomly on a page, and requires the test-taker to connect them in numerical order; it is largely a measure of processing speed and

attention. Part B has 25 circled number and letter (numbers 1-13 and letters A-L) that must be connected in alternating order (i.e., number-letter, number-letter). This second part also requires processing speed and attention, but additionally requires inhibition and shifting. The standard administration includes a practice trial for each condition. The examiner times the child, and gives a correct response orally when a mistake is made. Comprehensive normative data is not available for the TMT; however there are norms available for children ages 7-13, adolescents, and adults age 18-89. Part B has adequate test-retest reliability (.75). Part A and Part B have moderate correlations with one another, indicating that they are measuring similar but distinct constructs. Construct validity for the TMT has been reported to be between .36 and .93 and has been found highly sensitive to neurocognitive deficits (Strauss, et al., 2006).

Matrix Reasoning subtest (MR), Wechsler Abbreviated Scale of Intelligence (WASI)

The Wechsler Abbreviated Scale of Intelligence (WASI) is a brief, reliable measure of intelligence that can be used with individuals ages 6-89 years (Wechsler, 1999). It is composed of four subtests that are parallel to subtests found on the more detailed Wechsler intelligence tests (Wechsler Intelligence Scale for Children, 4th Edition; Wechsler Adult Intelligence Scales, 3rd Edition). Intended use of the WASI includes brief assessment of an individual's overall level of cognitive functioning. The particular subtest being used for this study, Matrix Reasoning (MR), is part of the nonverbal performance scale. Matrix Reasoning requires the child to determine a piece of a missing visual matrix from an array of answer choices. The WASI was normed

according to the 1997 census data. The normative sample included 2, 245 children and adults who were stratified based on geographic region, age, sex, ethnicity, and education level. The WASI demonstrates adequate reliability across both children (ages 6-16) and adults (ages 17-89). For children, the reliability for Matrix Reasoning score ranges from .80 to .90+ (Strauss, et al., 2006). This scale was included in the factor analysis as a possible measure of executive functioning because it seemed that Matrix Reasoning employs the attention, inhibition, and planning executive function abilities. The plan was to include Matrix Reasoning as part of the overall executive function score in later analysis if it was shown to load on the single executive function factor.

Abstract Visual Memory subtest (AVM), Test of Memory and Learning, Second Edition (TOMAL-2)

The Test of Memory and Learning, Second Edition (TOMAL-2) is a standardized battery used to measure different memory functions in individuals age 5 to 59 years. The TOMAL-2 was normed using a standardization sample on 1,961 individuals residing in 28 states. The sample was stratified based on the 2002 census and the following demographic characteristics were considered: gender, race, socioeconomic status, parent level of education, geographic region, exceptionality status, and age (Reynolds & Voress, 2007). The TOMAL-2 includes eight core subtests and six supplementary subtests; however, this study used only one subtest – Abstract Visual Memory (AVM). This subtest requires a child to look at an abstract design and then pick that design from a set of visually similar abstract designs on a different page. Adequate reliability has been

found for this subtest, with estimates ranging from .67 to .97 for ages six to eighteen. This scale was included in the factor analysis as a possible measure of executive functioning because it seemed reasonable that Abstract Visual Memory employs the attention, inhibition, and working memory executive function abilities. If Abstract Visual Memory were shown to load on the single executive function factor, the plan was to include it in the overall executive function score for later analysis.

PROCEDURE

Approval by Human Subjects Committee

This study complied with all ethical standards set forth by the American Psychological Association and The University of Texas at Austin. Prior to the beginning of the study, the Departmental Review Committee of the Department of Educational Psychology, the Institutional Review Board of The University of Texas at Austin approved the study.

Recruitment of Participants

This study did not involve direct interaction with any participants, or participant consent. Participants were children ages six to eighteen who received inpatient psychiatric treatment at a residential treatment center (RTC) between the years 2000-2009. The RTC provided services for severely emotionally and behaviorally disturbed children and adolescents in a residential setting. Diagnoses included, but were not limited to, Posttraumatic Stress Disorder and child maltreatment. The treatment center served

children of all ethnicities, including those of African-American, Caucasian, Hispanic, Native American/Alaska Native, and multiracial descent.

Data Collection

When a child was admitted to the RTC, a full neuropsychological evaluation was administered as part of the intake process, unless the child had recent (within one year) and valid test results. The neuropsychological evaluation included psychometric intelligence, academic achievement, memory, sensory and perceptual, motor, executive functioning, and social/emotional/behavioral testing. Each child was given a diagnosis, as per the DSM-IV-TR (2000) multi-axis diagnosis system, by a licensed psychologist and a board certified child and adolescent psychiatrist. I assisted with the original data collection process by conducting assessments for some of the children. At the end of the data collection period, I de-identified and entered all the assessment data into an electronic database. The original hard copy data is stored in a locked storage facility. The electronic database is kept on a password-protected computer in a locked office.

Data Analysis and Expected Results

Preliminary Analysis – Power

Before beginning a study, it is important to determine the number of participants needed in order to have a reasonable chance of rejecting a null hypothesis. Although the database being used in this study is already in existence, a pre-analysis power analysis was conducted using G-POWER version 3.0.10 (Faul, Erdfelder, Buchner, & Lang, 2009;

Faul, Erdfelder, Lang, & Buchner, 2007), in order to ascertain independently a sample size needed for adequate power. Given an estimated f of .25 (a medium effect size) with 7 independent variables and a significance level (alpha) of .05, a total sample size of 210 participants were needed in order to have a 95% chance of correctly rejecting a false null hypothesis.

A post hoc power analysis was conducted with G-POWER 3.0.10 in order to estimate power of the multiple linear regression, based on a preliminary sample size of 286 participants. Given an estimated f of .25 (a medium effect size) with 286 participants and a significance level (alpha) of .05, it is believed that the power of this analysis (1-β error probability) will be .998.

Analysis and Expected Results

Keith (2006) recommended preliminary analysis prior to any statistical analysis. In accordance with this, descriptive statistics including means, standard deviations, ranges, and variances were computed for all measures, sub-measures, and demographics, and examined for trends and to ensure normality. In addition, because the analysis used multiple regression, it was important to consider the assumptions of regression. In multiple regression variables should be normally distributed, it is assumed there is a linear relationship between the independent and dependent variables, the variables need to be measured without error, and the residuals need to be normally distributed (homoscedasticity) (Keith, 2006).

The first research question of this study concerned the formation of an overall score of executive functioning. Common factor analysis was used to address this question. The purpose of this step was to develop an overall score of executive functioning that can be used in addressing the following research questions. By assessing the five instruments using a common factor analysis, it allowed a test of whether or not they all seem to represent the same underlying construct.

It was hypothesized that the six different scores (i.e., COWAT total items, Trails A time, Trails B time, WCST perseveration errors, MR scaled score, and AVM scaled score) would load on a common factor, thereby allowing for the identification of one common executive function factor underlying these distinct measures.

The main objective of this study was to determine what effect trauma has on pediatric executive functioning skills. A sequential multiple regression was used to address this question. The composite executive functioning score were to be regressed on two blocks. The first block contained the variables of gender, ethnicity, age, DSM-IV-TR Axis II diagnosis, DSM-IV-TR Axis III diagnosis, and full scale IQ (FSIQ). These demographic variables, in combination with other medical diagnoses and overall cognitive functioning, may influence a child's executive functioning abilities, and were controlled for in the regression. The second block contained the variable of membership in the traumatized group (children with a 309.81 PTSD diagnosis or a 995.5 maltreatment diagnosis).

It was hypothesized that membership in the traumatized group would produce a statistically significant increase in R^2. Participants who had a diagnosis of PTSD or child maltreatment were also expected to have significantly lower executive functioning skills.

The third question of this study was whether or not gender plays a significant role in executive functioning deficit of traumatized pediatric populations. To answer this question, a second multiple regression was used that regressed the executive functioning composite score on a block of control variables, in this case, ethnicity, age, Axis II diagnosis, Axis III diagnosis, and FSIQ. The second block contained the variable of membership in the traumatized group and gender. It was expected that when the standardized coefficient (β) for gender is examined, it would be statistically significant and that female gender would be associated with a larger deficit in executive functioning.

The final question of this study was whether executive function plays a role in the difference between the group of traumatized children who developed PTSD and the group that did not. A third multiple regression was used, regressing the executive function composite score on the first block of control variables and a second block containing the variable of membership in the traumatized group. For this regression, group membership was dummy coded to represent those with PTSD and those without. It was hypothesized that group membership would produce a statistically significant increase in R^2, and that the group who did not develop PTSD would have more intact executive functioning skills than the traumatized group that did develop PTSD.

Chapter 4: Results

This chapter presents the statistical analysis for the study. First, descriptive statistics are used to describe and summarize the data collected. Next, results are provided for the preliminary factor analysis and the three main research questions.

DESCRIPTIVE ANALYSIS

The total sample size of the database was 667 participants, with male (58.8%) and female (41.2%) participants. The distribution of race and ethnicity for the participants was skewed toward Caucasian (64.8%) children, and though this makes the sample unrepresentative of the population at large, it is typical of RTCs, who tend to attract mainly white clients. The mean age was 13.8 (SD = 2.6) and the mean Full Scale IQ (FSIQ) was 92.7 (SD = 16). This is an important factor to note – although the children in the sample had significant emotional and behavioral problems, the mean FSIQ was in the average range. Further information about the sample can be found in Table 1. The total sample of 667 participants was used in the factor analysis and in the analysis of the effect of trauma on executive functioning.

Of this larger sample, 286 children had a DSM-IV-TR diagnosis indicating they had experienced trauma (see Table 1). The distribution of gender, race, and ethnicity, presence of Axis 2 and Axis 3 disorders, age, and FSIQ mirror the total sample. The trauma sample was used in the regression analysis of the effect of gender on the executive functioning of traumatized children, and in the analysis of the development of PTSD effect on executive functioning.

Table 1: Descriptive Statistics of Total Sample

		Total Sample (N=667)		Trauma Sample (N=286)	
		n	*%*	*n*	*%*
Gender	Male	392	58.8	152	53.1
	Female	275	41.2	134	46.9
Race/Ethnicity	A. American/ Black	94	14.1	41	14.3
	Asian	3	.4	1	.3
	Caucasian	432	64.8	188	65.7
	Hispanic	63	9.4	21	7.3
	Native Amer.	14	2.1	8	2.8
	Other	52	7.8	27	9.4
Positive for Axis 2 Disorder		306	45.9	141	49.3
Positive for Axis 3 Disorder		235	35.2	120	42
		Mean	*SD*	*Mean*	*SD*
Age		13.8	2.6	13.6	2.7
FSIQ		92.7	16	91.1	15.5

Further descriptive analysis was performed on the sample of 286 children who had suffered trauma. Of these, 80 had developed PTSD at the time of intake and 206 had not. This information is of particular importance to the last research question, and a summary of the descriptive statistics is below (see Table 2). On the whole, both the PTSD positive and PTSD negative sample mirror the total sample with respect to demographics. One notable difference, however, is that of children who developed PTSD after experiencing trauma, 63.8% were female and only 36.2% were male.

Table 2: Descriptive Statistics of PTSD Sample

		PTSD + (N=80)		PTSD - (N=206)	
		n	*%*	*n*	*%*
Gender	Male	29	36.2	123	59.7
	Female	51	63.8	83	40.3
Race/Ethnicity	A. American/ Black	9	11.2	32	15.5
	Asian	0	0	1	.5
	Caucasian	58	72.5	130	63.1
	Hispanic	5	6.2	16	7.8
	Native Amer.	1	1.2	7	3.4
	Other	7	8.8	20	9.7
	Positive for Axis 2 Disorder	34	42.5	107	51.9
	Positive for Axis 3 Disorder	39	48.8	81	39.3
		Mean	*SD*	*Mean*	*SD*
	Age	13.6	2.9	13.6	2.7
	FSIQ	90.6	14.1	91.3	16

PRELIMINARY FACTOR ANALYSIS

The initial question, and preliminary analysis needed for this study, was whether an overall score of executive functioning could be formulated from the six measures proposed. Principal axis factor, or common factor analysis, was conducted using the total sample of 667 participants to examine the factor structure of the six measures (Matrix Reasoning, Abstract Visual Memory, Trail A&B, WCST, and COWAT). Eigenvalues greater than 1 suggested retaining two factors, initially explaining a total of approximately 56% of the variance in the set of measures. The scree plot associated with the analysis suggested only retaining one factor, which would explain only 38% of the variance. After extracting the one factor, 28% of the variance was explained whereas 37% of the variance was explained in the measures by extracting 2 factors. The two-

factor solution was thus chosen, as it seemed to add a significant amount to the explanation.

It was unclear whether or not the factors were intercorrelated with one another, so an oblique (oblimin) rotation was chosen to examine the magnitude of correlations among the extracted factors. It was determined through the oblique rotation that the factors were highly intercorrelated (absolute values ranging from .22 to .78), so the oblique structure matrix was retained. Upon examining the item loadings, the COWAT measure did not load highly on either factor. It was removed, and the factor analysis was rerun.

The factor loadings for the 2-factor solution using the five measures are presented in Table 3. Trails A and B loaded more highly on Factor 1 which explained 30.9% of the overall variance, and Matrix Reasoning, Abstract Visual Memory, and WCST loaded more highly on Factor 2 which explained 9.4% of the variance. The two-factor solution suggested that there was not a satisfactory way to combine the various measures into a single executive functioning variable. In addition, the lack of simple structure with the strong cross-loadings of the measures (see Table 3) suggested that there was not a satisfactory way to combine a subset of the measures into a meaningful executive functioning variable. This changed the method used for the following analyses. Instead of conducting one regression for each research question with executive functioning as a dependent variable, each research question was analyzed with six regressions (i.e., one for each of the six measures used as a dependent variable). It should be noted that the

loadings were not substantial for the one-factor model, and thus were not examined further.

Table 3: Factor Analysis

	Factor	
	1	*2*
Matrix Reasoning	-.243	.561
Abstract Visual Memory	-.392	.599
WCST Perseveration Errors	.217	-.491
Trails A	.692	-.322
Trails B	.736	-.401

ANALYSIS OF RESEARCH QUESTION 1

The purpose of this research question was to determine whether the experience of trauma has an effect on children's executive functioning abilities after controlling for FSIQ, age, gender, ethnicity/race, and a diagnosis on Axis II or Axis III. To accomplish this purpose, a sequential regression analysis was conducted in which participants' scores on the six different measures proposed to gauge executive function were regressed first on the six control variables in one block, and then the presence or absence of trauma was added to the control variables as a predictor in the second subsequent block.

The results of the analysis are shown in Table 4. The overall regression equation for the first dependent variable, Matrix Reasoning, was found to be significant ($R^2 = .291$, $F[7, 666] = 38.59$, $p < .005$). This was also true for Abstract Visual Memory ($R^2 = .318$, $F[7, 666] = 43.812$, $p < .005$), WCST ($R^2 = .196$, $F[7, 666] = 22.942$, $p < .005$), Trails A ($R^2 = .097$, $F[7, 666] = 10.102$, $p < .005$), Trails B ($R^2 = .142$, $F[7, 666] = 15.569$, $p < .005$), and the COWAT ($R^2 = .158$, $F[7, 666] = 17.725$, $p < .005$). The significance of control variables is summarized below. Despite the overall significance of the six

regression equations, the trauma variable did not produce a significant change in explained variance for Matrix Reasoning ($\Delta R^2 = .001$, $p > .05$), Abstract Visual Memory ($\Delta R^2 = .000$, $p > .05$), WCST ($\Delta R^2 = .001$, $p > .05$), Trails A ($\Delta R^2 = .002$, $p > .05$), Trails B ($\Delta R^2 = .003$, $p > .05$), or the COWAT ($\Delta R^2 = .001$, $p > .05$) over and above the control variables.

Table 4: Multiple Regression of Research Question 1

Table 4.	*Variable*	*β*	*Probability*
Matrix Reasoning	**FSIQ**	**.511**	**<.001**
	Age	.005	.876
	Gender	-.005	.877
	Ethnicity/Race	**-.069**	**.037**
	Axis 2	.065	.060
	Axis 3	.026	.437
	Trauma	.026	.429
Abstract Visual Memory	**FSIQ**	**.524**	**<.001**
	Age	**-.075**	**.022**
	Gender	.029	.380
	Ethnicity/Race	.024	.468
	Axis 2	**.072**	**.034**
	Axis 3	-.011	.744
	Trauma	-.009	.785
WCST	**FSIQ**	**-.386**	**<.001**
	Age	**-.183**	**<.001**
	Gender	**.086**	**.017**
	Ethnicity/Race	-.058	.104
	Axis 2	**-.087**	**.018**
	Axis 3	.023	.534
	Trauma	-.029	.422
Trails A	**FSIQ**	**-.286**	**<.001**
	Age	**.099**	**<.001**
	Gender	**-.019**	**.009**
	Ethnicity/Race	-.009	.812
	Axis 2	.050	.197
	Axis 3	-.027	.476
	Trauma	.046	.223
Trails B	**FSIQ**	**-.310**	**<.001**
	Age	**.129**	**<.001**
	Gender	-.029	.430
	Ethnicity/Race	-.057	.121
	Axis 2	.024	.534
	Axis 3	-.067	.074
	Trauma	.058	.116
COWAT	**FSIQ**	**.378**	**<.001**
	Age	**.010**	**<.001**
	Gender	**-.081**	**.028**
	Ethnicity/Race	.017	.643
	Axis 2	-.055	.147
	Axis 3	.067	.071
	Trauma	.025	.485

Significant variables are in **bold.**

ANALYSIS OF RESEARCH QUESTIONS 2 AND 3

The purpose of the second research question was to determine whether gender plays a significant role in executive functioning of *traumatized* pediatric populations, after controlling for FSIQ, age, ethnicity/race, and a diagnosis on Axis II or Axis III. To accomplish this purpose, participants who were given a DSM-IV-TR diagnosis indicating trauma (n=286) had their scores on the six measures of executive function regressed on the five control variables and then on the control variables with gender as a predictor, using a sequential multiple regression analysis.

The results of the analysis are shown in Table 5. The independent variable gender did not produce a statistically significant change in explained variance for Matrix Reasoning ($\Delta R^2 = .001$, $p > .05$), Abstract Visual Memory ($\Delta R^2 = .002$, $p > .05$), WCST ($\Delta R^2 = .005$, $p > .05$), Trails A ($\Delta R^2 = .000$, $p > .05$), Trails B ($\Delta R^2 = .001$, $p > .05$), or the COWAT ($\Delta R^2 = .001$, $p > .05$) over and above the control variables.

Question three was concerned with whether or not there is a difference in executive functioning for children who develop PTSD after experiencing trauma and those who do not. The control variables in this regression are FSIQ, gender, age, ethnicity/race, and a diagnosis on Axis II or Axis III. Participants' scores on the six measures were regressed on the six control variables and then on PTSD status as well as the control variables using a sequential multiple regression analysis.

The results of the analysis are shown in Table 5. Dependent variables of Matrix Reasoning ($\Delta R^2 = .008$, $p > .05$), Abstract Visual Memory ($\Delta R^2 = .001$, $p > .05$), WCST ($\Delta R^2 = .001$, $p > .05$), Trails A ($\Delta R^2 = .002$, $p > .05$), Trails B ($\Delta R^2 = .000$, $p > .05$), and

COWAT ($\Delta R^2 = .000$, $p > .05$) were not significantly impacted by PTSD status over and above the control variables.

Table 5: Multiple Regression of Research Questions 2 & 3

Table 5.	*Variable*	*β*	*Probability*
Matrix Reasoning	**FSIQ**	**.558**	**<.001**
	Age	.022	.652
	Ethnicity/Race	**-.097**	**.051**
	Axis 2	.035	.506
	Axis 3	-.012	.815
	Gender	-.025	.614
	PTSD	.095	.061
Abstract Visual Memory	**FSIQ**	**.476**	**<.001**
	Age	**-.109**	**.036**
	Ethnicity/Race	-.006	.902
	Axis 2	.066	.223
	Axis 3	.000	.994
	Gender	.042	.421
	PTSD	.036	.502
WCST	**FSIQ**	**-.413**	**<.001**
	Age	**-.283**	**<.001**
	Ethnicity/Race	**-.113**	**.034**
	Axis 2	-.046	.413
	Axis 3	.064	.232
	Gender	.071	.189
	PTSD	-.030	.577
Trails A	**FSIQ**	**-.277**	**<.001**
	Age	.108	.064
	Ethnicity/Race	-.108	.759
	Axis 2	.089	.143
	Axis 3	-.033	.574
	Gender	-.013	.828
	PTSD	.044	.458
Trails B	**FSIQ**	**-.302**	**<.001**
	Age	.092	.105
	Ethnicity/Race	-.087	.121
	Axis 2	.049	.410
	Axis 3	**-.125**	**.029**
	Gender	-.304	.551
	PTSD	-.001	.985
COWAT	**FSIQ**	**.388**	**<.001**
	Age	.057	.317
	Ethnicity/Race	.100	.074
	Axis 2	**-.120**	**.042**
	Axis 3	-.010	.864
	Gender	.033	.563
	PTSD	-.017	.773

Significant variables are in **bold.**

Chapter 5: Discussion

This chapter will first summarize the results of this investigation in the context of existing research and theory and explore possible reasons why the study was unable to disprove the null hypotheses. Next, the limitations of this study will be explored and, finally, directions for future research will be discussed.

Summary and Integration of Findings

Trauma in childhood, especially trauma resulting from child maltreatment, is both a distressing social issue and a developmental concern for children. Trauma and one of its clinical outcomes, PTSD, have been clearly documented to hinder the psychosocial and cognitive development of children. Although much is believed to be known about the role trauma and PTSD play on brain development, and much is believed to be known about which brain structures are involved in executive functioning, there has been surprisingly little work to investigate how experiencing trauma may affect a child's ability to carry out executive functions. In 1997, Teicher, et al. theorized that the experience of trauma in a child may arrest the development of the prefrontal cortex region, preventing it from reaching full adult capacity, and that, in turn, it would be conceivable that functions associated with the prefrontal cortex would also not appropriately develop. The development of executive functions has been shown to be environmentally dependent, intimately linked with limbic functioning (Fishbein, et al., 2009), and it is known that trauma affects the limbic area and that maltreatment makes for a poor developmental environment.

Fishbein and colleagues (2009) have argued it is difficult to make assumptions about children who have experienced emotional trauma, because so much of the PTSD literature is based on adult studies. Empirical studies in recent years have given some support however, for the hypothesis that emotional trauma will affect children's executive functioning. Children who report higher levels of fear also have lower working memory span, impaired motor speed, and an increase in somatic complaints (Kushnir & Sadeah, 2010); sexually abused children's performance on tasks of attention and concentration were significantly impaired (Goodman, et al., 2009); and neglected children have lower executive function scores on NEPSY tasks (De Bellis, Hooper, Spratt, & Woolley, 2009). DePrince, Wienzierl, and Combs (2009) found that children who are exposed to familial trauma performed worse on executive functioning measures than children exposed to other types of trauma. Children who were exposed to domestic violence of any type, and subsequently developed PTSD, had slower and less effective learning strategies and an impaired effect of rehearsal on memory acquisition, and both children exposed to domestic violence with and without PTSD had below average executive functioning, attention, and intellectual ability (Samuelson, Krueger, Burnett, & Wilson, 2010).

Despite these and other findings, an omnipresent difficulty with research concerning trauma and executive functions is that studies fail to use a comprehensive sample of trauma victims, and across- the- board studies neither define nor measure executive functioning in the same terms. Calkins and Marcovitch (2010) argue that, to date, there has been no comprehensive study of how the different processes that

contribute to executive functioning are related, or become integrated, over the course of early childhood. Dalgleish, Meiser-Stedman, and Smith (2005) decry the dearth of solid empirical research in this area, and maintain that research which had been conducted supports the need for further exploration of the cognitive effects of traumatic stress on children. It is likely the most important information lacking in current research is how being exposed to trauma at an age when the PFC is still developing may impact the executive function skills that are dependent on the PFC. Although there is some suggestion that there is a disruption of functioning after traumatic stress, the studies contributing this information have used small sample sizes or narrow definitions of executive functioning.

The purpose of the current study was to expand the research base concerning the effects of trauma on pediatric executive functioning. Specifically, I sought to investigate the performance of children who have been maltreated or developed PTSD, on various psychometric measures purported to measure executive skills, thereby constructing a more holistic way to view executive functioning and trauma.

Toward a Unitary Executive Functioning Score

The first stage of this study was concerned with the concept of executive functioning, which is believed to be a set of disparate, but related, skills. Several measures were chosen as representative of executive functioning skills. These measures were chosen because they are commonly used in current literature measuring executive function (i.e., COWAT, TMT, WCST) and because, in my practical experience, they

appeared to require the engagement of executive skills (i.e. MR, AVM). The five instruments chosen were expected to load on a single factor, and therefore be appropriate to combine as an overall executive function score. The results of the factor analysis did not suggest a satisfactory one-factor solution, and the two-factor solution presented high cross-loadings, making it useless for the analysis. The only scores that clearly loaded onto a solitary factor were Trails A and Trails B of the TMT, hardly a surprise given their nature as two parts of one measure. The most surprising finding was that the COWAT did not contribute significantly to either the one- or two-factor solution, despite its acceptance as a common measure of executive functioning, although it was the only measure chosen which accessed verbal abilities rather than visuo-spatial.

It is possible that, although the skills thought to make up executive functioning are related, they are too disparate to be thought of in the cohesive manner that was proposed. It may be that, as some have argued (P. Anderson, 2008), the processes that have been conceptualized as executive functions should instead be thought of individually. In their 2009 study, DePrince and colleagues found that scales from the WISC-IV, Gordon Diagnostic System, and Brief Test of Attention measuring working memory, inhibition, auditory attention, and processing speed all loaded onto a common factor, and thus were able to be combined into a single score of executive functioning abilities. These tests may then be more representative of executive functioning. However it should be noted that the sample size for the DePrince study was smaller than that of this study (n=110), and no power analysis was reported. Due to the finding that executive functioning could not be explained by one score made of the chosen measures, each of

the remaining questions of the study required six regressions rather than one each to test the null hypothesis. This change in method likely impacted the outcome of those analyses. Each dependent variable was narrower than a composite dependent variable would have been, and tasks such as Matrix Reasoning, which is a component of full scale IQ (an independent variable), were not different enough to measure variability accurately.

Examining Emotional Trauma and Executive Functioning

The second stage of the study was concerned with the effect that traumatic stress has on the developing pediatric brain and its ability to adequately perform necessary executive functions. It was hypothesized that children who had been maltreated (the most common form of trauma among children in the United States) or who had developed PTSD would have significant impairment on executive functioning skills. Six regression equations were computed with each of the six executive function scores (for MR, AVM, WCST, Trails A, Trails B, and COWAT) used separately as dependent variables. Although each of the overall regression equations was significant, the addition of the trauma variable did not produce a significant amount of change, and thus could not disprove the null hypothesis. It is possible that, individually, the measures did not undergo detectable change due to the experience of trauma, but that the change may have been apparent had there been an overall score for executive function ability. Matrix Reasoning, in particular, was problematic in this regression as well as those conducted for the other two study questions. Though used as a dependent variable for each of the research analyses, Matrix Reasoning is also a score used to compute Full Scale IQ, a

control variable in the regression equations. This confounding of variables is troubling and likely impacted the results.

Literature indicates girls and women are more susceptible to the development of more chronic and severe forms of PTSD, and so it was hypothesized that female participants would have more executive functioning deficits than male participants in the study. When looking at the subsample (n=286) of participants who experienced trauma, gender did not contribute a significant amount of variance to the regression equation for any of the six dependent variables, and thus the null hypothesis could not be disproved. When examining the descriptive statistics, however, an interesting difference was found. Across the total sample, the trauma sample, and the group who experienced trauma but did not develop PTSD, the percentage of female participants remains relatively stable – 41.2%, 46.9%, and 40.3% respectively. However, when the group who experienced trauma and subsequently developed PTSD was examined, 63.8% of those children were female and only 36.2% were male. This seems to support findings in other research (Kimerling, Prins, Westrup, & Lee, 2003; Tolin & Foa, 2006) that female individuals are more susceptible to developing PTSD after experiencing emotional trauma.

Finally, the between group differences of the PTSD group and the non-PTSD group were examined for any significance that executive functioning abilities may have on the difference between children who suffer trauma and develop the clinical diagnosis of posttraumatic stress disorder and those who do not. After controlling for age, gender, ethnicity/race, FSIQ, and Axis II and Axis III diagnoses, the presence of PTSD did not contribute a significant amount of variance to the regression equation and therefore did

not support the hypothesis. This finding was expected after the failure to disprove the null hypothesis in research question one, which used the full sample, and is likely affected by the same difficulties noted for that analysis.

LIMITATIONS

There are limitations to this study. The use of a dataset gathered for other purposes (i.e., intake at the RTC) contributed to these limitations. Ideally, a study of this nature would have gathered more specific information about the emotional trauma experienced, including the period of time over which the trauma had taken place and the lapse in time since the trauma ceased. Although the assumption was made that the majority of participants in the study had experienced Type 2 trauma, definitive knowledge of whether a Type 1 or Type 2 event occurred would have been invaluable in defining the sample. Additionally, participants could be separated into groups based on time lapse since trauma ceased in order to get a more accurate view of the longitudinal impact trauma has on executive functioning as it is possible that at time of intake and assessment the participants had not developed symptoms associated with PTSD that they may have later developed. To this end, an excellent supplement to this analysis would be to gather information longitudinally with a repeated measures design for each participant. This would allow a researcher to determine trends in impact over time; for instance, it may be that trauma results in immediate detriment to executive functioning but becomes more stable over time, or that impairment is not noticeable until one year post-trauma.

Though not very feasible, a pre-trauma measure for the participants would have also been ideal. This would allow for a more accurate representation of the change in skills after the event. The final major limitation with the data set is the lack of a non-clinical control group. It is possible that impairments in executive functioning were not discernible in this study due to the wide-ranging impairment across the sample, despite whether or not the children had experienced trauma. By design, children who are receiving treatment at a residential treatment center have experienced significant difficulties of some nature. A non-clinical control group would allow for the exclusion of RTC residents who had not experienced trauma. Additionally, a control group would have allowed for age and gender matching, a method of data gathering which increases the strength of results.

One theory upon which this research was designed was the belief that emotional trauma has an impact on brain structures, particularly the prefrontal cortex (e.g., Ford, 2009; Kaufman, Aikins, and Krystal, 2004; Shin, Rauch, and Pitman, 2005). The nature of this study required that impaired PFC functioning be accepted as probable and focused exclusively on neuropsychological processes for analysis, a design which led to another limitation in the study. Gathering neuroimaging data for participants in the study would have been ideal, allowing for confirmation of disrupted brain development and functioning.

A final limitation to this study involves the absence of an emotional screener for participants. Currently, research indicates that people who suffer from emotional disorders such as depression and some anxiety issues have impaired executive

functioning, however it is unclear if the deficits in executive functioning are a symptom of the emotional difficulty or if they predate the disorder (Emerson, Mollet, & Harrison, 2005; Favre, et al., 2009; James, Reichelt, Carlsonn, & McAnaney, 2008; Mico, et al., 2009). In addition to being relevant to the research on PTSD and executive functioning, the presence of emotional symptoms may have impacted outcomes. If possible, it would have been ideal to gather emotional screening information for each participant and then include this in the independent control variables.

DIRECTIONS FOR FUTURE RESEARCH

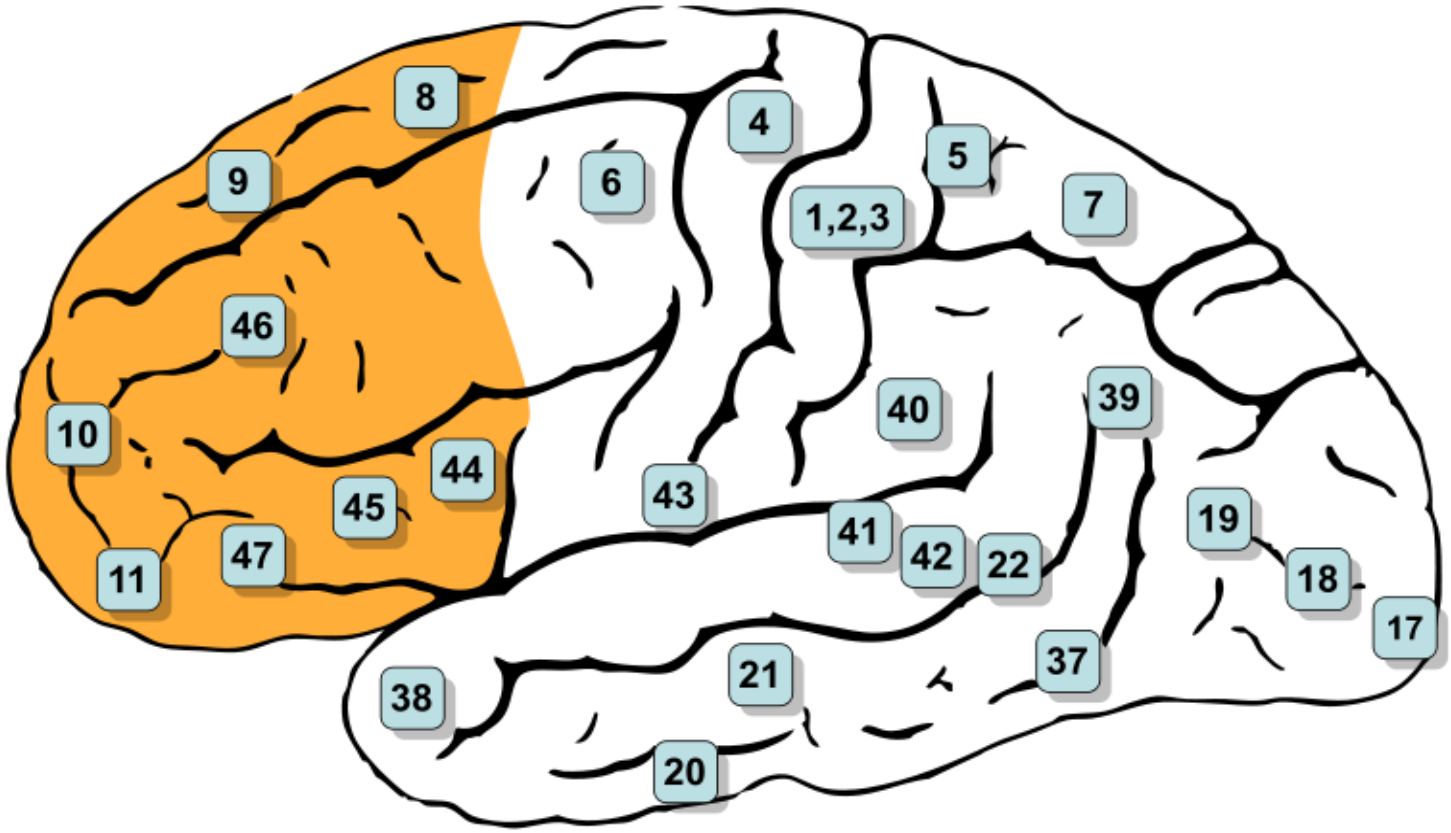
Children and adolescents in every country experience traumatic stress from natural disasters, accidents, war, poverty of care by those around them, and direct aggression from others (Hutchison, 2005). Unfortunately, the most frequent type of trauma experienced by children is maltreatment, which affects children's attachment, identity development, sense of self, and connection to the world around them. Most children will recover from traumatic stress, but others develop significant psychosocial or neurological symptoms (Ford, 2009; McFarlane, 1997; McDermott, 2004). PTSD, one of the most concerning outcomes of trauma, is associated with long-term neurological difficulties, including impaired development of the prefrontal cortex. Executive functions, a term encompassing processes which guide human behavior and personality, are believed by many researchers to be associated with the prefrontal cortex. Because of the importance of executive functioning and the other brain processes which may be affected by trauma and maltreatment it seems imperative to continue this line of research.

Future research should try to incorporate solutions to the limitations associated with the study conducted in this dissertation. Ideally, studies would gather both neuroimaging and neuropsychological data for participants. Researchers should consider a longitudinal, repeated-measures design and incorporate a non-clinical, age and gender matched control group. The ultimate goal of research in this area would be to inform first-response interventions for children and adolescents who have experienced an emotionally traumatic event. If a clear picture of how the pediatric brain responds to trauma was available, then in addition to providing treatment for PTSD or other emotional disorders, treatment teams could focus on intervening with neuropsychological processes, such as helping children increase their attentional or working memory abilities.

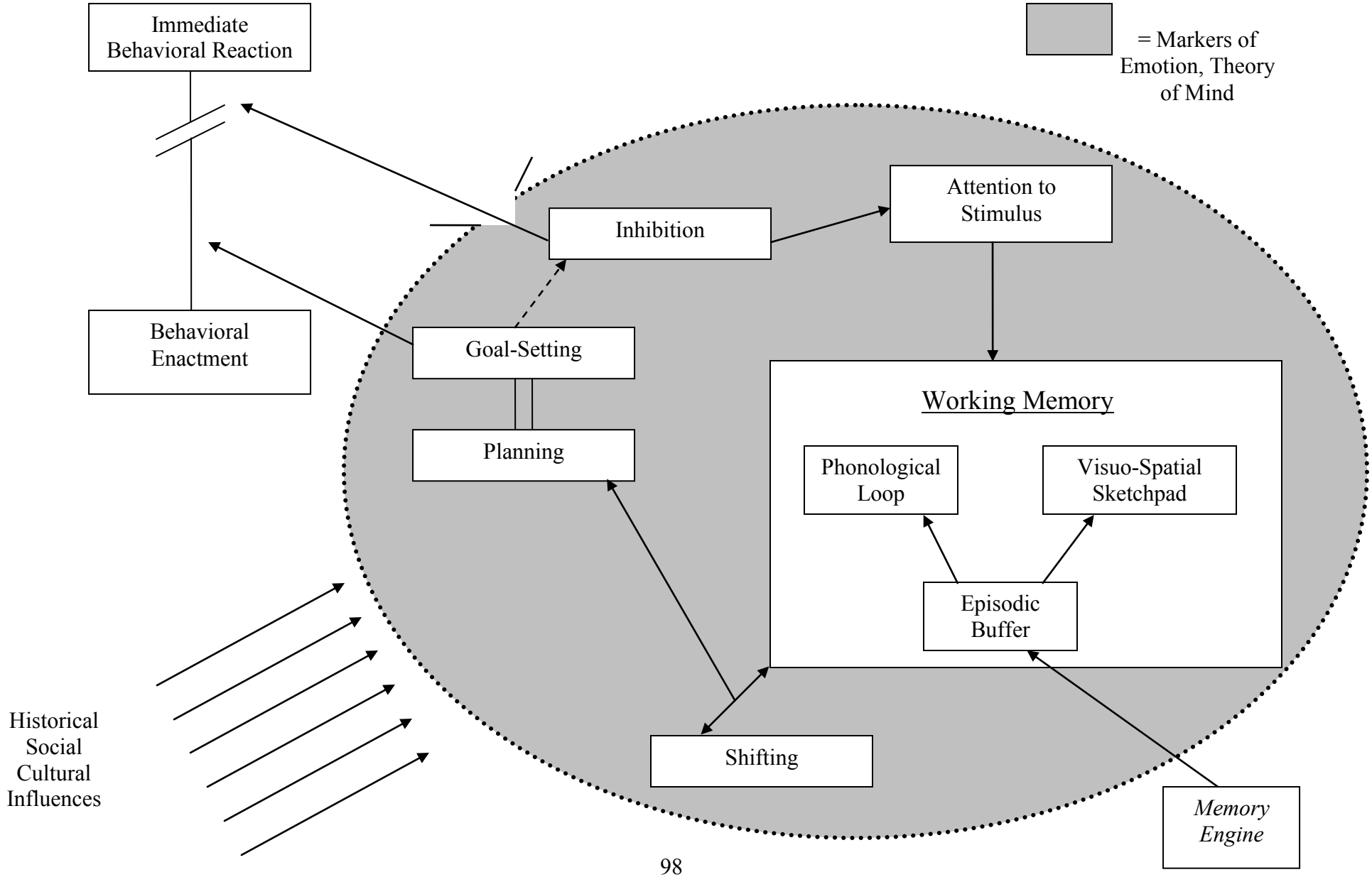
The purpose of this study was to determine whether the experience of maltreatment, or maltreatment resulting in the diagnosis of pediatric PTSD, had a significant impact on executive functioning skills. Although the null hypotheses could not be disproved, the study for this dissertation does provide an important review of the literature on executive functioning and childhood trauma, as well as information which adds to the growing body of empirical research in this area. By building on what was presented in this paper, future researchers and clinicians will be able to continue improving the services provided to child victims of trauma.

Appendix

The Creation of Adam by Michelangelo (http://commons.wikimedia.org/wiki/File:Creation_of_Adam_Michelangelo.jpg)



Lateral surface of the left cerebral hemisphere, showing Brodmann's Areas, with attention called to those of the prefrontal cortex (http://en.wikipedia.org/wiki/File:Gray726-Brodman-prefrontal.svg)


Immediate Behavioral Reaction
= Markers of Emotion, Theory of Mind
Attention to Stimulus
Inhibition
Behavioral Enactment
Goal-Setting
Working Memory
Planning
Phonological Loop
Visuo-Spatial Sketchpad
Episodic Buffer
Historical Social Cultural Influences
Shifting
Memory Engine

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