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Differential Executive Functioning, Impulsivity, And Motivation In Adulthood As A Function Of Experienced Child Abuse

Christopher Anton Mark

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DIFFERENTIAL EXECUTIVE FUNCTIONING, IMPULSIVITY, AND
MOTIVATION IN ADULTHOOD AS A FUNCTION OF EXPERIENCED CHILD
ABUSE

by

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Submitted to the Graduate Faculty

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This thesis, submitted by Christopher Anton Mark in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

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Date

PERMISSION

Title: Differential Executive Functioning, Impulsivity, and Motivation in Adulthood as a Function of Experienced Child Abuse

Department: Experimental Psychology

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Christopher Anton Mark
04/23/2017

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To my mother, Patricia

I couldn't have accomplished this without you

ABSTRACT

Introduction: While child abuse can only occur before the ages 18, there are long term neurological repercussions that can cause severe detriment to the abused individual. More specifically, normative neurological development during childhood is impeded upon, thus resulting in cognitive and emotional abnormalities in adulthood. Methods: The present study recruited 43 students from the University of North Dakota (Females = 23) with an age range of 18-23 years of age ($M = 19.6$ years, $SD = 1.545$). The participants were administered several prescreening measures, including a measure of physical child abuse, emotional child abuse, and sexual child abuse. Based on responses to these measures, participants were assigned to either a no child abuse group, a mild child abuse group, or a moderate-to-severe child abuse group. Next, three measures of executive functioning skill were administered while electroencephalographic data was collected. Results: There was a statistically significant main effect of child abuse group ($F = 3.712$, $p = .034$) for the probability of cognitive workload. Drug abuse, which served as a covariate, was also found to be significantly attenuated ($F = 6.33$, $p = .016$) during measures of attention. Conclusion: Individuals that have been abused as children must use significantly more mental effort to complete tasks as compared to their non-abused counterparts. Increased neurological effort could be used to explain poor decision making skills that is common within the population. Further analysis must be conducted on behavior data that collected for the present study. Likewise, new research should explore the relationship between drug use and abuse and neurological deficits in this population.

INTRODUCTION

Child Abuse and Impulsivity

Individuals who experience trauma and maltreatment in childhood often experience acute and/or chronic, negative psychological and physiological effects later in life. Studies have shown that experiencing even moderate levels of trauma can leave an individual without the necessary skills to properly deal with stress, which, in turn, can lead to a predisposition for depression and a host of other mental illnesses (Suzuki et. al., 2014). Although research in adults shows that childhood trauma predicts deficits in emotional regulation that can persist for decades, it is unknown whether neurological and behavioral changes can make one more vulnerable to disease. (Marusak et. al., 2015). A meta-analysis conducted by Nanni et. al. (2012) demonstrated that individuals who experience abuse in childhood are far less likely to respond to conventional treatment protocols. Furthermore, Marusak et. al. (2015) found that conflict regulation for emotions and emotional experiences, both positive and negative, are an underlying factor for an increased risk of psychopathology in adulthood. An inadequate ability to regulate one's emotions and behaviors, both interpersonally and intrapersonally, can lead to further traumatic experiences during childhood and adolescence which will only exacerbate the problem.

Emotional dysregulation often manifests as impulsivity in individuals who have experienced traumatic events (Velotti & Garofalo, 2015). Reacting impulsively, which can also be considered a lack of response inhibition, to emotionally intense situations is a

behavioral model that is found to be more common among individuals who are diagnosed with a mental illness (Del Carlo et. al., 2012; Wang et. al., 2015). Components of impulsivity include attentional deficits, suppression of responses, poor evaluation of consequences, and/or an inability to forgo immediate small rewards in favor of greater delayed rewards. Braquehais et. al. (2010) found that impulsivity is more prevalent in individuals who experienced early, prolonged, and intense childhood abuse (CA). Along with this finding, the researchers also found that impulsivity is a risk factor for the development of a pathological response to trauma. Thus, they suggest impulsivity could be one of the links between childhood trauma and suicidal behavior. Impulsive decision-making can be a very serious issue for many individuals including children and adolescents, and risky decisions have the potential to carry serious consequences. Therefore, understanding how impulsivity develops due to traumatic experiences and why individuals who have experienced CA are prone to impulsive behaviors is imperative in the development of effective treatment protocols. Ceschi et. al. (2014) found that impulsivity has a differential impact on emotional regulation and depressive mood depending on lifetime exposure to environmental factors, especially traumatic events. The presence of CA throughout childhood and adolescence may predict how impulsively an individual may react to emotionally intense situations.

Impulsivity is also often associated with attention deficit hyperactivity disorder (ADHD). This disorder is very common among children, with approximately five percent of U.S. children being diagnosed in 2010 according to the American Psychological Association (APA). Given that this disorder and the traits associated with it are relatively common, understanding factors contributing to the development of impulsivity may also

help in the treatment and prevention of ADHD. Studies, however, also suggest significantly higher levels of emotional impulsivity in children with ADHD compared to normal controls (Factor, Reyes, & Rosen, 2014). Factor, Reyes, and Rosen (2014) also found that children who are highly emotionally impulsive and diagnosed with ADHD are at a higher risk for developing comorbid disorders. Given that the population of individuals who experience CA are more likely to develop a host a mental disorders, it is far more likely that prevalence of ADHD will be significantly higher in this population as compared to their non-ADHD cohorts. Indeed, Retz-Junginger, Arweiler, and Retz (2015) demonstrated that ADHD subjects showed significantly higher rates in emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect according to Childhood Trauma Questionnaire (CTQ), a standard tool used to measure childhood abuse and neglect, subscales as compared to controls. Moreover, the authors also found that ADHD subjects who reported sexual abuse described significantly more anxious and depressive symptoms in childhood than non-abused ADHD subjects. Some of the measures of impulsivity used in ADHD research both with children and adults include measures of sustained attention, such as the Connor's Continuous Performance Task (Connor's CPT). The Connor's CPT has been found to be both highly valid and reliable, and serves as an effective tool for assessing attention and response inhibition in a naturalistic setting (Bart, Raz, & Dan, 2014).

Quantifying and qualifying instances and the intensity of trauma experienced during childhood is often accomplished by utilizing the CTQ. This measure has shown to be both valid and reliable when utilized with various populations, such as psychiatric patients, inmates, and adults (Dudeck et. al., 2015; Spinhoven et. al, 2014). Given that

adults attending mental health clinics are more likely to have experienced childhood trauma, and have a high likelihood of non-documentation of childhood trauma by mental health professionals, the use of a standardized questionnaire of childhood trauma assessment is recommended when working with this population (Rossiter et. al., 2015). A secondary measure of CA, the Violent Experienced Questionnaire-Revised (VEQ-R), will be included in the present study. The VEQ-R can indicate elevations in low base-rate aggressive acts among college students who were exposed to extreme forms of maltreatment prior to adulthood. Identifying aggressive tendencies can serve as further evidence of increased impulsivity in the CA population. Unlike the CTQ, the VEQ-R allows researchers to analyze abuse in terms of specific type (e.g., physical violence, verbal insults, bullying, etc.), and where this abuse was coming from (e.g., parents, siblings, peers, etc.). A study using the VEQ-R found a high correlation between the CTQ and the VEQ-RTOTAL scores ($r = .60$), thus demonstrating a large, positive correlation between the two measures (King & Russell, 2015). This study consisted of both a college ($N = 1,266$) and a national ($N = 1,290$) sample, and aimed to observe the psychometric properties of the VEQ-R. The VEQ-R appears to provide an additional option for childhood maltreatment researchers interested in analyzing co-occurring physical, sibling, peer, and/or domestic abuse (King & Russell, 2015). Including this measure in the current study will allow CA to be examined in a more complete scope.

The CTQ serves as the standard for quantifying abuse experienced in childhood, but due to budgetary issues, it cannot be used in the current study. Instead, the current study will utilize three separate measures, each of which will identify either physical abuse, psychological abuse, or sexual abuse. The Lifetime Report of

Physical/Psychological/Sexual Abuse (LPAA, PALA, and SALA, respectively) were developed by the Longitudinal Studies of Child Abuse and Neglect (LONGSCAN) consortium. Apart from identifying specific types of abuse, these measures also look to identify the perpetrator of the abuse, the age ranges at which the abuse occurs, the severity of the abuse (LPAA only), feelings of personal responsibility for the abuse, and the degree of impact of the abuse on the individual's life. Dubowitz et al., (2011) found that the pattern of correlations between the factor scores (i.e., physical needs, emotional support, and parental monitoring) of the three LONGSCAN measures, CPS reports, and measures of the parent-child relationship offered modest to moderate support for convergent validity of the three aforementioned scales.

Childhood Abuse and Motivation

Motivation is another factor that is closely related to impulsivity. This function of behavior drives an individual to both seek rewards and avoid punishment. Two behavioral systems are generally accepted to control motivation; that is the behavioral inhibition system (BIS) and the behavioral activation system (BAS). The BIS is responsible for sensitivity to punishment as well as avoidance motivation, while the BAS is responsible for sensitivity to reward as well as reward motivation (Gray, 1981). Individual differences in these systems can account for differences in personality. For example, an individual who is sensitive to punishment, thus having a more active BIS, is more likely to experience anxiety and depression (Braem, Duthoo, & Notebaert, 2013). Inversely, individuals with a sensitive BAS are more likely to engage in goal-directed efforts and experience these positive emotions when exposed to impending reward.

CA plays a large role in the development of normative motivation skills. Given that motivation is largely behavioral, it is shaped by the relationships one has in youth;

namely parental relationships. Vondra, Barnett, & Cicchetti (1990) found that children from maltreating families scored lower than their peers on ratings of motivation. The authors also suggest that relationship factors implicated in maltreatment may be more important in shaping motivation than previously thought, as socioeconomic status and quality of home environment were controlled for in this study. Thus, the relationship one has with family members, most specifically the primary caregiver(s), can shape reward/punishment motivation and behavioral contingencies.

Physiology also influences the development of the BIS/BAS. It was found that children with ADHD have higher connectivity in the orbitofrontal cortex, an area associated with reward motivation, and lower connectivity in the superior parietal cortex, a region involved in normative attention processing (Tomasi & Volkow, 2012). Knowing the physiological factors that influence motivation is important when trying to understand the way in which trauma can influence the neural structures that account for this behavior.

Carver and White (1994) developed the Behavioral Inhibition Scale and the Behavioral Activation Scale, which are also referred to as the BIS/BAS, as a standard measure of sensitivity of the two primary motivational systems. The BAS/BIS primary functions is to serve as a behavioral measure that looks at the drive an individual possesses. In doing this, the tool also has the potential to identify various personality traits, namely neuroticism/negative affect (BIS) and extraversion/positive affect (BAS). In a psychometric analysis, Yu et. al. (2011) demonstrated the convergent validity of BIS and BAS, indicated by positive correlations with internalizing problem behaviors or externalizing problem behaviors, respectively. For the purposes of the present study, this

measure will serve to indicate which behavioral system is most active during performance of executive functioning tasks, as well as determine if a difference exists between groups.

Comorbid Substance Use and Abuse

A fair amount of research has also focused on the association of CA with drug use and abuse. Adults with substance use disorders (SUDs) report higher rates of child abuse than adults without SUDs (Banducci et. al., 2014). The same study also found that individuals with substance use disorders who have been abused have particularly elevated rates of psychiatric and substance use disorders as a function of their abuse experiences. While the use of drugs and alcohol could function as a coping mechanism to deal with trauma, the fact that this population has an overall higher level of impulsivity increases the odds of drug use later in life (Sergentanis et. al., 2014).

Poor executive functioning skills may actually increase an individual's chance of initiating drug use. Pentz and Riggs (2013) demonstrated that effective executive functioning skills were the major predictor of lower substance use during adolescence. Physical activity and exercising with parents in childhood showed reciprocal positive relationships. This study also illustrates the importance of the parent-child relationship in neurological development, the development of effective and efficient cognitive skills, and a healthy life style. However, forming this kind of relationship is not likely to happen if a child is being abused and/or neglected.

The relationship between drug use, CA, and later life outcomes is well documented, but not fully understood. Early initiation of specific risk behaviors may have more wide-ranging negative consequences than are typically considered during

intervention or treatment, and strategies may need to target multiple domains of functioning (Horan & Widom, 2015). Given that drug use has the potential to alter normative cognitive functioning independently of CA, the present study will control for presence of frequent and heavy drug use and abuse.

Executive Functioning and Child Abuse

While many studies have been conducted that look at emotional regulation in terms of patterns of behavior and future mental health issues, comparatively fewer studies have focused on the neurological deficits that CA can produce when it is experienced during critical periods of development. Frontal lobe dysfunction has been linked to excessive impulsive and risky behaviors, and poor decision-making in drug users (Crews & Boettiger, 2009). The frontal lobes are responsible for abstract thinking, rule acquisition, planning and flexibility in responses including rule shifting, as well as initiating appropriate actions and inhibiting inappropriate actions. Research has shown that experiencing traumatic events as a child can lead to a host of deficits in executive functioning. For example, Naudé, du Preez, and Pretorius (2004) found a reduction in global executive functioning, which included memory and verbal processing abilities, in a population of individuals who were placed in a “Place of Safety” due to CA. Additionally, they found that abused subjects presented with symptoms such as depressed explicit-declarative memory (especially semantic memory), as well as poor error detection and restoration, despite advanced levels of social knowledge (episodic memory) (Naudé, du Preez, & Pretorius, 2004). Understanding the way that CA and other traumatic life events precipitate dysfunction in the frontal lobes in adulthood is imperative to developing effective treatment protocols for this population.

Developing effective, healthy, and appropriate decision making skills is a process that occurs over the course of one's life. However, frontal lobe development is at a critical period during adolescence. Thus, the development of these skills is accelerated during this period in one's life. Barrus et. al. (2015) found that, in rats, motor impulsivity was positively correlated with poor decision-making under risk. Furthermore, highly motor impulsive rats were slower to adopt an advantageous choice strategy and quicker to make a choice on individual trials. While impulsivity and decision-making abilities can be related, they are measured in different manners. The Adult Decision Making Competence Index (ADMC-I) is a self-report measure that has demonstrated both validity and reliability, and appears to be a distinct construct relevant to adults' real-world decisions (Bruine de Bruin, Parker, & Fischhoff, 2007). The ADCM-I will be utilized in this study to measure participants' ability to make normative, real world decisions.

Various psychiatric conditions are often associated with not only behavioral and emotional deficits, but also with neurological deficits. Early life stress (not necessarily linked to CA) has shown to be associated with structural anomalies in the corpus callosum in children and the hippocampus in adults (McCroy, DeBrito, & Viding, 2010). Moreover, the authors of the aforementioned study also reported that extreme stressors in early life could lead to atypical activation of several brain regions, including decreased activity in the prefrontal cortex. This lends further credence to the claim that early life stress, which very often is in the form of CA and neglect (with 619,000 unique cases in 2014 according to the National Children's Alliance), can cause deficits in neurological

function, brain development, and increase the likelihood of being diagnosed with at least one mental illness.

Children who experience CA have been found to function differently in the cognitive areas of working memory and intelligence. Pandey (2011) found working memory and intelligence levels to be inferior in abused children as compared to their non-abused counterparts. Another study found that, of children admitted to psychiatric hospitals, 54 percent of abused children presented with brain-wave abnormalities compared to only 27 percent of non-abused children (Ito et. al., 1993). The authors also found that the location of abnormalities depended on the type of abuse that was sustained (physical and/or sexual vs. only psychological abuse). Additionally, Mothes et. al. (2015) found that the number of instances of CA significantly impacted executive functioning during adolescence. From these studies, it becomes clear that both the type of abuse and number of instances of abuse influence the severity of dysfunction and the specific variety of deficits in the frontal lobe.

A large variety of tests and measures exist that look at an individual's functioning across multiple domains of executive functioning. This study will specifically look at reasoning abilities, memory span, and attention span. To accomplish this, the Wisconsin Card Sorting Task (WCST), the Operation Span Task (OSPAN), and the Connor's Continuous Performance Task (Connor's CPT) will be utilized. A meta-analysis of studies using WCST found that effect sizes indicated significantly poorer performance for participants with frontal damage as compared to those with posterior brain damage (Demakis, 2003), making the WCST a sensitive instrument of frontal lobe function. Heitz, Schrock, and Engle (2005) found that an automated version of the OSPAN

correlates well with others measures of working memory capacity, and demonstrates high internal consistency and test-retest reliability. Performance on the Connor's CPT was found to differ significantly between children with and without ADHD (Bart, Raz, & Dan, 2014). Finally, Rueckert and Grafman (1996) showed that individuals who have frontal lobe legions have slower reaction times when completing the Connor's CPT as compared to a control. This indicates that these individuals have deficits in sustained attention skills. Individuals who have a legion on the right frontal lobe performed worse on this task as compared to those with a legion on the left frontal lobe (Rueckert & Grafman, 1996).

Individuals who experienced CA regularly score significantly lower on the WCST as compared to the normal population, indicating less cognitive flexibility (Spann et. al., 2012; Pema & Kiefner, 2013). Similar results were found with individuals who were subjected to CA when they took the Connor's CPT. That is, this population exhibited decrease modulation and response times as compared to the normative sample (Miller et. al., 2015). While the OSPAN is not commonly used to test working memory in the CA population, individuals with a history of CA have been reported to show poorer outcomes on tests of working memory and information processing speed compared to normal controls (Lysaker et. al., 2001). The OSPAN will be used in this study because of its ease of administration and availability in a computer-based format.

Physiological Imaging and Monitoring

The majority of studies looking at physiological functioning of the brain during performance of cognitive tests in individuals with frontal lobe damage have utilized both self-report and clinically administered assessments. This allows researcher to indirectly

measure executive functioning skills in a cost effective manner. Many studies that include an imaging component have relied on technologies such as Magnetic Resonance Imaging (MRI). These studies have shown that atrophy in various lobes of the brain can predict poorer performance on standard neuropsychological measures, such as the Stroop Task and the Delis-Kaplan Executive Functioning System Sorting Task (D-KEFS) (Heflin et. al., 2011; Fine et. al., 2009).

However, further insight can be gained from utilizing an electrical and temporal measure of neurological functioning in individuals with a history of CA and trauma, such as electroencephalography (EEG). Past studies have shown that asymmetry of frontal cortical EEG activity in children is influenced by their social environment and considered a marker of vulnerability to emotional and behavioral problems (Peltola et. al., 2014). Cook et. al. (2009) demonstrated that those with childhood trauma had significantly higher EEG coherence in the frontal, central, temporal, and parietal areas as compared to those with either only adulthood trauma or no past trauma. These long-term neural correlates of childhood appear to suggest information processing differences, as well as demonstrating the lasting impact CA has on neuronal connectivity (Cook et. al., 2009).

A study conducted by Miskovic et. al. (2010) found that maltreated youths exhibited more left hemisphere EEG coherence than the control youths, suggesting a suboptimal organization of cortical networks, as well as reduced frontal (anterior) interhemispheric coherence. The researchers found this by analyzing resting regional EEG intra- and interhemispheric α -band (7.5–12.5 Hz) coherence. However, alpha waves are not the only bandwidth that can serve as a marker for behavioral and

emotional problems as a function of past CA. Black (2004) found that theta waves play a role in the brain functioning of individuals who have experienced childhood sexual abuse. Prior to this research, the alpha bandwidth was the primary focus of research and treatment. Loo et. al. (2009) explored the difference in electrical activity of the frontal lobe in individuals with ADHD. This research found both a decrease in alpha power and an increase in beta power in ADHD adults compared to the controls. These patterns of frontal and parietal activation indicated increased cortical arousal during completion of the attention task in the ADHD group.

Abnormal beta bandwidths may serve as way to identify an individual at risk for alcoholism. Rangaswamay et. al. (2004) found that males with a high risk for alcoholism had higher low beta power (measured as 12.5Hz -16 Hz) and high-risk females had increased mid and high beta power (midrange beta power was measured from 16-20Hz, while high range beta power was measured from 21-28Hz) compared to low risk participants. Based on these studies the present investigation will look at the relationship between EEG power within traditional frequency bins (alpha, theta, and beta), self-reported drug and alcohol habits, increased impulsivity, and poor decision-making skills associated with the history of CA.

Present Study

The purpose of this study is to gain insight into the developmental impact of CA and the way in which it affects neural activity and executive functioning skills. It is hypothesized that individuals who have experienced either moderate or severe childhood trauma as classified by the CTQ will have a lower level of executive functioning as measured by WCST, the Connor's CPT, and the OSPAN, when compared to those who

experienced no or low levels of childhood trauma (H₁). Secondly, individuals who have experienced either moderate or severe childhood trauma as classified by the CTQ will score outside the normative ranges on the ADMC-I on at least three of the seven subgroups as compared to those who have experienced no or low levels of childhood trauma as classified by the CTQ (H₂). Next it is hypothesized that individuals who have experienced either a moderate or severe childhood trauma will exhibit a higher beta, and/or theta power, as well as lower alpha power in the frontal regions of the brain (H₃) suggesting greater cortical activation and desynchronization. Next, it is hypothesized that individuals who have experienced either moderate or severe childhood trauma will exhibit elevated scores in multiple subcategories of the VEQ-R as compared to individuals who have experienced no or low amounts of childhood trauma as classified by the CTQ (H₄). Finally, it is hypothesized that individuals who have experienced either a moderate or severe amount of childhood trauma as classified by the CTQ will exhibit greater impulsive tendencies and deficits in response inhibition, thus having a more active behavioral activation system (H₅). This will also be reflected in their scores on the Connor's CPT and the BIS/BAS Scale.

METHODS

Participants

A total of 64 students from the University of North Dakota will be recruited for the study using the SONA system, with an approximate age range of 18-23 years. As part of the research requirement introduced in conjunction with some of the participants' undergraduate psychology classes, the students will complete a packet of online instruments that will include a demographic questionnaire, the Lifetime Report of

Physical Abuse (LPAA), the Lifetime Report of Psychological Abuse (PALA), and the Lifetime Report of Sexual Abuse (SALA), among other instruments. On the basis of their scores, individuals will be assigned into two groups ($n = 32$), those who have experienced either low levels of abuse or no abuse and those who have experienced moderate to severe childhood abuse. Inclusion into these groups will be based on the total score of stem questions positively endorsed on the LPAA, the PALA, and the SALA, with a maximum possible score of 36. Individuals with a total score of 4 or fewer will be assigned to the no-to-low abuse range, unless a positive endorsement is given to any item on the SALA. If this happens, an individual will automatically be assigned to the moderate-to-severe child abuse group. Individuals with a total score of 5 or greater will be assigned to the moderate-to-severe child abuse group. These cutoff scores are based on conservative estimates based off of sample frequencies of each stem item being positively endorsed (LONGSCAN, 2000). There are no exclusion criteria for the current study. Written informed consent will be obtained from each participant prior to testing.

Instruments

Childhood Abuse Questionnaire

The Lifetime Report of Physical Abuse (LPAA), the Lifetime Report of Psychological Abuse (PALA), and the Lifetime Report of Sexual Abuse (SALA) are childhood abuse scales designed to assesses a young adult's self-reported history of lifetime abuse (respectively for each scale) and harsh parenting. The LPAA and the PALA consist of twelve behavioral stem items that ask if the adolescent has ever experienced a specific parent or caregiver was physically/psychologically abusive or displayed harsh behaviors. Positive endorsements trigger follow-up items assessing the

frequency of occurrence, perpetrator, and injury outcomes (but only for the LPAA). For the SALA, eleven stem items ask about specific sexually abusive caregiver behaviors; four of these items have gender-specific wording for boys or girls. After a participant has completed all appropriate stem items, follow-up items assess the frequency of occurrence and perpetrator(s). For the purposes of the current study, only scores of the stem questions for each of the three scales were used to designate an individual into one of the three child abuse groups (i.e., no abuse, mild abuse, and moderate-to-high abuse), with a possible maximum score of 36. Individuals with a score of 0 will be assigned to the no child abuse group. Individuals with a score of 1-3 will be assigned to the mild child abuse group. Finally, individuals with a score of 4 or greater will be assigned to the moderate-to-high child abuse group. Research has found that the self-reporting of child abuse often leads to a more accurate determination of the type and severity of abused that has been experienced, as opposed to determinations made by protective organizations such as Child Protective Services (CPS) (Barnett, Manly, Cicchetti, 1993; Everson et al., 2008).

Childhood Experiences Survey

Abuse experienced in childhood will also be assessed using the Violent Experiences Questionnaire-Revised (VEQ-R) (King, 2012). The VEQ-R is a brief reflective self-report instrument which provides 12 estimates of the yearly occurrence, defined by number of days within a given year, with which parent-child physical abuse (CPA), sibling physical abuse (SPA), observed parental abuse (OPA), peer bullying (BULL), corporal punishment (CORP), parent-child verbal discord (PVD), sibling verbal discord (SVD), observed parental discord (OVD), parent-child physical threats (PPT), sibling physical threats (SPT), observed parental threats (OPT), and peer teasing (TEAS)

occurred from ages 5 to 16. This scale was designed to identify adults who are more likely to exhibit hostility and aggression towards others and themselves due negative childhood experiences. The VEQ-R has proven to be both reliable and valid through test-retest procedures for both the college and national populations. The VEQ-R is being used in conjunction with the CTQ because it taps into the frequency and severity of the type of abuse that has occurred in childhood. The VEQ-R can provide more detail on those who indicate that they experienced abuse.

Decision-Making Survey

The Adult Decision Making Competence Index (ADMC-I) is a brief self-report instrument that presents seven assorted task groups designed to measure one's ability to make decisions under a variety of conditions. The seven groups are resistance to framing, recognition of social norms, under/overconfidence, applying decision rules, consistency in risk perception, resistance to sunk costs, and path independence. Together, these seven task groups consist of eighty-seven questions. These tasks represent the theoretical normative characterization of decision-making. Bruine de Bruin, Parker, and Fischhoff (2007) showed that the ADMC-I exhibits internal consistency and test-retest reliability across all components. The component groups are scored individually. Thus, an individual can demonstrate different decision-making competencies across different components. For example, an individual can demonstrate that s/he displays either under or over confidence in s/he decision-making abilities, but has a more difficult time recognizing social norms. For the purposes of the current study, only the "Applying Decision Rules" subtest will be used, as this test specifically measures integration, which

judges the quality of a decision by its process rather than by its outcome (Bruine de Bruin, Parker, & Fischhoff, 2007).

Behavioral Measure

It is generally accepted that two motivational systems underlie behavior. The behavioral approach system is (BAS) assumed to regulate behavior that moves an individual towards a goal or desire. The behavioral inhibition system (BIS) is said to regulate aversive motives, which are those that move a person away from something undesirable. The Behavioral Inhibition and Activation Scale (BIS/BAS) was designed to assess the dispositional sensitivity between these two systems. The BIS/BAS consists of twenty-four Likert scale questions, which are designed to delineate between both over and under active BIS and BAS. Individuals who exhibit an overactive BAS tend to demonstrate impulsive tendencies and deficits in response inhibition. Upon the analysis of data from a convergent and divergent validity analysis, Carver and White (1994) found that the BIS/BAS scale is related to, but also distinguishable from, alternative measures of these behavioral constructs, such as the Minnesota Multiphasic Personality Inventory (MMPI) Hypomania scale and the Socialization scale from the California Psychological Inventory (CPI).

Drug Use Questionnaire

Childhood physical abuse severity is associated with an earlier initiation into drug use. Any level of abuse is associated with more extensive life-time and recent polydrug use (Darke & Torok, 2014). The Texas Christian University Drug Screen V (TCUDS-V), which is an updated version of the TCUDS-II, screens for mild to severe substance use disorder. This self-administered questionnaire serves to quickly identify

individuals with a history of moderate to heavy drug use or dependency. This scale asks questions about specific drugs used by the individual, as well as the ways in which drug use has affected the individual's personal and professional life in the past twelve months. Psychometric criteria for this instrument have been established, particularly focusing on its internal consistency (Knight, 2002). The sensitivity of the TCUDS-V makes it particularly useful in minimizing inappropriate treatment referrals for drug users (Knight, Simpson, & Hiller, 2002). For the purposes of this study, a drug use score will serve as a covariate during statistical analyses.

Physiological Measurements

Advanced Brain Monitoring's (ABM) B-Alert Software coupled with the X-10, 9-channel EEG system allow for the acquisition, presentation, and storage of physiological signals, namely various bandwidths of brainwaves, from participants. These bandwidths are organized into Alpha (8-12Hz), Beta (13-29Hz), Theta (1-7Hz), and Sigma (30-40Hz) and are displayed as EEG power spectral densities (PSDs), which are computed by performing a Fast Fourier Transform (FFT) on a segment of data and calculating the sinusoidal components for the designated bandwidths (B-alert x10: User manual, 2010). This system ensures that EEG recordings are within recommended impedance tolerances. Impedance values that are $<40k\Omega$ are optimal. However, values between $40k\Omega$ and $80k\Omega$ are acceptable. Three baseline cognitive assessment tasks are provided and completed by each individual. This serves to acquire raw data, perform decontamination, and to provide ABM's cognitive state and workload metrics. In the first task, titled 3-choice psychomotor vigilance task (3-CVT), the participant's cognitive load is measured. Participants are instructed to use the left and right arrow keys on a laptop to respond yes

or no, respectively, to various symbols presented on the screen. A “yes” response should be made when an upward facing triangle is presented. A “no” response should be made when either a diamond or a downward facing triangle is presented. For the second task, titled eyes open (EO), distractibility is measured. The participant is instructed to press the space bar every two seconds with his/her eyes open. A red circle appears on the screen every two seconds to help the participant keep time. The final task, titled eyes closed (EC), requires the participant to press the space bar every two-second with his/her eyes closed. A short tone is played to help the participant keep time. A unique classification file is then generated for each participant. Once the raw, traditional signals are filtered and decontaminated, they are transformed into PSD’s for the above frequency bins (B-alert x10: User manual, 2010).

During data acquisition, metrics of cognitive load, engagement, and distractibility will be compared to the baseline report based on the three neuropsychological tasks, which will be outputted in a separate file in terms of probabilities for high engagement, low engagement, distraction, and onset of sleep. Various studies have demonstrated validity of these EEG-based algorithms. For example, Johnson et. al. (2011) found that the B-Alert X-10 EEG-derived algorithms were able to effectively predict performance changes associated with sleep deprivation, and, conversely, alertness. Stikic et. al. (2011) investigated the capability of EEG to assess the impact of fatigue on both present and future cognitive performance during the 3-choice cognitive vigilance task (3CVT). The study demonstrated the ability of EEG-derived probabilities of high fatigue to estimate not only present, but also future cognitive performance, utilizing a single, combined reaction time (RT), and accuracy performance metric. The correlations between observed

and estimated performance, for both present and future performance, were strong, with reported measures up to $r = 0.89$ and $r = 0.79$, respectively (Stikic et. al., 2011).

Reasoning Task

The Wisconsin Card Sorting Task (WCST) is a classic measure of one's executive functioning. Namely, it is used as a measure of the selectivity feature of attention, and can reflect a variety of cognitive impairments. A computerized version will be employed in this study. This task will consist of four stimulus cards and 128 response cards. The test proceeds through a number of shifts in a set (sorting principles) that varies along three dimensions (color, form, and number). Successful performance on the WCST requires the participant first to determine the correct sorting principle on the basis of computer feedback, and then to maintain this sorting principle or set. The WCST dependent measures will include: number of trials administered, trials to complete the first category (the number of trials to make 10 consecutive correct responses), total number of categories achieved, total number/percentage correct, failure to maintain set (interruption of the correct sorting strategy after five consecutive correct responses has been made), perseverative errors/responses (responses that would have been correct under the previous sorting rule) and their corresponding percentages, total number of errors, total number of correct trials, conceptual level responses (consecutive correct responses occurring in runs of three or more), and the mean overall difference in the percentage of errors calculated for each completed category. The present study will utilize the Modified Card Sorting Task (MCST), which is a simpler, less ambiguous version of the WCST that participants can generally complete more easily. (Nelson,

1976). Nelson (1976) devised this modification, and found that it possesses similar validity and reliability to the traditional WCST, while be more intuitive for participants.

Attentional Task

The Connor's Continuous Performance Task (Connor's CPT) is a psychological measure of sustained/selective attention and impulsivity. During this 16-minute task, of which the first two minutes are training, participants are shown a series of letters in the center of a computer screen that appear briefly and are presented at variable intervals. Participants are instructed to click the right mouse button for every letter they see except for the letter "X". When an "X" is shown, they are not to respond in any way. There are eleven dependent measures that fall into three broader categories. These categories are: inattention, impulsivity, and vigilance. Inattention includes number of omissions, number of commissions, hit reaction time (HRT), HRT standard error, variability, detectability, HRT inter-stimulus interval (ISI) change, and hit standard error ISI change. Impulsivity includes number of commissions, HRT, and preservations. Vigilance includes, HRT block change and Hit stand error block change. The Connor's CPT exhibits both validity and split-half reliability, as it has satisfactory accuracy in terms of both false negatives and false positives (Connor & Lyon, 2015).

Memory Span Task

Working memory is an essential aspect of executive functioning where in information is stored, manipulated, and processed. Developed by Turner and Engle (1989), the Operation Span Task (OSPAN) can assess an individual's general working memory capacity. In this task, participants will read and verify a simple math problem (e.g., "Is $(4/2)-1=1$?"), and then read a word after the operation (e.g., SNOW). After a

series of operation-word pairs have been presented, participants will be asked to recall the words that followed each operation. The number of operation-word strings in a sequence will be increased and decreased during the course of the task to measure the participant's operation span. Operation span measures predict verbal abilities and reading comprehension even though the subjects are solving mathematical problems. For the purposes of this experiment, an automated, computerized version of OSPAN will be administered. This version of OSPAN correlates well with other measures of WM capacity and has both good internal consistency and test-retest reliability (Unsworth, Heitz, Schrock, & Engle, 2005).

Procedure

Participants will first complete an initial prescreening procedure on the SONA system. The prescreen will consist of eight questionnaires: The Young Adult Report of Psychological Abuse, The Young Adult Report of Sexual Abuse, The Young Adult Report of Physical Abuse, the Violent Experiences Questionnaire – Revised, the “Applying Decisions Rules” subscale of the Adult Decision Making Competence Questionnaire, the Texas University Drug Screen V, the Behavioral Inhibition and Activation Scale, and a demographic questionnaire. Informed consent will be obtained in the form of an electronic signature from each participant prior to the completion of any measures. Participants will be assigned to one of the three child abuse groups based on responses to the three child abuse questionnaires. Next, participants will be invited to participate in the in-lab portion of the study. Written informed consent will be obtained from each participant prior to any testing. EEG data will be collected during all experimental tasks using the B-Alert X-10 wireless wet electrode system with 9 channels

corresponding to scalp locations according to the International 10-20 system (frontal channels: F3, Fz, F4; central channels: C3, Cz, C4; parietal and occipital channels: P3, POz P4). The researcher will properly apply the EEG electrode strip to the participant and run an impedance check, ensuring that the impedances are all within an acceptable range. Participants will then complete three baseline tasks that will measure cognitive load, distractibility, and fatigue. Upon completion of the baseline measures, EEG acquisition will begin. Participants will complete the Wisconsin Card Sorting Task, the Conner's Continuous Performance Task, and the Operation Span Task. These tasks will be counterbalanced between participants using a Latin Square. Start and end markers will be inputted by the researcher in the EEG data to denote the start and stop time of each of the three tasks. Upon completion of the tasks, EEG data acquisition will end and the headset will be removed from the participant.

Statistical Analysis

The design of this study will include one between subject factor of group with 2 levels; child abuse versus no child abuse, and one covariate (drug use total score on TCUDS-V). The dependent measures are decision-making skills, behavioral activation, physiological arousal (measured through EEG), reasoning skills, attention span, and memory span. Specific dependent variable measures for each of the tasks are described above. A one-way fixed analysis of covariance (ANCOVA) will be performed on the abuse and no abuse groups, with drug use (as measured by the TCUDS-V) serving as a covariate. Performing an ANCOVA will allow for the adjustment of each individual's scores and correct for any variance due to drug use within the last 12 months. A medium to large effect size ($r = .35$) is anticipated. A meta-analysis of the WCST and brain

damage revealed larger effect sizes for individuals who have experienced damage to the frontal lobe as compared to individuals who have suffered damage to non-frontal regions of the brain (Demakis, 2003). Mowinckel et. al (2015) calculated the average effect sizes for different decision-making domains and the Connor's CPT through meta-analysis. They found these two variables show robust small to medium effect sizes. A power analysis for the experiment was performed using G*Power 3.1. Based on the minimum acceptable power of .80, two groups, a single numerator degree of freedom, and a medium-to-large effect size of $d = .35$, a total sample size of approximately 64 participants (32 per group) will be needed. A medium to large effect size is justified in this experiment, as the relationship between deficits in executive functioning and early life maltreatment has been demonstrated in previous research. Vasilevski and Tucker (2015) examined whether maltreated adolescents exhibited cognitive deficits across a number of cognitive domains and found that maltreated groups showed significant impairments on measures of executive function and attention, working memory, learning, visuospatial function and visual processing speed, with effect sizes ranging from $d = .54$ – $d = .81$. Another study found medium effect sizes ($d = .30$) when looking at executive functioning as a function of familial exposure to trauma (DePrince, Weinzierl, & Combs, 2009). An expected effect size of $d = .35$ is reasonable given previous findings.

RESULTS

Participants were a total of 43 University of North Dakota students, most whom were female ($n = 33$), and had an average age of 19.6 years ($SD = 1.545$). The average child abuse score for these participants was 1.814 ($SD = 2.302$; out of a maximum possible score of 36), while the average drug abuse score (as measured by the Texas

Christian University Drug Screen (TCUDS-V)) was .767 ($SD = .2.103$; out of a possible score of 13). A series of 72 two-way between groups 2 x 2 ANCOVAs were performed. The independent variable of “Child Abuse Level” (which consisted of 3 levels: no abuse, mild abuse, and moderate-to-high abuse) and was the same for all of the tests while dependent variables were specific to each test. The covariate for each ANCOVA was the participant’s total drug use score based of the TCUDS-V. Based on the distributions of child abuse within the final sample ($N = 43$), three abuse groups were employed as opposed to the originally proposed two. Furthermore, only the primary hypothesis (i.e., that individuals who have experienced either moderate or severe childhood trauma as classified by the LPAA, the PALA, and the SALA would have a lower level of executive functioning as measured by WCST, the Connor’s CPT, and the OSPAN, when compared to those who experienced no or mild levels of childhood trauma) of the current study was tested. This is because time constraints made complete analysis of all collected data unrealistic. A medium- to-large effect size ($r = .35$) was expected based on previous literature (Demakis, 2003; Mowinckel et al., 2015). Our originally proposed sample size of 64 was based on this effect size, the minimum acceptable power of .80, and two groups.

However, after an analysis of abuse data from the retained subjects ($N = 43$), a three-group model more accurately reflected the “abuse categories” in which individuals identified no abuse, mild abuse, and moderate-to-high abuse. With total scores ranging from 0 to a possible 36, an exploratory analysis of the distribution of the sample revealed that the 25th to the 50th percentile contained all individuals with a score of 0 (i.e., no abuse). The 50th to the 75th percentile consisted of individuals with scores ranging from 1

to 3 (i.e., mild abuse). Finally, the 75th to 100th percentile contained individuals with scores ranging from 4 to 11 (i.e., moderate-to-high abuse). So while the intended sample size ($N = 64$) was not obtained, when one adjusts the power analysis for the new model, a corrected total sample size of approximately 49 participants (~25 per group) was sufficient to detect a moderate-to-large effect size ($r = 0.35$) of group (3 levels) with the minimum acceptable power of 0.80.

Only four ANCOVAs showed any significance. As such, these will be the only analyses described. There was a statistically significant main effect of group ($F = 3.712$, $p = .034$) for the probability of cognitive workload averaged over FBDS (forward digit span) and BDS (backward digit span) models on the Operation Span Task (OSPAN). Pairwise comparisons (LSD) between groups showed that those in the moderate-to-high child abuse groups had a significantly ($p=0.03$) higher workload during completion of OSPAN ($M=0.56$, $SD=0.11$) than those in the no child abuse group ($M=0.36$, $SD = 0.31$).

There was a statistically significant main effect of group ($F = 3.259$, $p = .049$) for the error omission rate (i.e., the rate of errors when an “X” or an “A” was presented, but no response was given) on the Connor’s CPT Part 2. Pairwise comparisons (LSD) between groups showed that those in the moderate-to-high child abuse groups had a significantly ($p = 0.046$) higher error omission rate ($M = 0.05$, $SD = 0.053$) than those in the no child abuse group ($M = 0.02$, $SD = 0.02$).

There was a statistically significant main for the covariate of drug abuse group ($F = 6.33$, $p = .016$) for the total beta bandwidth power (13-29Hz) on the Connor’s CPT Part 1. In order to better understand the relationship between drug abuse and the power of beta waveform, the continuous variable of total score on the TCUDS-V was further divided

into three drug abuse groups based on quartile distributions of scores. The no drug abuse group contained participants all with a score of 0 (<50th percentile). The mild drug abuse group contained participants with a score ranging from 1 to 3 (50th-75th percentiles). The moderate-to-high drug abuse group contained participants with scores of 4 or greater (>75th percentile). Pairwise comparisons (LSD) between groups showed that those in the moderate-to-high drug abuse group had a significantly ($p = 0.028$) higher total beta bandwidth power ($M = 1.953$, $SD = 0.282$) than those in the no drug abuse group ($M = 1.868$, $SD = 0.271$).

Finally, there was a statistically significant main effect for the covariate of drug abuse group ($F = 5.459$, $p = .025$) for the total beta bandwidth power on the Connor's CPT Part 2. Pairwise comparisons (LSD) between the three drug abuse groups were not significant. Scores were then divided into two groups at the 50th percentile, where scores of 0 indicated no drug abuse, and scores of 1 or greater indicated drug abuse. The between subjects ANOVA showed a significant main effect ($F = 6.664$, $p = .014$) for total beta power during the Connor's CPT Part 2. Those in drug abuse group ($M = 1.629$, $SD = .270$) had significantly higher beta power than those in the no drug abuse group ($M = 1.343$, $SD = .259$).

DISCUSSION

Due to constraints on time and data acquisition during part two of the current study, only EEG data (i.e., PSDs and cognitive state metrics) and data from the three executive functioning tasks, along with abuse scores acquired from the three primary child abuse questionnaires and the TCUDS-V, were analyzed. The measures that were

not analyzed were the Behavioral Inhibition/Activation Scale, the Adult Decision Making Competency Index, and the Violent Experiences Questionnaire.

Significance of Executive Functioning Task and EEG Findings

A significant difference was found between individuals who have not experienced abuse versus those who have experienced moderate-to-high levels of abuse in the cognitive state metric of average workload during the OSPAN task. Cognitive workload refers to the total amount of mental effort being used when one performs a task; in this case, working memory. ABM's average workload measurement is the average of both the raw scores from the obtained workload measures of individuals during administration of the Forward Digit Span Task (which ABM found to be the best model for 85% of the population), and the Backwards Digit Span Task (which ABM found to be the best model for only 15% of the population) (B-alert x10: User manual, 2010). Sciarini, Grubb, and Fatolotis (2014) showed that ABM's model of working memory is only sensitive to changes associated with the attentional demands and cognitive processes linked to inhibition, which suggests this metric is a sensitive and valid measure of a participant's workload.

The B-Alert model that is used to generate an individual's baseline profile, which is necessary to measure workload, is based off four levels of alertness (sleep onset, distraction/relaxed wakefulness, low engagement, and high engagement). The values of the participant's power spectral densities (PSDs) in the theta, alpha, beta, and gamma ranges during the three baseline tasks are used to calculate coefficients for a discriminant function that produces classification probabilities for each epoch (one-second period) during the data acquisition of the three benchmark tasks (Stikic et al., 2011). The 3-

Cognitive Vigilance Task (3CVT), in which participants are asked to respond positively to one primary geometric stimuli, and negatively to two secondary geometric stimuli, was developed by ABM and features the most common measurements of sustained attention (Johnson et al., 2011). The validity of the 3CVT, which is the baseline task that is most important to generating the cognitive metric of workload (B-alert x10: User manual, 2010), has been confirmed against the commonly used Psychomotor Vigilance Test (PVT-192) (Johnson et al., 2011).

The findings of the present study are consistent with the previous research on the topic that showed that individuals who had been subjected to moderate-to-high levels of child abuse from ages 3-9 may exert more mental effort in order to complete a working memory task as compared to their non-abuse counterparts (Cowell, Cicchetti, Rogosch, & Toth, 2015). Cowell, Cicchetti, Rogosch, and Toth (2015) suggest the results indicate that maltreatment during infancy and toddlerhood, a period of major brain organization and development, disrupts the normative neurological structure formation and functioning, which is further exacerbated by prolonged stress during the early years of life. This partially supports the primary hypothesis, insofar that more abused individuals did display characteristics of lower executive functioning skills, which is indicated by the exertion of higher levels of mental effort. This was the only significant finding in regards to EEG data and childhood abuse groups.

Nonetheless, this neurological finding was further supported by the results of attentional testing. Specifically, individuals who had experienced a moderate-to-high level of abuse as a child showed a significantly higher omission error rate on the Connor's CPT compared to individuals who did not experience any child abuse. The

error omission rate refers to the failure to produce a response to a target letter when a target is present. This suggest failure to sustain attentional focus perhaps due to more limited cognitive resources.

Given that obtained significant main effects were found for average workload on the OSPAN between abused and non-abuse individuals, paired with the significant main effects of the omission error rates on the Connor's CPT, there is sufficient evidence that individuals who have been abused as children do in fact have lower levels of executive functioning that is evident abuse group membership independent of drug abuse.

However, those who have been abused as children are at a higher risk of experiencing drug abuse in adulthood (Banducci et. al., 2014). Consequently, this population is at the highest risk of presenting with reduced executive function skills. Further research must be conducted in order to make any distinct statements about the relationships between these variables, and for proper intervention and treatment methods to be developed to help increase behavioral and neurological functioning caused by child abuse.

Previous research clearly documents the relationship between Substance Use Disorder (SUD) and neurological functioning. Mumtaz et al., (2016) found significant differences among alcohol abusers and non-abusers in neurological functioning. Specifically, beta band activity was significantly attenuated for alcohol abusers during an Eyes Closed task (similar to the baseline task in the current study, in which the participant presses the spacebar on a keyboard when he/she hears the sound of a bell). Beta rhythms are indicative of normal, healthy cognitive functioning when an individual is conscious and alert. For alcoholics, beta power might be regarded as physiological indicator of the imbalance in the excitation–inhibition homeostasis in the cortex which

was associated with impulsive behaviors that are characteristic of chronic alcohol abuse (Tomkins & Sellers, 2001; Ward, Lallemand & Witte, 2009). Brunelle and Flood (2016) also found that university students who meet criteria for hazardous alcohol use perform significantly worse on measures of executive function as compared to both non users and those who meet criteria for hazardous drug use. The findings of Mumtaz et al. (2016) do not support the findings of the current study, but this is likely due to a fundamental difference between the tasks that were utilized. The current study utilized measures that are cognitively demanding (e.g., WCST, OSPAN, and the Connor's CPT), while Mumtaz et al., (2016) relied on measures that were not cognitively challenging (e.g., EC task). Evidence suggests that in active wakefulness, such as during a task that requires active participation, sensory stimulation increases activity in the beta range, while beta activity is attenuated during quiet wakefulness, such as when a person is awake but relaxed and with the eyes closed (Grønli et al., 2016). So the findings of Mumtaz et al., (2016) do not necessarily contradict those of the current study. When taken in conjunction with Grønli et al., (2016), as well as other previous literature, they actually further support the current study's findings that there is increased beta power observed during completion of Connor's CPT in individuals who have reported moderate-to-high levels of drug abuse as compared to those who have experienced no drug abuse.

The significant findings of the drug abuse on the Connors's CPT Part 1 and Part 2 need to be examined more closely. The TCUDS-V does not define any score greater than 0 as necessarily indicating drug abuse. A score of 2-3 indicates a mild disorder, 4-5 indicates a moderate disorder, and 6 or greater indicates a severe disorder. In the present study, a score of 1-3 was indicative as mild drug abuse, and a score of 4 or greater was

indicative of moderate-to-high drug abuse. Furthermore, the mean of the mild drug abuse group in the current study was 2.18, and the mean for the moderate-to-high drug abuse group was 5.43. Both of these mean scores fall within the ranges that the TCUDS-V utilizes to identify severity of SUD. However, pairwise analysis of this effect found no significance. When the drug abuse group was made into two groups, as opposed to three, this effect was still found to be significant. It is likely, however, that these findings are spurious, as the abuse group only contained 7 participants and no previous literature regarding drug abuse specifically altering beta power during the Connor's CPT. Regardless, the findings of the three-group model of the present study are likely valid, and individuals who experience moderate-to-high drug abuse present with greater beta bandwidth power. These findings support previous literature, and should also serve as evidence for further research that aims to more adequately examine the interaction of the severity of one's alcohol and/or drug abuse on neurological functioning.

Heathcote et al. (2015) collected similar measures of cognitive workload by using the OSPAN task. While direct EEG measurements were not utilized in their study, novel methods of workload measurement, which they demonstrated to be reliable and valid, the obtained results were similar to the present studies. That is, dual task performance (as is required during the OSPAN task) significantly decreases an individual's overall cognitive workload, thus increasing mental effort. When combined with findings that state child abuse can decrease frontal lobe functioning later in life (Naudé, du Preez, & Pretorius 2004), and that a decrease in executive functioning skills can increase one's chances of initiating drug use (Pentz & Riggs, 2013), it becomes highly likely that the findings of the current study support its primary hypothesis.

The decrease in average workload among abused individuals is also comparable to the results of the error omission rate of part two of the Connor's CPT. Given that dual task performance leads to an overall increase in workload due to sharing of this limited processing capacity between simultaneous tasks (Heathcote et al., 2015), it stands to reason that individuals who already have compromised executive functioning skills (i.e., the moderate-to-high abuse group) would have a more difficult time successfully completing part two of the Conner's CPT. This is because part two of this task introduces an extra step of responding if and only if an "X" appears after the letter "A" (i.e., Connor's CPT Part 2), as opposed to just responding every time an "X" appears (i.e., Connor's CPT Part 1). While the Conner's CPT is not a measurement of workload, there is sufficient evidence to suggest that further research be conducted into the nature of the behavioral and neurophysiological relationship between them.

Study Limitations

A major limitation to the current study is the number of overall ANCOVAs that were conducted. Performing a total of 72 ANCOVAs greatly increased the probability of the significant results being due to Type I error. However, the significant findings of the current study are likely to be valid and not due to Type I error. The results of the ANCOVAs that specifically looked at the effects of abuse level on cognitive workload, as well as those of the ANCOVA that looked at error omission rate on the Conner's CPT, are in similar to the findings of previous literature (Naudé, du Preez, & Pretorius 2004; Heathcote et al., 2015). Furthermore, DePrince, Weinzierl, & Combs (2009) also found similar finding to those of the significant effects of drug use level on overall beta bandwidth activity for the Conner's CPT.

On a multitude of occasions, the mastoid sensors (i.e., grounding electrodes) of the B-Alert X-10 EEG Unit, which are used to reduce electrical impedance, malfunctioned. When this occurs, no viable signal can be obtained from the EEG unit. Various methods of trying to solve this problem were used, but most often this issue resulted in the participant being dismissed. Due to this issue, data could not be acquired from a total of 16 participants who signed up to participate for part two of the study. Furthermore, given that the EEG unit is currently being used by several studies, it is transported often. As such, the available times for extended use of the unit were sometimes extremely limited.

Future Directions and Conclusions

There are several directions that the current study can continue regarding data analysis and connections of the negative effects of child abuse to varying domains of functioning. Data from measures of behavioral activation and inhibition, as well as measures of decision-making have not yet been processed. If the findings of previous research hold true, then this data should further support the findings of the current study. Bresnahan, Anderson, and Barry (1999) suggest that decreased beta activity may be linked to hyperactivity and increased theta activity to impulsivity in samples of adolescents and adults whom have an ADHD diagnosis. While the present study did not obtain information regarding an ADHD diagnosis within its sample, the present study does lend credence to these findings. Analyses of data from BIS/BAS should further clarify these findings.

While there is evidence that the BIS/BAS measure will likely support the behavioral data from the current the study, the same cannot be said about the ADMC-I.

No significant differences were found between the abuse groups on the Wisconsin Card Sorting Task (WCST) in the current study. Spann et al., (2012) found that physical abuse and neglect are associated with diminished cognitive flexibility and judgment making skills, which was evident from preservative errors (which is defined as an incorrect response within the current rule set) on the WCST. These differences were not identified in the current study, possibly due to the fact that the majority of participants did not score highly on the physical abuse measure. Scores that were identified as being in the moderate-to-high abuse range were primarily found in the psychological abuse measure, while the physical abuse measure consisted primarily of scores that fell within either the no abuse or mild abuse range. Furthermore, the present study was only sensitive enough to detect moderate-to-large effect sizes due to the obtained sample size. It is possible that differences between these groups exist, but the present study just did not have sufficient power to detect them. Further research with participants who specifically identify as being physical abused as children, as well as research with larger samples sizes from this population should be conducted to further explore the effects of abuse on decision making skills.

Studies have also shown that individuals who are classified as drug abusers should display signs of reduced decision consistency (Bashara et al., 2010). Similar results were likely not found in the current study due to the minimal sample size of individuals who identified as experiencing mild and moderate-to-high levels of drug abuse ($n = 10$, $n = 14$, respectively). Finally, Cicek and Nalcaci (2001) found significant negative correlations between EEG activity and WCST performance in the lower alpha bandwidth (8-10 Hz). Thus, as the number of completed categories during the WCST

increase, overall lower alpha bandwidth decreased. While their study was purely correlative, the small partial eta square value of the abuse group on total alpha bandwidth indicates a low effect size (partial $\eta^2 = .032$). Given that the WCST measures reasoning abilities, it is likely that no significant difference will be found between groups on the ADMC-I. Further research into the effects of abuse specifically on decision making skills should be conducted.

Outside of the current study, future research should also focus on individuals who have experienced mild levels of abuse. There were no significant differences between the no abuse group and the mild abuse group in the current study. This may mean that experiencing relatively small amounts of abuse as a child will have no lasting impact on individuals in adulthood, but there is currently not enough research in this area to make any substantial claims. Future research should also focus on the interaction of child abuse and drug use. While there is much evidence on the negative psychological effects of drug use (Pentz & Riggs, 2013), less research has been conducted on child abuse as a direct predictor for drug use as an adult. Banducci et al. (2014) found that abused individuals who have been abused as children are at a particularly high risk for SUD. However, the best ways in which to help this population in terms of therapy and treatment is still unknown.

TABLES AND FIGURES

Table 1. Total Power Spectral Density (PSDs) Means and Standard Deviations for Theta, Alpha, Beta, and Gamma Bandwidths on the WCST, the OSPAN, and the Connor’s CPT under No Child Abuse, Mild Child Abuse, and Moderate-to-High Child Abuse Conditions

	No Abuse				Mild Abuse				Moderate-to-High Abuse			
	Theta (3- 7Hz)	Alpha (8- 13Hz)	Beta (13- 29Hz)	Gamma (30- 40Hz)	Theta	Alpha	Beta	Gamma	Theta	Alpha	Beta	Gamma
Test 1 (WCST)	M = 2.491 SD = .104	M = 2.491 SD = .184	M = 2.489 SD = .184	M = 2.489 SD = .233	M = 2.464 SD = .037	M = 2.451 SD = .225	M = 2.451 SD = .209	M = 2.355 SD = .164	M = 2.634 SD = .401	M = 2.527 SD = .252	M = 2.477 SD = .283	M = 2.522 SD = .323
Test 2 (OSPAN)	M = 2.723 SD = .223	M = 2.267 SD = .246	M = 2.313 SD = .247	M = 2.322 SD = .240	M = 2.302 SD = .128	M = 2.302 SD = .272	M = 2.436 SD = .299	M = 2.347 SD = .2644	M = 2.409 SD = .387	M = 2.331 SD = .257	M = 2.373 SD = .291	M = 2.396 SD = .364
Test 3 (CPT 1)	M = 1.892 SD = .280	M = 1.908 SD = .258	M = 1.988* SD = .271	M = 1.845 SD = .276	M = 2.020 SD = .193	M = 2.011 SD = .263	M = 2.060 SD = .283	M = 1.972 SD = .250	M = 2.080 SD = .407	M = 1.999 SD = .256	M = 1.868* SD = .281	M = 2.011 SD = .357
Test 4 (CPT 2)	M = 1.569 SD = .257	M = 1.589 SD = .209	M = 1.510 SD = .218	M = 1.497 SD = .173	M = 1.734 SD = .283	M = 1.670 SD = .269	M = 1.710 SD = .321	M = 1.701 SD = .271	M = 1.739 SD = .461	M = 1.622 SD = .316	M = 1.576 SD = .325	M = 1.700 SD = .581

Significant values of $p < .05$ are denoted with an asterisk ().*

Table 2. Demographics of Age, Child Abuse, and Drug Abuse for Total Sample

Characteristic	(N = 43)	Sample Size (n)	Valid Percent of Sample Size (%)
Age (<i>M</i> = 19.60, <i>SD</i> = 1.545)			
	18	8	18.6
	19	19	44.2
	20	6	14.0
	21	7	16.3
	22	1	2.3
	23	1	2.3
	26	1	2.3
Sex			
	Female	33	76.7
	Male	10	23.3
Child Abuse Group (<i>M</i> = 1.884, <i>SD</i> = .879)			
	No Abuse	19	44.2
	Mild Abuse	10	23.3
	Moderate-to-High Abuse	14	32.6
TCUDS-V Score (<i>M</i> = .767, <i>SD</i> = 2.103)			
	0	35	81.4
	1	1	2.3
	2	3	7.0
	4	1	2.3
	5	1	2.3
	6	1	2.3
	11	1	2.3

The demographics of the total sample size of participants who completed both Part 1 and Part 2 of the current study are listed above (n = 43). Participants were placed in one of the Child Abuse Groups based on total scores of the LPAA, the PALA, and the SALA (e.g., 0 = no abuse, 1-3 = mild abuse, and ≥ 4 = moderate-to-high abuse group).

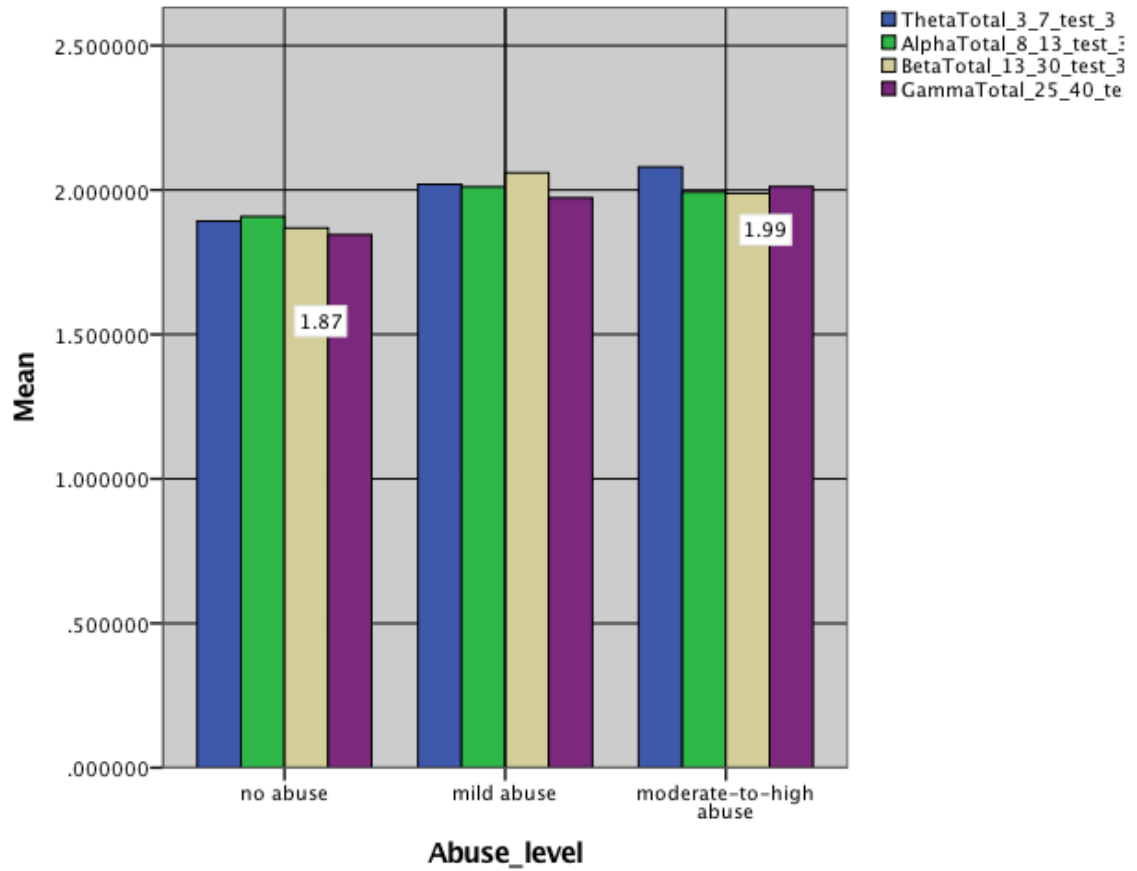
Table 3. Probability Means and Standard Deviations for Cognitive Metrics on the WCST, the OSPAN, and the Connor’s CPT under No Child Abuse, Mild Child

Cognitive Metric						
	Probability of Sleep Onset	Probability of Distraction	Probability of Low Engagement	Probability of High Engagement	Cognitive State	Probability of Average Workload
Test 1 (WCST) No Abuse	M = .004 SD = .010	M = .018 SD = .057	M = .030 SD = .092	M = .030 SD = .092	M = .070 SD = .163	M = .149 SD = .120
Mild Abuse	M = .005 SD = .010	M = .001 SD = .002	M = .005 SD = .010	M = .094 SD = .290	M = .101 SD = .284	M = .174 SD = .246
Moderate-to-High Abuse	M = .072 SD = .145	M = .073 SD = .259	M = .080 SD = .256	M = .069 SD = .245	M = .080 SD = .203	M = .121 SD = .163
Test 2 (OSPAN) No Abuse	M = .412 SD = .143	M = .432 SD = .129	M = .397 SD = .127	M = .420 SD = .127	M = .481 SD = .179	M = .363* SD = .113
Mild Abuse	M = .342 SD = .166	M = .376 SD = .155	M = .359 SD = .147	M = .353 SD = .156	M = .542 SD = .241	M = .508 SD = .253
Moderate-to-High Abuse	M = .363 SD = .223	M = .365 SD = .184	M = .374 SD = .146	M = .405 SD = .211	M = .572 SD = .229	M = .557* SD = .308
Test 3 (CPT 1) No Abuse	M = .738 SD = .098	M = .717 SD = .106	M = .680 SD = .113	M = .661 SD = .085	M = .617 SD = .159	M = .600 SD = .171
Mild Abuse	M = .756 SD = .175	M = .776 SD = .100	M = .732 SD = .138	M = .696 SD = .101	M = .640 SD = .106	M = .652 SD = .129
Moderate-to-High Abuse	M = .998 SD = .803	M = .955 SD = .707	M = .922 SD = .676	M = .891 SD = .608	M = .846 SD = .592	M = .722 SD = .381
Test 4 (CPT 2) No Abuse	M = .552 SD = .132	M = .598 SD = .142	M = .574 SD = .156	M = .581 SD = .137	M = .584 SD = .143	M = .590 SD = .153
Mild Abuse	M = .567 SD = .056	M = .596 SD = .088	M = .591 SD = .081	M = .612 SD = .098	M = .603 SD = .066	M = .816 SD = .620
Moderate-to-High Abuse	M = .710 SD = .410	M = .698 SD = .353	M = .667 SD = .347	M = .657 SD = .238	M = .719 SD = .286	M = .801 SD = .566

Abuse, and Moderate-to-High Child Abuse Groups

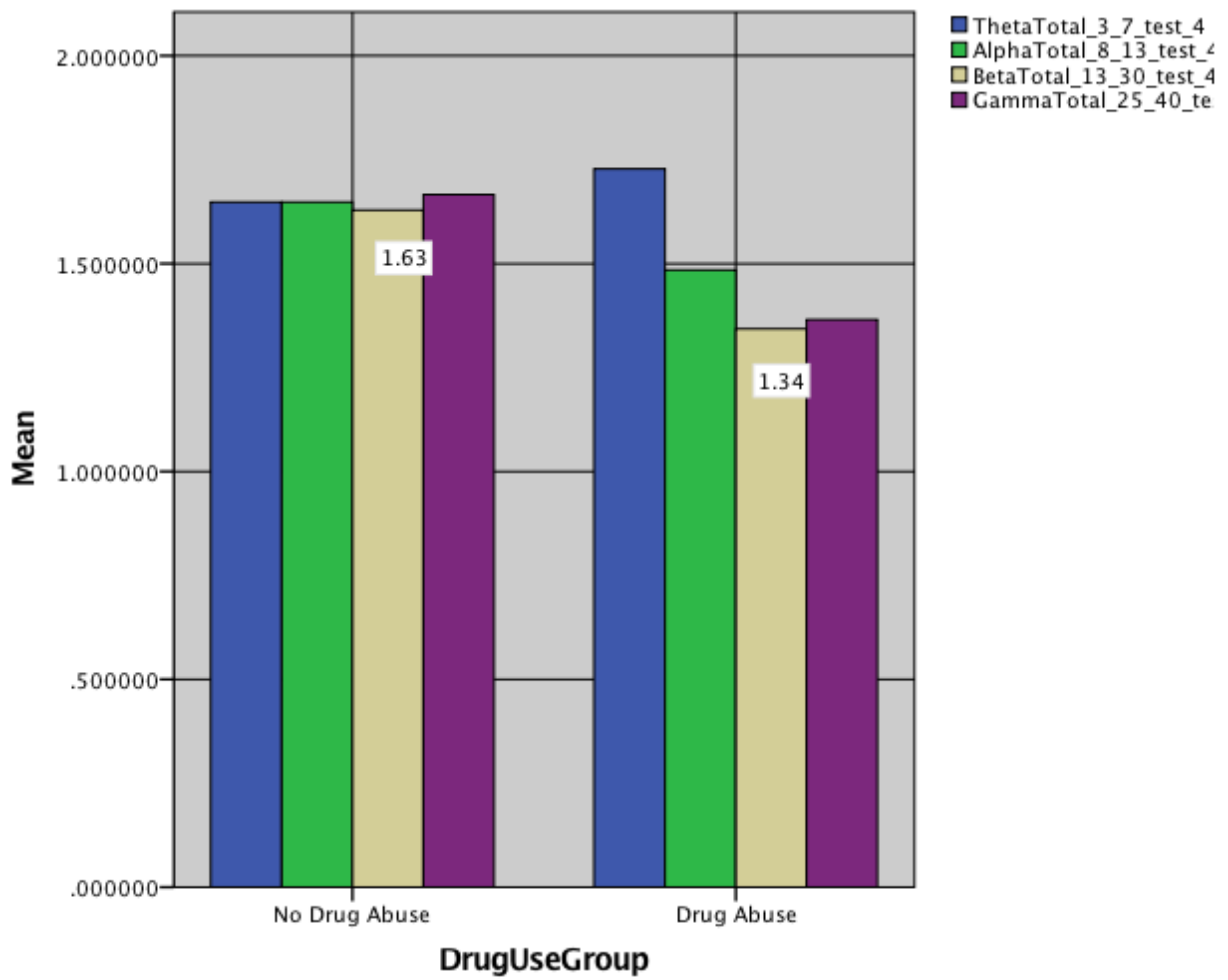
The above values represent the mean probability (and standard deviation) that an individual is experiencing in the corresponding cognitive state each second during data acquisition of each of the four tests. The groups are separated by severity of abuse (no abuse, mild abuse, and moderate-to-high abuse). The values are based on the participant’s performance of the three initial baseline tasks, in which a unique definition file is created. Significant values of $p < .05$ are denoted with an asterisk ().*

Figure 1. Mean Bandwidth for Theta, Alpha, Beta, and Gamma across No, Mild, and Moderate-to-High Drug Abuse Groups on the Connor's CPT 1



Significant beta bandwidth means are indicated by a numerically represented mean value.

Figure 2. Mean Bandwidth for Theta, Alpha, Beta, and Gamma across No Drug Abuse and Drug Abuse Groups on the Connor's CPT 2



Significant beta bandwidth means are indicated by a numerically represented mean value

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