Adverse Childhood Experiences, Executive Functions, and Substance Use in an Indigenous Residential Treatment Program

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Abstract

Intergenerational trauma among Indigenous peoples in Canada is identified as an ongoing detrimental outcome of Canadian colonialism. Both adverse childhood experiences (ACEs) and substance use problems appear to be difficulties perpetuating intergenerational trauma among this population. While it is known that ACEs increase risk for a multitude of poor mental and physical health outcomes, the underlying mechanisms are less clear. Executive functions (EFs) may be one plausible mechanism linking ACEs to substance use difficulties, as EFs are both affected by chronic stress during childhood and are associated with poor outcomes later in life. This community-based research project was driven by Indigenous partnership who wanted to better understand how ACEs are implicated in the substance use difficulties their clients are facing. With this in mind, the goal of this study was to examine the interrelationships between ACEs, EF, and substance use outcomes among clients at an Indigenous substance use treatment program in Northwestern Ontario. To do this, 80 participants completed self-report questionnaires at two time points while in treatment. Ultimately, the number of ACEs experienced did not predict EF difficulties. However, family substance use predicted difficulties across all EFs and severity of neglect predicted difficulties in working memory specifically. ACEs did not predict age of first alcohol or cannabis use, though this relationship approached statistical significance. More than half of the sample demonstrated clinically significant post-traumatic stress disorder symptoms, which were both associated with number of past ACEs and predicted EF difficulties seen within the sample. Ultimately, this study serves as a preliminary step toward better understanding the link between ACEs and EFs among Indigenous adults with substance use difficulties, providing a knowledge base for future prevention, intervention, and research pursuits.

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Preface

Preface

In 2016, I moved to Thunder Bay, Ontario, to begin my Master of Arts in Clinical Psychology at Lakehead University. At this point, I was rather naïve and un-informed about the health disparities experienced by Indigenous peoples in Canada. In 2017, I began my first clinical practicum at a residential treatment program for adolescents with substance use difficulties. Here, I was introduced to First Nations adolescents who were struggling with substance use after being relocated to Thunder Bay, hundreds of kilometers away from their Northern communities, to attend high school. This was the first time I was exposed to the geographical complexities that First Nations communities often endure and the impact it has on community members. From there, I went on to another clinical practicum, this time at an adult residential treatment centre for substance use difficulties at Dilico Anishinabek Family Care. Little did I know, this practicum would define the trajectory of my graduate work and would be the foundation of the work collated in this dissertation.

Dilico Anishinabek Family Care (Dilico) is a large Indigenous-led organization that uses a culturally centred approach to care for children, families, and communities through the provision of health services, child welfare, and mental health and addictions. Culture is embedded in all of their models of care. The opportunity to learn about this approach was critical to my developing worldview as a clinical psychology trainee. At the treatment centre, I also saw the complexity of the mental health difficulties faced by First Nations adults from various communities in Canada. While no two experiences were alike, themes of historical trauma, complex grief, socioeconomic disparities, and ongoing adversity seen intergenerationally, were echoed time and time again. Moreover, substance use difficulties were not only discussed at the individual level but seen in the greater context of family and community struggles. While the

degree of trauma faced by these clients was shocking to me, so was their relentless determination to access services to ameliorate their lives. This was particularly apparent through their engagement in the embedded cultural programming throughout the treatment program. I was given the opportunity to see the benefit of engagement with Elders, sweat lodges, and ongoing cultural teachings and activities. I knew that I had so much learn regarding the ongoing mental health disparities seen in Indigenous communities and paths forward and I was eager to focus my doctoral research in this direction.

This ultimately led me to join the research laboratory of Dr. Christopher Mushquash. At this point, Dr. Mushquash had built an awe-inspiring program of research dedicated to promoting knowledge acquisition and the development of clinical interventions to service the needs of Indigenous children and adults in Northwestern Ontario. In particular, Dr. Mushquash and Dilico had worked together to build a research partnership with Lakehead University that aimed at reaching these shared goals. This provided me with the opportunity to learn about the development of community-based research partnerships that work harmoniously and collectively to prioritize Indigenous community needs through the application of clinical research. With Dr. Mushquash's mentorship, I began my doctoral work to better understand how early adversity was impacting clients' substance use difficulties at Dilico's treatment centre.

I went on to complete more practicums with Dilico that contributed to my development as a clinical psychology trainee, including work with First Nations children with mental health difficulties that frequently linked back to early adversity. I simultaneously went on to coordinate various research projects with Dilico aimed at better supporting their communities, including clinical interventions aimed at reducing substance use, mental health difficulties, and homelessness. As my doctoral work progressed, I was offered the opportunity to work at Dilico

as a clinically supervised therapist at Thunder Bay's Managed Alcohol Program, Kwae Kii Win. Kwae Kii Win services Indigenous adults, largely from Northern Ontario, who have experienced chronic alcohol use and homelessness. This work largely involved palliative mental health care, with clients who were approaching end of life due to health complications associated with chronic alcohol use. The amount of grief and trauma experienced by these clients was disheartening and further emphasized the severity and complexity of the health disparities among First Nations communities, the cyclical nature of the adversity endured, and how far we are from any longstanding solutions. Nonetheless, these clients demonstrated humour, openness, and fortitude throughout our sessions. Their willingness to engage despite their difficult past experiences with service providers was astonishing. I carry forward the lessons I have learned from their resilience and believe that its relevant context for the motivations underlying this doctoral work.

Ultimately, the core of my development as both a research and clinical trainee are through lessons learned working with Dilico Anishinabek Family Care and Dr. Chris Mushquash. It is this background that sets the stage for this document. To that end, it is the hope that this dissertation captures one of the seven Grandfather teachings – *Debwewin*, or "truth". Indeed, it is my hope that this work captures the truth of many Indigenous adults struggling with substance use in Northwestern Ontario, including the knowledge needed to support paths forward in healing and wellbeing.

Chapter 1:

Introduction

Introduction

The field of developmental psychology was in part founded on attempts to understand the role of early life experiences on various facets of development and subsequent adult outcomes. This field of research was revolutionized in 1998 when Felitti and colleagues published outcome data from the CDC-Kaiser Adverse Childhood Experiences (ACE) Study, often referred to as the "ACE Study". The ACE Study was the first large scale study to demonstrate that ACEs put individuals at an increased risk for various adult health risk behaviours and diseases in a dose response fashion. In other words, the more ACEs an individual experiences, the higher the risk for poor health outcomes. Felitti and colleagues (1998) examined various ACEs retrospectively, including emotional, physical, and sexual abuse, exposure to violence against the mother, household member with a mental health problem, household member with a substance use problem, a family member who had been incarcerated, and parental divorce.

After the original ACE Study was published, many other studies were conducted to examine the influence of ACEs on a range of health outcomes leading to a quickly growing body of research demonstrating the link between ACEs and negative physical and psychological health outcomes (Anda et al., 2006; Briere et al., 2008), health risk behaviours (Brown et al., 2010; Dube et al., 2010), and decreased life expectancy (Brown et al., 2009). These findings further emphasized the importance of prevention and intervention through child welfare organizations and related services. They also served as the inception for various studies attempting to understand the mechanisms by which exposure to ACEs act to increase risk for these health outcomes. One such avenue has included considering how ACEs impact brain development and subsequent development of psychopathology later in life (Sheridan & McLaughlin, 2020). More specifically, early childhood stress has been shown to impact various aspects of the developing

brain, including changes in the hypothalamus-pituitary-adrenal (HPA) axis, the limbic system, and the prefrontal cortex (PFC).

The structural and functional impact of chronic stress on the HPA axis and associated PFC appear to impact the cognitive processes carried out in the PFC, namely executive functions (EF; DePasquale et al., 2020). EFs serve as an umbrella term used to describe a group of high-order cognitive processes mediated by the prefrontal cortex that underlie goal-directed behaviour (Diamond, 2013). These processes include working memory, inhibitory control, attention, cognitive flexibility, emotion regulation, self-monitoring, organization, and planning (Naglieri & Goldstein, 2017). EFs appear to develop across childhood and adolescence (Zelazo et al., 2008) and are sensitive to environmental input into early adulthood (Friedman et al., 2016). EFs are largely hereditary (Friedman et al., 2008) but are also malleable via childhood experiences (Thompson & Steinbeis, 2020). EFs are linked to positive outcomes across the lifespan as they are integral to goal pursuit and decision-making processes (Blair & Razza, 2007; Allan et al., 2016; Laweson et al., 2015).

While most ACE research has led to advancements in understanding links between ACEs and poor mental and physical health outcomes, putative mechanisms underlying these relationships are viewed as complex and less clear. The interrelationships between ACEs, EFs, and mental health outcomes, for instance, are not well understood. However, theoretical frameworks on the development of adaptive self-regulation (Blair, 2010) and secure attachment (Bernier et al., 2015) are compelling models for understanding the relationship between ACEs, EF difficulties, and risk for poor outcomes across the lifespan. In particular, early parent-child relationships provide children with an avenue to learn and practice emotional and cognitive self-regulation (Sroufe, 1996). This learning then generalizes across social contexts and various

facets of goal directed behaviour (i.e., executive functions; Bernier et al., 2015). Caregiver behaviour, therefore, appears to be integral to executive function development (Fay-Stammbach et al., 2017), and is predictive of mental health and substance use difficulties later in life (Mikulincer & Shaver, 2012).

EF difficulties that persist into adulthood are implicated in intergenerational transmission of EF to subsequent generations (Jester et al., 2009), both through parenting practices and hereditability (Bridgett et al., 2015). Parents with EF difficulties are at a higher risk of exposing their children to ACEs, including experiences of mental illness and substance use difficulties (Zelazo, 2020), incarceration (Meijers et al., 2015), and increased risk for exposing children to abuse and neglect (Fontaine & Nolin, 2012). EF difficulties also increase the risk for substance use problems (Nigg et al., 2006). It therefore becomes plausible that EF difficulties may in part explain the intergenerational transmission of ACEs. Moreover, parents who have experienced ACEs themselves are more likely to demonstrate parental distress (Steele et al., 2016), impaired maternal-infant bonding (Muzik et al., 2013), decreased sensitivity (Pereira et al., 2012), and hostility towards children (Bailey et al., 2012), leading to patterns of adversity seen across generations.

The intergenerational transmission of ACEs among Indigenous peoples (often encapsulated in the phrase *intergenerational trauma*) is identified as a detrimental outcome associated with Canadian colonialism, and in particular, the residential school system that was implemented from 1863 to 1996 (Bombay et al., 2009). The residential school system exposed Indigenous children to familial and cultural fragmentation and many experienced various forms of maltreatment, including physical and sexual abuse (The Truth and Reconciliation Commission [TRC], 2015). The experiences of those who attended residential schools, as well as other

widespread experiences of poverty, poor living conditions, marginalization, and discrimination associated with colonialism, have put generations of Indigenous peoples at risk for various negative physical, mental, and social outcomes (Hackett et al., 2016; Oelke et al., 2016; Ross et al., 2015). These experiences have been documented intergenerationally, such that the experiences of parents who attended residential schools are associated with parenting difficulties and subsequent mental health difficulties seen in their children (Bombay et al., 2011; RSH National Team, 2007). The risk for continued intergenerational transmission of ACEs among Indigenous communities is high, and effective prevention and intervention methods are needed. In order to develop effective strategies, a thorough understanding of the ways in which ACEs are propagated across generations of Indigenous peoples is first required. In particular, past ACEs appear to be highly prevalent among Indigenous adults with chronic substance use difficulties (Marsh et al., 2018).

Given the potential implications of EF in intergenerational transmission of ACEs and substance use difficulties, it may be a possible mechanism that in part explains the relationship between ACEs and substance use difficulties seen among Indigenous adults. However, to date, no research has examined the relationship between ACEs, EF, and substance use in tandem, nor among an Indigenous population. This lack of knowledge base has made it difficult for Indigenous substance use treatment settings to support complex clients who present with a history of ACEs and ongoing EF difficulties. This prompts the goal of this dissertation, which is driven by community partnership with Dilico Anishinabek Family Care's (Dilico) Adult Residential Treatment Centre (ARTC), a 22-bed residential treatment facility that provides 4-5 week single and mixed-gender treatment cycles aimed at supporting Indigenous people

experiencing difficulties with substance use. The program integrates cultural supports and healing practices with Western biomedical approaches to addiction treatment.

Counselling and clinical staff at ARTC expressed ongoing concerns that many of their Indigenous clients with histories of early adversity had difficulty engaging in the treatment program, significant challenges with emotion regulation and impulsivity, and demonstrate a high likelihood of relapse post-treatment. They requested support in better understanding the needs of their clients, including how early adversity may be connected to clinical complexity and ongoing substance use difficulties. This request was brought to Dilico's leadership, who then approved it as a worthwhile research endeavour to be discussed with their organizational Research Advisory. From there, a community-based research partnership between Dilico and Lakehead University was developed to support ARTC in beginning to better understand the substance use difficulties their clients were facing in relation to past ACEs and EF difficulties.

As such, the overall objective of this doctoral dissertation was to better understand the relationship between ACEs, EF, and substance use among clients attending an Indigenous residential substance use treatment program, with the goal that this knowledge base may be used to inform future culturally informed preventative and intervention pursuits. To do this, various research endeavours were implemented. First, to better contextualize the current state of literature relating to ACEs and EF among Indigenous adults experiencing substance use difficulties, a literature review (Chapter 2) and two systematic reviews were completed. The first systematic review (Chapter 3; manuscript published in 2020) examined the relationship between ACEs and EF difficulties among child studies. The second systematic review (Chapter 4; manuscript currently under review) examined the relationship between ACEs and EF difficulties among clinical and non-clinical adult studies. Second, an original quantitative research study was

conducted that examined ACEs, EF difficulties, and substance use among clients attending an Indigenous substance use treatment program in Northwestern Ontario. This study was a community-based research project conducted in partnership with Dilico Anishinabek Family Care (Chapter 5 details the study methodology). Study objectives included examining the following relationships: ACEs and EFs; ACEs, EFs and age of first substance use; ACEs, EFs, and substance use motives; and ACEs, EF, and relapse post treatment (Chapter 6 details the study results and Chapter 7 involves a discussion of the findings). This was done through the administration of self-report questionnaires completed by participants twice across their treatment cycle, over a 2-year period of data collection. An environmental scan and review (Chapter 8; manuscript in preparation) was completed to consolidate existing research detailing promising avenues to address EF difficulties associated with ACEs, ultimately with the intention to inform clinical implications and future directions of this work. Given that this dissertation involves three chapters that were written in manuscript form for publication in peer-reviewed journals, some necessary content is repetitive across chapters. Finally, a brief chapter (Chapter 9) is presented at the end of the dissertation that provides an overall summary and drawn conclusions from the previous chapters.

Chapter 2:

Literature Review

Literature Review

In 1998, Felitti and his colleagues published the first paper of their novel research program, connecting adverse childhood experiences (ACEs) to many leading causes of death in the US, otherwise known as the ACE study. Prior to this time, child maltreatment literature had certainly existed that examined specific forms of adversity (e.g, sexual abuse) and related mental health outcomes (Cicchetti & Rizley, 1981). However, Felitti's theoretical ACE framework was grounded in the notion that experiences of child maltreatment and household dysfunction do not occur in isolation, and instead often occur in tandem, and thus understanding the cumulative effects of these experiences is needed (Struck et al., 2021; Felitti et al., 1998). In particular, they defined ACEs as maltreatment (including physical and emotional neglect, and emotional, sexual, and physical abuse) and household dysfunction (family mental illness, parental substance use, parental divorce, intimate partner violence exposure, and family member incarceration). This framework led to the birth of a new research field, with the ACE measure used by Felitti and colleagues implemented across the fields of developmental psychology and preventative medicine, with approximately 800 articles involving ACEs being published between 1998 and 2018 (Struck et al., 2021).

The ACE framework represents a cumulative risk model, where an individual receives a cumulative score from 0 to 10, based on the number of ACEs they have experienced. Cumulative risk models have been used to understand the relationship between child development and psychopathology far prior to the seminal ACE study. Indeed, Sameroff and colleagues (1987) proposed that analysis of one single risk factor may underestimate its influence on child development, and that prediction of outcomes can be better understood through combining multiple risk factors experienced, regardless of whether the variables overlap or are independent

of one another (Kraemer et al., 2005). This framework views exposure to stress as "the sum is greater than its parts", suggesting that multiple stressors are likely to impact healthy child development more than one event in isolation.

Due to the abundance of research findings connecting ACEs to health outcomes, the ACE measure has become a widespread topic for possible knowledge dissemination and for its potential clinical utility. However, the use of an ACE score as a clinical tool to predict risk at the individual level is not advised (Anda et al., 2020; McLennan et al., 2020). Moreover, there are some recent cautions for its use in research studies due to field advances, including whether there are other ACEs beyond the 10 studied worth incorporating, and potential limitations with the construction of individual items in the measure (McLennan et al., 2020). However, within the last decade, the ACE measure has continued to be widely used in part due to its ability to capture cumulative experiences of child maltreatment and household dysfunction together, with few other measures capturing these experiences in a dose response fashion. Indeed, measures of child maltreatment (e.g., Bernstein et al., 1998) and household chaos (e.g., Matheny et al., 1995) exist that are widely accepted and psychometrically valid, yet do not provide a means to evaluate these constructs in tandem, in order to capture the effects of both together on overall outcomes. This maintains the ACE measure as a tool with some merit and utility, given its consistent ability to predict a multitude of health outcomes associated with cumulative ACEs.

Indeed, the predictive ability of ACEs across health domains is a strength of the ACE model. For instance, the more ACEs an individual experiences, the higher the risk for various mental health issues, including depression, post-traumatic stress disorder (PTSD), suicidality, and substance use (Chapman et al., 2004; Dube et al., 2001; Dube et al., 2003; Fuller-Thomson et al., 2016; Kalmakis & Chandler, 2015). Similarly, ACEs increase risk for various negative

physical health outcomes, including ischemic heart disease, lung disease, cancer, and skeletal fractures (Bellis et al., 2014; Kalmakis & Chandler, 2015). Extensive reviews have also explored underlying mechanisms regarding ACEs and related health outcomes, including obesity (Wiss & Brewerton, 2020), cardiovascular disease (Su et al., 2015), and psychopathology (Sheridan & McLaughlin, 2020). For the purposes of this dissertation, a focus on the relationship between ACEs and substance use is presented.

ACEs and Substance Use. The original ACE study demonstrated a strong relationship between ACEs and substance use problems. Individuals exposed to four or more ACEs were four to twelve times more likely to develop alcohol or drug use problems (Felitti et al., 1998). Individuals with five or more ACEs were seven to ten times more likely to report illicit substance use problems (Dube et al., 2003). ACEs are also associated with earlier age of first substance use (Stein et al., 2017), and individuals with high ACE scores are more likely to relapse post treatment (Derefinko et al., 2019). Indeed, childhood trauma was associated with relapse among 88% of an alcohol use treatment sample, compared to a relapse rate of 64% among those without a history of childhood trauma (Greenfield et al., 2002). The experiences of ACEs are implicated in the severity, duration, and course of problematic alcohol use (Lotzin et al., 2016). While the initial ACE study provided influence on a dose-response relationship between early adversity and substance use problems, this relationship had long been understood anecdotally among clinicians in the field of addictions (Bernstein et al., 2000; Mate, 2012).

Certain ACEs appear to be differentially predictive of substance use problems compared to others, with parental substance use, physical abuse, and sexual abuse, commonly identified as the strongest predictors (Choi et al., 2017). Substance use difficulties are in part hereditary (Volkow & Mueke, 2012) thus partially explaining the relationship between parental substance

use and child substance use outcomes. However, environmental factors associated with parental substance use may also be connected to the development of substance use difficulties. Notably, children of parents with substance use problems are also at risk for neglect, abuse, impoverished living conditions, and household chaos (Lander et al., 2013), all of which are stressors that influence brain development pathways implicated in addiction.

Early Stress and Brain Development

The hypothalamus-pituitary-adrenal axis (HPA axis) is integral to the brain's response to early stress and how stress impacts subsequent brain development. The HPA axis is a hormonal response system that involves the hypothalamus, the anterior pituitary gland, and the adrenal glands, and is activated in response to various mental and physical stressors. When an individual encounters a stressor, the HPA axis is activated through the release of corticotropin-releasing hormone from the paraventricular nucleus of the hypothalamus, which then stimulates the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary gland. ACTH is then circulated through the bloodstream and causes the synthesis and release of cortisol from the adrenal cortex. Cortisol acts to increase glucose levels in the bloodstream to respond to the stressor through activation of glucocorticoid receptors. Over time, chronic stress and sustained output of cortisol can lead to dysregulation of the HPA axis (Miller et al., 2007). The chronic stimulation of the HPA axis in the face of stressors is associated with acute increased levels of cortisol and an eventual gradual decline in cortisol (Heim et al., 2000) as chronic over-production of cortisol can cause eventual down-regulation (Miller et al., 2007).

Individuals with a history of ACEs have chronic lower levels of cortisol than those without ACEs (Kalmakis & Chandler, 2015). Chronic exposure to stress can cause long lasting changes in the HPA axis due to its malleability as it is a major neuroendocrine system that is still

developing (Gunmar & Donzella, 2001; Tarullo, & Gunmar, 2006). Dysregulated levels of cortisol can produce a heightened state of vigilance during experiences of childhood maltreatment, thus serving an adaptive purpose at the time, however this has lifelong implications for how the body will respond to future stressors, including a lower threshold for perceived stress and an exaggerated stress response (Tarullo & Gunmar, 2006). The dysregulation of the HPA axis is also found in many different mental illnesses, and may be associated with the development and maintenance of psychopathology later in life (Staufenbiel et al., 2012)

HPA axis dysregulation is thought to have implications on other brain processes and structures, including the limbic system. The limbic system is a network of structures that include the thalamus, hypothalamus, amygdala, and hippocampus, and its key functions relate to emotions, memory, and arousal. A function of the amygdala includes receiving input and assigning an emotional value to a stimulus in response to a threat, as well as producing a behavioural response. Limbic regions of the brain are particularly susceptible to the effects of chronic stress during critical periods of development due to a high density of glucocorticoid receptors in this area (Sanchez et al., 2000). Notably, adults who have experienced childhood maltreatment demonstrate hyper-responsive amygdala activation after the presentation of angry and fearful facial expressions compared to individuals who were not exposed to childhood maltreatment (Dannlowski et al., 2012), suggesting that aspects of their limbic system were altered because of maltreatment exposure.

The prefrontal cortex (PFC) is physically situated ahead of the frontal cortex and is involved in various complex cognitive processes including planning, decision making, impulse control, and moderation of social behaviour. The tasks performed by the PFC are largely

described as executive functions (EFs). Both the HPA-axis and the limbic system are highly interrelated to the PFC, and thus chronic stress and dysregulation occurring in these areas of the brain likely influence the development and refinement of executive functions. The PFC is one of the last to finish developing (Diamond, 2002), making it particularly vulnerable to childhood stressors. Glucocorticoid receptors are extremely dense in the prefrontal cortex (Grossman et al., 2006) which suggests that the PFC may be influenced by the effects of chronic stress associated with ACEs.

The PFC is also involved in regulating the neuroendocrine cascade that occurs through the HPA-axis and as such, dysregulation of the PFC is associated with decreased ability to assess threat and provide an appropriate response to regulate the HPA-axis (Liberzon & Martis, 2006; Shin et al., 2006). Chronic stress during childhood appears to alter structural development of the PFC. For instance, children with a history of trauma and post-traumatic stress symptoms demonstrate a smaller gray matter volume of specific areas of the PFC than healthy control children (Carrion et al., 2010). Exposure to childhood maltreatment is also associated with reductions in cortex volume in areas of the PFC dedicated to regulation of emotional behaviour (Van Harmelen et al., 2010).

Neurobiological studies have demonstrated that, with increases in stress exposure, the PFC decreases in functioning and the corticostriatal-limbic system increases in functioning. The corticostriatal-limbic circuit is heavily involved in motivation and learning of behaviour, and integral to addiction pathways in the brain (Sinha, 2008). This shift in brain pathways in the face of stress thus makes the brain susceptible to reward intense experiences, such as substance use (Arnsten & Goldman-Rakic, 1998; Li & Sinha, 2008). However, there is evidence to suggest that experiences of certain forms of stress, including sexual and physical abuse, may exert unique risk

on addiction vulnerability (Clark et al., 1997). Notably, it appears that these stressors are associated with brain pathways connected to negative emotionality and subsequent psychopathology, including depression, anxiety, and PTSD, which then increase risk for substance use difficulties to cope with relevant symptoms (Sinha, 2008).

Executive Functions

Chronic stress associated with exposure to ACEs has longstanding implications on the developing PFC. Subsequently, exposure to ACEs appear to increase the risk for deficits in actions and behaviours that are executed by the PFC, largely described as EFs. EF serves as an umbrella term used to describe a group of high-order cognitive processes mediated by the prefrontal cortex that underlie goal-directed behaviour (Diamond, 2013). These processes include working memory, inhibitory control, attention, cognitive flexibility, emotion regulation, self-monitoring, organization, and planning (Naglieri & Goldstein, 2017). EFs develop across childhood and adolescence (Zelazo et al., 2008) and continue to be sensitive to environmental input into early adulthood (Friedman et al., 2016). EFs appear to be more predictive of school achievement than intelligence (Blair & Razza, 2007). Low EF is associated with poor health behaviours (Allan et al., 2016), increased risk for psychopathology (Laweson et al., 2015), difficulties in occupational functioning (Barkley & Fischer, 2011), and higher risk of mortality in older adults (Johnson et al., 2007). Exposure to ACEs is related to deficits across EFs, as documented in detail in the systematic reviews presented in Chapter 3 and Chapter 4.

EF Measurement. Many theorists differ in how best to conceptualize and define EFs. While some theorists view EF as its own, overarching entity (Hughes, 2009; Naglieri & Goldstein, 2013), others suggest that the many mental processes that fall under the umbrella term of EF are distinct and should be studied individually (McCloskey, 2009; Roberts & Pennington,

1996). Meanwhile, some suggest that the mental processes that are described as EFs are distinct yet overlap substantially when used (Diamond, 2013; Lezak, 1995). For instance, working memory and inhibitory control may be viewed as distinct processes that commonly co-occur and utilize each other in carrying out their desired functions (Diamond, 2013). While some theories purport that there are only a select few higher-order EFs, others suggest there are many (including processes such as planning, emotion regulation, and self-monitoring; Anderson, 2002). Conceptualizations of EF are also often categorized based on frontal lobe positioning, as EFs are thought to be executed in this area of the central nervous system. Neurologically-based conceptualizations of EF suggest that EFs can be categorized into "cold" and "hot" EFs (Chavez-Arana et al., 2018). "Cold" EFs carry out actions in the dorsolateral prefrontal cortex, and involve working memory, inhibition, and set shifting (Poon, 2018). Meanwhile, "hot" EFs refer to emotionally laden EFs that are largely exhibited in the ventromedial prefrontal cortex, such as emotion regulation and decision-making that involves affect (Rubia, 2011).

The inconsistency in defining EFs is also further amplified with difficulty measuring EFs, where many performance-based tasks have difficulty isolating a single EF, and instead often engage more than one EF at a time (such as the Delis-Kaplan Executive Function System [DKEFs; Delis, Kaplan, & Kramer, 2001). For example, the widely used Trail Making Test is a measure of both visual attention and cognitive flexibility. Meanwhile, rating scales (such as the Behaviour Rating Inventory of Executive Functions [BRIEF; Roth et al., 2005] or the Comprehensive Executive Function Inventory [CEFI; Naglieri & Goldstein, 2013]) only capture practical behaviours associated with EFs, rather than the EFs themselves. However, rating scales may better capture "hot" EFs, as they involve self-report and observer ratings of EFs in affect related contexts, while performance-based tasks often measure "cold" EFs in the absence of

affect. Notably, findings suggest that rating scales (such as the CEFI and BRIEF) are more sensitive and better suited for measuring EF among individuals with substance use disorders (Hagen et al., 2016). However, such measures have been shown to be sensitive to psychological distress, and therefore relevant psychologically-oriented covariates are warranted when using rating scales to measure EF among individuals with substance use disorders (Hagen et al., 2019).

EF and Substance Use Problems. Deficits in EF are associated with various mental health difficulties (Snyder et al., 2015) and substance use problems (Wilens et al., 2011). The relationship between EF and substance use is bidirectional, such that substance use has been shown to predict future EF difficulties, and EF difficulties have been shown to predict future substance use (Brockett et al., 2018; Gustavson et al., 2017). In general, there is an association between EF deficits and the use of alcohol (Goudriaan et al., 2006; Sullivan et al., 2000; Oscar-Berman et al., 2004), tobacco (Durazzo et al., 2007), cannabis (Solowij et al., 2002), opioids (Lyvers & Yakimoff, 2003), polysubstance use (Verdejo-Garcia & Perez-Garcia, 2007), as well as various other illicit substances (Ersche et al., 2006; Hester & Garavan, 2004; Roberts et al., 2016). While research has largely focussed on the effects of long-term use of substances on EF (e.g., Hagen et al., 2017; Tapert et al, 2002), longitudinal research also demonstrates that EF deficits predict later substance use. For example, self-regulation of behaviour and response inhibition has been shown to predict substance use among adolescents (Nigg et al., 2006). Among adolescents, poorer inhibitory control predicted more alcoholic consumption at one time, more days of alcohol consumption, and more cannabis use by ages 17-18 (Squeglia et al., 2014). Moreover, greater experience of aversive drinking-related consequences and reports of intentionally drinking alcohol to achieve intoxication among young adults is linked to poor EF (Giancola et al., 1996; Deckel et al., 1995).

Martins and colleagues (2018) examined whether individual differences in EF tasks (measuring working memory, inhibitory control, and cognitive flexibility) moderate the relationship between motives for drinking and alcohol use. They hypothesized that drinking motives would more strongly predict alcohol use and heavy drinking among individuals with poorer EF. However, their study did not demonstrate consistent evidence that EF abilities alter the effects of drinking motives on alcohol use. Nonetheless, this does prompt an important consideration of the role of executive functions in relation to affect-driven motivations for use. While Martins and colleagues (2018) found that the relationship between motives for use and alcohol use was not moderated by EF, it is possible that certain EF deficits relate to the types of drinking motives individuals possess toward using. Moreover, EF impairments appear to decrease behaviour change needed to refrain from substance use (Blume & Marlatt, 2009)

EF deficits may moderate the relationship between ACEs and substance use outcomes. For example, women who engaged in crack-cocaine use and who had a history of childhood trauma (emotional abuse or neglect, physical abuse or neglect, and sexual abuse) demonstrated worse EF and higher levels of impulsivity (Narvaez et al., 2012). Moreover, women engaging in crack-cocaine use who had a history of childhood physical neglect had more deficits in verbal fluency, inhibition, working memory, cognitive flexibility, attention, and decision making, compared to those who did not have a history of physical neglect (Viola et al., 2013). Beyond these studies, little is known regarding the role of ACEs on EF development in populations with substance use problems.

Intergenerational Transmission of EF. Research findings demonstrate a connection between parent EF difficulties and child EF difficulties (Bridgett et al., 2015), suggesting intergenerational transmission. EF deficits appear to be largely hereditary, though also

transmitted intergenerationally through environmental risk factors (Bridgett et al., 2015). ACEs appear to be implicated in this transmission, as parents who have experienced ACEs themselves are also more likely to demonstrate parental distress (Steele et al., 2016), as well as impaired maternal-infant bonding (Muzik et al., 2013), decreased sensitivity (Pereira et al., 2012), and hostility towards children (Bailey et al., 2012). Moreover, parents' past ACEs are implicated in conflict they experience with their own children, and this is mediated by parental EF (including capacity for working memory, inhibitory control, and attention shifting; Guss et al., 2018). Parents who have perpetuated abuse demonstrate deficits in "hot" EFs, though this is not apparent among parents perpetuating neglect (Fontaine & Nolin, 2012). Capturing this intergenerational transmission, Bridgett and colleagues (2015) proposed the Self-Regulation Intergenerational Transmission Model. This model captures both neurobiological foundations (including genetic, epigenetic, and gene-environmental processes) alongside prenatal programming, parenting behaviour, inter-parental relationship behaviours, and household chaos, all as contributors to intergenerational pathways to EF difficulties. Ultimately, these findings may also apply to Indigenous peoples in Canada, where EF difficulties may be a potential mechanism perpetuating ACEs and substance use difficulties seen across generations.

Indigenous Peoples in Canada

Indigenous peoples in Canada refer to individuals identifying as First Nations, Métis, or Inuit. According to the 2016 Canadian Census, there were 1,673,785 Indigenous people living in Canada, accounting for almost 5% of the total population (Statistics Canada, 2017a). From 2006 to 2016, the Indigenous population in Canada grew by 43% and is expected to exceed 2.5 million people over the course of the next two decades. The Indigenous population is relatively young, with 22-33% of First Nations, Métis, and Inuit people being 14 years of age or younger.

Moreover, the mean age of Indigenous people in Canada is 32 years, which is a decade younger than the mean age of the non-Indigenous population (42 years; Statistics Canada, 2017a).

Indigenous peoples lived in what is now called Canada long before European settlers first arrived. Through European colonization and the creation of Canada, Indigenous people lost control over their land, whether through the process of negotiation of Treaties or forceful seizing and land occupation (TRC, 2015). In 1867, the newly formed Canadian government did not allow Indigenous peoples to autonomously engage in their own political and economic decision-making. The Canadian government made decisions and enacted policy with the goal to assimilate Indigenous peoples into mainstream Euro-Canadian culture, denying Indigenous peoples the ability to engage in their cultural practices or express their identity. This included sending many Indigenous children to residential schools, where they were separated from their parents and were not able to maintain or engage with their cultures. Tens of thousands of Indigenous children were involved in mass removal from their homes and placed for adoption at the hands of child welfare authorities between 1960 and 1990 (often referred to as the "60s scoop"). These high rates of Indigenous youth within the child welfare system continue to persist today (Ma et al., 2019).

Residential Schools. Residential schools were a main tenant of the federal government's Aboriginal policy. It is estimated that more than 150,000 Indigenous children attended residential schools (TRC, 2015). Forced attendance at these schools meant children were prohibited from practicing their culture or engaging in use of their native languages. Many children grew up in the residential school system with little exposure to their own traditions, and many without much contact with their parents or other family members. Not only were Indigenous children prohibited from expressing their identities during this time, but residential schooling also often

included substandard living conditions and exposure to abuse. Many children experienced physical and emotional abuse during this time, and various adults who attended residential schools as children also report experiences of sexual abuse (TRC, 2015).

The Canadian government's assimilative policies, including residential schools and all that children endured in attendance, have left those involved to deal with the loss of identity and the aftermath of familial separation and exposure to various forms of abuse. These experiences not only affected those who experienced residential schools, but subsequent generations as well, often referred to as intergenerational trauma (Aguiar & Halseth, 2015). Loss of culture and the developmental and psychological sequalae of familial separation and abuse put individuals at risk for various mental health problems (First Nations Information Governance Centre [FNIGC], 2018). These experiences often affect individuals' ability to parent and provide their children with the protective and supportive structure that both culture and community offer (Bombay et al., 2011).

Mental Health of Indigenous Peoples. In the 21st century, many Indigenous peoples in Canada continue to contend with impoverished living conditions, the loss of culture and ways of living once carried out by previous generations, the impacts of intergenerational trauma from the residential school system, as well as longstanding and ongoing experiences of racism and marginalization. While steps are being taken by communities to heal, Indigenous peoples' mental health has been affected across generations. In Canada, Indigenous peoples are at an increased risk for mental health difficulties (FNIGC, 2018). For example, First Nations people living on reserve have increased levels of anxiety and depressive symptoms compared to non-Indigenous population data (FNIGC, 2018). The national rate of suicide among First Nations communities is double that of the general public and the rate among First Nations youth is approximately three

times higher than non-Indigenous people in Canada (Kumar & Tjepkema, 2019). Moreover, the rate of suicide in Inuit communities is estimated to be nine times higher than non-Indigenous people in Canada (Kumar & Tjepkema, 2019). Notably, among a sample of Indigenous adults experiencing homelessness in Canada, the number of ACEs predicted reported level of mental health difficulties (Smith et al., 2021).

Residential school attendance serves as a risk factor for increased levels of psychological distress in First Nations people (FNIGC, 2018). This is experienced in subsequent generations as well, such that individuals with parents who attended residential schools demonstrate greater depressive symptoms compared to those whose parents did not attend (Bombay et al., 2011). This relationship is moderated by exposure to stressors including ACEs, trauma as adults, and perceived discrimination. Moreover, ACEs in this population mediated the relationship between parental residential school attendance and adult trauma. The broad impact of colonization on Indigenous peoples is understood to be associated with ACEs seen in subsequent generations of Indigenous families. Indeed, First Nations adults have reported that their parents' residential school attendance had an impact on the quality of parenting they received (RSH National Team, 2007). These effects appear to be ongoing, where past parent/grandparent residential school attendance predicted past child welfare involvement among Indigenous adults with substance use difficulties (Barker et al., 2019).

Social Determinants of Health. The mental health disparities between Indigenous and non-Indigenous peoples in Canada can also be considered through the impact of colonization on social determinants of health. Social determinants of health refer to the various social and economic factors that influence the overall health of an individual (Canadian Public Health Association, 2019). The longstanding effects of colonization are associated with various social

determinants that impact Indigenous peoples' health, including housing, income, education, food security, and racism, among others. Moreover, it is suggested that colonization itself can be viewed as a sociohistorical determinant of health, such that it impacts the health outcomes among populations effected in a myriad of ways (Greenwood & de Leeuw, 2012). In Canada, Indigenous people are disproportionately represented among the number of individuals experiencing homelessness (Belanger et al., 2013). In 2016, among Indigenous people with housing, 19% lived in a dwelling that needed major repairs and 18% lived in housing that was overcrowded (Statistics Canada, 2017b). Further, Indigenous children are more likely to be involved with child welfare services than non-Indigenous children (Statistics Canada, 2018), which increases likelihood of future homelessness (Barker et al., 2014). Indigenous youth experiencing homelessness, street involvement, or housing instability also have a greater likelihood of experiencing a mental health or substance use problem compared to non-Indigenous youth experiencing homelessness (Kidd et al., 2017).

Indigenous peoples disproportionately experience unemployment and lack of education compared to non-Indigenous people in Canada. The number of First Nations peoples living on-reserve who are unemployed is four times that of the national average of unemployment (Canadian Institute for Health Information [CIHI], 2009). Moreover, among First Nations peoples living on-reserve, they are half as likely to complete their high school education by 20 years of age compared to non-Indigenous people (CIHI, 2009), which decreases likelihood of employment opportunities, income, food security, and housing stability (Reading & Wien, 2013). Low socio-economic status serves as a risk factor for increased levels of psychological distress in Indigenous peoples (FNIGC, 2018), and thus social determinants contributing to Indigenous peoples' access to education, employment, and housing, all relate to mental health and substance

use problems within this population. These social determinants are also relevant in child welfare involvement and ACEs, whereas Indigenous families involved in child maltreatment cases face worse socioeconomic conditions and are more often investigated for suspicion of neglect when compared to non-Indigenous families (Blackstock et al., 2004).

The intergenerational impact of colonization has put Indigenous peoples in Canada at an increased risk for substance use problems compared to non-Indigenous individuals. Indeed, Indigenous youth often engage in substance use earlier than non-Indigenous youth and are more likely to move into consistent use more quickly (Johnson et al. 2017). Findings suggest that among American Indian adolescents, first use of alcohol, marijuana, and nicotine occur between 11 and 13 years of age (Novins et al., 2001; Whitbeck and Armenta, 2015), and this use often precedes illicit drug use (Novins et al., 2001; Whitesell et al., 2006). Externalizing disorders (i.e., conduct disorder, oppositional defiance disorder, and attention deficit/hyperactivity disorder) which are associated with EF impairments (Romero-Lopez et al., 2017), are associated with increased odds for alcohol use and cannabis use disorder in Indigenous adolescents (Hautala et al., 2018). Peak risk for substance use disorder appears to decline in Indigenous peoples earlier than in the general population (Hautala et al., 2018). The increased risk for substance use disorder seen in Indigenous peoples may reflect the increased risk for early use, rather than increased risk across the lifespan (Copeland et al., 2017). General population data suggests ACE exposure increases risk for substance use difficulties, and therefore this relationship is likely among Indigenous peoples as well. However, in a sample of Indigenous adults experiencing homelessness, number of ACEs did not predict patterns of substance use (Smith et al., 2021). Ultimately, few studies have examined this relationship and further research is needed.

It is possible that the experiences of intergenerational trauma, exposure to ACEs, and subsequent substance use problems seen among Indigenous peoples in Canada may be associated with impairments in EF. In Canadian forensic contexts, Indigenous offenders are more likely to have cognitive difficulties than non-Indigenous offenders (38% to 21% respectively; Stewart et al., 2015). These findings may reflect the relationship between EF deficits and problematic substance use, as Indigenous offenders in Canadian federal correctional institutions are much more likely to have a substance use disorder than non-Indigenous offenders (86% vs 56% respectively; Correctional Service Canada, 2014). Ultimately, it is possible that EF deficits associated with exposure to ACEs may increase the risk for substance use problems in Indigenous peoples, and may contribute to intergenerational transmission of trauma, though these relationships have yet to be examined.

Chapter 3:

Adverse Childhood Experiences and Executive Function Difficulties in Children: A Systematic Review

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In 1998, Felitti and colleagues published outcome data from the CDC-Kaiser Adverse Childhood Experiences Study making it the first large scale study to demonstrate that cumulative exposure to adverse childhood experiences (ACEs) increased individuals' risk for various health risk behaviours and diseases. These ten ACEs remain broadly defined as forms of abuse, neglect, and household dysfunction that occur during childhood (Felitti et al., 1998), including emotional, physical, and sexual abuse, emotional neglect, physical neglect, violence against the mother, household member with substance use problem, a mental health problem, or a family member who had been incarcerated. Since the original ACEs studies, two decades of research on ACEs and their influence on various health outcomes have been documented. One area of prominent research in the field includes an examination of the relationship between ACEs and mental health outcomes. Indeed, Felitti and colleagues (1998) noted a dose-response relationship between ACEs and depression, suicide, alcoholism, and problematic substance use, such that risk for these outcomes increased 12-fold in adults who had experienced four or more ACEs. Early experiences of ACEs are also associated with subsequent mental health difficulties in children, such that for every additional ACE a child aged 3-5 years had already experienced, the odds of presenting with mental health difficulties were increased by 32% (Kerker et al., 2015)

With robust data suggesting a relationship between ACEs and mental health outcomes in both childhood and adulthood, many hypotheses have also been explored to consider the mechanism by which ACEs increase risk for psychopathology across the lifespan. Researchers have often considered the role of stress response in psychopathology, and the possibility that ACEs may cause dysregulation in related systems (Heim et al., 2008). Specifically, the hypothalamic-pituitary-adrenal (HPA) axis is a neuroendocrine system often considered in relation to ACEs and mental health outcomes. Chronic stress in childhood, including the stress

accompanied with ACEs, increases sustained output of cortisol, leading to subsequent dysregulation of the HPA axis (Kalmakis et al., 2015; Miller, Chen, & Zhou, 2007). This chronic stimulation of the HPA axis in the face of stressors can provide children with a heightened state of vigilance during adverse experiences. Although such a response can serve a temporary adaptive purpose, it has lifelong implications for how the body will respond to future stressors, including a lower threshold for perceived stress and an exaggerated stress response (Tarullo & Gunmar, 2006). The dysregulation of the HPA axis is found in many different mental illnesses and may be associated with the development and maintenance of psychopathology across childhood and into adulthood (Staufenbiel et al., 2013).

Dysregulation of the HPA axis has implications for other areas of brain development, including the limbic system and the prefrontal cortex (PFC). The PFC is involved in various complex cognitive processes including planning, decision making, and moderation of social behaviour, largely described as executive functions. The HPA axis is highly interrelated to the PFC, and thus chronic stress and dysregulation occurring in these areas of the brain likely influence the development and refinement in executive functions. The PFC is one of the last brain structures to finish developing (Diamond, 2002), making it particularly vulnerable to childhood stressors. Glucocorticoid receptors are extremely dense in the PFC (Grossman et al., 2006) which suggests that the PFC may be influenced by the effects of chronic stress associated with ACEs. The PFC is also involved in regulating the neuroendocrine cascade that occurs through the HPA-axis and as such, dysregulation of the PFC is associated with decreased ability to assess threat and provide appropriate response to regulate the HPA-axis (Liberzon & Martis, 2006; Shin, Rauch, & Pitman, 2006).

Chronic stress during childhood also appears to alter development of the PFC. For instance, children with a history of trauma and post-traumatic stress symptoms demonstrate a significantly larger gray matter volume of specific areas of the PFC than children without a history of trauma or PTSD (Carrion, Weems, Richert, Hoffman, & Reiss, 2010). Exposure to childhood emotional maltreatment is also associated with reductions in cortex volume in areas of the PFC dedicated to regulation of emotional behaviour (Van Harmelen et al., 2010). Chronic stress associated with exposure to ACEs likely has longstanding implications on the developing PFC. Subsequently, exposure to ACEs appears to increase the risk for deficits in actions and behaviours that are executed by the PFC, largely described as executive functions (EFs). Executive functioning serves as an umbrella term used to describe a group of high-order cognitive processes exerted in the prefrontal cortex that underlie goal-directed behaviour (Diamond, 2013). These processes often include working memory, inhibitory control, attention, cognitive flexibility, emotion regulation, self-monitoring, organization, and planning (Naglieri & Goldstein, 2012). Deficits in EF are also seen in most forms of psychopathology (Snyder, Miyake, & Hankin, 2015), and thus the relationship between ACEs and mental health difficulties may be better understood by considering the relationship between ACEs and EF.

Method

Searches were conducted and subsequent results were reported in adherence with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. Figure 1 summarizes the complete study selection process. A total of 16 peer-reviewed electronic databases and 17 grey literature electronic databases were searched and are summarized in Table 1. Searches were modified to list results by relevance and review was limited to the first 1000

results in each database. Search terms were customized to each database and are outlined in Table 1.

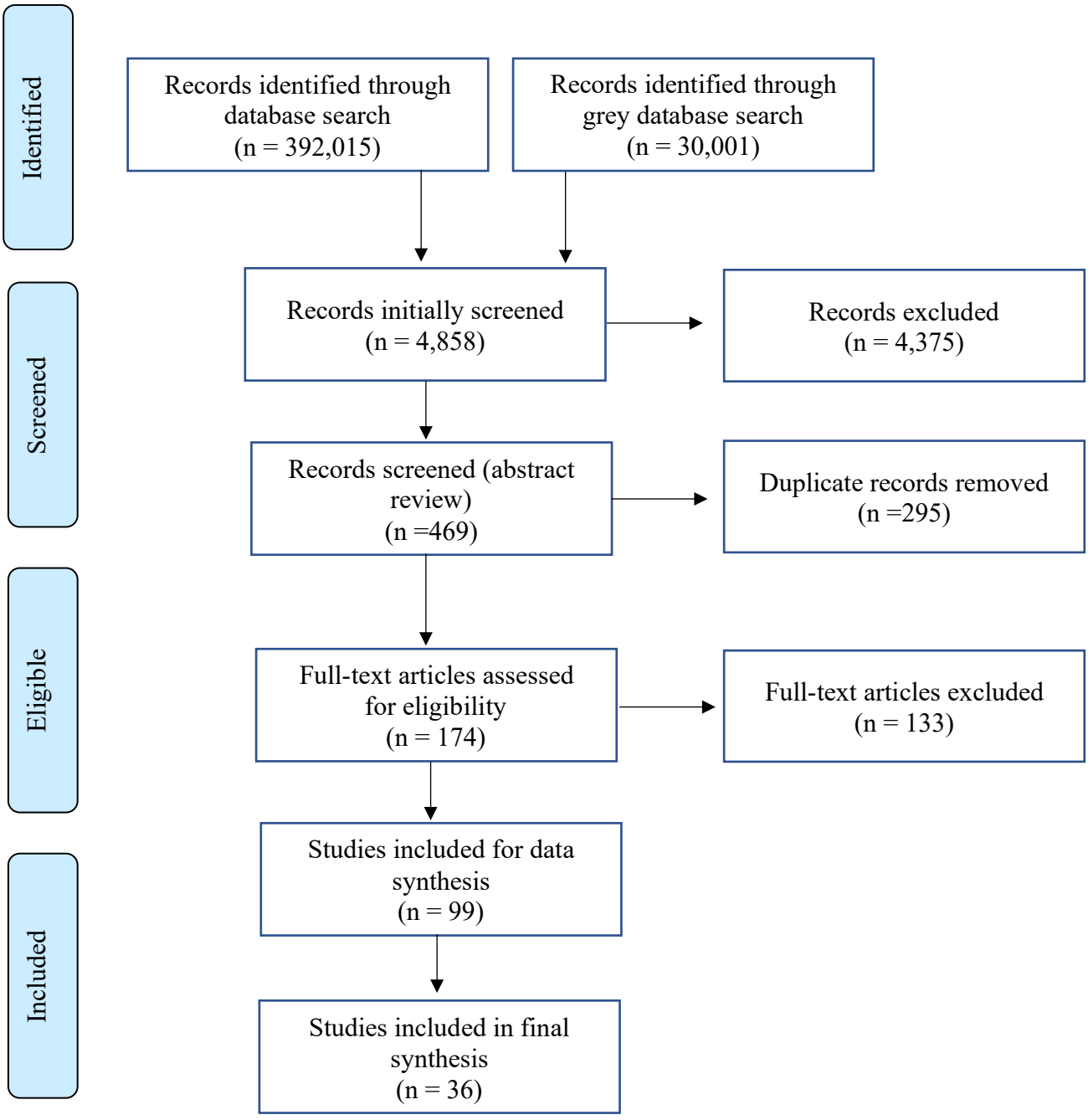

Figure 1. PRISMA diagram of included studies

Table 1.

Databases Searched and Search Terms Used

Databases	Grey Literature
Academic Search Complete The Cochrane Library ERIC (Educational Resources Information Center) Evidence Based Medicine (EBM) Reviews JSTOR MEDLINE PubMed ProQuest Dissertations and Theses Database PsycARTICLES PsycINFO Public Health Department of the Cree Health Board ScienceDirect Social Sciences Citation Index Social Services Abstracts SSRN (Social Science Research Network) Web of Science	Ontario Centre of Excellence for Child and Youth Mental Health McCreary Centre Society Canadian Child Welfare Research Portal Child Welfare League of Canada First Nations Child & Family Caring Society Canadian Coalition for the Rights of Children PLEA Community Services New York Academy Grey Literature Report Open Grey Repository Mental Health Commission of Canada Centre for Children and Youth in Challenging Contexts Assembly of First Nations ementalhealth.ca Institute of Mental Health Research (IMHR) CHEO Research Institute Ottawa Hospital Research Institute (OHRI) ClinicalTrials.gov
Search Terms: “early life” OR “adolescent” OR “child*” OR “infant” OR “youth” AND “advers*” OR “trauma*” OR “abus*” OR “maltreat*” OR “neglect” OR “household dysfunction” OR “parent separat*” OR “divorce” OR “parent* mental” OR “maternal mental” OR “maternal psych*” OR “mother mental*” OR “mother psych*” OR “paternal mental*” OR “mother mental*” OR “domestic abuse” OR “parent* substance” OR “parent* alcohol” OR “parent* addiction” OR “maternal substance” OR “maternal addiction” OR “maternal alcohol” OR “paternal substance” OR “paternal addiction” OR “paternal alcohol” OR “parent* incarcerat*” OR “mother incarcerat*” OR “maternal incarcerat*” OR “father incarcerat*” OR “paternal incarcerat*” AND “executive function*” OR “executive dysfunction*”	

Inclusion and Exclusion Criteria

Studies were included if they:

(a) identified any type of formally classified ACEs (emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, violence against the mother, household member with substance use problem, household member with a mental health problem, or a family member who had been incarcerated).

(b) quantitatively compared any EF in individuals exposed to ACEs compared to those not-exposed to ACEs or compared different types of ACEs and resultant EF outcomes.

(c) were written in the English language, were peer-reviewed, and were published from 2000 to the date of the searches (June 2019).

Studies were excluded if:

(a) they included participants with traumatic brain injuries.

(b) they only considered maternal perinatal substance use.

(c) if there was insufficient information to extract methodology/results of the study.

Data Extraction and Synthesis

Titles and abstracts were reviewed manually based on eligibility criteria and appropriate articles were saved to a reference manager. Upon full-text literature review, relevant information pertaining to the study design, the sample, and the relationship between ACEs and EF outcomes were extracted. Given that definitions of EF and the variables used to measure EF varied substantially across the academic literature, findings that focused on latent variables of EF, as well as individual EF variables were included. Working memory, attention, inhibitory control (or inhibition), cognitive flexibility (or set shifting), planning, and initiation were included in data retrieval, based on such variables being commonly identified as core EF variables in the literature (Naglieri & Goldstein, 2012).

Findings pertaining to variables identified in studies as EF that involved processing speed, verbal ability, or other variables core to intellectual ability were not extracted in order to uniquely capture the effects of ACEs on EF rather than its effects on intellectual ability (Bengwasan, 2018), which served as a covariate in many studies. While emotion regulation is sometimes referenced in relation to executive functions, we did not examine emotion regulation

variables as the relationship between ACEs and emotion regulation involves a large body of literature that has been reviewed elsewhere (e.g., Dvir, Ford, Hill, & Farzier, 2015). In full text reviews, articles that measured broad childhood traumatic experiences (including traumas like natural disasters or community violence) were excluded if they did not differentiate the relationship between EF and ACEs specifically. Studies that considered maltreatment as an overall variable were included. Studies were also removed if they were not specific to, or did not differentiate, between child and adult participants.

Results

A total of 4858 articles were initially screened leading to 469 title and abstract reviews. After the initial screening, 174 articles were identified for full-text review and 99 were identified for initial data synthesis. Following the inclusion criteria, 36 studies were identified and included in the final results. Each included study is outlined in the data synthesis table (Table 2), including the study design, participant description, ACEs reviewed, EFs reviewed, and main study findings. The measures used to assess both ACEs and EF outcomes are included in Table 3. Two studies (Kirkesmith et al., 2014; 2016) reported on the same sample and findings related to EF and ACEs, and thus are only referenced once in the synthesis table. Across all studies, 27866 children were included, ranging from 15 months to 18 years of age. Notably, one study (Baker & Kuhn, 2017) included 18174 children and mother dyads and considered the relationship between maternal depression and child EF outcomes, thus accounting for approximately two-thirds of the total number of children included. Data included six longitudinal studies and 30 cross-sectional studies. Among included studies, 13 studies utilized retrospective measures to ascertain previous experiences of ACEs, while 23 used child welfare files or measured ACEs prospectively (mental illness, substance use). Among the 36 studies, 31 included some form of behavioural measures to

assess EF, while five studies used self-report measures [all five studies used versions of the Behaviour Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000), specifically].

Maltreatment

Cumulative maltreatment. Eighteen studies in this review examined experiences of abuse, neglect, and exposure to intimate partner violence as a means to analyze broader cumulative relationships between maltreatment and executive function deficits. In particular, many studies considered exposure to sexual, physical, and/or emotional abuse, emotional and/or physical neglect, as well as exposure to intimate partner violence in the home, forming overall groups defined by broad experiences of maltreatment. Overall, experiences of these types of maltreatment were associated with EF deficits (De Prince et al., 2009; Hodgdon et al., 2018; Sheridan et al., 2017) as well as specific poor outcomes including attention (Beers & De Bellis, 2002; Bruce et al., 2013; De Prince et al., 2009; Kirke-Smith et al., 2016; Nooner et al., 2018; Vasilevski & Tucker, 2016), working memory (Augusti & Melinder, 2013; Bücker et al., 2014; Carvalho, 2018; De Prince et al., 2009; Kirke-Smith et al., 2016; Martin et al., 2019; Perna & Kiefner, 2012; Vasilevski & Tucker, 2016), cognitive flexibility (Beers & De Bellis, 2002; Carvalho, 2018; De Prince et al., 2009; Martin et al., 2019; Nooner et al., 2018; Perna & Kiefner, 2012; Spann et al., 2011; Vasilevski & Tucker, 2016), and inhibitory control (Beers & De Bellis, 2002; Carvalho, 2018; De Prince et al., 2009; Kirke-Smith et al., 2016; Sheridan et al., 2017; Vasilevski & Tucker, 2016). The ranges of effect sizes found between maltreatment and EF outcomes are summarized in Figure 2. Among self-report measures that considered specific indices of EF, exposure to maltreatment was associated with poor behavioural regulation (β =.22; p <0.01; inhibition, cognitive flexibility, and emotion regulation) and metacognition (β =.19; p

<0.01; initiation, working memory, planning, organization, and self-monitoring; Hodgdon et al., 2018).

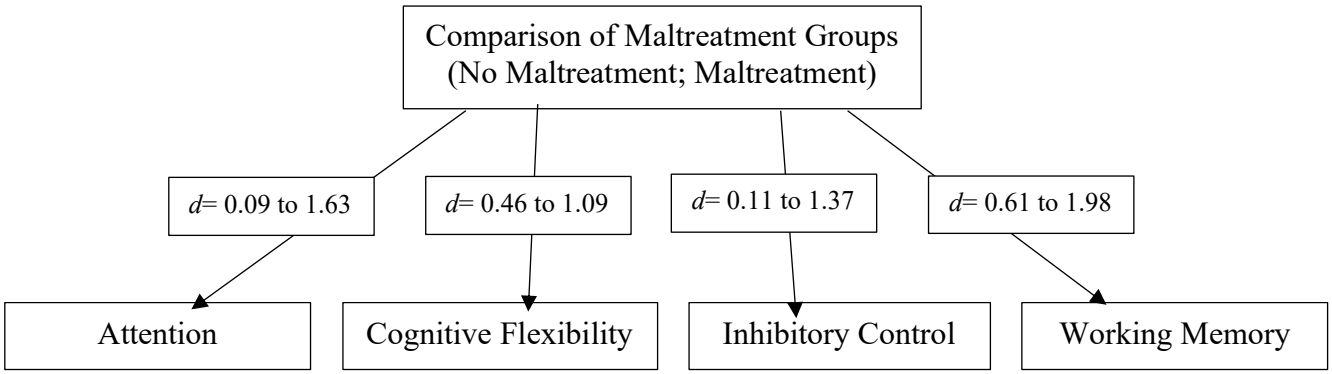

Figure 2. Effect sizes of studies that considered maltreatment and child EF outcomes

Studies also reported lack of significant findings between maltreatment and certain EF outcomes, including working memory (Mothes et al., 2015; Sheridan et al., 2017) inhibitory control (Augusti & Melinder, 2013; Bruce et al., 2013; Carrion et al., 2008; Mezzacappa et al., 2001) and cognitive flexibility (Augusti & Melinder, 2013; Bücker et al, 2014; Mothes et al., 2015; Vasilevski & Tucker, 2016). Notably, one study controlled for abuse when examining the associations between neglect and EF, and vice versa (Sheridan et al, 2017). When abuse was controlled for, neglect (physical and/or emotional) was associated with overall EF ($\beta = 0.25$, $p = 0.007$) and specifically poorer inhibitory control ($\beta = 0.25$, $p = 0.008$) but was not significantly associated with working memory. Meanwhile, when neglect was controlled for, abuse (sexual, physical, or emotional) was not related to overall EF, or any significant differences in inhibitory control or working memory.

Comparisons among types of maltreatment. One study considered differences between three groups of children who had experienced neglect, abuse, or a combination of abuse and neglect (Kirke-Smith et al., 2016) and found that there were no significant differences between

maltreatment group types (neglect vs. abuse/neglect and abuse; abuse/neglect vs. abuse) for verbal and non-verbal working memory or verbal inhibitory control. However, the group that had experienced neglect demonstrated better non-verbal inhibitory control and aspects of directed attention compared to the group that experienced both abuse and neglect as well as those who had experienced abuse. Meanwhile another study (Nolin & Ethier, 2007) considered EF differences in those who had experienced neglect compared to those who had experienced both neglect and physical abuse and found that children who had experienced both neglect and physical abuse demonstrated poorer scores on a measure of problem-solving and planning than children who had experienced neglect only (F= 5.09, p = 0.007, d = 0.73). In a study that examined differences between familial trauma (physical abuse, sexual abuse, and exposure to intimate partner violence) and non-familial trauma, familial trauma predicted poorer overall EF (composite of working memory, inhibitory control, auditory attention, and processing speed) compared to non-familial trauma [$t(107) = 3.20$, $p < .01$, $r = .3$; De Prince et al., 2009]. In the one study that reported on sex differences, none were found (Nooner et al., 2018).

Neglect. Nine studies considered the relationship between early physical and/or emotional neglect and executive function deficits. In an American sample, children who had experienced neglect demonstrated poorer visual attention (De Bellis et al., 2009). Meanwhile, another study showed that children adopted internationally into the US demonstrated poorer overall EF (Hostinar et al., 2012). Children experiencing neglect in a Canadian sample demonstrated poorer EF on a measure of attention, inhibitory control, and cognitive flexibility than controls, but there were no significant differences in visual or auditory attention specifically (Nadeau & Nolin, 2013). Notably, six studies involved samples from Romania, where governmental policies led to increased birth rates and significant lack of resources to support

children in care, leading to thousands of children who experienced substantial physical and/or emotional neglect. Studies have examined children who were adopted in comparison to those who remained institutionalized, thus serving as comparison groups for the effects of neglect. Children who had been institutionalized demonstrated poorer behavioural regulation (inhibition, cognitive flexibility, emotion regulation; $f = 2.49$, $p = .027$), than those who had never been institutionalized (Groza et al., 2008). Children who had been placed in institutions also had poorer inhibitory control than both those in foster care and those adopted (Colvert et al., 2008; McDermott et al., 2012). Children who had remained institutionalized had similar outcomes to those put in foster homes with regards to attention and spatial working memory, though both groups performed more poorly than the control group that had never been institutionalized (Wade et al., 2019). There were also no significant differences in rates of improvement in attention or spatial working memory between the institutionalized group and the group in care.

Merz and colleagues (2013) provide some comparative findings between emotional neglect versus both physical and emotional neglect by considering two samples of children who had experienced different forms of institutionalization. A sample of Romanian children had received adequate physical conditions but were deprived psychosocially, meanwhile a sample of Russian children had been deprived both physical and psychosocially. The Russian children demonstrated poorer overall EF than the Romanian children ($F(1, 561) = 14.99$, $p < .001$). In this sample, children adopted at older ages had more EF problems than younger adopted children ($F(2, 561) = 7.54$, $p < .01$). In another study, children who spent less time with their birth family before placement demonstrated poorer overall EF, as did those who were institutions with poorer physical and social care (Hostinar et al., 2012). Similarly, Colvert and colleagues (2008) reported that the longer children experienced physical neglect in the Romanian institutions, the worse

their performance on a task that measured attention, cognitive flexibility, and inhibitory control. One study examined sex differences and found none in relation to EF outcomes (Hostinar et al., 2012).

Intimate partner violence. While six studies included intimate partner violence exposure in the home as a variable among cumulative experiences of maltreatment, no studies uniquely examined exposure to intimate partner violence exposure in relation to EF outcomes.

Family Member Mental Illness

Eight studies considered the relationship between parental mental illness and executive function deficits. Among these studies, maternal depressive symptoms were most commonly examined and were associated with EF deficits across different age groups. Maternal depressive symptoms during children's infancy predicted deficits in sustained attention and EF in first grade (β =-.20, p <.01; β =-.16, p <.05 respectively) independent of maternal depressive symptoms at 36 months, 54 months, and first grade (Wang & Dix, 2017). Similarly, maternal depressive symptoms at 15 and 24 months predicted children's EF difficulties at 48 months (β = −.09, p = .05; β = −.09, p = .03, respectively; Gueron-Sela et al., 2019). Maternal depressive symptoms at ages 2-4 also predicted children's EF deficits at age 6 (β = -.27; p< 0.05; 95% C.I. = -.49 to -.05; Hughes et al., 2013) and speed of reduction of maternal depressive symptoms was marginally associated with EF (β=-.26; p = 0.06; 95% C.I. = -.53, .01), such that rapid reduction of symptoms was associated with higher EF.

The relationship between maternal depression and EF deficits may be mediated by decreases in maternal sensitivity and warmth experienced as a function of depressive symptomology. Maternal depressive symptoms were associated with executive function deficits in children's inhibitory control, working memory, and attention (rs = -.04 to -.09; p < .01) and

this relationship was completely mediated by maternal parenting practices (i.e., warmth and home learning stimulation; (β = -.00; p < .01; Baker & Kuhn, 2017). Similarly, maternal depressive symptoms during infancy predicted low maternal sensitivity at 36 months which in turn predicted poor sustained attention (β =-.03, p < .01) and executive function in children (β = -.11, p <0.05) at school entry (Wang & Dix, 2017). One study did not find a relationship between maternal lifetime history of depression and offspring EF outcomes (Wagner et al., 2015). Meanwhile, one study considered parental depressive symptoms (either maternal or paternal) and found that it predicted difficulties in cognitive flexibility, on two behavioural measures but did not predict difficulties in inhibitory control or verbal working memory (Craun et al., 2019). Another study found that parental depression and anxiety did not predict EF difficulties (Halse et al., 2019). Lastly, no significant total effects were found for maternal mental illness (measured at child's age of 4-5 years) on a visual executive function composite outcome (including visual attention, visual working memory, and visuospatial problem solving) measured at the child's age of 14-15 years of age (Berthelsen et al., 2017).

Family Member Substance Use

One study considered the relationship between parental substance use and executive function difficulties in children. Grekin and colleagues (2005) found that paternal alcohol use disorders predicted worse outcomes on a measure of inhibitory control, attention, and cognitive flexibility (F= 4.83; p = 0.03) but not on a specific measure of cognitive flexibility among adolescents. Covariates included gender, marital status, maternal education, maternal depression, and paternal antisocial personality disorder. The diagnosis of alcohol use disorder was made based on past or present alcohol dependence.

Family Member Incarceration

No studies examined the relationship between parental incarceration and EF outcomes.

ACEs, EF, and Psychopathology

Four studies included analyses that help inform our understanding of the development of psychopathology in relation to EF deficits. Three comparative studies included subsamples of children that had post-traumatic stress disorder (PTSD) or post-traumatic stress symptoms (PTSS). Among these studies, some findings suggested that children who had experienced ACEs and developed PTSD or PTSS demonstrated poorer inhibitory control (Beers & De Bellis, 2002), attention (Beers & De Bellis, 2002; De Bellis et al., 2009), and cognitive flexibility (Beers & De Bellis, 2002) than healthy controls. However, Carrion and colleagues (2008) did not find any differences in inhibitory control between those with PTSS and healthy controls. Moreover, when comparing differences between children with past ACEs with PTSD or PTSS versus those without PTSD or PTSS, there were no differences in visual attention (De Bellis et al., 2009).

Hodgdon and colleagues (2018) examined whether indirect effects via deficits in EF would exist between experiences of caregiver trauma and outcomes of internalizing, externalizing, and post-traumatic stress (PTS) symptoms. The path from caregiver trauma to externalizing problems through EF was significant (β = .19, 95% C.I.= .006, .031), and accounted for 38% of the relationship between caregiver trauma and externalizing problems. The path from caregiver trauma to post-traumatic stress (PTS) symptoms through EF was significant (β = .04, 95% C.I. =009, .033), and accounted for 5% of the association between caregiver trauma and PTS symptoms. The path from caregiver trauma to internalizing symptoms through EF was not significant.

Table 2.

Data Synthesis Results

Author	Study design	Participant description	ACEs reviewed	EFs reviewed	Main findings and covariates
1. Augusti & Melinder, 2013	Cross-sectional, retrospective	43 children from Norway. 21 children had experienced ACEs and 22 were control participants. Age range = 8-12 years	Physical abuse and witnessed violence (24%), witnessed intimate partner violence (62%), and neglect (14%)	Spatial working memory, cognitive flexibility, inhibitory control	Spatial working memory was significantly worse in maltreated group (η^2 = .10, p = .047). There were no significant differences in cognitive flexibility or inhibitory control between groups.
2. Baker & Kuhn, 2017	Cross-sectional	18174 children and their mothers in the United States (US); Child mean age= 5.6 years; Mother mean age = 34.1 years.	Maternal mental illness (depression)	Cognitive flexibility, working memory, inhibitory control, latent variable of EF	Significant relationship between maternal depression and cognitive flexibility (β =-.04; p < 0.01), working memory (β =-.09; p < 0.01), inhibitory control (β =-.08; p < 0.01), and overall EF (β = -.09; p < 0.01). Covariates: child age, child gender, maternal age, child education, ethnicity, maternal education, neighbourhood safety, number of people living in household
4. Beers & De Bellis, 2002	Cross-sectional, retrospective	29 children from the US. 14 pediatric outpatients with exposure to maltreatment and PTSD and 15 control participants without exposure to trauma. Mean age =11.38 and 12.17 years, respectively.	Sexual abuse (50%), physical abuse (14%), witnessed intimate partner violence (36%)	Attention, cognitive flexibility, and inhibitory control	Maltreated group with PTSD performed significantly worse on a measure that involves attention, cognitive flexibility and inhibitory control than healthy control participants (t=2.37 p =0.03), as well as on a measure of cognitive flexibility (t=2.52; p <0.01), and a measure of visual attention (t=2.71, p=0.006). There were no significant differences on another measure of cognitive flexibility.
5.Berthelsen et al., 2017	Longitudinal	4819 children from Australia. Maternal mental illness was assessed when children	Maternal mental illness	Executive function latent variable (visual attention, visual working memory, and	No significant total effects for maternal mental illness on executive function outcomes at 14-15 years.

		were 5-6 years and EF was measured when children were 14-15 years.		visuospatial problem solving)	Covariates: gender, child age; Indigenous status; language at home; receptive vocabulary from age 4-5.
6. Bruce et al., 2013	Cross-sectional	22 children from the US. 11 maltreated children in foster care and low-income residences and 11 non-maltreated children living with biological parents. Age range= 9-12 years.	Physical neglect (91%), emotional abuse (82%), physical abuse (55%), and sexual abuse (9%)	Inhibitory control, attention	Children in the maltreatment group demonstrated poorer attention than those in the control group $F(1, 20) = 5.65$, $p = .05$). No group differences in in inhibitory control.
7. Bücker et al., 2012	Cross-sectional, retrospective	60 children from Brazil. 30 participants had history of early trauma (before age 4) and 30 matched controls. Age range =5-12 years	Sexual abuse, maltreatment, neglect (type of maltreatment/neglect not provided)	Working memory and cognitive flexibility	Children who had experienced early trauma had poorer working memory ($F(1,51) = 8.55$, $p = .005$) than those who had not. There were no significant differences in cognitive flexibility.
8. Carrion et al., 2008	Cross-sectional, retrospective	30 children from the US. 16 participants who had experienced trauma and had PTSS symptoms and 14 healthy matched controls. Age range= 10-16 years.	Sexual abuse, (27%) physical abuse (37%), witnessed violence (20%)	Inhibitory control	There were no significant differences in inhibitory control between participants who had experienced trauma and had PTSS symptoms compared to healthy matched controls.
9. Carvalho 2018	Cross-sectional, retrospective	55 children from Brazil. 30 participants who have experienced maltreatment and 25 healthy controls. Age range= 8-12 years	Sexual abuse (47%), physical abuse (70%), emotional abuse (57%), neglect (63%)	Cognitive flexibility, inhibitory control, and working memory	Participants who had experienced maltreatment demonstrated poorer cognitive flexibility (d= 0.58), inhibitory control (d = 0.76) and working memory (d = 0.88).

10. Colvert et al., 2008	Cross-sectional	165 children from Romania and the UK. 144 Romanian children adopted into the UK from deprived institutional settings and a comparison group of 52 children adopted within UK before 6 months of age. Age range= 6 to 11 years.	Neglect	Attention, inhibitory control, and cognitive flexibility	The children who experienced neglect performed poorer on a measure of attention, inhibitory control, and cognitive flexibility than those who had not ($F(2, 174) = 12.12$, $p < 0.001$). There was a significant correlation between executive function and duration of deprivation ($r = 0.26$; $p < 0.01$) such that the longer children experienced physical neglect in the Romanian institutions, the worse their scores on a measure of attention, inhibitory control, and cognitive flexibility.
11. Craun et al., 2019	Cross-sectional	135 children and their parents in the US. Child age range= 8-12	Parental mental illness (depressive symptoms)	Cognitive flexibility, inhibitory control, verbal working memory	Parental depressive symptoms predicted difficulties in cognitive flexibility on two measures [($\beta = 0.73$; p <0.05) and ($\beta = -.15$; $p <.05$) but did not predict difficulties in inhibitory control or verbal working memory. Covariates: age, gender, IQ, depressive symptoms of child
12. De Bellis et al., 2009	Cross-sectional, retrospective	106 children from the US. 22 participants had experienced neglect and have PTSD, 39 participants had experienced neglect and do not have PTSD, and 35 participants were controls. Age range= 3-12.	Neglect (type not specified)	Attention	Both neglect groups (with and without PTSD) had worse visual attention than the control group ($F(10,168) =3.04$, $p <0.001$). There were no significant differences between those who had experienced neglect with and without PTSD. Covariate: IQ
13. De Prince et al., 2009	Cross-sectional, retrospective	110 children from the US. 44 children had experienced familial	Physical abuse, sexual abuse, and	Working memory, inhibitory control, and auditory attention, and	Familial trauma was associated with poorer working memory ($r_{\text{effect size}} =$ .27), inhibitory control ($r_{\text{effect size}} = .22$),

		trauma, 38 children had experienced non-familial trauma, and 28 were not exposed to trauma. Mean age = 10.39	exposure to intimate partner violence	latent variable of EF (working memory, inhibitory control, auditory attention, and processing speed)	auditory attention ($r_{\text{effect size}}$ = .18), a measure of inhibitory control, attention, and cognitive flexibility ($r_{\text{effect size}}$ = .09), and overall EF ([$t(107) = 3.20$, $p <$ .01, ($r_{\text{effect size}}$ = .3] than non-familial and no-trauma groups.
14. Grekin et al., 2005	Cross-sectional	816 children and their parents in the US. Children mean age =15.2 years.	Parental substance use (alcohol use disorder)	Inhibitory control, attention, cognitive flexibility	Paternal AUDs predicted adolescent scores on a measure of poor inhibitory control, attention, and cognitive flexibility (F = 4.83; p = 0.03) but not on another measure of cognitive flexibility. Covariates: gender, marital status, maternal education, maternal depression, and paternal antisocial personality disorder.
15. Groza et al., 2008	Cross-sectional	123 children who were adopted from Romania. 82 had experienced institutionalization and 41 had never been institutionalized. Child mean age= 10.00 years.	Neglect	Behavioural regulation (inhibition, cognitive flexibility, emotion regulation) and metacognition (initiation, working memory, planning, organization, and self-monitoring)	Children who had never been institutionalized demonstrated better behavioural regulation than children still residing in non-family setting for 3 more years (F = 2.49, p = .027). There was no significant difference for metacognition. Covariates: gender and age.
16. Gueron-Sela et al., 2019	Longitudinal	1037 children and their mothers in the US. Maternal depression assessed when child was 15 and 24 months and child's EF was assessed 48 months.	Maternal mental illness (depressive symptoms)	Latent variable of EF (working memory, inhibitory control, and cognitive flexibility)	Mothers' depressive symptoms at 15 and 24 months predicted children's EF difficulties at 48 months ($\beta = -.09$, p = .05; $\beta = -.09$, p = .03, respectively). Covariates: ethnicity, family income, maternal education, child sex, early cognitive abilities, maternal general distress, and child care experiences.

17. Halse et al., 2019	Cross-sectional	1070 children and their parents in Norway. Ange range= 4 to 10 years	Parental mental illness (depression and anxiety)	Latent variable of EF (inhibition, cognitive flexibility, emotion regulation, initiation, working memory, planning, organization, self-monitoring)	Depression and anxiety did not predict EF difficulties. Covariates: parental education, parental occupation, harsh parenting, and positive parenting.
18. Hodgdon et al., 2018	Cross-sectional	672 children from residential treatment centres in the US. Age range= 11 to 18 years.	Neglect (65%), physical abuse (55%), sexual abuse (46%), emotional abuse (61%), and exposure to domestic violence (40%).	Latent variable of EF (inhibition, cognitive flexibility, emotion regulation, initiation, working memory, planning, organization, and self-monitoring), and indices behavioural regulation (inhibition, cognitive flexibility, emotion regulation) and metacognition (initiation, working memory, planning, organization, and self-monitoring)	Caregiver trauma was associated with EF (β =.21; p <0.01), behavioural regulation (β =.22; p <0.01), and metacognition (β =.19; p<0.01) deficits. Path from caregiver trauma to externalizing problems through EF was significant [β = .19, 95% CI=.006, .031], and accounted for 38% of the relationship between caregiver trauma and externalizing problems. Path from caregiver trauma to PTSS through EF was significant [β = .04, 95% CI= .009, .0330], which accounted for 5% of the association between caregiver trauma and PTS symptoms. The path from caregiver trauma to internalizing symptoms through EF was not significant.
19. Hostinar et al., 2012	Cross-sectional, retrospective	90 children internationally adopted into the US. 60 participants were adopted with previous experiences of institutionalization and 30 participants were	Physical and emotional neglect	Latent variable of EF (cognitive flexibility, working memory, and inhibitory control)	Post-institutionalized children scored significantly lower on latent variable EF [F(1,73) = 10.45, p = 0.002] than controls. There were no sex differences. Less time spent with birth family before placement in an institution and lower quality physical/social care in institution

		controls. Age range = 16 and 36 months of age.			predicted poorer EF [partial $r(43) = 0.29$, $p = 0.047$; and partial $r(37) = 0.37$, $p = 0.018$ respectively] Covariate: IQ
20. Hughes et al., 2013	Longitudinal	126 children and their mothers in the United Kingdom. Mother-child interactions were assessed at ages 2 and 4 and EF assessed at age 6.	Maternal mental illness (depressive symptoms)	Latent variable of EF (inhibition, working memory, planning)	Maternal depressive symptoms at ages 2-4 predicted child's EF deficits at age 6 (β = -.27; p< 0.05; 95% C.I. = -.49 to -.05) and the slope was reported as marginally significant, suggesting that rapid reduction of maternal depressive symptoms was associated with higher EF (β=-.26; p=0.06; 95% C.I. = -.53, .01) Covariates: working memory at age 2, maternal education, and direct observations of maternal positive control at ages 2 and 6.
21.Kirke-Smith et al., 2014; 2016	Cross-sectional, retrospective	80 adolescents from the UK. 40 participants who had experienced maltreatment and 30 non-maltreated matched participants. Age range = 11-18 years. Neglect only group (n = 13), abuse only group (n= 18), abuse/neglect combined group (n=9), and control group (n=40)	Physical abuse (40%), sexual abuse (33%), neglect (55%), and witnessing intimate partner violence (23%).	Working memory, cognitive flexibility, inhibitory control, and attention.	Maltreatment group demonstrated poorer verbal and nonverbal inhibitory control [$F(1, 77) = 10.71$, $p < 0.01$; $F(1, 77) = 13.48$, $p < 0.001$, respectively], directed attention ($F(1, 75) = 6.11$, $p < 0.01$), and verbal and non-verbal working memory [$F(1, 77)=12.67$, $p<0.001$; and $F(1, 77)=15.91$, $p < 0.001$] than control group. There were no significant differences in cognitive flexibility. There were no significant differences between maltreatment group types (neglect only vs. abuse/neglect and abuse only; abuse/neglect vs. abuse only) for verbal and non-verbal working memory or verbal inhibitory control. Neglect only group demonstrated better non-verbal inhibition

					and aspects of directed attention than abuse/neglect and abuse only. Covariate = IQ
22. Martin et al., 2019	Cross-sectional, retrospective	104 adolescents from South Africa. Age range= 13 to 18 years.	Emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect	Cognitive flexibility and working memory	Maltreatment predicted deficits in cognitive flexibility (B = 1.36, p=0.019) and working memory (B= −1.17, p =0.036) Covariates: SES, ethnicity, depression scores, anxiety proneness
23. McDermott et al., 2012	Cross-sectional	208 children from Romania. 68 children had remained in institutional care, 68 had been in foster care, and 72 control participants.	Neglect	Inhibitory control	Children in institutionalized care demonstrated poorer inhibitory control than those in foster care or those who had never been institutionalized [F(2,114)=7.12, p<.001]. Children in foster care also demonstrated poorer outcomes in inhibitory control than the control group.
24. Merz et al., 2013	Longitudinal	581 children from Russia and Romania. 471 participants were adopted from psychosocially depriving institutions that provided adequate physical resources in Russia and 111 children adopted from institutions in Romania and experienced both physical and psychosocial neglect. Children ages 6 to 18 years were assessed over two years.	Physical and emotional neglect	Latent variable of EF (inhibition, cognitive flexibility, emotion regulation, initiation, working memory, planning, organization, and self-monitoring), and indices behavioural regulation (inhibition, cognitive flexibility, emotion regulation) and metacognition (initiation, working memory, planning, organization, and self-monitoring)	Globally deprived children had poorer overall EF than psychosocially derived children (F(1, 561) = 14.99, p < .001, d= .44). Children adopted at older ages had higher levels of EF problems than younger adopted children (F(2, 561) = 7.54, p < .01). Covariate: age at assessment

25. Mezzacappa et al., 2001	Cross-sectional	126 male children from the US. 25 participants had experienced abuse and attended therapeutic school for difficulties, 52 had not experienced abuse and attended therapeutic school for difficulties, and 48 were control participants from public school. Age range = 6 to 16 years.	Physical abuse (92%) sexual abuse (60%)	Inhibitory control	There were no significant differences in inhibitory control between children with abuse and without abuse history from therapeutic schools. Covariates: IQ and medication status.
26. Mothes et al., 2015	Cross-sectional, retrospective	83 adolescents from Brazil. 24 participants had experienced single type maltreatment, 19 had experienced multi-type maltreatment and 40 had no history of maltreatment. Age range = 12-18 years.	Sexual abuse, physical abuse, emotional abuse, physical neglect, emotional neglect.	Working memory, Cognitive flexibility	There were no significant differences among groups with regards to working memory or cognitive flexibility.
27. Nadeau & Nolin, 2013	Cross-sectional	60 children from Canada. 30 children who had experienced neglect and 30 matched controls. Age range = 8 to 12 years.	Neglect (Type of neglect not specified).	Attention, inhibitory control, cognitive flexibility	Children who had experienced neglect demonstrated more difficulty on a measure of attention, inhibitory control, and cognitive flexibility ($F(1, 56) = 8.33$, $p < 0.05$). There were no significant differences in visual or auditory attention. Covariates: Anxiety, post-traumatic stress problems, IQ
28. Nolin & Ethier, 2007	Cross-sectional	79 children from Canada. 56 participants had experienced	Neglect, physical abuse	Attention, planning, self-regulation, problem-solving	Children who had experienced neglect and children who has experienced neglect and physical abuse demonstrated lower scores

		neglect and physical abuse, 28 participants had experienced neglect only, and 53 control participants. Age range =6-12 years.	(Type of neglect not specified).		than the control group on auditory attention (F= 1.35, d = .305, p= .000). There were no group differences in visual attention. Children who had experienced both neglect and abuse demonstrated poorer scores on a measure of problem-solving and planning (F= 5.09, d =0.73, p =0.007) than children who had experienced neglect only. There were no significant differences among the three groups in inhibitory control.
29. Nooner et al., 2018	Cross-sectional	202 children from the US. 98 participants who had experienced maltreatment and 104 control participants. Mean age =12.18 Sex differences were considered via the following four groups: maltreated males, maltreated females, nonmaltreated males, nonmaltreated females.	Neglect, physical abuse, sexual abuse, emotional abuse, and witnessed intimate partner violence	Attention, cognitive flexibility	Maltreated males demonstrated poorer attention than both the non-maltreated male and female control groups (d= .71, and d=.68 respectively). There were no significant sex differences between maltreated males and females in attention. Both maltreated male and female groups demonstrated poorer cognitive flexibility than both non-maltreated male and female control groups (d=.65 and d=.89 respectively). There were no significant sex differences between maltreated males and females in cognitive flexibility.
30. Perna & Kiefner, 2013	Cross-sectional	41 children from the US. 18 participants had experienced physical and/or emotional abuse or neglect and 23 participants were	Physical abuse, emotional abuse, physical neglect, emotional neglect	Working memory, cognitive flexibility	Individuals who had experienced abuse and/or neglect demonstrated poorer working memory (η_p^2=.245, p=0.010) and cognitive flexibility (η_p^2=.219, p =.017) Covariate: IQ

		controls with no history of maltreatment. Mean age = 11.4.			
31. Sheridan et al., 2017 (Study 1)	Cross-sectional, retrospective	168 adolescents from the US. Ages =13-17 and mean age = 14.91.	Sexual abuse, physical abuse, emotional abuse, physical neglect, and emotional neglect.	Inhibitory control, working memory, latent variable of EF (inhibitory control, cognitive flexibility, emotional control, initiation, working memory, planning, organization, self-monitoring)	Children who experienced neglect (physical and/or emotional) demonstrated poorer inhibitory control (β =0.25, p =0.008) and overall EF (β =0.25, p = 0.007). Neglect was not related to any significant differences in working memory. Covariates included abuse and community violence exposure. Abuse (sexual, physical, or emotional) was not related to any significant differences in inhibitory control, working memory, or overall EF. Covariates included neglect and parental education.
32. Spann et al., 2011	Cross-sectional, retrospective	30 adolescents from the US. Age range= 12-17	Emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect.	Cognitive flexibility	More experiences of maltreatment (higher CTQ score) was associated with worse cognitive flexibility (β = −.42, p = 0.02). Physical abuse and physical neglect were both found to be associated with poor cognitive flexibility r = −.43, p = .019 and r = −.46, p = .011, respectively). Emotional abuse and neglect were not found to be associated with poor cognitive flexibility.
33. Vasilevski & Tucker, 2016	Cross-sectional	82 adolescents from Australia. 39 participants had experienced maltreatment and 43 were controls.	Maltreatment (not specified)	Working memory, cognitive flexibility, attention, and inhibitory control	Participants who had experienced maltreatment demonstrated worse working memory than the control group on one measure (F= 8.83, p< 0.001) but not on another.

		Age range =12-16 years.			Participants who had experienced maltreatment performed worse on a measure of attention, cognitive flexibility, and inhibitory control than the control group (F=11.68, p <0.001). No significant differences were found with a measure of cognitive flexibility specifically.
34. Wade et al., 2019	Longitudinal	161 children from Romania. 47 children were in the care as usual group, 52 children were removed from institutions and placed into high-quality foster homes. 62 were matched children who had never been institutionalized. Assessed at ages 8, 12 and 16.	Neglect	Attention, spatial working memory	Participants who had never been institutionalized performed had better attention at age 8 than the two groups who were in care. All three groups improved at the same rate from age 8 to 16. Participants who had never been institutionalized had better spatial working memory than the two groups who were in care. There were no differences in spatial working memory between the two groups in care. All three groups showed improvements in spatial working memory over time to age 16, but the group that had never been institutionalized improved at a faster rate than the two groups who had been in care. There were no significant differences in rates of improvement between the two groups in care. (Growth parameters, intercepts, and slopes not reproduced here). Covariates: gender, birth weight
35. Wagner et al., 2015	Cross-sectional	493 adolescents and their mothers in the US; 12-13 years of age	Maternal mental illness (depression)	Latent variable of EF (working memory, attention)	Maternal lifetime history of depression was not associated with offspring EF performance.

36.Wang & Dix, 2017	Longitudinal	1364 child and their mothers in the US. Maternal depressive symptoms were reported across child's infancy and early childhood. EF was measured at school entry and third grade.	Maternal mental illness (depressive symptoms)	Sustained attention, and latent variable of EF (inhibition, working memory, and planning)	Independent of maternal depressive symptoms at 36 months, 54 months, and first grade, maternal depressive symptoms during child's infancy predicted deficits in sustained attention and EF in first grade (β =-.20, p <.01; β =-.16, p <.05 respectively). Maternal depressive symptoms during infancy predicted low maternal sensitivity at 36 months which in turn predicted poor sustained attention (β =-.03, p < .01) and executive function (β = -.11, p <0.05) at school entry.

Table 3.

ACE and EF Measures Used

Article	ACE measure	EF measure
Augusti & Melinder, 2013	Trauma Symptom Checklist for Young Children (TSCYC)	1.Cambridge Neuropsychological Test Automated Battery: Spatial Working Memory Test and Intra/Extradimensional Set Shift 2. Delis-Kaplan Executive Function System (DKEFS): Color-Word Interference Test
Baker & Kuhn, 2017	Abbreviated version of the Original 20-item Centre for Epidemiological Studies of Depression scale	1. Dimensional Change Card Sort 2. The Woodcock-Johnson III Tests of Cognitive Abilities: Numbers Reversed subtest 3. The Child Behaviour Questionnaire-Short Form
Beers & De Bellis, 2002	Psychiatric trauma interview	1. Stroop Color and Word Test 2. Digit Vigilance Test 3.Wisconsin Card Sorting Test 4. DKEFS: Trail Making Test B
Berthelsen et al., 2017	Kessler K6 Measure	1. Cogstate Assessment Battery: Identification Task, One Back Memory Task, Groton Maze Task
Bruce et al., 2013	Child welfare records	1. Go/No Go Task 2. Child Behaviour Checklist: Attention problems subscale
Bücker et al., 2012	Interview questions based off of A1 PTSD Criteria from DSM-IV.	1.Wechler Intelligence Scale for Children III (WISC-III): Digit Span 2.Wisconsin Card Sorting Test
Carrion et al., 2008	Clinician Administered PTSD Scale (CAPS-CA)	1. Go/No Go task
Carvalho et al., 2018	Juvenile Victimization Questionnaire (JVQ)	1. WISC-IV: Digit Span 2. DKEFS: Trail Making Test B 3. Hayling Test 4. Go/No-Go Task
Colvert et al., 2008	Child welfare records	1.Stroop Color and Word Test
Craun et al. 2019	MINI International Neuropsychiatric Interview	1. DKEFS: Trail Making Test B, Color-Word Interference Test 2. Wisconsin Card Sorting Task 3. Stanford-Binet Fifth edition: Verbal Working Memory
De Bellis et al., 20	Child welfare records	1. NEPSY: Visual Attention
De Prince et al., 2009	UCLA PTSD Index	1. WISC-IV: Arithmetic, letter-number sequencing, digit spn 2. Gordon Diagnostic System 3. Brief Test of Attention 4. Stroop Color and Word Test
Grekin et al., 2005	Structured Clinical Interview for the DSM-IV	1. Stroop Color and Word Test 2. Wisconsin Card Sorting Task

Groza et al., 2008	Child welfare records	1. Behaviour Rating Inventory of Executive Function
Gueron-Sela et al., 2019	Brief Symptom Inventory-18	1. Working Memory Span 2. Pick the Picture Game 3. Silly Sounds Stroop 4. Spatial Conflict 5. Animal Go/No-Go 6. Something's the Same Game
Halse et al., 2019	Beck Anxiety Inventory and Beck Depression Inventory	1. Behaviour Rating Inventory of Executive Function
Hodgdon et al., 2018	Trauma History Profile (THP) of the UCLA Posttraumatic Stress Disorder Reaction Index	1. Behaviour Rating Inventory of Executive Function
Hostinar et al., 2012	Interview with adoptive parents	1. Dimensional Change Card Sort (DCCS) scale 2. Spin the Pots Task 3. Delay of Gratification Task
Hughes et al., 2013	Beck Depression Inventory	1. Stanford Binet Intelligence Scales: Beads Working Memory Task 2. Day/Night Game 3.Tower-of-London Task
Kirke-Smith et al., 2014; 2016	Student records, interviews with teachers/tutors	1. Listening Recall Task 2. The Odd-One-Out Task 3. Verbal Fluency Test: Category Switching task, 4. Verbal Inhibition/Motor Inhibition task 5. DKEFS: Color-Word Interference Test, Design Fluency Test
Martin et al., 2019	Childhood Trauma Questionnaire	1. DKEFS: Trail Making Test B 2. Senior South African Individual Scale-Digits Backward test
McDermott et al, 2012	Child welfare records	1. Go/No Go Task
Merz et al., 2013	Child welfare records	1. Behaviour Rating Inventory of Executive Function
Mezzacappa et al., 2001	Informant interviews, child welfare records	1. The Stop Signal Task
Mothes et al., 2015	Childhood Trauma Questionnaire	1. DKEFS: Trail-making Test B 2. WISC-III and WAIS-III: Digit Span
Nadeau & Nolin, 2013	Child welfare records	1. DKEFS: Color Word Interference 2. NEPSY: Visual Attention subtest
Nolin & Ethier, 2007	Child welfare records	1. NEPSY: Visual Attention subtest, Auditory Attention and Response Set subtest, Knock and Tap subtest, the Statue Subtest, the Tower subtest
Nooner et al., 2018	Child welfare records	1. Conner's continuous Performance Test-II 2. Wisconsin Card Sorting Test
Perna & Kiefner, 2013	Child welfare records	1. WISC-IV: Working Memory indices 2. Wisconsin Card Sorting Test Categories
Sheridan et al., 2017	Childhood Experiences of Care and Abuse interview and	1. Behaviour Rating Inventory of Executive Function

	the Childhood Trauma Questionnaire	
Spann et al., 2011	Childhood Trauma Questionnaire	1. Wisconsin Card Sorting Test
Vasilevski & Tucker, 2016	Child welfare records	1. Stroop Color and Word Test 2. WISC-IV: Working Memory Index 3. Swanson Sentence Span Task
Wade et al., 2019	Child welfare records	1. Cambridge Neuropsychological Test Automated Battery (CANTAB)
Wagner et al., 2015	Schedule for Affective Disorder and Schizophrenia	1. WISC-IV: Digit Span Subtest 2. Test of Everyday Attention for Children
Wang & Dix, 2017	Center for Epidemiologic Studies Depression Scale	1.Continuous Performance Task 2. Woodcock-Johnson Psycho- Educational Battery: Memory for Sentences subtest 3.Tower of Hanoi task

Discussion

This systematic review examined the relationship between ACEs and EF outcomes in children from a range of countries and backgrounds. While the relationship between ACEs and EF outcomes among children has been understood among researchers and clinicians in the field for decades, research considering the strength of this relationship, as well as the types of ACEs and types of EFs involved in the relationship, has not been consolidated to date. As such, this systematic review served as an attempt to assess the state of existing literature regarding the different types of ACEs and EF outcomes, as well as the relationship between cumulative ACEs and EF outcomes.

Maltreatment

Half of the included studies examined maltreatment-specific ACEs. This often included physical, emotional, and sexual abuse, physical and emotional neglect, and exposure to intimate partner violence. Among these studies, there were compelling findings that suggest exposure to any of these forms of maltreatment is associated with overall negative EF outcomes, as well as specific deficits in attention, working memory, cognitive flexibility, and inhibitory control.

However, some studies did report lack of significant findings in these domains of EF. Inconsistency among these findings may be a result of the measure of cumulative maltreatment, rather than considering the unique effects of each type of maltreatment. In particular, when neglect was uniquely examined, all reported studies demonstrated significant findings, such that neglect was associated with overall EF deficits and specific deficits in inhibitory control, working memory, and attention.

It is possible that different forms of maltreatment have different implications for the development of EF. Indeed, recent theory (Sheridan & McLaughlin, 2014) and associated findings (Miller et al., 2018) suggest that maltreatment may differentially impact the HPA axis, dependent on the type of exposure. Forms of maltreatment that impose threat, such as physical, emotional, and sexual abuse, as well as exposure to intimate partner violence may lead to changes in structure and function of the ventromedial prefrontal cortex as a result of fear response in this area and chronic activation of the HPA axis associated with chronic threat (McLaughlin et al., 2014). Meanwhile, forms of maltreatment that are related to deprivation, including physical and emotional neglect, are thought to prevent typical neural development in the PFC due to less frequency/complexity of social and cognitive inputs (McLaughlin et al., 2014), resulting in documented reductions in cortical thickness size in this area (Frodl et al., 2010). This was reflected in one reviewed study that compared abuse versus neglect and demonstrated specific differences in inhibitory control and attention (Kirke-Smith et al., 2016). Notably, early experiences of neglect were also associated with chronic EF deficits and no significant rates of improvement, regardless of whether children had been placed in care or remained institutionalized (Wade et al., 2019). These findings suggest that early experiences of deprivation have lasting effects on EF and likely the PFC, irrespective of subsequent

interventions during childhood that involve psychosocial and physical care. These findings also highlight the need for the examination of timing of ACE exposure in order to fully understand how ACEs increase risk for EF deficits.

Cumulative Experiences of Adversity

The effects of multiple forms of ACEs cumulatively further complicate our understanding of subsequent EF outcomes. In this review, there were a few studies that have attempted to delineate these differences. One study noted that experiences of both abuse and neglect did not lead to differences in outcomes of non-verbal working memory or verbal inhibitory control compared to children who had experienced abuse or neglect alone (Kirke-Smith et al., 2016). However, there were differences such that those who had experienced neglect demonstrated better non-verbal inhibitory control and aspects of directed attention compared to those who had experienced both abuse and neglect. Meanwhile, another study found those who had experienced both abuse and neglect demonstrated poorer planning and problem-solving than those who had experienced neglect only (Nolin & Ethier, 2007).

Among the studies that considered neglect as a result of institutionalization, there was compelling evidence to suggest there are differences in EF outcomes based on the type of neglect experienced. In particular, one study compared differences between only emotional neglect versus experiences of both physical and emotional neglect and found that those who experienced both forms of neglect had poorer overall EF than those who had experienced only emotional neglect (Merz et al., 2013). Ultimately, no studies examined all ten ACEs, nor considered whether there is a dose-response relationship between number of ACEs experienced and severity of EF deficits. As ACEs are associated with dysregulation of the HPA axis (Kalmakis et al., 2015), it is possible that with more ACEs, further disruption in the HPA axis and subsequent

effects on the PFC occurs. However, to date there is insufficient evidence to delineate this relationship. Furthermore, it is possible that the duration of the ACE(s) influences severity of outcomes rather than solely prevalence or number of ACEs experienced. This was certainly seen among findings from Colvert and colleagues (2008), whereby length of physical neglect was associated with worse outcomes in attention, cognitive flexibility, and inhibitory control.

Family Member Mental Illness

In this review, eight studies examined the relationship between parental mental illness and subsequent EF difficulties seen among children. Overall, there appears to be a significant relationship between maternal depression and overall EF outcomes. Early experiences of maternal depression and subsequent child EF difficulties appear to be long-lasting, such that maternal depression during infancy had effects on EF later in childhood in multiple studies (Gueron-Sela et al., 2019; Hughes et al., 2012; Wang & Dix, 2017). This relationship appears to be mediated through similar processes as neglect, such that maternal depression was associated with decreases in maternal warmth and sensitivity, which mediated the relationship between maternal depression and EF outcomes (Baker & Kuhn, 2017; Wang & Dix, 2017). Moreover, though reported as only marginally significant, speed of reduction of maternal symptoms was associated with EF outcomes, such that children of mothers who recovered faster from their depressive symptoms demonstrated better EF outcomes.

There were less consistent findings when parental mental illness, rather than maternal mental illness specifically, was examined (Craun et al., 2019; Halse et al., 2019). It is possible that maternal sensitivity and warmth may uniquely contribute to the development of EFs, and when paternal mental illness is also considered, statistical significance is lost. Moreover, when maternal mental illness was examined broadly, rather than depression specifically, there was no

significant relationship to EF outcomes (Berthelsen et al., 2017). Ultimately, the relationship between having a family member with a mental illness and EF outcomes is difficult to demonstrate definitively as EF deficits are inherent in many forms of psychopathology (Snyder, Miyake, & Hankin, 2015), and thus subsequent EF deficits seen in offspring may be a result of the biological and genetic underpinning of EF deficits in psychopathology. Results of this review suggest that there are specific pathways that increase risk for EF difficulties, and maternal warmth and sensitivity may be an avenue for further examination and possible intervention.

ACEs Needing Further Study

There were next to no studies that examined the relationships between family member substance use and family member incarceration on EF outcomes. One study considered parental alcohol use disorder and found that it was associated with worse outcomes in adolescents on a measure of inhibitory control, attention, and cognitive flexibility, but not on a measure that looked at cognitive flexibility more specifically (Grekin et al., 2005). Much like mental illness, substance use disorders are associated with poor EF (Nigg et al., 2006), and thus it is possible that this relationship is explained through hereditary EF difficulties, rather than a result of exposure to parental substance use. Substance use disorders increase the risk for various forms of maltreatment (including intimate partner violence exposure in the home, physical neglect, emotional neglect, and sexual, physical, and emotional abuse; Widom & Hiller-Sturmhöfel, 2001). As such, it is possible to consider the role of family member substance use on EF by considering it as a risk factor for maltreatment exposure. Ultimately, more research is needed in this area.

No studies considered the relationship between family member incarceration and EF outcomes. Much like substance use within the family, the relationship between family member

incarceration and EF outcomes may be in part explained through other ACE variables. In particular, parental incarceration may be associated with parental substance use disorders, intimate partner violence exposure, as well as physical and emotional neglect. Regardless, further research is needed to expand upon this relationship.

ACEs, EF, and Psychopathology

Facets of EF deficits are inherent in most forms of psychopathology (Snyder, Miyake, & Hankin, 2015). As such, understanding the relationship between EF and psychopathology in relation to early adverse experiences may help us better understand this relationship. Four studies provided preliminary evidence to better understand the possible moderating relationship between ACEs and subsequent psychopathology. In particular, children with PTSD did not demonstrate differences in attention problems compared to children who had experienced trauma but did not develop PTSD (De Bellis et al., 2009), suggesting that attention problems associated with ACEs are not solely a function of presenting psychopathology. However, Hodgdon and colleagues (2018) did find that EF deficits moderated pathways between ACEs and externalizing problems and PTSS. Ultimately, further research is needed to delineate whether EF simply co-occurs with psychopathology or whether EF deficits increase risk for psychopathology, potentially providing further insight into the relationship between ACEs and risk for psychopathology.

Limitations

There are some limitations inherent in the studies reviewed. Among the 36 studies, 13 included retrospective designs, and thus may be subject to recall bias. There was also a lack of consistency in what variables were used to define EFs, and thus there was variability among the EF variables measured and reported in the reviewed studies. Further, many studies only examined one or two types of EFs, thus leading to an inability to definitively delineate whether

there are differences in other EF variables not included. It is difficult to isolate individual EF in behavioural tasks, and as such many behavioural measures of EF assess multiple forms of EF simultaneously. This makes it difficult to fully differentiate specific EF outcomes influenced by ACEs. A limitation inherent in this review is that the strength of studies was not analyzed, with variability in types of studies included (e.g., studies that had small samples due to the use of fMRI as well as large longitudinal cohort studies with significant statistical power).

Conclusions

The past twenty years of research on ACEs has broadened our understanding of how early childhood experiences can influence both physical and mental health outcomes. The prominence of this work is perpetuated by the clinical utility and applicability of knowledge to prevention and treatment efforts across health settings. While we have increased our understanding of these relationships, subsequent endeavors remain to quantify, clarify, and specify these relationships across populations, regions, and health-based research disciplines. This systematic review has attempted to extend this research to include another avenue of ACE outcome and transmission exploration, executive functioning. Through rigorous examination of the outcomes associated with ACEs, including those that incorporate biological, social, and psychological indicators of health, improved responses to these early childhood experiences can be implemented. Further, we may move closer to a future where the outcomes of ACEs are more accurately treated, and to a future where a child's ability to thrive is focused not on the absence of maladaptive experiences, but rather to the presence of positive, pro-social experiences that promote overall growth and wellbeing.

Chapter 4:

A Systematic Review of Childhood Adversity and Executive Functions Outcomes among Adults

Written in manuscript form – under review as of October 2021

Developmental psychopathology research has established early life adversity as a consistent risk factor for mental disorders. Indeed, adverse childhood experiences (ACEs) have been implicated in increased risk for many different forms of psychopathology in adulthood, including depression, anxiety, substance use disorder, post-traumatic stress disorder (PTSD), among others (Sheffler et al., 2020). Cumulative risk models of adversity, such as the foundational ACE study published by Felitti and colleagues in 1998, have highlighted that the more adversity an individual experiences during childhood, the higher their risk for negative health outcomes, including psychopathology. Building off the cumulative risk model, researchers studying ACEs have since begun to include more nuanced variables when considering the ways in which ACEs are implicated in psychopathology. This has included consideration for timing, chronicity, severity, type of adversity, and intergenerational transmission of ACEs (Narayan et al., 2021; Schalinski et al., 2016). Such explorations have clarified mechanisms by which adversity increases risk for psychopathology.

With increased examination into the relationship between adversity and psychopathology in adulthood, studies have established underlying neurobiological responses that occur in the face of adversity. For instance, chronic stress associated with ACEs is linked to dysregulation of the hypothalamic-pituitary adrenal (HPA) axis (Heim et al., 2008), changes in volume/structure of core brain structures (Calem et al., 2017; Teicher & Samson, 2016), and other lasting adaptations to neural circuitry associated with both threat and deprivation (Colich et al., 2020; Herzog & Schmahl; 2018). These research avenues have also helped delineate transdiagnostic mechanisms that may be linking ACEs to various different forms of psychopathology development later on in life.

The Dimensional Model of Adversity and Psychopathology (DMAP; McLaughlin et al., 2016), provides a framework for understanding how ACEs influence cognitive, emotional, and neurodevelopment. In particular, a newly emphasized focus has been placed on the ways in which ACEs are implicated in cognitive development, and how this is associated with the development of psychopathology. Higher ACE scores (i.e., more ACEs experienced) have been associated with poorer neurocognitive outcomes (Hawkins et al., 2020), and executive functioning in childhood (Lund et al., 2020). It is theorized that threat-related adversity (abuse and exposure to violence) is associated with adaptations in normative socio-cognitive development, while deprivation-related adversity (forms of neglect) is associated with inadequate input to promote sufficient socio-cognitive development (McLaughlin et al., 2016). Much like the cumulative risk model asserts, adversities often co-occur, and thus the cumulative effects on neurodevelopment are complex and more severe. However, there is also theory and coinciding evidence to suggest that children experiencing adversity adapt to best meet their needs in a given environment, which at times, may lead to enhanced sociocognitive skills, rather than deficits (Ellis et al., 2020).

Executive functions (EFs) are a worthwhile domain to consider in relation to adversity and neurodevelopment as they are also implicated in many forms of psychopathology. EFs include functions exhibited in the prefrontal cortex and surrounding areas and are used to carry out goal-directed behaviour, including the domains of working memory, inhibitory control, cognitive flexibility, and attention, among others. EFs are also implicated in social competence (Benavides-Nieto et al., 2017) and self-regulation, with findings demonstrating that EFs in-part underlie emotion regulation (Zelazo & Cunningham, 2007). EF deficits are seen among many disorders, including major depressive disorder (Biringer et al., 2005; Fossati et al., 2002), bipolar

disorders (Dixon et al., 2004; Mur et al., 2007), anxiety disorders (Affrunti et al., 2015; Sharp et al., 2015) PTSD (Aupperle et al., 2012; Nyvold et al., 2021; Polak et al., 2012), substance use disorders (Duijkers et al., 2016; Wilens et al., 2011), schizophrenia (Minzenberg et al., 2009; Orellana & Slachevsky, 2013), attention deficit and hyperactivity disorder (Martel et al., 2007; Swanson 2003), and autism spectrum disorder (Robinson et al., 2009; Rosenthal et al., 2013). This commonality has prompted consideration for EFs as a possible transdiagnostic mechanism that underlies the development of psychopathology (Snyder et al., 2019). Moreover, understanding the ways in which EFs are implicated in the development of psychopathology may serve clinically relevant purposes in both prevention and intervention.

To date, two known systematic reviews have been conducted that focus on the relationship between adversity and EF difficulties (Lund et al., 2020; Op den Kelder et al., 2018). However, both reviews focused on ACEs and EF outcomes in child samples. Indeed, most literature examining EF difficulties focus on child samples, as EFs are often emphasized among neurodevelopmental disorders predominantly studied in children. Still, knowing that the prefrontal cortex continues to develop into early adulthood and EFs have been found to change between adolescence and adulthood due to environmental influence (Friedman et al., 2016), a review of the relationship between ACEs and EF difficulties seen in adulthood is warranted. Specifically, the present study will examine how difficulties associated with ACEs persist across the lifespan, and whether EF difficulties are implicated in psychopathology seen in adulthood. However, a review of the relationship between ACEs and EF difficulties seen in adulthood is warranted in order to consider whether these difficulties persist across the lifespan, and whether EF difficulties are implicated in psychopathology seen in adulthood.

Method

The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA; Moher et al., 2009) guidelines were used to conduct all relevant searches and to report relevant findings. Figure 3 summarizes the selection process, whereby 16 peer-reviewed electronic databases and 17 grey literature electronic websites/databases were searched. The databases searched and search terms used are summarized in Table 4.

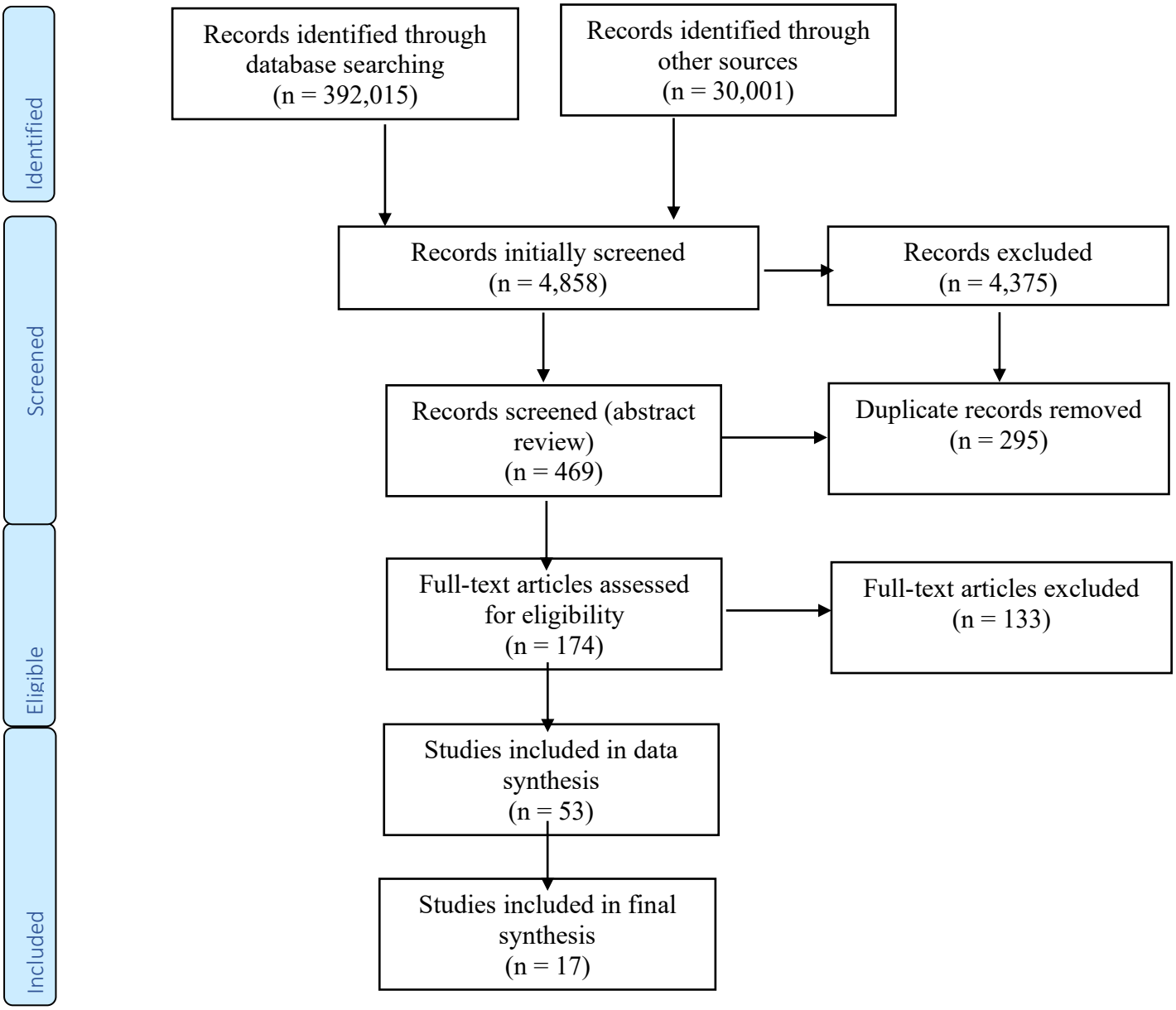

Figure 3. *PRISMA* diagram of included studies

Table 4.

Databases Searched and Search Terms Used

Databases	Grey Literature
Academic Search Complete The Cochrane Library ERIC (Educational Resources Information Center) Evidence Based Medicine (EBM) Reviews JSTOR MEDLINE PubMed ProQuest Dissertations and Theses Database PsycARTICLES PsycINFO Public Health Department of the Cree Health Board ScienceDirect Social Sciences Citation Index Social Services Abstracts SSRN (Social Science Research Network) Web of Science	Ontario Centre of Excellence for Child and Youth Mental Health McCreary Centre Society Canadian Child Welfare Research Portal Child Welfare League of Canada First Nations Child & Family Caring Society Canadian Coalition for the Rights of Children PLEA Community Services New York Academy Grey Literature Report Open Grey Repository Mental Health Commission of Canada Centre for Children and Youth in Challenging Contexts Assembly of First Nations ementalhealth.ca Institute of Mental Health Research (IMHR) CHEO Research Institute Ottawa Hospital Research Institute (OHRI) ClinicalTrials.gov
Search Terms: “early life” OR “adolescent” OR “child*” OR “infant” OR “youth” AND “advers*” OR “trauma*” OR “abus*” OR “maltreat*” OR “neglect” OR “household dysfunction” OR “parent separat*” OR “divorce” OR “parent* mental” OR “maternal mental” OR “maternal psych*” OR “mother mental*” OR “mother psych*” OR “paternal mental*” OR “mother mental*” OR “domestic abuse” OR “parent* substance” OR “parent* alcohol” OR “parent* addiction” OR “maternal substance” OR “maternal addiction” OR “maternal alcohol” OR “paternal substance” OR “paternal addiction” OR “paternal alcohol” OR “parent* incarcerat*” OR “mother incarcerat*” OR “maternal incarcerat*” OR “father incarcerat*” OR “paternal incarcerat*” AND “executive function*” OR “executive dysfunction*”	

Inclusion criteria for the study included the following:

1. Identified any type of formally classified ACEs (emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, violence against the mother, household member with substance use problem, household member with a mental health problem, or a family member who had been incarcerated).

2. Quantitatively compared any EF in individuals exposed to ACEs compared to those not exposed to ACEs or compared different types of ACEs and resultant EF outcomes.

3. Involved a measure of EF in adulthood.

4. Were written in the English language, were peer-reviewed, and were published from 2000 to the date of the searches (June 2019).

Studies were excluded from this study if:

1. They included participants with traumatic brain injuries.

2. They only ACE considered was maternal perinatal substance use.

3. If there was insufficient information to extract methodology/results of the study.

Data Extraction and Synthesis

Each title and abstract were reviewed manually using the eligibility criteria. Each search was modified to list results based on relevance and only the first 1000 results were evaluated at each database. Among those that met the study criteria, a full-text review was conducted to confirm inclusion/exclusion criteria, and to retrieve relevant information related to study design, sample, covariates used, and measured used to assess for ACEs and evaluate EF. The present study focussed on formally identified ACEs based on the initial ACE study by Felitti and colleagues in 1998 (including emotional abuse, physical abuse, sexual abuse, emotional neglect, physical neglect, violence against the mother, household member with substance use problem, household member with a mental health problem, or a family member who had been incarcerated). As such, any study that examined adversity outside of the above-mentioned ACEs, including variables such as natural disasters or community violence, were not included. However, studies that used a cumulative adversity variable, based off the ACEs identified by Felitti and colleagues, were included.

There is significant variation across literature regarding what constitutes an EF, and whether it is best to assess for a global EF composite (a latent variable of EF), or examine individual EFs (e.g., working memory, cognitive flexibility, inhibitory control, attention, etc.). As such, for the purposes of this study, findings that included latent variables of EF or that measured individual EF variables were included. This included the following variables: working memory, attention, inhibitory control (inhibition), cognitive flexibility (set-shifting), planning, and initiation, as these variables are commonly included in composites of EF (Naglieri & Golstein, 2012; Roth et al., 2005). Neurocognitive measures often include both EF measures and cognitive measures to assess intellectual ability. Measures that solely captured processing speed, verbal ability, fluid reasoning, or other variables core to intellectual ability were not included to avoid conflating outcomes associated with EF versus intellectual abilities. However, working memory, which is a core EF and also discussed in relation to intellectual ability, was included, due to its relevance in EF measures and conceptualizations. Meanwhile, emotion regulation was not included as a variable to consider, despite its connection to EF, as this is a different body of research well summarized elsewhere (see Dvir et al., 2014). Due to lack of articles in this area, as well as significant variation in measurement, EFs considered, and variety of clinical populations included within the articles included in this review, retrieved studies were not evaluated for their quality.

Results

A total of 4858 articles were initially screened leading to 469 title and abstract reviews. After the initial screening, 174 articles were identified for full-text review and 53 were identified for initial data synthesis. After close analysis with the inclusion/exclusion criteria, 17 studies were identified and included for review.

Across all studies, 10105 adults were included. Notably, one study (Feeney et al., 2013) included 6707 non-clinical older adults, which considered the relationship between sexual abuse and EF outcomes in adulthood, thus accounting for approximately 66% of the total number of adults included. Data included one longitudinal study and 16 cross-sectional studies. Among included studies, 16 studies utilized retrospective measures to determine previous experiences of ACEs, and one study used legal court documentation. Each included study is detailed in the data synthesis table (Table 2), including information on study design, participants, relevant diagnostic factors, ACEs and EFs evaluated, and main study findings.

Clinical Samples

Among included studies, there were 11 of 17 (65%) studies that involved clinical samples. This included studies focusing solely on one or more clinical population(s) or that had a majority presenting with a particular symptom presentation. Participants included those with experiences of first episode psychosis, diagnosed schizophrenia, bipolar disorder, depressive disorder with psychotic features, major depressive disorder without psychotic features, PTSD or PTSD symptoms, and substance use disorder. All 11 clinical sample studies were cross-sectional and reported ACEs retrospectively. These studies included 2108 participants total, with 1563 participants among the clinical samples and 545 participants in the control groups.

Psychotic disorders. There were four of 11 (36%) studies that involved participants with diagnoses of either schizophrenia, bipolar disorder, or depression with psychotic features. Among a sample experiencing first episode psychosis (either a schizophrenia, bipolar, and depression diagnosis), ACEs (including physical and sexual abuse, death of a parent, and being separated from home for over a year) were associated with poorer attention and concentration (p=0.047) and trended toward poorer EF and working memory (p=0.089; Aas et al., 2011a).

However, another study involving EF outcomes among those with first episode psychosis with versus without childhood abuse history found no significant differences (Sideli et al., 2014). In a sample of individuals diagnosed with schizophrenia, bipolar disorder, or depression with psychotic features, abuse and neglect were associated with deficits in working memory and EF, however, after controlling for IQ, these were no longer statistically significant (Aas et al., 2012).

In considering diagnostic differences, one study found there was no association between ACEs and EF among those with a diagnosis of schizophrenia (Aas et al., 2011). Meanwhile, the association between ACEs and EF for those with depression or bipolar trended toward significance (p=0.067; p=0.070 respectively). Similarly, Aas and colleagues (2012) also uniquely looked at each diagnostic profile and found a stronger relationship between physical abuse and EF difficulties in those with bipolar disorder. In a study that involved participants with bipolar disorder and healthy controls (Marshall et al., 2016), ACEs (emotional, physical, and sexual abuse, and emotional and physical neglect) in both groups were associated with poorer inhibitory control than those in the control group without ACEs. However, the two bipolar groups (those with and without ACEs) did not differ significantly in inhibitory control. Moreover, increased trauma exposure was associated with poorer inhibitory control (Marshall et al., 2016). Lastly, Aas and colleagues (2011) found gender differences among those with psychotic disorders, such that male participants' EF were more heavily influenced by ACEs than female participants.

Major Depressive Disorder. Three studies considered overall ACEs and EF outcomes among those diagnosed with MDD, and all three found no significant relationships (Dannehhl et al., 2017; Kaczmarczyk et al., 2018; Saleh et al., 2017), other than one study finding an association between adversity and working memory difficulties (Saleh et al., 2017). However, the number of adversities experienced predicted poorer performance on two measures of EF ($p <$

0.05; Dannehl et al., 2017). Moreover, physical abuse was found to be associated with a poorer performance on two tasks measuring EF and emotional abuse was associated with greater EFs.

Post-Traumatic Stress Disorder. Two studies considered ACEs and EF among samples where most individuals were experiencing post-traumatic stress symptoms. One study (Corbo et al., 2016) involved a comparison of military veterans who were exposed to ACEs (physical abuse, sexual abuse, family violence) versus those not exposed to ACEs. Ultimately, there were no differences in attention though there was a significant difference in affective control (a measure of inhibitory control involving affect). There were also no differences seen in EF outcomes based on PTSD symptom severity (Corbo et al., 2016). Meanwhile, in a small sample of women exposed to child sexual abuse with post-traumatic stress symptoms (83% of participants) versus controls (Rivera-Velez et al., 2014), sexual abuse was associated with poor working memory, but there were no differences in measures of attention. In this study, PTSD symptom severity was associated with difficulties in working memory and attention (Rivera-Velez et al., 2014).

Substance Use Disorder. One study examined the relationship between ACEs and EF among those with crack cocaine use disorder. Narvaez and colleagues (2012) found that ACEs (emotional, physical, and sexual abuse, and emotional and physical neglect) were associated with poorer EF, working memory, and impulsivity.

Non-Clinical Samples

Among included studies, there were six of 17 (35%) studies that involved non-clinical samples. There were three clinical sample studies that provided sufficient information regarding their control groups that outcomes could be summarized here. The non-clinical sample includes samples of university students, parents from a parent-child dyad study, middle-age adults from a

prospective study, and older adults. Six of the seven studies including non-clinical samples were cross-sectional and ACEs were reported retrospectively. Among these studies, four of them focussed on maltreatment-related ACEs (abuse, neglect, and family violence), one formally assessed all ten ACEs, and one focused on parental alcohol use.

There were three studies that examined ACEs and EF outcomes among university students. Two studies examined EF using a self-report measure (the Behaviour Rating Inventory of Executive Function [the BRIEF]). Daly and colleagues (2017) found that a history of adversity (abuse and/or neglect) was associated with metacognition difficulties (p=0.03) as well as cognitive inhibition and switching (p=0.01). However, abuse was not associated with any differences in impulsivity or another measure of EF (Wisconsin Card Sorting Test). Meanwhile, Schroeder and Kelly (2008) examined university student EF outcomes associated with parental alcohol use and found that participants who had parents with alcohol use disorder had greater behavioural regulation difficulties (p <0.05) and specifically in set-shifting (p <0.01), emotional control (p <0.05), and self-monitoring (p <0.01). However, there were no differences seen in the metacognition composite. Lastly, Daly and colleagues (2017) also found that severity of maltreatment among university students was implicated in EF measures inhibition and switching. Meanwhile, Mark and colleagues (2019) focussed solely on abuse (physical, emotional, and sexual) and found that a history of abuse was associated with poorer working memory (p <0.05) and moderate to high levels of abuse were associated with poorer attention (p <0.05) among university students.

In a sample of adults ages 18-45 years (35% diagnosed with depression and 9% diagnosed with PTSD), various relationships between certain ACEs and EF were found (Gould et al., 2012). In particular, abuse was associated with difficulties in set-shifting while neglect was

associated with difficulties in affective control. Emotional abuse/neglect was associated with difficulties in affective control while physical abuse/neglect was associated with attentional set-shifting. Moreover, sexual abuse associated with attentional set-shifting and working memory. Meanwhile in a sample of 73 parents (predominantly mothers), the number of ACEs predicted EF difficulties (Guss et al., 2018). In a cohort study of 792 middle-age adults (mean age= 41 years; Nikulina & Widom, 2013), a composite measure of maltreatment (physical neglect and abuse, and/or sexual abuse) was associated with poorer EF. However, in looking at each type of maltreatment individually, only neglect was associated with poorer EF (p <0.001). Lastly, in a study of 6707 older adults (50 years and older; Feeney et al., 2013), childhood sexual abuse was associated with better EF, meanwhile there were no differences in attention seen between those exposed to CSA versus the control group.

Among the outcomes of healthy controls reported in the clinical studies, Aas and colleagues (2011) found no association between ACEs and EF among healthy controls. Meanwhile, Dannehl and colleagues (2017) found that emotional neglect was associated with poor outcomes in working memory among healthy controls. Marshall and colleagues (2016) found that their control group exposed to ACEs demonstrated poorer inhibitory control than those who had no ACE exposure. Sideli and colleagues (2014) found that childhood abuse history was associated with poorer EF and working memory among their healthy control group

Table 5.

Data Synthesis Results

Author (17)	Study design	Participant description	Diagnostic factors	ACEs reviewed	EFs reviewed	Main findings
Aas et al., 2011	Cross-sectional; retrospective	276 participants ages 16-65. 138 participants with first episode psychosis and 138 controls.	First episode psychosis (schizophrenia, bipolar disorder, and depression with psychotic features)	Physical abuse; sexual abuse; death of a parent; separated from home for over a year	Executive function and working memory; attention and concentration	ACEs associated with poorer attention and concentration ($p=0.047$) and trended toward poorer executive function and working memory ($p=0.089$). No association between ACEs and EF among participants with schizophrenia. Trend toward significance for the association between ACEs and EF among participants with bipolar disorder ($p= 0.070$). Trend toward significance for participants with depression for attention, concentration, and mental speed ($p=0.070$) and executive function and working memory ($p=0.067$). Gender differences found, whereby males' attention, concentration, and mental speed, and executive function and working memory, were more heavily influenced by the examined ACEs.
Aas et al., 2012	Cross-sectional; retrospective	406 participants with psychotic disorders	Schizophrenia; bipolar; depression with	Physical abuse; sexual abuse; emotional abuse;	Working memory; executive function	Physical abuse, sexual abuse, and physical neglect were all associated with deficits in working memory and executive function ($p = 0.04$ to $p <$

		(mean age = 30 years)	psychotic features	emotional neglect; physical neglect		0.001). After controlling for IQ, these no longer reached statistical significance. In separating sample based on diagnostic profiles, a stronger relationship between physical abuse and executive function difficulties emerged in those with bipolar disorder. Covariates: IQ, age, and gender
Corbo et al., 2016	Cross-sectional; retrospective	240 military veterans (mean age = 30). 80 participants with history of ACEs.	PTSD symptoms	Physical abuse; sexual abuse; family violence	Attention; affective control	No significant differences in attention between those with and without ACEs; significant difference in affective control (p=0.021; p=0.039) No differences seen based on level of PTSD severity. Covariates: age, PTSD severity and education level.
Daly et al., 2017	Cross-sectional; retrospective	110 university students (ages 18-23 years). 66 participants with history of ACEs.	n/a	Emotional, physical, sexual abuse; emotional, physical neglect	Individual EF variables from BRIEF (inhibition, cognitive flexibility, emotion regulation, initiation, working memory, planning, organization, and self-monitoring), and indices behavioural regulation (inhibition, cognitive flexibility, emotion regulation) and metacognition (initiation, working memory, planning,	Maltreatment group performed worse on cognitive inhibition and switching (p=0.01). History of childhood maltreatment associated with more meta cognition difficulties (p=0.03) Severity of maltreatment predicted poorer performance on tasks of inhibition and switching. Covariates: IQ, depression, anxiety

					organization, and self-monitoring)	
Dannehl et al., 2017	Cross-sectional, retrospective	131 participants (mean age =36 years); 91 participants with MDD and 40 healthy controls.	Major depressive disorder (MDD)	sexual, physical and emotional abuse, and physical and emotional neglect	Executive functions, working memory	Childhood adversity did not influence EF outcomes in patients with MDD. Number of traumas predicted poorer performance on two measures of executive functions in those with MDD ($p < 0.05$). Physical abuse predicted poorer performance on two different measure of executive function ($p < 0.05$) among those with MDD. Emotional abuse was associated with better performance in executive function ($p <0.05$) among those with MDD. Among healthy controls, emotional neglect predicted poorer working memory ($p < 0.05$).
Feeney et al., 2013	Cross-sectional, retrospective	6707 older adults (50 years and older, mean age = 59 years); 451 experienced child sexual abuse.	n/a	Sexual abuse	Executive function, attention	No differences in attention. Those exposed to CSA demonstrated greater executive function ($p <0.05$). Covariates: age, gender, education
Gould et al., 2012	Cross-sectional, retrospective	93 participants (age range =18-45 years). 60 participants	MDD (35%), PTSD (9%)	emotional, physical, and sexual abuse, and emotional	Attentional set shifting, visual attention, working memory, affective control	Abuse associated with difficulties in set-shifting. Neglect associated with difficulties in affective control. Emotional abuse/neglect associated with difficulties in affective control. Sexual

		with history of ACEs.		and physical neglect.		abuse associated with attentional set-shifting and working memory. Physical abuse/neglect associated with attentional set-shifting. Covariates: age and depression
Guss et al., 2018	Cross-sectional, retrospective	73 parent participants (predominantly female)	n/a	10 formal ACEs	Overall EF; meta cognition (Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor scales); Behavioral Regulation (self-monitoring, conversion, control, and emotion suppression)	Number of ACEs predicted overall EF score ($p < 0.05$) Covariates: family demographics
Kaczmarczyk et al., 2018	Cross-sectional, retrospective	143 participants (mean age 36 years). 68 participants with MDD and 75 healthy controls.	MDD	emotional, physical, and sexual abuse, and emotional and physical neglect.	Executive function, working memory	No significant findings.
Mark et al., 2019	Cross-sectional, retrospective	43 university student participants (age range = 18 to 23 years). 24 participants with ACE history.	n/a	Abuse (physical abuse, emotional abuse, sexual abuse)	Executive function, attention, working memory	Abuse history associated with poorer working memory ($p < 0.05$). Those with moderate to high levels of abuse showed poorer attention ($p < 0.05$). No other significant findings.

						Covariate: drug use
Marshall et al., 2016	Cross-sectional, retrospective	323 participants (mean age = 39 years). 233 individuals with bipolar disorder and 90 healthy controls	Bipolar Disorder	emotional, physical, and sexual abuse, and emotional and physical neglect	Inhibitory control	Both trauma groups (BD and HC) showed poorer in inhibitory control than the HC normative group ($p < 0.01$). Both BD groups (trauma and no trauma) did not differ significantly in inhibitory control. Increased trauma (total CTQ score) related to poorer inhibitory control ($p = .006$) Covariate: depression
Narvaez et al., 2012	Cross-sectional, retrospective	84 participants (mean age= 29 years). 67% had history of ACEs.	Substance use disorder (crack cocaine use disorder)	emotional, physical, and sexual abuse, and emotional and physical neglect.	Executive function, working memory, impulsivity	Childhood trauma associated with working memory scores ($p=0.038$) but not after controlling for education. Childhood trauma was associated with poor executive function ($p<0.05$; $p < 0.01$) Childhood trauma was associated with impulsivity after controlling for education ($p=0.039$)
Nikulina and Widom, 2013	Prospective cohort study	792 middle adults (mean age = 41 years). 57% exposed to ACEs and 43% control group.	n/a	Physical neglect, physical abuse, sexual abuse	Executive function	Child maltreatment predicted poorer performance in executive function (trail making A: $p < 0.001$; trail making B: $p < 0.001$) Sexual and physical abuse did not predict poor executive function, but neglect did ($p < 0.001$) Covariates: age, sex, race, IQ, depression, excessive alcohol use

Rivera-Velez et al., 2014	Cross-sectional, retrospective	24 female participants (mean age = 29 years). 12 participants with ACE history, 12 controls.	PTSD symptoms (83%)	Sexual abuse	Working memory; attention	CSA associated with poorer working memory ($p = 0.28$). No significant differences were found in measures of attention. PTSD symptom level associated with difficulties in working memory and attention.
Saleh et al., 2017	Cross-sectional, retrospective	129 university student participants (age range =20 to 50 years. 64 participants with MDD and 65 healthy controls	Major depressive disorder	Physical abuse; sexual abuse; domestic violence; neglect; divorce	Executive function, working memory	No significant effect of total early adversity score on EF. Early adversity was associated with difficulties in working memory ($p = 0.026$). Covariates: age, sex, and education.
Schroeder & Kelley, 2008	Cross-sectional, retrospective	272 university student participants. 84 with parents with alcohol use disorder users; 188 in control group.	n/a	Parental alcohol use	Metacognition (initiate, working memory, plan/organize, organization of materials, and monitor scales); Behavioral regulation (self-monitoring, conversion, control, and emotion suppression)	Adults with parents with alcohol use disorder had greater behavioural regulation difficulties ($p <0.05$). No significant differences in metacognition. Differences also seen in set-shifting ($p <0.01$) emotional control ($p ,0.05$); and self-monitoring ($p <0.01$).
Sideli et al., 2014	Cross-sectional, retrospective	259 participants (mean age= 29 years). 134 participants with first episode psychosis and	First episode psychosis	Physical and sexual abuse	Executive function, working memory, attention	Control group who had experienced abuse performed more poorly in executive function and working memory than control group without abuse history ($p= 0.03$). No significant differences among those with psychosis with and without abuse history in terms of EF outcomes.

		125 healthy controls.				

Discussion

This systematic review summarized studies that have examined ACEs and EF outcomes among adult samples across a range of clinical and non-clinical populations and ages. While it is understood that ACEs are related to deficits in EF among child samples (Lund et al., 2020; Op den Kelder et al., 2018), no known reviews to date have summarized these outcomes in adulthood or among adult clinical samples. Based on the findings of the present review, there is evidence to suggest that ACEs (abuse and neglect in particular), are associated with EF difficulties seen in early and middle adulthood. Moreover, there appears to be differences in outcomes based on the type of adversity experienced, and in relation to different mental disorder presentations.

The majority of reviewed articles involved adult clinical samples. Research on EF includes frequent measurement across community samples in school age children thus providing a broader understanding of EF in child samples. Meanwhile, EF measurement among adult samples is often done in clinical settings among those presenting with mental disorders. Ultimately, there was some evidence to suggest that EF difficulties are associated with ACEs among those with first episode psychosis, though it was not consistent (Aas et al., 2011; Sideli et al., 2014). When looking at EF among those who have been diagnosed with a psychotic disorder for longer periods of time, there was an association between ACEs and EF, though this was no longer significant when controlling for IQ (Aas et al., 2012). Notably, two studies found that there was an association between ACEs and EF difficulties among those diagnosed with bipolar disorder more so than schizophrenia (Aas et al., 2011; Aas et al., 2012), and that increased exposure to ACEs among those with bipolar was associated with poorer inhibitory control (Marshall et al., 2016). Both ACEs and EF are commonly seen among those with psychotic

disorders. In particular, severity of EF difficulties is associated with schizophrenia severity and long-term outcomes of the disorder (Orellana & Slachevsky, 2013; Reed et al., 2002). As such, the current findings do not clarify whether ACEs and EF difficulties simply might co-occur among this clinical population, or whether ACEs increase risk for EF difficulties among this population. However, there is compelling evidence to suggest there is a relationship between ACEs and EF difficulties among those with bipolar disorder in particular.

Overall, the present review found minimal evidence to suggest that ACEs are associated with EF difficulties among those with major depressive disorder (Dannehhl et al., 2017; Kaczmarczyk et al., 2018; Saleh et al., 2017). However, there were some nuanced findings to suggest that the number of ACEs and physical abuse both predicted poorer EF among those with MDD. Moreover, ACEs were found to be associated with poorer working memory (Saleh et al., 2017). A history of child maltreatment is associated with a higher risk of depression as well as more severe depressive symptoms (Humphreys et al., 2020). This may be conflating the association between ACEs and EF among this population, where if ACEs are linked to symptom severity, this may also implicate EF (whereas increased EF difficulties are also associated with symptom severity among MDD; Snyder, 2014).

Among those with PTSD, ACEs appear to be associated with certain EF difficulties. In particular, ACEs may increase difficulties in inhibitory control involving affect but may not be associated with attention difficulties (Corbo et al., 2016; Rivera-Velez et al., 2014). Notably, there was inconsistency regarding whether PTSD symptom severity influenced EF difficulties (Corbo et al., 2016; Rivera-Velez et al., 2014). Previous findings suggest EF deficits moderate pathways between ACEs and PTSD in childhood (Hodgdon et al., 2018), and the findings from the present study provide some support toward this framework. Moreover, there is evidence to

suggest that those with PTSD demonstrate hypoactivity in the ventromedial prefrontal cortex and hyperactivity in the amygdala (Koenigs & Grafman, 2009). These changes may be based on timing of adversity among those with PTSD, with earlier adversity more heavily associated with amygdala reactivity (Sicorello et al., 2020).

The present study also included findings from non-clinical samples, which largely support a relationship between ACEs and EF among those in early and middle adulthood. However, there appears to be differences in EF outcomes depending on the adversity experienced. One study found that abuse was associated with difficulties in cognitive flexibility and working memory, while neglect was associated with poor affective inhibitory control (Gould et al., 2012). Meanwhile, another study found that only neglect, not abuse, was associated with poorer executive function (Nikulina & Widom, 2013). These findings are similar to those reported among child samples (Lund et al., 2020), and suggest consideration for type of adversity, as well as the duration, chronicity, and severity of adversity, in terms of influence on EF outcomes. Indeed, it is possible that threat-related adversity (abuse and exposure to domestic violence) may be associated with socio-cognitive adaptations and subsequent changes in EF development to best meet the needs of the environment. Meanwhile, there is significant evidence among child samples that suggest that neglect is associated with poor EF development (Lund et al., 2020), which may be linked to insufficient social input.

There were two studies that reported significant findings regarding ACEs and improved EF outcomes. In particular, a large study on older adults found that exposure to child sexual abuse was associated with greater EF than those who did not experience sexual abuse (Feeney et al., 2013). Moreover, emotional abuse among those MDD was associated with better EF outcomes (Dannehl et al., 2017). These findings are consistent with the “Hidden Talents”

theoretical framework (Ellis et al., 2020), which suggests that children may develop enhanced skills for problem-solving among adverse and stressful environments. This appears to be particularly likely among those exposed to abuse. Ultimately, limitations in current studies, including solely focusing on cumulative adversity as predictors, as well as difficulty accurately measuring each form of adversity experienced, leads to confounded results. Moreover, adversities often co-occur, thus leading to Felitti's ACE work as an effective preliminary model (Felitti et al., 1998). However, it often negates the possible adaptive skills/resilience demonstrated, by focusing on overall net negative outcomes. In particular, measures of adversity that include abuse and neglect together may be minimizing the impact of neglect and maximizing the impact of abuse on EF difficulties.

Limitations

There were some limitations inherent in the articles reviewed. In particular, all but one was cross-sectional. As such, they only captured associations and were not able to ascertain EF changes in the aftermath of ACE exposure. Moreover, all but one of the studies involved retrospective reporting of ACEs, which may influence accuracy. EF measurement varied significantly across studies, and thus may influence interpretation of outcomes. There were insufficient studies to report on ACEs and EF outcomes among older adults. Finally, the present study is limited in that we did not evaluate the quality of the manuscripts incorporated after they met inclusion criteria. As such, there is variability across studies, with varying sample sizes, covariates examined, data analysis plans, and measures used to capture ACEs and EF.

Future Directions

While many of the reported findings across the reviewed studies are inconsistent, they represent knowledge building toward better understanding how early adverse life experiences

shape the development of EFs. Future research may warrant exploring the influence of ACEs on EF in an older adult population who are also more susceptible to EF difficulties with aging. Moreover, studies are beginning to examine relevant brain structures and pathways implicated in the prefrontal cortex through imaging (e.g., Sheridan et al., 2017), in order to better understand the underlying mechanisms by which ACEs change the development of EFs. This research, alongside more nuanced examinations of type, severity, chronicity, and duration of adversity may continue to shape our understandings. Finally, due to the prevalence of EF difficulties in psychopathology, research is beginning to consider the transdiagnostic role of EF among clinical disorders (Romer et al., 2021) and as a possible mechanism of change among clinical interventions (Weldon, 2020).

Conclusion

The past three decades of research have increased our understanding of how adverse experiences during child development can increase risk for EF difficulties. There is evidence to suggest that these are implicated in both clinical and non-clinical adult populations. There are preliminary findings to suggest that adult outcomes of EF associated with adversity vary based on the type of adversity experienced. Moreover, some unique findings suggest that adversity, namely abuse, may be associated with certain enhanced EFs. Ultimately, further work is needed to disentangle the pathways by which these relationships exist. Even further, knowing the neurodevelopmental risks associated with childhood adversity may have important clinical utility. With increased understanding of such relationships, and subsequent clarification and specificity of these relationships across various groups of individuals, clinicians may better understand how to intervene and mitigate harms.

Chapter 5:

Method

Method

This community-based research study was established within Dilico Anishinabek Family Care (Dilico), a large Indigenous community-governed organization that provides culturally centred wrap-around supports through child welfare, health services, and mental health and addictions in order to support individual, family, and community needs across First Nations communities in the Robinson-Superior Treaty Area. The inception of this project came from the Director and Assistant Director of Mental Health and Addictions at Dilico who were looking to better support clients experiencing ongoing difficulties in relation to childhood adversity and at their Adult Residential Treatment Centre (ARTC) for substance use difficulties.

ARTC is a National Native Alcohol and Drug Abuse Program (NNADAP; Indigenous Services Canada) with funding from both NNADAP and the Local Health Integration Network (LHIN) and is located on Fort William First Nation near Thunder Bay, Ontario. It is a 22-bed residential treatment facility that hosts 4-5 week single and mixed-gender treatment cycles aimed at supporting adults experiencing difficulties with substance use through the integration of cultural supports and healing practices (e.g., Sweat Lodge, Elders, traditional practices) with Western biomedical approaches to addiction treatment (e.g., access to nursing/medication management, opioid agonist therapy). Each year, ARTC provides approximately nine 4-5-week cycles that admit 18-22 clients per cycle. ARTC receives various streams of referral, including through corrections, child welfare, community social or health service providers, or self-referrals. ARTC accepted both Indigenous and non-Indigenous adults into treatment, with the intent to support anyone who can benefit from their culturally-based treatment program.

Dilico has a longstanding organizational research protocol used to carry out valuable research endeavours guided by community needs, maintaining that all projects follow

Ownership, Control, Access, and Possession (OCAP™) principles. OCAP™ principles include standards for how First Nations data should be collected, protected, used, and shared and includes that First Nations have control over their data collection processes in their community (FNIGC, 2014). As such, all knowledge, data, and information collected from this study are owned by Dilico Anishinabek Family Care and the communities they serve. Novel research projects, like the current study, are first proposed to Dilico's Research Advisory which is composed of individuals who demonstrate an understanding of the First Nations peoples serviced in the Robinson-Superior Treaty Area as well as Dilico's organizational mandates and policies. The Research Advisory ensured that this project aligned with the values of the organization and the mandate from the governing First Nations.

This project was then brought forward for approval by Dilico's Board of Directors[1], who include members from involved First Nations communities, many of whom are band councillors or chiefs in their communities. These members maintain regular communication with their own community to represent broad community needs at Board of Director meetings. Once this project was approved by the Board of Directors, it was brought back to Dilico's Research Advisory Board where all data collection methods used were decided upon. Agreed upon data collection methods included the administration of various self-report questionnaires completed at two separate points during treatment cycle. A detailed overview of data collection is provided in the Procedures section.

The Research Advisory Board included quarterly meetings allowing for ongoing updates by the research team on study methodology where modifications could be made as necessary, maintaining that Dilico retained control over research processes at every stage. The research team was composed of a tenured faculty lead, two doctoral students (including this writer), and

[1]See https://www.dilico.com/about/governance/ for Dilico's Board of Directors.

three research assistants. Both doctoral students led all stakeholder engagement. Regular meetings with ARTC leadership and staff also occurred to provide relevant information and updates from the study, thus allowing ongoing organizational access to de-identified data and useful information for the involved communities. In particular, this was an avenue to provide staff with data from the study they could use in providing more informed clinical care. For example, within the first year of data collection, preliminary data highlighted the large proportion of participants who presented with post-traumatic stress symptoms. This was brought forward to leadership staff who were able to inform their clinical care accordingly. Finally, Dilico also controls possession over the data collected including the ways in which it is evaluated and disseminated, in keeping with OCAP™ principles. The present study also received approval from Lakehead University's Research Ethics Board (protocol number: 1466763).

Research Questions

In the present study, four research questions were examined in order to meet the overall objective set forward by the Indigenous community partner, which was to better understand the relationship between ACEs and substance use concerns among clients attending an Indigenous substance use treatment program. After discussions with both organizational leadership and treatment staff, as well as reviews of the relevant literature (detailed in the preceding three chapters), the following research questions were developed:

1. Do ACEs predict EF difficulties among clients attending an Indigenous substance use treatment program?
2. What is the relationship between ACEs, EFs, and the age substances were first used among clients attending an Indigenous substance use treatment program?

3. What is the relationship between ACEs, EFs, and substance use motives among clients attending an Indigenous substance use treatment program?

4. Do ACEs or EF predict speed of relapse post substance use treatment?

The above-mentioned research questions were then used to inform four sets of hypotheses, as detailed in the following section.

Hypotheses

H1: ACEs and EFs

H1.1. ACE scores will predict EF outcomes, such that higher ACE scores will predict more significant deficits in overall EF, as well as individual EFs including working memory, attention, emotion regulation, inhibitory control, and cognitive flexibility.

H1.2 Individual ACEs will predict worse overall EF, as well as individual EFs including working memory, attention, emotion regulation, inhibitory control, and cognitive flexibility.

H1.4. Severity of neglect will predict overall EF, as well as individual EFs including working memory, attention, emotion regulation, inhibitory control, and cognitive flexibility.

H1.5. Individuals exposed to childhood neglect will demonstrate poorer outcomes in cognitive flexibility than those exposed to physical, emotional or sexual abuse.

H1.6. Individuals exposed to neglect will demonstrate differences in outcomes in cognitive flexibility and initiation than multi-type adversity (experiences of both abuse and neglect).

H2: ACEs, EFs, and age of first substance use

H2.1. ACE scores will predict age of first substance use, such that higher ACE scores will be associated with earlier age of first use.

H2.2. EF scores will predict age of first use, such that more significant deficits in overall EF, working memory, attention, emotion regulation, inhibitory control, or cognitive flexibility will be associated with earlier age of first use.

H2.3. Overall EF, working memory, attention, emotion regulation, inhibitory control, and cognitive flexibility scores will moderate the relationship between ACE scores and age of first use.

H3: ACEs, EF, and substance use motives

H3.1. ACE scores will predict self-reported motives for engaging in substance use, such that individuals with higher ACE scores will be more likely to engage in substance use for coping-anxiety and coping-depression motives than those with lower ACE scores.

H3.2. EF scores may be associated with self-reported motives for engaging in substance use. This hypothesis is largely exploratory, and thus no specific hypotheses regarding specific EFs and motives were proposed.

H4: ACEs, EF, and relapse post treatment

H4.1. Among participants who have attended treatment before, ACE score will predict time sober post treatment, such that higher ACE score will predict fewer days before relapse.

H4.2. Among participants who have attended treatment before, EF deficits will predict time sober post treatment, such that deficits in attention, emotion regulation, inhibitory control, and cognitive flexibility will predict fewer days before relapse.

Participants

Participants in the study included 80 adults receiving treatment for substance use problems at Dilico Anishinabek Family Care's (Dilico) Adult Residential Treatment Centre (ARTC). Data collection occurred over two years (January 2019 – January 2021) across 18 treatment cycles. The mean age of the sample was 35 years (SD=10.17; age range=20 to 65 years). Relevant participant demographic information can be found in Table 6. To meet criteria for the study, participants had to be 18 years of age or older, be clients of ARTC at the time of participation, fully capable to consent and participate in all study procedures (e.g., completion of self-report questionnaires), and read, speak, and understand English. Individuals who had a mental illness with psychotic symptoms or those with a significant diagnosed brain injury (liable to confound ACE as a driver of brain health) were excluded from the study. Table 7 provides overview of relevant mental health and substance use variables.

Table 6.

Participant Demographics

Variable		Total (N=80; %)
Sex	Male	43 (54)
	Female	37 (46)
Gender identity	Male	43 (54)
	Female	34 (43)
	Gender fluid	1 (1)
Indigenous	Indigenous	57 (71)
	Non-Indigenous	18 (23)
	Did not disclose	5(6)
Education	Elementary	1 (1)
	Some high school	27 (34)
	High school graduate or GED	15 (19)
	Some college	30 (38)
	University degree	6 (6)
Marital status	Married	5 (6)
	Common law/serious relationship	22 (28)

	Widowed	3 (4)
	Separated/Divorced	10 (12)
	Single	38 (48)
Annual income	< $10 000	29 (36)
	$10 000 to $19 000	24 (30)
	$20 000 to $29 999	8 (10)
	$30 000 to 39 999	3 (4)
	$40 000 to $60 000	3 (4)
	> $60 000	5 (6)
Employment status	Full time	13 (16)
	Part-time	3 (4)
	Student	5 (6)
	Sick leave	3 (4)
	Unemployed	19 (24)
	Retired	8 (10)
	Disability (ODSP, OW)	29 (36)
	Home/parenting	3 (4)

Table 7.

Participant Mental Health and Substance Use

Variable		Total (N=80; %)
Prior FASD diagnosis		6 (1)
Depressive symptoms[a]		15 (19)
PTSD symptoms[b]		49 (61)
Primary substance used	Alcohol	37 (46)
	Crack Cocaine/Cocaine	21 (26)
	Opioids	5 (6)
	Amphetamine	5 (6)
	Other	4 (5)
Previous treatment attendance		45 (56)

[a]Number of participants that met DASS clinical threshold for moderate or above depressive symptoms

[b]Number of participants that met PCL-5 clinical threshold for PTSD symptoms

Procedure

Recruitment

The research team (two doctoral students and/or research assistants) conducted a group session at ARTC during the first few days of each cycle where the study was explained to clients (see Appendix H for verbal script) and an informational letter (see Appendix I) was provided. Clients were assured that their decision to take part or not to take part in the study, or to drop out of the study at a later time, would not affect their access to services or the care provided by the staff at ARTC. Participants were informed their data would be confidential and anonymous. Further, participants were explained that data collection would occur at two time points, and that the second time point would involve more sensitive questions to be completed with the support of their counselor. They were also explained that participation would involve access to their intake form to collect demographic information. If they indicated they would like to participate, they were then be given a consent form (see Appendix J) to sign.

Data Collection

Data collection occurred at two time points. The first phase of data collection occurred within the first few days of the treatment cycle, immediately after participants had provided informed consent. Participants individually completed the following self-report measures at this phase: ARTC Intake Measure (Appendix A), Time 1 Questions from the HHQ (Appendix B), the DASS21 (Appendix E) and PCL-5 (Appendix F). Approximately halfway through treatment, participants completed the Time 2 Questions from the HHQ (Appendix C) and the CEFI (Appendix D). These questionnaires were completed with the help of the participant's individual treatment counselor. The HHQ questions on ACEs were administered at this time as it coincides with when childhood trauma is discussed in the treatment process, thus minimizing discomfort or

distressing emotions from completing the more sensitive items of the questionnaire. Moreover, participants' counselors were there to provide support to participants this time. The CEFI was administered at this second time point to minimize the role that recent substance use before entering treatment and subsequent experiences of withdrawals may play on EF outcomes. Participants were able to withdraw from the study at any point as well as request that their data be removed at any time. All physical data, including signed consent forms and paper participant de-identified measures, were stored in a restricted, secure area, within Dilico and will remain there for a period of 5 years, consistent with OCAP™ principles.

Measures

Adult Residential Treatment Centre (ARTC) Intake Measure (Appendix A). The Adult Residential Treatment Centre (ARTC) intake measure is a clinical tool used by the treatment centre to assess past substances used, age of first substance use for substances of choice, previous treatment attendance, days sober post treatment previously, and other clinically relevant information of clients at time of intake into residential treatment. From this measure, age of first alcohol or cannabis use was included for those who provided this information. Further, days sober post treatment was also used.

Family Health History Questionnaire (HHQ; Appendices B and C). The findings linking ACEs to various health outcomes published by Felitti and colleagues in 1998 came from data collected in the CDC-Kaiser Adverse Childhood Experiences Study (Felitti et al., 1998). This study utilized the Family HHQ in data collection. The portions of the HHQ used for the study involve demographic items (e.g., age, gender, and socioeconomic status), items related to substance use and mental health (e.g., previous diagnoses of mental disorders), and items related to experiences of child abuse and neglect and household dysfunction. Among the HHQ, there are

items that measure five types of child harm (physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect) and five types of household dysfunction (incarceration of a family member, household substance use, household mental illness, parental divorce, and mother experienced domestic violence). Each ACE variable was scored according to methods utilized by the ACE Study as described by Dubes and colleagues (2003).

Physical abuse was assessed with the following questions "*Sometimes parents or other adults hurt children. While you were growing up, during the first 18 years of your life, how often did a parent, step-parent or adult living in your home: Actually push, grab, shove, slap, or throw something at you?"* and *"Hit you so hard that you had marks or were injured?*" These items are on a 5-point Likert scale (1= "Never to 5= "Very Often"). Responses of "Sometimes", "Often", or "Very Often" to either item defines physical abuse (Dube et al., 2003). Emotional abuse was assessed with the following questions: "*Sometimes parents or other adults hurt children. While you were growing up, during the first 18 years of your life, how often did a parent, step-parent or adult living in your home: Swear at you, insult you, or put you down?*" and *"Act in a way that made you afraid that you might be physically hurt"* These items are on a 5-point Likert scale (1= "Never True" to 5 = "Very Often True"). Responses of either "Often" or "Very Often" on either item defines emotional abuse (Dube et al., 2003).

Sexual abuse was assessed with the following questions: "*Some people, while growing up in their first 18 years of life, had a sexual experience with an adult or someone at least five years older than themselves. These experiences may have involved a relative, family friend, or stranger. During the first 18 years of your life, did an adult, older relative, family friend, or stranger ever sexually abuse you? This can include an adult touching your body in a sexual way, having you touch their body in a sexual way, attempting to have any type of sexual intercourse*

(oral, anal, or vaginal) with you, or having sexual intercourse with you." and "*Anyone ever force or threaten you with harm in order to have sexual contact, such as touching your sexual parts or trying to have intercourse with you?"* A "yes" response to either item indicates experience of sexual abuse (Dube et al., 2003). There are also questions pertaining to age and frequency of sexual abuse. These questions were modified from the original HHQ for the purposes of this study. The HHQ contained four items measuring more specific information regarding the sexual abuse respondents endured (e.g., specific descriptors around attempted/carried out oral, anal, or vaginal intercourse). We collapsed these into only two items to minimize distress for respondents.

Emotional neglect was assessed with the following questions: "*There was someone in my family who helped me feel important or special*."; "*I felt loved.*" "*People in my family looked out for each other*."; "*People in my family felt close to each other.*" and *"My family was a source of strength and support."* Each item is on a 5-point Likert scale (1= "Never True" to 5= "Very Often True) and is reverse scored. Scores of 15 or greater represent experiences of emotional neglect (Dube et al., 2003). Physical neglect was assessed with the following questions: "*I didn't have enough to eat*."; "*My parents were too drunk or too high to take care of me.*"; "*I had to wear dirty clothes."*; "*There was someone to take me to the doctor if I needed it.*"; and "*I knew there was someone there to take care of me and protect me.*" The latter two items are reversed scored. Each item is on a 5-point Likert scale (1= "Never True" to 5= "Very Often True"). Scores of 10 or greater represent experiences of physical neglect (Dube et al., 2003). To determine an overall composite of severity of neglect, each item was added to create an overall neglect composite score, incorporating both physical and emotional neglect.

Incarceration of a family member was assessed with the following question: *"Did a household member go to prison?".* A "yes" response indicated incarceration of a family member. Household substance use was assessed with the following questions: "*During your first 18 years of your life, did you live with anyone who was a problem drinker or alcohol?* and *"Did you live with anyone who used street drugs?*" A "yes" response to either item indicated having lived with a household member using substances. Household mental illness was assessed with the following two questions: "*Was a household member depressed or mentally ill?"* and *"Did a household member attempt suicide?".* A "yes" response to either item indicated household member had a mental health issue. Parental divorce was assessed with the following question *"Were your parents ever separated or divorced?"* where a "yes" response indicates parental separation or divorce.

The presence and frequency of each respondent's mother's experiences of intimate partner violence was assessed with the following questions: "*Sometimes physical blows occur between parents. While you were growing up, in the first 18 years of your life, how often did your mother's partner (ie: father/stepfather/boyfriend) do any of these things to your mother (or stepmother)?: Push, grab, slap, or throw something at her?; Kick, bite, hit her with a fist, or hit her with something hard?; Repeatedly hit her over at least a few minutes?;*" and "*Threaten her with a knife or gun to hurt her?"* on a 5-point Likert scale (1= "Never" to 5= "Very Often"). A response of "Sometimes", "Often" or "Very Often" to the first or second question or any response except for "Never" to the third or the fourth question defined whether the respondent's mother experienced domestic abuse (Dubes et al., 2003).

Comprehensive Executive Function Inventory Adult (CEFI – Adult; Appendix D). The CEFI – Adult (Naglieri & Goldstein, 2017) is a comprehensive self-report measure of

executive functions in adults aged 18 years or older consisting of 80 items. The CEFI assesses attention, inhibitory control, planning, emotion regulation, initiation, self-monitoring, flexibility, organization, and working memory and overall executive functioning. Respondents rate the frequency of each item in the past four weeks on a 5-point Likert Scale (0= "Never" to 5= "Always"). An example item from the attention subscale is "*pay attention for a long time?".* An example item from the inhibitory subscale is "*show self control?*". An example item from the planning subscale is "*plan ahead?*". An example item from the emotion regulation subscale is "*stay all when handling small problems?*". An example item from the initiation subscale is "*start tasks easily?*". An example item from the self-monitoring subscale is "*know when a task was completed?*". An example item from the flexibility subscale is "*come up with different ways to solve problems?*" An example item from the organization subscale is "*get things done efficiently?*". An example item from the working memory subscale is "*remember many things at one time?*". The CEFI adult has strong psychometric properties, including a full-scale internal consistency reliability of $\alpha = .97$ and test-retest reliability of $r = .93$ (Naglieri & Goldstein, 2017).

Depression-Anxiety-Stress Scale 21 (DASS21; Appendix E). The Depression-Anxiety-Stress Scale 21 (DASS21; Lovibond & Lovibond, 1995) is a 21 item self-report measure that includes three subscales to assess states of depression, anxiety, and stress. Each item is on a 4-point Likert scale (0= "Did not apply to me at all" to 3= "Applied to me very much, or most of the time"). An example item of the depression subscale is "*I felt that I had nothing to look forward to".* An example item of the anxiety subscale is *"I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)".* An example item of the stress subscale is "*I found it hard to wind down".* The DASS-21 subscales have been

shown to have good concurrent validity with relevant measures (Antony, Bieling, Cox, Enns, & Swinson, 1998). The depression subscale has strong concurrent validity with the Beck Depression Inventory (r =.77) and the anxiety subscale has strong concurrent validity with the Beck Anxiety Inventory (r=.84). The measure also demonstrated good internal consistency among subscales (α= .94 for depression; α =.87 for anxiety; and α=.91 for stress).

PTSD Checklist for DSM-5 (PCL-5; Appendix F). The Post-Traumatic Stress Disorder Checklist (PCL-5; Weathers et al., 2013) is a 20 item self-report measure of PTSD symptoms that corresponds with the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). It includes subscales that assess the four categories of PTSD symptoms in the DSM-5, including intrusion, avoidance, arousal and hyperactivity, and changes in cognition and mood. An example of an item includes whether, in the past month, an individual was bothered by *"repeated, disturbing, and unwanted memories of the stressful experience?"* and responses are on a 5-point Likert scale (0= "Not at all" to 4= "Extremely"). A total score of 33 or higher is associated with a provisional diagnosis of PTSD. The PCL-5 demonstrates high internal consistency (α = .94) and test-retest reliability (r = .82; Weathers et al., 2013).

Drinking & Substance Use Motives Questionnaire (DSMQ; Appendix G). The Drinking Motives Questionnaire Revised (DMQ-R; Cooper, 1994) is a 20-item self-report measure of the relative frequency of drinking for four distinct motive dimensions (enhancement, social, conformity, and coping motives). The DMQ-R was modified by Blackwell and Conrad (2003) to include 28 items. This was done to account for a five-factor model of drinking motives, where coping motives are separated into two separate scales: drinking to cope with depressive feelings and drinking to cope with anxious feelings. The DMQ-R has been shown to have good psychometric properties (Grant, Stewart, O'Connor, Blackwell, & Conrod, 2007).

In this study, the DMQ-R has been further revised to not only assess motives for drinking but to assess motives for using other substances as well. To revise the DMQ-R, the paragraph that introduces the measure was slightly modified to include the text in italicizes: Below is a list of reasons people sometimes give for drinking *alcohol or using drugs*. Thinking of all the times you drink alcohol *or use drugs*, how often would you say that you drink*/use* for each of the following reasons? Respondents rate their frequency of drinking or using substance each indicated reason on a 5-point Likert scale (1= "Almost Never/Never" to 5= "Almost Always/Always"). An example item of enhancement motives is "*Because I like the feeling*". An example item of social motives is "*As a way to celebrate*". An example item of conformity motives is "*To be liked*". An example item of coping with depressive symptoms is "*To cheer me up when I'm in a bad mood*". An example item of coping with anxiety symptoms is "*To relax*".

Study Attrition

This study was conducted as part of a larger research program aimed at examining ACEs within this treatment population and involved a larger sample than discussed here (178 participants to date, though data collection is ongoing). As such, many measures, beyond the scope of this dissertation, were also administered at both time points. Many participants only completed the first set of questionnaires due to several factors including early discharge from treatment, staff-related error/circumstance collecting data, participant withdrawal from study, early treatment shut down due to the COVID-19 pandemic, and university halting of research with human participants due to the COVID-19 pandemic (see Table 8). For the purposes of this study, only participants who completed the CEFI (at the second time point for data collection) were included (n=80 total).

Table 8.

Participant Attrition in Study

	Count (%)
Total consented sample	178 (100%)
Completion all measures	80 (45%)
All measures not completed due to competing staff demands	30 (17%)
Participant attrition	33 (19%)
Client Early Treatment Termination	18
Client refusal to complete Time 2 measures	13
Other	2
Early Termination of Treatment due to COVID-19	27 (15%)
Unknown	8 (5.7%)

Impact of COVID-19 Pandemic

Data collection was halted in March 2020 as ARTC stopped and clients were asked to leave the treatment program due to the development of the COVID-19 pandemic. The treatment program did not resume until June 2020, and with substantially fewer clients (7-10 per cycle) to ensure safe distancing and provincial mandates could be maintained. Moreover, in November and December 2020, Lakehead University suspended in-person research with human participants due to the pandemic, which ultimately impacted data collection. Unfortunately, these factors did impact the anticipated sample size for this study. However, Dilico maintained the value in resuming data collection as soon as possible. This included minimizing staff involved in the project and the inclusion of comprehensive organizational health and safety protocols. Special

approval was sought from the University Research Ethics Board to re-commence research at Dilico's discretion, and this approval was gained in January 2021. Ultimately, a sample size of 80 participants allowed for the core analyses and provides a foundation for future research examining ACEs and EF within this population. Moreover, it was sufficient to provide valuable feedback back to the community partner, who has been able to use the findings to inform treatment considerations.

Software Used for Statistical Analyses

The computer software program Statistical Package for the Social Sciences – Version 25 (SPSS- 25) was used for all analyses.

Pre-Analysis Issues

Missing values. There were two forms of missing values within this study. First, there were full sections of measures not completed due to the second time point of data collection being missed by some participants. Second, there were missing values at random throughout completed questionnaires. Participants who did not complete full measures required for analyses were excluded from the relevant analyses (this included the removal of 99 cases). Meanwhile, missing values at random were dealt with following recommendations from Tabachnick and Fidell (2014). In particular, Tabachnick and Fidell (2014) note that if 5% or less are missing in a random pattern in a large data set, one can estimate the missing data. Within this study, missing values largely involved errors in completing the Likert-type scale questionnaires, where a single item contributing to an overall subscale score was skipped. To assess the randomness of the missing values, the missing data pattern analysis function of SPSS was used. In an examination of the potential patterns among the missing values of data, they were found to be insignificant, and the missing data were deemed to be random. This randomness of the missing values

establishes that there is low likelihood of bias in terms of which data are missing. Due to this randomness, multiple imputation was a viable option for dealing with the missing values.

Multiple imputation is a widely accepted method that utilizes regression within the available data to determine the missing variables (Tabachnick & Fidell, 2014). Before running the Multiple Imputation, the random seed was set using the Random Number Generator. Mersenne Twister was chosen, a random number generating program, and then the Fixed Value was left to the default of 2000000. This allows for the randomization of numbers when the multiple imputations are run. Multiple Imputation runs multiple imputations, through regressions, to best place the missing values. The method of imputation used was Automatic, such that SPSS chose the imputation method based on a scan of the data. From there, in all subsequent analyses run, each imputation, as well as a pooled estimate based on each imputation, were calculated. The pooled estimates are presented as main findings in the result section.

Outliers. To address potential univariate outliers, histograms were analyzed, and z-scores were calculated for each variable. To determine outliers based on z-scores, a conservative approach, values less than -2.68 or greater than 2.68, were determined as outliers. Ultimately, no univariate outliers were found. Meanwhile, to assess for multivariate outliers, Mahalanobis distances were calculated, which considers the covariances of each variable's distributions into consideration in a multivariate analysis through the use of linear regression. From there, the Mahalanobis distances are compared to a chi-square distribution with same degrees of freedom. This presents multivariate outliers as any new probability cases that are less than 0.01, this being a very conservative probability estimate for outliers (Tabachnick & Fidell, 2014). Ultimately, no multivariate outliers were found.

Normality. In order to assess the normality of the continuous variables, skewness and kurtosis was analyzed. Skewness may distort the mean and distort the standard deviation, ultimately skewing bivariate statistics. While skewness involves the symmetry of the distribution, kurtosis represents the peakedness of the distribution. Non-normal kurtosis may create an underestimate of the variance in a given variable. For skewness, each variable was assessed to determine skewsness as greater than .8. No variables were determined to be skewed. Meanwhile, for kurtosis, output was examined to see if it is clustering close to zero. No significant kurtosis was found across variables. To assess multivariate normality, bivariate scatterplots were examined. Multivariate normality was seen across bivariate plots examined.

Multicollinearity. To assess multicollinearity of the predictor variables, a variance inflation factor (VIF) was calculated for each variable. The variance inflation factor is the ratio of variance in a model with multiple predictors, divided by the variance of a model with one predictor alone. A calculation of the VIF provides a number for the severity of multicollinearity associated with each predictor by quantifying how much the variance of each predictor in the regression is inflated. A VIF between 5 and 10 indicates high collinearity. All VIFs examined were between 1.032 and 1.336, suggesting no significant multicollinearity among multivariate predictors.

Chapter 6:

Results

Results

Hypothesis Set 1: ACEs and EF Outcomes

The first hypothesis set involved examining the relationship between ACEs and EF outcomes. Among participants, the total mean ACE score was 5 (SD=2.57). Table 9 demonstrates how many participants experienced each type of ACE within the sample. Meanwhile, Table 10 includes a summary of overall EF, and different domains of CEFI, compared to American population norms.

Table 9.

Frequency of Each ACE within the Sample

ACE	Frequency (N; %)
Family substance use	68 (85)
Family mental illness	60 (75)
Parental divorce	58 (73)
Sexual abuse	39 (49)
Physical neglect	38 (48)
Physical abuse	35 (44)
Domestic violence exposure	31 (39)
Family incarceration	28 (35)
Emotional neglect	26 (33)
Emotional abuse	25 (31)

Table 10.

Mean Raw Scores of Each EF Domain Compared to Average Population Norms

EF Domain	Study sample mean (SD)	Average population norm range
Overall EF		
18-22 years	179 (32.7)	185-248
23-29 years	216 (51.8)	196-287
30-44 years	206 (45.7)	197-264
45-64 years	225 (49.9)	209-266
Working memory		
18-22 years	20 (6.0)	21-27
23-29 years	24 (6.6)	21-28
30-44 years	21 (6.3)	22-29
45-64 years	25 (5.7)	23-30
Attention		
18-22 years	17 (4.9)	20-26
23-29 years	22 (7.6)	21-27
30-44 years	20 (6.2)	21-28
45-64 years	22 (6.5)	22-29
Inhibitory control		
18-22 years	24 (6.3)	22-29
23-29 years	25 (6.3)	22-30
30-44 years	24 (5.6)	23-30
45-64 years	25 6.2)	24-31
Cognitive flexibility		
18-22 years	24 (8.3)	19-26
23-29 years	25 (6.2)	20-27
30-44 years	23 (7.0)	20-27
45-64 years	24 (5.2)	21-27
Emotion regulation		
18-22 years	23 (8.7)	20-27
23-29 years	24 (6.6)	21-28
30-44 years	21 (7.1)	22-29
45-64 years	23 (5.3)	23-29

Note. Number of participants in each age group as follows: 18-22 years, N=8; 23-29 years, N=17; 30-44 years, N=34; 45-64 years, N=14

H1.1. Four linear regression analyses were conducted to assess whether participants cumulative ACE scores predicted outcomes in attention, emotion regulation, inhibitory control, cognitive flexibility, working memory, and overall EF (Table 11). The independent variable for each regression was the cumulative ACE score, and each executive functioning outcome served as the dependent variable for each respective analysis. Ultimately, ACE score did not predict any of the EF outcomes.

Table 11.

Six Linear Regressions with ACE Scores as Predictors and Each EF Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
ACE score	Overall EF	-.952	.947	-.068	-1.005	.315
ACE score	Working memory	-.407	.292	-.164	-1.397	.167
ACE score	Attention	-.107	.120	-.045	-.888	.375
ACE score	Inhibitory control	-.073	.261	-.032	-.281	.779
ACE score	Cognitive flexibility	-.109	.292	-.042	-.372	.710
ACE score	Emotion regulation	-.291	.313	-.107	-.929	.353

Two linear regression analyses were conducted to assess whether participants cumulative ACE scores predicted possible covariates, PTSD and depressive symptom severity. ACE score was found to predict both PTSD and depression symptom severity (Table 12.)

Table 12.

Two Linear Regressions of ACE Scores as Predictors and Mental Health Outcomes

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
ACE score	PTSD	1.715	.690	.271	2.486	**.013***
ACE score	Depression	.557	.232	.261	2.400	**.016***

**p <0.05.*

Three linear regression analyses were conducted to examine whether the covariates (FASD, PTSD symptoms, and depressive symptoms) predicted EF (Table 13). Overall, PTSD symptoms predicted overall EF difficulties, but depressive symptoms and a previously documented diagnosis of FASD did not.

Table 13.

Linear regressions of Mental Health Predictors and Overall EF Outcomes

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
PTSD	Overall EF	-1.128	.354	-.373	-3.189	**.001***
Depression	Overall EF	-.234	1.100	-.026	-.213	.831
FASD	Overall EF	-9.016	20.228	-.066	-.446	.658

**p <0.05.*

Multiple linear regression analyses were conducted to examine the degree to which PTSD and depression symptom severity predicted outcomes in attention, emotion regulation, inhibitory control, cognitive flexibility, working memory, and overall executive functioning (Table 14). PTSD symptom severity predicted each EF outcome and the EF composite score. Depressive symptom severity did not predict EF outcomes, though approached significance with attention.

Table 14.

Multiple Linear Regression with Mental Health Predictors and Each EF Outcome

Predictor variables	Outcome variable	*B*	*SE B*	β	t	p-value
PTSD	Overall EF	-.1381	.394	-.456	-3.509	**.000***
Depression		1.630	1.143	.182	1.426	.154
PTSD	Working	-.169	.047	-.429	-3.573	**.000***
Depression	memory	.160	.140	.137	1.146	.252
PTSD	Attention	-.155	.050	-.389	-3.124	**.002***
Depression		.280	.148	.237	1.897	.058
PTSD	Inhibitory	-.120	.045	-.333	-2.669	**.008***
Depression	control	.061	.134	.057	.455	.649
PTSD	Cognitive	-.143	.050	-.352	-2.844	**.004***
Depression	flexibility	.172	.139	.142	1.153	249
PTSD	Emotion	-.150	.054	-.349	-.2.799	**.005***
Depression	regulation	.108	.160	.085	.677	.499

**p <0.01.*

H1.2. Ten additional linear regression analyses were conducted to examine the relationship between individual ACE variables and EF outcomes. To do this, each ACE variable was used as a predictor and the EF composite score served as the dependent variable (Table 15). Family substance use was found to predict overall EF.

Table 15.

Ten Linear Regressions with each ACE as Predictors and Overall EF Outcomes

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
Emotional neglect	Overall EF	-.1514	1.112	-.079	-1.362	.173
Physical neglect	Overall EF	-2.096	1.386	-.059	-1513	.130
Emotional abuse	Overall EF	-14.649	12.331	-.140	-1.188	.235
Physical abuse	Overall EF	2.076	11.722	.021	.177	.859
Sexual abuse	Overall EF	-.2566	11.693	.026	-.219	.826
Domestic violence exposure	Overall EF	8.528	12.129	.086	.703	.482
Family substance use	Overall EF	-43.772	17.848	-.308	-2.453	**.014***
Family mental illness	Overall EF	-2.039	14.082	-.018	-.145	.885
Family incarceration	Overall EF	4.014	12.028	.040	.334	.739
Parental divorce	Overall EF	5.960	13.885	.053	.429	.668

**p <0.05.*

Due to the found significant relationship between family substance use and EF composite score, further analyses were conducted to examine the relationship between family substance use and individual EF outcomes (attention, emotion regulation, inhibitory control, cognitive flexibility, and working memory; Table 16). Family substance use predicted difficulties in working memory, attention, cognitive flexibility, and emotion regulation. Family substance use did not predict inhibitory control, though this was approaching significance.

Table 16.

Five Linear Regressions with Family Substance Use as Predictor and EF Outcomes

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
Family substance use	Working memory	-4.285	2.175	-.232	-1.970	**.049***
Family substance use	Attention	-4.603	2.334	.051	-1.972	**.049***
Family substance use	Inhibitory control	-3.732	2.064	-.220	-1.808	.071
Family substance use	Cognitive flexibility	-5.447	2.274	-.286	-2.395	**.017***
Family substance use	Emotion regulation	-6.496	2.563	-.321	-2.535	**.013***

**p <0.05.*

A multiple linear regression analysis was conducted with family substance use and covariates PTSD and depressive symptoms, to examine the outcome variable EF composite (Table 17). Both family substance use and PTSD symptom severity predicted overall EF difficulties.

Table 17.

Multiple Linear Regression with ACE and Mental Health as Predictors and EF Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
PTSD	Overall	-1.286	.388	-.322	-3.310	**.001***
Depression	EF	1.650	1.134	.159	1.455	.146
family substance use		-36.071	17.178	-.242	-2.100	**.036***

**p <0.05.*

H1.3. A linear regression analysis was conducted to examine the relationship between severity of neglect (cumulative experience of physical and emotional neglect) on EF outcomes (Table 18). Ultimately, severity of neglect predicted working memory difficulties. No other relationships were statistically significant.

Table 18.

Linear Regression with Severity of Neglect as Predictor and EF Outcomes

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
Neglect	Overall EF	-1.260	.734	-.205	-1.718	.086
Neglect	Working memory	-.201	.088	-.251	-2.268	**.023***
Neglect	Attention	-.100	.094	-.124	-1.069	.285
Neglect	Inhibitory control	-.092	.084	-.125	-1.092	.275
Neglect	Cognitive flexibility	-.101	.094	-.122	-1.070	.285
Neglect	Emotion regulation	-.095	.103	-.108	-.921	.357

**p <0.05.*

The relationship between neglect and working memory was examined with covariates PTSD and depressive symptoms (Table 19). Neglect no longer predicted working memory difficulties after the inclusion of covariates.

Table 19.

Multiple Linear Regression with Mental Health and ACE Predictors and Working Memory Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
Neglect	Working	-.141	.092	-.176	-1.525	.127
PTSD	memory	-.152	.049	-.386	-3.098	**.002***
Depression		.231	.142	.198	.1635	.102

**p <0.05.*

H1.4. To examine differences in EF outcomes based on experiences of neglect versus abuse, five t-tests had initially been proposed. However, the sample demonstrated high levels of abuse and neglect such that 46% had experienced both abuse and neglect, and therefore this analysis was not possible.

H1.5. Five t-tests were proposed to establish whether there is a significant difference in EF outcomes (attention, emotion regulation, inhibitory control, cognitive flexibility, and initiation), between participants who experienced neglect only versus those who had experienced abuse only or multi-type maltreatment (both abuse and neglect). However, only seven participants had experienced neglect only, and therefore this analysis was not possible.

Hypothesis Set 2: ACEs, EF, and Age of First Substance Use

Among participants, the mean age of first alcohol or cannabis use was 13 years (SD=2.82) and ranged from 5 to 19 years.

H2.1. A linear regression analysis was proposed to examine whether ACE scores predict age of first alcohol or cannabis use, where the ACE score is the independent variable, and age of first use serves as the dependent variable (Table 20). Ultimately, the hypothesis was not supported, though the regression was approaching significance.

Table 20.

Linear Regression with ACE as Predictor and Age of First Use Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
ACE score	Age of first use	-.311	.164	-.280	-1.909	.058

H2.2. A multiple regression analysis had been proposed to assess whether EF domains predict age of first substance use. However, two hypotheses needed to be supported in order for the theoretical underpinning of this analysis to be founded. ACE score needed to predict both EF outcomes and age of first use in order to suggest that it is possible that EF may also predict age of first use, as a possible mediator between ACE score and age of first use. However, without either hypothesis supported, there is not sufficient evidence to assume any directionality between EF and age of first use, which have been found to have a bidirectional relationship in previous literature.

H2.3. A multiple regression analysis had been proposed to assess for EF as a mediator between ACEs and age of first use should H1.1 and H2.1 be supported. Ultimately, H1.1 and H2.1 were not supported, and therefore this hypothesis was not computed.

Hypothesis Set 3: ACEs, EF, and Substance Use Motives

H3.1. Four linear regression analyses were conducted to evaluate whether cumulative ACE score predicts substance use motives (Table 21). In these analyses, ACE score served as the independent variable and each self-reported motive (social, coping-anxiety, coping-depression, enhancement, and conformity) served as dependent variables. ACE score was found to predict

motives for substance use that involve coping with depressive symptoms. No other motives were found to be predicted by ACE score.

Table 21.

Five Linear Regressions with ACE Score as Predictors and Each Substance Use Motive Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
ACE score	Social	.014	.247	.007	.058	.954
ACE score	Enhancement	.055	.215	.030	.254	.799
ACE score	Coping – depression	.820	.340	.266	2.411	**.016***
ACE score	Coping – anxiety	-.036	.182	.023	.199	.843
ACE score	Conformity	-.004	.239	-.002	-.016	.987

**p <0.05.*

H3.2. Four exploratory correlation analyses were conducted to examine possible relationships between EF and motives for substance use. No significant correlations were found (Table 22).

Table 22.

Pearson Correlations between EF Domains and Substance Use Motives

Variables	Substance use motives (R)				
EF Domains	Social	Enhancement	Coping – depression	Coping – anxiety	Conformity
Overall EF	.043	.142	.125	.110	-.053
Working memory	.013	.080	.071	.087	1.00
Attention	.020	.049	.123	.056	.077

Inhibitory control	.051	.040	.027	-.044	-.003
Cognitive flexibility	.051	.040	-.027	-.044	-.003
Emotion regulation	.094	1.33	-.009	.097	.058

Hypothesis Set 4: ACEs, EF, and Relapse Post-Treatment

H4.1. In a subsample that had attended substance use treatment previously, a linear regression analysis was conducted to assess whether cumulative ACE score predicted relapse substance use post treatment (Table 23). ACE score was not found to predict relapse post treatment.

Table 23.

Linear Regression with ACE Score as Predictor and Relapse Time as Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
ACE score	Relapse time	.051	.062	.130	.828	.407

H4.2. In a subsample that had attended substance use treatment previously, six individual linear regression analyses were conducted to assess whether EF variables (EF composite, attention, emotion regulation, inhibitory control, cognitive flexibility, and working memory) predicted immediate relapse post substance use treatment (Table 24). No significant relationships were found, though the relationship between emotion regulation and relapse approached significance.

Table 24.

Six Linear Regressions with EF as Predictors and Relapse Time as Outcome

Predictor variable	Outcome variable	*B*	*SE B*	β	t	p-value
Overall EF	Relapse	-.004	.003	0.180	-1.109	.268
Working memory	Relapse	.001	.025	.008	.052	.958
Attention	Relapse	-.019	.023	.025	-.827	.402
Inhibitory control	Relapse	-.042	.026	-.244	-1.627	.104
Cognitive flexibility	Relapse	-.030	.022	-.197	-1.360	.174
Emotion regulation	Relapse	-.045	.024	-.311	-1.881	.060

Chapter 7:

Discussion

Discussion

The objective of this dissertation was to examine the relationships between ACEs, EFs, and substance use outcomes within an Indigenous substance use treatment-seeking population. By considering these relationships, we aimed to better understand the degree to which EF is implicated in the relationship between ACEs and substance use among Indigenous adults experiencing chronic substance use problems. To date, there is a lack of research examining ACEs and EF among those with substance use problems, despite research connecting ACEs to EF difficulties (Lund et al., 2020), and EF difficulties to later substance use problems (Wilens et al., 2011). Substance use and EF difficulties appear to both be transmitted intergenerationally (Bridgett et al., 2015; Volkow & Mueke, 2012), in part through parenting difficulties, including exposure to childhood adversity. Indigenous peoples in Canada experience high rates of intergenerational trauma due to adverse experiences associated with colonization, including the residential school system, mass removal of Indigenous children into the child welfare system, loss of culture, and other ongoing forms of discrimination, marginalization, and poor living conditions inflicted on Indigenous peoples (Bombay et al., 2011). As such, an examination of ACEs and EF within an Indigenous substance use program was viewed as a foundational study aimed at identifying a possible underlying mechanism connecting intergenerational trauma to ongoing substance use difficulties seen among Indigenous communities.

Within the present study, the number of ACEs experienced did not predict overall EF nor individual outcomes in working memory, attention, inhibitory control, cognitive flexibility, or emotion regulation. Within both systematic reviews conducted (Chapter 3 and 4), no previous studies had examined whether cumulative ACE scores (involving all 10 forms of adversity) predicted EF outcomes. As such, this is viewed as a novel, but preliminary finding. Instead,

many studies found significant relationships between individual ACEs, or among composite scores of maltreatment (including neglect, abuse, or exposure to domestic violence).

There are a few possible mechanisms that may explain the lack of relationship between ACEs and EF difficulties. First, 60% of the sample demonstrated clinically-significant symptoms of PTSD that met threshold for a provisional diagnosis. PTSD severity is associated with various EF difficulties (Rivera-Velez et al., 2014), and there is evidence to suggest that post-traumatic stress symptoms are implicated in the relationship between ACEs and EF difficulties among both child (Rivera-Velez et al., 2014) and adult samples (Hodgdon et al., 2018), though the literature is inconsistent. Because of the high prevalence of PTSD symptoms within the present sample, it is possible that the pathway between ACEs and EF may be unique. Indeed, number of ACEs was found to predict both PTSD and depressive symptoms within the sample. Moreover, PTSD symptoms were found to predict deficits in each EF examined, including overall EF, attention, working memory, inhibitory control, attention, cognitive flexibility, and emotion regulation. This coincides with neuroimaging studies demonstrating that children with a history of childhood trauma and post-traumatic stress symptoms demonstrate structural changes in the prefrontal cortex (Carrino et al., 2010; Van Harmelen et al., 2010), where EFs are carried out.

It is also possible that the high number of ACEs within the sample caused ceiling effects limited by the sample size. Indeed, the number of ACEs experienced within the sample was much higher than the normative population (Finkelhor, 2020). A very large sample size becomes needed to distinguish incremental differences within these variables. Furthermore, the EF values within the sample were higher than expected, given the expected difficulties in EF associated with chronic substance use. As such, it is possible that participants may have overestimated their EF abilities. While the CEFI-adult has a scale to capture negative impressions (the likelihood an

individual underestimated their abilities), it does not currently have a positive impression scale (the likelihood an individual overestimated their abilities) which would have been helpful to mitigate this potential overestimation.

Limitations of the ACE measure as a meaningful construct within smaller samples may also explain the lack of statistical significance between ACEs and EF. Felitti's ACE study provided an important foundational basis for measuring health outcomes among individuals who had experienced a life of significant adversity. Indeed, experiences of poverty, household chaos, insecure attachment, and parenting difficulties are likely to be higher among families that experience mental illness, substance use, incarceration, and divorce. However, there is a lack of evidence to suggest that each of these experiences are uniquely additive. Instead, they are often overlapping constructs that capture underlying mechanisms. A high cumulative ACE score is likely to capture households that are at higher risk for an inability to meet children's needs across a variety of social, cognitive, and emotional domains. Regardless, among large data sets, like Felitti's (1998) study with 9508 participants, patterns between ACEs and outcomes are likely to emerge. However, within smaller samples, such as the current study, the ACE measure likely does not adequately capture the underlying mechanisms connecting adversity to EF difficulties.

It is important to note that recently, after the current study was developed and implemented, attention has been directed toward the flaws in the ACEs questionnaire as a psychometrically valid tool (McLennan et al., 2020). Notably, McLennan and colleagues identified that the ACE questionnaire involves sufficient issues that call to question its use in research or clinical activities. They argue that the questionnaire does not adequately capture all possible and relevant ACEs in its items, there is concern for item construction, and that the item scoring (additive 0-10) is fairly rudimentary and does not capture psychometric advances in

questionnaire development. However, the argument can be made that the ACE measure remains a useful tool, given its ability to capture experiences of child maltreatment and household dysfunction together, with few other measures capturing these experiences in a dose response fashion. While the ACE measure may demonstrate poor construct validity in its attempt to accurately measure the severity of "adverse childhood experiences", it all the while demonstrates solid criterion validity in providing an incremental measure for those most likely to be affected by childhood adversity.

To better understand how early adversity is connected to EF difficulties, an examination of the predictive ability of each individual ACE on overall EF was conducted. One ACE emerged as a predictor: family substance use. This is consistent with past literature (Grekin et al., 2005) and is likely in part capturing the hereditary components of both substance use and EF. However, it is also possible that early life experiences among children whose family members (parents in particular) experienced substance use problems may contribute to EF difficulties. Notably, family substance use predicted difficulties in overall EF, attention, working memory, cognitive flexibility, and emotion regulation. The relationship between family substance use and EF difficulties remained significant after controlling for covariates PTSD and depression, suggesting this relationship is robust and separate from the effects of PTSD on EF.

Aside from hereditability, the environmental mechanism by which family substance use may impact an individual's EF difficulties may be viewed in parallel to childhood experiences of neglect. In particular, it is widely understood that chronic substance use is an important predictor of neglect cases within child welfare (Lander, 2013). Within past literature, neglect, and early neglect in particular, is highly associated with EF difficulties (Lund et al., 2020). Consistent with past studies, severity of overall neglect was found to be a predictor for working memory

difficulties within the current study. Moreover, the relationship between severity of neglect and overall EF approached significance. However, when covariates PTSD and depressive symptoms were included in the analyses, the relationship between neglect and working memory was no longer significant. Due to inaccuracy with retrospective reporting, age of neglect was not captured within this study. Studies connecting timing of neglect with EF are largely prospective or involve measurement through past child welfare documentation and were beyond the means of this study.

Ultimately, the findings from the current study demonstrated that two ACEs, family substance use and neglect, are implicated in EF difficulties within this population. This is consistent with difficulties seen among Indigenous communities, where family substance use and experiences of neglect are identified as two of the major forms of adversity experienced. Indeed, neglect is identified as the most common form of maltreatment experienced among First Nations communities (Sinha et al., 2011). Indigenous families involved in child welfare are more often investigated for suspicion of neglect when compared to non-Indigenous families (where physical abuse is most commonly investigated; Blackstock et al., 2004). Moreover, the over-representation of First Nations children involved in child welfare is driven by the number of neglect-related cases (Sinha et al., 2011).

Poverty, substance use difficulties, and housing instability, are viewed as key factors contributing to experiences of neglect among First Nations families involved in child welfare (Sinha et al., 2011). Moreover, First Nations families are more likely to involve sole caregivers, with higher numbers of children in the home, and live in overcrowded housing conditions, ultimately placing extreme caregiving demands on individuals grappling with poor socio-economic living conditions (Sinha et al., 2011). The experiences of neglect among Indigenous

families facing socio-economic hardships often occur in tandem with substance use difficulties. Indeed, substance use difficulties have been found to be prevalent among Indigenous caregivers (Trocme et al., 2004). In a large study on Canadian child welfare investigations, Sinha and colleagues (2011) found that 40% of First Nations female caregivers reported alcohol use difficulties and 47% of First Nations male caregivers (compared to 8% of non-Indigenous female caregivers and 17% of male non-Indigenous caregivers respectively).

Substance use difficulties appear to be prevalent across generations of Indigenous peoples, where Indigenous youth have been shown to engage in alcohol and cannabis younger than non-Indigenous youth (Johnson et al. 2017). This was consistent with the current study, where the average age of first alcohol or cannabis use was 13 years, with the youngest age reported being 5 years. Past studies have demonstrated that early substance use is associated with subsequent EF difficulties as well as chronic substance use problems (Stein et al., 2017), making it a significant concern. In this study, the number of ACEs did not predict age of first use, though was approaching statistical significance. This finding was inconsistent with past literature. It is likely that this relationship would be significant with more statistical power. In particular, the ACE of family substance use has been shown to increase likelihood of earlier use among youth (O'Loughlin et al., 2019). This is connected to hereditability, exposure to substances at an early age, among other factors.

In order to better understand the mechanisms by which ACEs and EF are implicated in substance use difficulties, substance use motives were also analyzed. Notably, number of ACEs predicted the depressive coping motive among participants. Number of ACEs also predicted depressive symptom severity. In other words, the more ACEs an individual has experienced, the more severe depressive symptoms they had, and the more likely they were to endorse using

substances to cope with depressive symptoms. While depression is associated with EF difficulties, findings from our systematic review on adult samples (Chapter 4) found that these difficulties were not associated with past ACEs. It is possible that the relationship between ACEs, depression, and motives for use is a unique neurodevelopmental pathway related to chronic substance use warranting further examination. This finding is particularly useful to consider in relation to Indigenous peoples specifically. In particular, McQuaid and colleagues (2015) found that the relationship between childhood trauma and depressive symptom severity was mediated by perceived discrimination among First Nations adults. The authors concluded that experiences of discrimination and unsupportive interactions uniquely contributed to depressive symptoms among adults who had experienced early adversity (McQuaid, 2015). The current findings may extend this research and suggest it is possible that experiences of depression among Indigenous adults connected to past adversity and discrimination increase risk for coping through substance use.

Within the current sample, over half had reported attending treatment previously, and were asked to report on how long they maintained sobriety post treatment. Past ACEs did not predict speed of self-reported relapse, nor did EFs. However, emotion regulation did approach statistical significance. This was at odds with past research, where both ACEs and EF have been shown to be implicated in relapse (Blume & Marlatt, 2009; Derefinko et al., 2019). Ultimately, there are many other factors that are involved in an individual's sobriety post treatment, including their social supports, housing, the substance of choice, age, among others.

Limitations

While there are inherent strengths to this study, there are important limitations to consider as well. The main limitations within the current study are related to its cross-sectional design and

small sample size. It is not possible to ascertain directionality with substance use and EF outcomes without temporal precedence achieved through a longitudinal and prospective design. Indeed, it is expected that chronic substance use may impair EF outcomes, thus potentially affecting EF as a variable in this population. Similarly, we cannot assume causality with respect to exposure to ACEs and EF outcomes, as it is possible that EF deficits were present before the exposure to ACEs. There is also evidence to suggest that EF may be partly hereditary (Friedman et al., 2008), which may confound some results as parent EF deficits may be associated with children's increased ACE exposure. The small sample size was also a significant limitation. Multiple analyses approached statistical significance, and likely would have been useful findings with a larger sample size. Indeed, many of the relationships examined within this study are nuanced and complex, requiring a large data set in order to fully understand.

More recently, concerns have been raised in the literature regarding the ACE measure's utility and accuracy in adequately measuring early adversity (McLennan et al., 2020). Within this sample, the high level of adversity seen across participants made it impossible to discern differences in EF difficulties across different forms of maltreatment, leading to a few hypotheses that could not be evaluated. Moreover, the standard ACE measure does not capture other forms of childhood adversity often experienced by Indigenous peoples (e.g., stigma, racism, discrimination, under-funding of services, child welfare engagement, among others; Radford et al., 2020). Another limitation included that retrospective and self-report measures should always be interpreted with caution due to potential bias in response. Indeed, there was possible positive impression bias in completing the CEFI that is uncontrolled for, given the average scores seen across the CEFI. Within the current sample, six participants had previous diagnoses of FASD. It is likely that other participants have undiagnosed FASD, which were not able to be fully

controlled for within these analyses, despite FASD's connection to EF difficulties. Furthermore, it is important to note that the sampling related to relapse was biased, given that it is highly likely that individuals who maintained sobriety post treatment would not be attending substance use treatment again, and therefore this sample may have captured clients with overall higher ACEs and lower EF, should these variables be implicated in relapse outcomes.

Lastly, despite being an Indigenous treatment program, 29% of the sample did not identify as Indigenous, and thus generalizability across Indigenous adults with substance use difficulties is cautioned. However, the findings are representative of the typical clients seen within the community partner's treatment program, thus making them directly applicable and useful to inform their intervention program. Similarly, PTSD symptoms were highly prevalent within this sample, and predictive of EF difficulties. As such, the current findings may not be generalizable to similar samples who do not demonstrate PTSD symptoms. Despite these limitations, this study provided a comprehensive foundation for the relationship between ACEs, EF, and substance use within an Indigenous treatment program which can be used to inform future research pursuits and clinical intervention efforts.

Implications and Future Directions

In this study, we identified family substance use during childhood and severity of neglect as predictive of EF difficulties among Indigenous adults with substance use difficulties. To our knowledge, this is the first study to identify a possible underlying psychological mechanism connected to substance use difficulties experienced among Indigenous adults in Canada with a history of childhood adversity. It highlights the importance of the work done by Blackstock (2011) who has identified the over-representation of First Nations youth exposed to neglect in Canada, and who advocates for needed government action to address social, economic, and

health disparities contributing to neglect among Indigenous families. It also highlights the importance of the Calls to Action put forward by the Truth and Reconciliation Commission of Canada in 2015, which advocates for a reduction of Indigenous children in child welfare as well as redressing systemic underfunding. Moreover, the current findings provide some context for the transmissible nature of neglect and substance use seen across generations of Indigenous communities, as ongoing EF difficulties appear to be implicated.

The current study also identifies the need for interventions aimed at addressing EF difficulties associated with neglect, family substance use, and PTSD. In the final chapter of this dissertation (Chapter 8), an environmental scan and review examines existing interventions that demonstrate effectiveness in addressing EF difficulties associated with ACEs. As such, these will not be discussed in detail here. However, Chapter 8 did not capture any culturally-driven interventions, and therefore it is useful to consider culturally informed interventions that may be uniquely able to support EF difficulties among Indigenous peoples. Notably, Simard (2009) put forward a culturally-restorative child welfare framework, with an emphasis on cultural attachment theory. In particular, the author identified that child welfare practice should promote cultural identity and cultural attachment strategies to support resilience among Indigenous parents. In particular, Simard (2009) identified that, through cultural engagement, both cultural teachings and ceremonial practices can help support Indigenous families engage in cultural roles and responsibilities within their communities that contribute to child development and care, in turn minimizing the perpetuation of ACEs. Coinciding with this framework, parenting programs that are culturally driven or adapted and found to be useful among Indigenous families are needed (Toombs et al., 2021).

Future research pursuits may explore how various traditional healing practices are connected to positive outcomes in EF, and how these were systematically disrupted across diverse Indigenous communities through more than a century of residential schooling. Indeed, mindfulness appears to be an effective intervention in supporting EF difficulties (as reviewed in Chapter 8). Anecdotally, Indigenous traditional activities such as smudging and drumming have been suggested to be comparable activities to mindfulness among non-Indigenous peoples, and therefore may be a useful avenue to consider in addressing EF difficulties. Moreover, given the relationship between EF difficulties and PTSD found within this study, culturally-adapted interventions that target PTSD (such as *Seeking Safety*; Marsh et al., 2016) may be connected to improvements in EF, though research is needed.

Past research also suggests that resilience moderates the relationship between exposure to childhood trauma and post-traumatic stress symptoms among First Nations youth (Zaradnik et al., 2009). In particular, resilience appeared to minimize the PTSD symptom of re-experiencing among this sample. In this study, both individual and contextual resilience were implicated (Zaradnik et al., 2009), thus capturing the importance of promoting self-efficacy and social support among Indigenous youth as a way to promote resilience and potentially mitigate outcomes like PTSD and EF difficulties among those exposed to early adversity.

Ultimately, it is important to better understand how the effects of ACEs on EF difficulties are implicated in substance use. In particular, longitudinal designs are needed to capture the EF difficulties that Indigenous youth may be facing, and how these are implicated in substance use and mental health outcomes across the lifespan. Moreover, a larger sample size within the current study would allow for more nuanced statistical analyses that further delineate the role of EF. Clinical interventions aimed specifically at addressing depressive symptomology and

substance use coping motives among Indigenous adults with histories of adversity and discrimination might at least partially mitigate negative outcomes. Finally, examination of the potential for cultural connectedness and resilience factors specific to Indigenous youth and adults at risk of EF difficulties associated with ACEs can provide additional avenues for prevention and early intervention.

Chapter 8:

Addressing Executive Function Difficulties Associated with Childhood Adversity: State of the Literature and Promising Directions

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The Adverse Childhood Experiences (ACEs) model is a cumulative risk framework used to assess the association between experiences of adversity and poor health outcomes seen across the lifespan. Felitti and colleagues (1998) initially assessed ten types of ACEs, capturing experiences of abuse, neglect, and household dysfunction. That research has since led to an invested interest in examining how ACEs are implicated in various outcomes implicated in socio-emotional wellbeing and physical health outcomes. Notably, the more ACEs an individual experiences, the higher the risk for various mental health issues, including depression, post-traumatic stress disorder (PTSD), suicidality, and substance use (Chapman et al., 2004; Dube et al., 2001; Dube et al., 2003; Fuller-Thomson et al., 2016; Kalmakis & Chandler, 2015). Similarly, ACEs increase risk for various negative health outcomes, including ischemic heart disease, lung disease, cancer, and skeletal fractures (Bellis et al., 2013; Kalmakis & Chandler, 2015).

There are a variety of plausible mechanisms that have been purported to explain the underlying relationships between ACEs and poor health outcomes over time. Indeed, extensive reviews have explored underlying mechanisms regarding ACEs and health outcomes (e.g., Sheridan & McLaughlin, 2020; Su et al., 2015; Wiss & Brewerton, 2020). Across the suggested plausible mechanisms, the influence of stress on the developing hypothalamic-pituitary-adrenal (HPA) axis is frequently viewed to underlie the relationship between ACEs and mental health difficulties. The HPA axis is a hormonal response system that involves the hypothalamus, the anterior pituitary gland, and the adrenal glands, and is activated in response to various mental and physical stressors. It is heavily interconnected to various facets of a child's developing brain, including the limbic system and the prefrontal cortex (PFC). Notably, exposure to chronic stress during childhood is associated with changes in the PFC (Arnsten et al., 2015).

The effects of chronic stress on the HPA axis and associated PFC appear to impact the cognitive processes carried out in the PFC, namely executive functions. Executive functions (EF) serve as an umbrella term used to describe a group of high-order cognitive processes mediated by the prefrontal cortex that underlie goal-directed behaviour (Diamond, 2013). These processes include working memory, inhibitory control, attention, cognitive flexibility, emotion regulation, self-monitoring, organization, and planning (Naglieri & Goldstein, 2017). EFs develop across childhood and adolescence (Zelazo et al., 2008) and continue to be sensitive to environmental input into early adulthood (Friedman et al., 2016). EFs are in part hereditary (Friedman et al., 2008) but are also malleable via childhood experiences (Thompson & Steinbeis, 2020). EFs are particularly influential to several outcomes across the lifespan. For instance, EFs appear to be more predictive of school achievement that intelligence (Blair & Razza, 2007). They are also associated with poor health behaviours (Allan et al., 2016), increased risk for psychopathology (Laweson, Papadakis et al., 2015), difficulties in occupational functioning (Barkley & Fischer, 2011), and higher risk of mortality in older adults (Johnson et al., 2007). The developmental link between ACEs and EF difficulties thus becomes an important consideration, given the detriments of EF difficulties experienced across indicators of quality of life. Indeed, ACEs increase the risk for executive function difficulties in childhood (Lund et al., 2020; Op den Kelder et al., 2018) and adulthood (Lund et al., under peer review). EFs have also been shown to mediate the relationship between ACEs and psychopathology and health-risk behaviours (Trossman et al., 2021).

The mechanism by which ACEs disrupt normative EF development becomes more evident when considering the role of parent-child relationships on developing EFs. Early parent-child relationships provide children with an avenue to learn and practice emotional and cognitive

self-regulation (Sroufe, 1996). This learning then generalizes across social contexts and various facets of goal directed behaviour (Bernier et al., 2015). ACEs appear to interrupt attachment processes between children and their caregivers (Cooke et al., 2019; Thomson et al., 2017). Moreover, caregiver practices related to emotion socialization, including reactions to children's emotions, appear to moderate the relationship between maltreatment and EF among preschoolers (Fay-Stammbach et al., 2017)

Attachment processes are also implicated in the development of EF. Longitudinal studies demonstrate that insecure attachment between children and caregivers predicts EF deficits (Bernier et al., 2015; Bohlin et la., 2012; Thorell et al., 2012). Moreover, meta-analytic findings across 42 studies suggest that positive parental behaviours (warmth, responsiveness, sensitivity) are associated with better EF outcomes (Valcan et al., 2018). Meanwhile, negative parental behaviours (control, intrusiveness, detachment) are associated with worse EF outcomes. This is also seen in neuroimaging studies, where quality of mother-infant interactions predicted brain activity in the frontal cortex (Bernier et al., 2016). Such findings highlight how experiences of abuse or exposure to violence in the home may impact neurobiological processes that promote EF development. Meanwhile, parental behaviours that foster cognitive development (such as autonomy support, scaffolding, and cognitive stimulation), are associated with positive EF outcomes as well, with this relationship moderated by age, such that younger children's EF are more heavily impacted by cognitive parental behaviours. Adversity, such as neglect, may impede EF development, particularly among younger children (Valcan et al., 2017). These findings are consistent with biologically based studies, where cortisol levels, which modulate activity in the PFC, partially mediated the relationship between parental support and EF outcomes across early development (Blair et al., 2011).

A theoretical framework proposed by Poon (2018), categorizes EFs into either "cold" or "hot" domains and underscores the notion that ACEs may uniquely impact EF and the PFC. It is identified that "cold" EFs carry out actions in the dorsolateral prefrontal cortex and involve non-affect related problem solving. Meanwhile, "hot" EFs refer to EFs that are largely exhibited in the ventromedial prefrontal cortex, and involve emotionally laden goal-directed processes, including tension between instant gratification and long-term reward (Poon, 2018). While "cold" EFs have been studied through performance-based testing for decades, less is known about "hot" EFs, nor the links between adversity and either form of EF. However, there is evidence to suggest that difficulties with "hot" EFs are prevalent among those with maltreatment histories (Navalta et al., 2006). Notably, Welsh and colleagues (2017) found that "hot" EFs mediated the relationship between child maltreatment and academic outcomes among a college sample.

Ultimately, a consideration for EF interventions for those who have experienced ACEs is warranted due to an established relationship between ACEs and EF difficulties in the literature, as well as possible unique pathways regarding affect related EF difficulties due to disrupted attachment processes associated with ACE exposure. To date, significant attention has been put towards EF interventions among those with neurodevelopmental disorders (such as attention deficit hyperactivity disorder or autism spectrum disorder), while less emphasis has been placed on interventions that support EF difficulties explicitly associated with adversity. This may be part due to limited discussion regarding qualitative differences in EF difficulties associated with ACEs compared to those with EF difficulties not associated with adversity. However, there is evidence to suggest that even the type of adversity (abuse versus neglect) experienced can impact the way in which EF difficulties manifest themselves (Lund et al., 2020).

Overall, the aforementioned findings, alongside the high prevalence of ACEs seen nationally among children today (Crouch et al., 2019), invite a consideration for approaches aimed at addressing EF difficulties uniquely associated with ACEs. While the literature generally focusses on EF interventions at the child level, adults with EF difficulties continue to struggle across various life domains. Moreover, parents with EF difficulties are more likely to demonstrate parenting difficulties and raise children who experience EF difficulties as well (Korucu et al., 2020). As such, the present paper will provide an environmental scan, review, and discussion of the current state of the academic literature on intervention methods that address EF difficulties associated with ACEs among both children and adults. Interventions that have documented improvements in EFs among those with a history of ACEs, alongside effective general population or clinical EF interventions that may translate to individuals with ACEs, will be discussed. Finally, this paper concludes with a broader discussion of EF difficulties and systems-level considerations.

A few different search strategies were used to collate existent literature on effective interventions for addressing EF difficulties among individuals who have been exposed to ACEs. First, a database search was conducted to find any documentation of interventions among children or adults with ACEs that reported on EF outcomes. Second, a search of trauma interventions was conducted to examine if any EF outcomes had been reported. Third, a search of EF interventions was conducted to examine if any were studied in samples with a history of ACEs. Finally, promising directions were considered by examining published reviews that summarized evidence-based EF interventions in samples without ACEs. In summary, the studies discussed in this review either documented EF outcomes in a sample that had experienced ACEs

or involve promising interventions for EF that should be considered among samples who have experienced ACEs in the future.

Child and Adolescent Interventions

Research into the effectiveness of EF interventions for children often focus on those for neurodevelopmental disorders with EF dysfunction, such as attention deficit hyperactivity disorder and autism spectrum disorder. To date, there is no mental disorder diagnosis that captures the array of EF difficulties associated with ACEs among children. However, Van der kolk and colleagues (2005; 2009) proposed the inclusion of a developmental trauma disorder diagnosis into the DSM-5 to capture an array of specific symptoms that children demonstrate in the aftermath of exposure to interpersonal trauma and disruptions in caregiving. Among their categories of proposed symptoms, they include "attentional and behavioural dysregulation" which includes impairments in sustained attention and learning, and an "inability to initiate or sustain goal-directed behaviour." Ultimately, conceptualization of EF difficulties associated with affect-driven goal-directed behaviour, and through the impact of attachment processes with caregivers, is integral in considering relevant interventions, as depicted in the interventions found to be effective below. The following section includes interventions with explicit EF outcomes, which ultimately fall across attachment and cognitive behavioural orientations. A discussion of future avenues needing further research is also provided.

Attachment-Based Interventions

Attachment and Biobehavioral Catch-up (ABC). The ABC intervention is a 10-session home-visiting program aimed at helping caregivers nurture and respond to their infants sensitively in order to support the development of secure attachment, self-regulation, and minimal fear inducing situations by parents (Grube & Liming, 2018). Initially, ABC was

designed for parents with infants specifically (ABC-I) and has been shown to be effective in producing sensitive caregiving (Bick & Dozier, 2013), attachment security (Bernard et al., 2012), and changes in cortisol levels (Bernard et al., 2015). Infants in foster care demonstrated greater EF (cognitive flexibility) at age 5 after their caregivers received ABC-I (Lewis-Morraty et al., 2012). Due to this success, ABC-I was then developed into a toddler version, ABC-T, with extra emphasis on supporting independent regulation strategies that develop at this age (Lewis-Morrarty et al., 2012), and helping parents be "co-regulators" for their children. ABC-T is also shown to be effective in improving EF (attention and cognitive flexibility) among toddlers in foster care (Lind et al., 2017). Outcomes in EF appear to be sustained, with children in care demonstrating improved inhibitory control into middle childhood after receiving ABC-I (Korom et al., 2020).

Neuro-Physiological Psychotherapy (NPP). NPP is described as a wrap-around, neuro-sequential, attachment focussed intervention for both children and parents. It is aimed at families who present with multiple emotional and behavioural difficulties associated with ACEs (McCullough et al., 2016), with a focus on adopted children. It has been shown to be associated with positive outcomes in EF, in both overall EF and behavioural regulation among adopted children who experienced prior trauma with their birth families (McCullough et al., 2016; McCullough & Mathura, 2019). However, these results are preliminary, and more studies are required to establish whether NPP demonstrates improved EF outcomes in larger samples and over time.

Cognitive Behavioural Therapies

Trauma-Focused Cognitive Behavioural Therapy (TF-CBT). Children who experience ACEs are at risk of developing PTSD. PTSD symptoms are also associated with EF

difficulties among youth (Woon et al., 2016). More specifically, EF difficulties appear to correlate with severity of PTSD symptoms, such that the more severe the PTSD, the worse the EF difficulties (Woon et al., 2016). As such, interventions designed to treat PTSD among children may simultaneously address EF difficulties. Meta-analytic findings on treatments for child and adolescent PTSD note that Trauma-Focused CBT (TF-CBT; Cohen et al., 2016) has the largest evidence base and largest effect sizes to support its use in treating PTSD (Morina et al., 2016). It is also effective in reducing depressive symptoms (which are frequently comorbid). This same meta-analysis found that there were no other interventions with sufficient evidence to be promoted.

TF-CBT is a skills-based intervention that involves affective regulation, cognitive processing of the trauma, trauma narrative, exposure, relaxation, enhancing future safety, psychoeducation and parenting skills, and conjoint child-parent sessions. While not explicitly designed to treat EF difficulties, TF-CBT has recently been connected to significant improvements in EF, including domains of attentional control, behavioural control, emotional control, and problem solving (Lee, 2020). This coincides with documented changes in functional connectivity of the medial prefrontal cortex over the course of trauma-focused CBT (Zantvoord et al., 2013).

Interestingly, there are mixed findings regarding whether parent involvement in the intervention is associated with better overall outcomes. Previous meta-analytic findings suggest that parent involvement is associated with better outcomes in TF-CBT (Harvey and Taylor, 2010), however a more recent meta-analysis found no difference (Morina et al., 2016). No existent findings have considered whether parent involvement in TF-CBT is associated with better EF outcomes. However, given the role of parenting behaviours on EF outcomes, it is

possible that parenting skills endorsed in the intervention may prove to be a possible mechanism of change. Moreover, the effectiveness of TF-CBT is for those with PTSD associated with a particular event, and therefore may not be generalizable to EF difficulties associated with ACEs that do not result in PTSD symptoms.

Dialectical Behavioural Therapy (DBT). DBT is a third wave CBT originally developed to treat individuals presenting with borderline personality disorder (BPD) and suicidality (Linehan et al., 2006). DBT is an effective intervention for adolescents experiencing significant emotion dysregulation, non-suicidal self-injury, suicidal ideation, and those with depressive symptoms (Cook & Gorraiz, 2016; DeCou et al., 2019). Notably, DBT has become a gold-standard intervention for those with a history of ACEs, and particularly those with BPD (Neacsiu et al., 2014). National study data suggest adults who have experienced four or more ACEs have approximately 5 times greater risk of being diagnosed with BPD, and 10 times greater risk of being diagnosed with BPD and comorbid substance use disorder (Fall, 2020). Further, each form of ACE is predictive of BPD (Fall, 2020 dissertation). Attachment insecurity is viewed as a possible mechanism contributing to symptom presentations among those with BPD who have experienced ACEs (Ehrenthal et al., 2018).

DBT consists of both individual psychotherapy and skills groups focussed on mindfulness, interpersonal effectiveness, emotion regulation, and distress tolerance. DBT for adolescents also includes parent-adolescent skills groups. Notably, in a study among adolescents with experiences of nonsuicidal self-injury, DBT was shown to be effective in improving EF difficulties (Smith et al., 2019). In particular, improvements in cognitive flexibility and overall executive functioning were found. However, it is unclear how many participants had a history of ACEs in this sample, nor whether DBT is effective in treating EF difficulties among adolescents

without experiences of nonsuicidal self-injury. Despite this, these preliminary findings are compelling, especially given that ACEs are highly associated with risk of nonsuicidal self-injury in adolescents (Liu et al., 2018), and EF difficulties may be linked to risk for nonsuicidal self-injury (Fikke et al., 2011).

Emerging Interventions

Profiles of EF difficulties are seen among typically developing children as well as those with neurodevelopmental disorders or a history of ACEs. As such, interventions have been developed to address EF difficulties seen across children, regardless of etiology, particularly in school settings. Notably, comprehensive reviews from Takacs and Kassai (2019), Diamond and Lee (2011), and Diamond and Ling (2016) discuss the state of the research on these interventions at length. Consistent with the aims of this paper, a discussion of evidence-based interventions for EF among children and adolescents that theoretically may be effective among youth with ACEs, though that have not been uniquely studied to our knowledge, are discussed. Given the unique pathways between ACEs and the development of EF difficulties, future studies with this population are needed to confirm the applicability of the following interventions.

Mindfulness-Based Interventions. Significant attention has been placed toward the possibility that mindfulness-based interventions may be associated with improvements in EF among children and adolescents. Mindfulness involves selecting a point of focus, and attending to it non-judgmentally, such as the breath. It is hypothesized that mindfulness practice facilitates selective attention, self-monitoring, and cognitive flexibility (through practicing disengaging from a distracting thought; Mak et al., 2018). A systematic review of mindfulness on EF among children and adolescents found that 5 of 13 studies demonstrated efficacy (Mak et al., 2018). In particular, significant effects in sustained attention (Sidhu, 2013), inhibitory control (Felver et

al., 2014), and cognitive flexibility (Purohit & Pradhan, 2016) were documented. Similarly, Takacs and Kassai's (2019) meta-analysis of effective EF interventions summarized that mindfulness appears to be a promising treatment given initial findings.

The studies involved in the aforementioned reviews did not explicitly examine mindfulness for EF difficulties among youth with histories of ACEs. However, mindfulness has been shown to be effective in improving other symptom profiles among youth with ACEs, including improvements in emotion regulation and coping skills, decreased rumination, anxiety, and depression, and improvements in social behaviour (Ortiz & Sibinga, 2017). It is possible that changes in EF associated with mindfulness interventions may be contributing to these outcomes, though further studies are needed. Notably, a mindfulness intervention among low-income youth who may have experienced ACEs was associated with a flatter cortisol curve over the course of the intervention, suggesting biological changes, and implications regarding the regulation of the HPA axis (Siblinga et al., 2013). However, there are findings to suggest that mindfulness-based interventions may be counter-indicated among some individuals with histories of traumatic life events or post-traumatic stress symptoms, as they were predictive of distress during meditation (Zhu et al., 2019). Ultimately, further research is needed to delineate the utility of mindfulness in improving EF difficulties associated with ACEs.

Exercise Interventions. Interventions involving physical activity and engagement in team sports appear to be associated with significant improvements in EF among youth. Indeed, meta-analytic findings concluded that exercise interventions improved overall EFs and inhibitory control in particular (Xue et al., 2019). Greater EF improvements were seen among those with higher body mass index, while age and exercise duration were not found to be covariates (Xue et al., 2019). This was seen across both sports and physical activity (defined as multiple exercise

sessions per week typically over 6 weeks total). However, aerobic exercise without a cognitive component does not appear to be effective (Diamond & Ling, 2016). Most recently, Hsieh and colleagues (2021) found that acute doses of high intensity interval training were associated with improvements in inhibitory control and working memory among children. Best and Miller (2010) hypothesized that physical activity may support EF improvement due to three factors; First, team sports or ball games engage strategies and cognitive demands that involve practicing EF skills (e.g., selective attention, switching flexibly between tasks). Second, complex motor activity engages brain regions connected to the prefrontal cortex, and thus may support changes in EF through this pathway. Third, physical activity is associated with immediate physiological responses and associated brain changes that facilitate learning.

To date, no known studies have examined whether the effectiveness of exercise interventions on EF applies to youth with ACEs. However, exercise interventions have been associated with symptom reductions among youth experiencing PTSD (Diaz & Motta, 2008), and it is hypothesized that exercise facilitates enhanced cognitive function, promotes neuroplasticity, and may normalize HPA function (Hegberg et al., 2019). However, most studies examining exercise and PTSD have focussed on aerobic exercise (Motta al., 2012), which appears to be less effective for EF improvement (Diamond & Ling, 2016). Ultimately, more research is needed.

School and Computer-Based Interventions. Reviews by Takacs and Kassai (2019), Diamond and Lee (2011), and Diamond and Ling (2016) highlight the effectiveness of both computer-based training and school-based programs in promoting positive outcomes in EF among the general child population. In particular, the computer program CogMed has seen gains in working memory and Braingame have seem gains in inhibitory control and cognitive

flexibility (Takacs & Kassai, 2019). However, meta-analytic findings suggest that individualized EF training, such as computer programs, do not generalize beyond the training exercise (Kassai et al., 2019). Meanwhile, Diamond and Lee (2011) hypothesized that broader interventions that also target children's socioemotional and physical development, instead of specified computer programs, may be more effective. In particular, school programs such as Tools of the Mind and Montessori, that involve embedded daily EF skill building, have shown promising outcomes and may be more generalizable (Diamond & Lee, 2011).

Adult Interventions

Less is known about the relationship between ACEs and EF among adults, as EF difficulties are predominantly studied among child populations. However, systematic review findings suggest that ACEs may increase risk for EF difficulties among both the adult general population and clinical samples (including among those with diagnoses of schizophrenia, bipolar disorder, PTSD, and substance use disorder; Lund et al., unpublished manuscript). As such, it is worth considering the evidence base for interventions aimed at improving EF in adulthood. Among adult populations, more emphasis has been placed on EF interventions for specific clinical populations. As the research is more limited among adult samples, the follow section is presented based on the state of the literature, including interventions aimed at certain age demographics or specific clinical presentations.

Young Adults. The PFC continues to develop into young adulthood, and thus it is hypothesized that EFs are still developing at this period of time as well (Best et al., 2011). As such, young adults represent a demographic where efforts to intervene with EF difficulties may be particularly effective. Bettis and colleagues (2017) examined the effectiveness of an online cognitive training program, in comparison to a six-week manualized coping skills-based

intervention. The online cognitive training program involved games that target either working memory, attentional control/inhibitory control, or cognitive flexibility. Students played the games 15 to 20 minutes per days, 5 days a week for 6 weeks. Both interventions were associated with decreases in social stress. However, students in the cognitive training intervention demonstrated greater reductions in EF (behaviour regulation in particular) compared to those in the coping skill intervention. There is also evidence to suggest that focused video games that target specific EF skills across contexts, and that progress in difficulty, may be a promising avenue for supporting improvements in EF among young adults (Mayer et al., 2019; Parong et al., 2017). Finally, there is evidence to support that, like in children, high-intensity intermittent exercise improves EF among young adults (Kujach et al., 2018). Notably, this exercise also demonstrated cortical activation in the left-dorsal-lateral prefrontal cortex, demonstrating a neurodevelopmental pathway corresponding to the EF gains.

Older Adults. ACEs appear to be associated with poor outcomes among older adults, including a higher risk for dementia (Tani et al., 2020). Notably, earlier exposure to adversity during childhood (before age 6) is associated with larger risk of dementia, though this relationship is attenuated in older children (Ravona-Springer et al., 2012). ACEs are also associated with poor cognition among older adults, and in particular, EF difficulties (Gold et al., 2021; Petkus et al., 2018). However, there is some evidence to suggest that certain experiences of ACEs, including severe abuse (Ritchie et al., 2011) and sexual abuse (Feeney et al., 2013), are associated with positive cognitive outcomes among older adults.

Due to the link between EF and dementia (Stopford et al., 2012), there are extensive reviews of interventions aimed at targeting EF among older adults with mild cognitive impairments. These include technology-based cognitive training and rehabilitation (Ge et al.,

2018; Shah et al., 2017), exercise programs (Chen et al., 2020), and social engagement (Kelly et al., 2017). Ultimately, there is insufficient evidence to suggest that cognitive difficulties seen among older adults with a history of ACEs require unique intervention. Therefore, to date, best practices for EF interventions among this population align with those that are also effective for older adults more broadly.

Adults with Substance Use Disorder. ACEs appear to increase risk for EF difficulties among those with substance use disorders (Nigg et al., 2006), and EF difficulties appear to predict later substance use (Wilens et al., 2011). This relationship is bi-directional, such that chronic substance use also increases risk for EF difficulties (Brockett et al., 2018; Gustavson et al., 2017). Due to the high prevalence of ACEs among those with substance use disorders (Dube et al, 2003), EF interventions may be a relevant intervention to support positive treatment outcomes and may even serve as a mechanism of change among interventions. Lechner and colleagues (2019) provide a review of possible interventions to support EF among those with addictions. In summary, they conclude that potentially viable interventions include Working Memory Training, Cognitive Bias Modification, future episodic thinking, mindfulness-based interventions, and pharmacological treatments. In particular, future episodic thinking and mindfulness-based interventions appear to be the most promising in supporting EF improvement.

Future episodic thinking is a strategy that challenges individuals to consider the distal rewards or gains relative to proximal ones, thus targeting inhibitory control (Atance & O'Neil, 2001). Among those with alcohol use disorder, future episodic thinking has been shown to decrease impulsivity and reduce cravings (Bulley & Gullo, 2017). Meanwhile, mindfulness-based interventions appear to be effective in reducing cravings and severity of use (Li et al., 2017). As mentioned previously in the child intervention section, there is evidence to suggest a

trauma-informed approach is needed when using mindfulness among those with a history of ACEs (Zhu et al., 2019).

A recent review by Anderson and colleagues (2021) found that cognitive remediation, and specifically goal management training, may improve impulsivity among those with addictions. Meanwhile, there was not sufficient evidence to suggest that computerized cognitive training or pharmacological interventions were effective. Goal management training involves explicit training around goal-related decisions and involves mindful reflection regarding where attention is placed, including the role of impulsivity in decision making (Anderson et al., 2021), and appears conceptually similar to future episodic thinking. Ultimately, research is needed to examine the effectiveness of these strategies among adults with a history of ACEs and chronic substance use.

Adults with Affective and Psychotic Disorders. EF deficits are prevalent among those diagnosed with depression, bipolar disorder, and schizophrenia (Abe et al., 2018). ACEs also increase the risk for these disorders (Carbone et al., 2019; van Nierop et al., 2015). Review findings suggest that ACEs are associated with EF deficits among those with bipolar disorder, to some extent schizophrenia, but not those with a diagnosis of depression (Lund et al., unpublished manuscript). As such, there is currently no evidence to suggest unique EF intervention considerations for those with past ACEs among those with schizophrenia or depression. However, DBT (summarized in the child section) has been shown to be a promising EF intervention for individuals with a diagnosis of bipolar disorder (Afshari et al., 2019). Notably, DBT was associated with lower scores of mania, depression, emotion dysregulation, as well as improvements in mindfulness, planning, problem-solving, and cognitive flexibility. DBT may be

a particularly useful intervention to address EF difficulties associated with ACEs among those with bipolar and BPD, given these findings.

Meanwhile, computerized cognitive training for those with diagnoses of depression, bipolar, or schizophrenia diagnoses appear to be promising (Medalia & Freilich, 2008). In particular, cognitive training has been shown to be effective in improving cognitive flexibility, attention, and overall EF among those with depression or bipolar diagnoses (Preiss et al., 2013). Similarly, Siegle and colleagues (2007) provide a comprehensive summary of cognitive control training for depression. Of note, the Neuropsychological Education Approach (NEAR), a cognitive remediation model, is associated with positive outcomes in cognition across affective and psychotic disorders (Hodge et al., 2010; Naismith et al., 2010; Medalia & Freilich, 2008).

Adults with PTSD. There are currently highly effective interventions to treat PTSD among adult samples (Jonas et al., 2013). However, there are still many individuals who are unresponsive to gold standard treatments (Jonas et al., 2013). EF difficulties are related to PTSD symptom severity among adults (Woon et al., 2016), and there is evidence to suggest that PTSD symptoms, including attentional biases toward trauma-related stimuli and hyperarousal, are linked to EF deficits (Aupperle et al., 2012). Indeed, PFC dysfunction has been documented among those with PTSD (Aupperle et al., 2012). Notably, a computer-based interference control training is associated with improvements in re-experiencing symptoms and interference control among those with PTSD (Bomyea et al., 2015). Interference control is viewed as a facet of inhibitory control, involving the ability to regulate unwanted thoughts (Unsworth, 2010). Similarly, computerized attention control training, which involves learning to disconnect emotional value from threat related cues, was associated with PTSD symptom reduction and

changes in attentional bias (Badura-Brack et al., 2015), and appears to be a promising avenue for treating PTSD.

Recently, Clausen and colleagues (2019) also proposed a computer-based EF training as a possible alternative or additional treatment for adults with PTSD, due to the relationship between EF and PTSD symptoms. At this time, only the feasibility of this intervention has been published, and thus outcome studies are still needed. However, ACEs appear to be implicated in reactivity to threat-related cues (Herzog & Schmahl, 2018), and are associated with severity of adult PTSD (Wilson & Newins, 2018), and thus the aforementioned EF-based interventions are promising avenues for those with PTSD and a history of ACEs.

System-Level Considerations

Thus far, this review has focused on individual-level interventions across the lifespan to address EF difficulties associated with exposure to ACEs. Research in the realm of clinical psychology often focuses on individual level variation to develop evidence-based interventions to support individuals presenting with relevant symptomology. However, there are relevant research findings that highlight the need for broader system-level considerations when discussing the connection between early adversity and EF difficulties. Importantly, a discussion of the intergenerational transmission of EF difficulties, as well as the influence of poverty and inequality in relation to ACEs and EF is warranted.

There is a wealth of studies connecting parent EF difficulties to child EF difficulties through the impact of EF on parenting. These suggest EF deficits are transmitted intergenerationally both through environmental exposure and hereditability (Bridgett et al., 2015). This simultaneously coincides with research purporting the intergenerational transmission of ACEs (Madigan et al., 2019). In other words, exposure to ACEs may increase risk for EF

difficulties among children; then, these individuals as adults are at an increased risk for EF difficulties contributing to parenting difficulties, interpersonal difficulties, psychopathology, and substance use, ultimately perpetuating ACEs among the next generation. For example, higher ACEs predicts parental distress (Steele et al., 2016), as well as impaired maternal-infant bonding (Muzik et al., 2013), decreased sensitivity (Pereira et al., 2012), and hostility towards children (Bailey et al., 2012). Notably, there is a lack of research on the unique influence of paternal ACEs on parenting outcomes.

Parents' past ACEs are implicated in conflict they experience with their own children, and this is mediated by parental EF (including capacity for working memory, inhibitory control, and attention shifting; Guss et al., 2018). In particular, parents who have perpetuated abuse demonstrate deficits in "hot" EFs, though this is not apparent among parents perpetuating neglect (Fontaine & Nolin, 2012). Bridgett and colleagues (2015) provide an extensive review of the literature on intergenerational transmission of EF (self-regulation in particular) and propose the Self-Regulation Intergenerational Transmission Model. This model captures both neurobiological foundations (including genetic, epigenetic, and gene-environmental processes) alongside prenatal programming, parenting behaviour, inter-parental relationship behaviours, and household chaos, all as contributors to intergenerational pathways to EF difficulties.

Ultimately, this conceptualization highlights the need for broader parenting interventions. ACE screening may prove to be an effective way to identify parents who may benefit from EF interventions. Consistent with considerations for prenatal programming of EF deficits (Buss et al., 2011), ACE screening and resultant EF interventions among expecting mothers may be a particularly valuable prevention/early intervention pathway. Similarly, identification of children

exposed to ACEs (e.g., through child welfare services or school identification) may serve as an efficient way to capture candidates for EF interventions.

Much like the intergenerational nature of EFs, poverty is also a necessary variable to consider in relation to EF difficulties seen across communities, and in relation to ACEs. Indeed, ACEs including mental illness, neglect, incarceration, and substance use, are highly elevated among those experiencing poverty, and are arguably directly associated with poverty (Steele et al., 2016). Perhaps unsurprisingly, there is a link between poverty and EF difficulties (Merz et al., 2018). Notably, chronic family poverty has predicted EF outcomes among children (Raver et al., 2013), and this appears to be mediated by cortisol levels (Blair et al., 2011). Moreover, household chaos (e.g., lack of routines, excessive noise, and disarray), predicts maternal and child EF among those in low socioeconomic contexts (Andrews et al., 2021; Deater-Deckard et al., 2012). Recently, Vogel and colleagues (2021) found that lower socioeconomic status (SES) predicted higher deprivation (forms of neglect) and threat (forms of abuse and exposure to violence in the home). Moreover, SES fully mediated the relationship between deprivation and poor EF. These findings highlight the integral role poverty plays in the relationship between ACEs and EF outcomes.

Experiences of poverty appear to increase risk for insufficient stimulation as well as increased levels of threat during childhood (Vogel et al., 2021). The effects of poverty outside of the family are also seen to influence EF. For instance, teacher stress has been shown to predict student EFs, and this was moderated through school-level poverty (Neuenschwander et al., 2017). Similarly, neighbourhood poverty is also associated with poor EF outcomes among children, independent of family income (Tomlinson et al., 2020). Overall, these findings suggest that broader systemic interventions to address poverty are needed to interrupt the continual

intergenerational transmission of ACEs and subsequent EF deficits. To that end, Raver and Blair (2020) provide a critical discussion of social, racial, and economic inequality in relation to EF, and research avenues to move the field forward.

Conclusion

In this review, we provided an overview for promising interventions that may be used to treat EF difficulties among children and adults with a history of ACEs. Notably, targeted interventions for EF have been developed to improve early attachment processes and parenting skills for at risk parent-child dyads. Moreover, TF-CBT and DBT, while not designed to address EF explicitly, appear to demonstrate positive EF outcomes. There is a lack of studies that examine EF interventions among those with ACEs, though there are some promising EF interventions for children and adults, where next steps may involve examining their effectiveness among those with ACE histories specifically. Lastly, addressing ACEs and EF difficulties should be broached through a systems-level approach that considers both the role of intergenerational transmission and the broad effects of social and economic poverty on both ACEs and EFs.

Chapter 9:

Conclusions

Conclusions

The overall objective of this doctoral dissertation was to better understand the relationship between ACEs and EFs among adults attending an Indigenous substance use treatment program. This objective was decided upon as a means to develop a preliminary knowledge base that could then be used to inform future preventative and intervention pursuits. To achieve this objective, various research endeavours were completed. The field of research linking ACEs to EFs in the general population had not been reviewed prior to this work, nor studied among Indigenous samples in Canada. As such, two systematic reviews were first conducted to summarize the current state of literature relating to ACEs and EF among broader child (Chapter 3) and adult (Chapter 4) samples. Ultimately, there was substantial evidence to suggest ACEs increase risk for various EF difficulties among child samples. Among adult samples, there were findings to suggest this relationship is also present, though the literature base was less robust.

With the knowledge base provided in the two systematic reviews, an original community-based research study was developed to examine the relationship between ACEs, EF, and substance use outcomes among adult clients at an Indigenous residential substance use treatment program in Northwestern Ontario. Ultimately, family substance use and severity of neglect were found to predict EF difficulties among participants. Moreover, PTSD symptom severity was associated with ACEs and increased risk for EF difficulties within this population. These findings have direct implications for the community partner treatment program, who now better understand the prevalence and impact of ACEs, post-traumatic stress, and EF difficulties on their clients and can adjust treatment accordingly. This has ultimately supported their goal of better understanding the influence of ACEs on the substance use difficulties their clients face.

Across the literature reviews and original research completed in this dissertation, a consistent relationship between individual ACEs and EF difficulties is documented, albeit the findings are variable. To translate these findings into meaningful clinical implications, an environmental scan and review (Chapter 8) was completed that involved a discussion of prominent interventions aimed at addressing EF difficulties among children and adults with past ACEs. Ultimately, this area of research is limited, with the most evidence-base focussing on early attachment-related interventions. Nonetheless, the review of the literature provides an overview that can inform the development of future interventions including which interventions may be culturally adapted to support Indigenous peoples in Canada specifically.

Most notably, a consideration for interventions that encourage attachment processes from a culturally informed lens is warranted. For example, Indigenous midwifery programs which enable more Indigenous births to be supported through ceremony and Indigenous values may promote culturally grounded attachment among future generations. Similarly, attachment-based interventions may be reconsidered to not only consider the child-caregiver dyadic relationship, but the multi-layers of attachment which form between child and multiple caregivers in the community, given the shared responsibility among Indigenous communities for caring and nurturing children which differs from Western views of dyadic attachment processes (Neckoway et al., 2007).

While culturally relevant interventions at the individual-level are required to support Indigenous youth and adults experiencing EF difficulties, system-level changes are also central to addressing the ongoing intergenerational trauma experienced among Indigenous communities that may be perpetuating EF difficulties. As noted in Chapter 8, poverty both in the home and community at large appears to be highly connected to EF difficulties among youth. This

coincides with the core dissertation findings noted in Chapter 6, whereby the two ACEs found to predict EF difficulties, neglect and substance use, are also common signifiers of poverty. Indigenous children in Canada continue to experience high rates of poverty, particularly among those who live on reserve (Beedie et al., 2019). As such, system-level policy changes aimed at reducing poverty provide a concrete avenue to support EF development among Indigenous communities. A multi-pronged approach to addressing Indigenous poverty is needed given the complexity of the poverty experienced among Indigenous communities (Beedie et al., 2019). This includes ongoing concerns related to food security, housing overcrowding, accessibility to clean drinking water and mitigation of toxin exposure, as well as infrastructure that supports timely access to culturally relevant mental health supports. Notably, a worthwhile first step involves a federal poverty reduction plan that fully acknowledges the degree of poverty experienced among Indigenous communities and that prioritizes Indigenous partnership and financial self-determination (Beedie et al., 2019).

Ultimately, the effects of intergenerational trauma among Indigenous communities are pervasive and ongoing and EF difficulties may represent one affiliated variable, among many, contributing to the ongoing trauma seen across generations. Indeed, the outcomes of colonialism are witnessed through the trauma and loss impacting each Indigenous client attending substance use treatment in Canada, and certainly those whose experiences are captured in this study. Despite this, each client demonstrates resilience in their pursuit toward healing for themselves and their communities. The findings of this dissertation, including the high prevalence of ACEs, post-traumatic stress, and their impact on EFs, only further demonstrate the magnitude of resilience held by Indigenous clients who choose to seek substance use treatment. It is the hope that the findings of this dissertation can be used to better understand the ongoing effects of

intergenerational trauma among Indigenous communities; Further, it is the hope that these findings inform future culturally informed prevention, intervention, and research pursuits that address the ongoing effects of historical trauma inflected on Indigenous peoples in Canada and that support Indigenous wellness across future generations.

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Appendix A: ARTC Intake Form

THIS SECTION: TO BE COMPLETED BY CLIENT

ADDICTION HISTORY

Primary Substance	Approximate Date of Last Time Used	Age of First Use	Age Regular Use Began
1.			
2.			
3.			

Substances used in the last 12 months: (please check all that apply)

☐ Alcohol	☐ Crack	☐ Methadone
☐ Amphetamines, *i.e. Ritalin*	☐ Glue/inhalant	☐ Oxycontin
☐ Barbiturates, *i.e. Phenobarbital*	☐ Hallucinogens, *i.e. Ecstasy*	☐ Over-the-counter Codeine, *i.e. Tylenol #1 & 3's*
☐ Benzodiazepine, *i.e. Ativan, Valium*	☐ Heroin/opium	☐ Prescription Opiods, *i.e. Morphine*
☐ Cocaine	☐ Marijuana	

Have you ever experienced any of the following: (please check all that apply)

☐ Hangovers	☐ Vomiting	☐ Shakes	☐ Paranoia
☐ Blackouts	☐ Seizures	☐ Hallucinations	☐ Health Problems

Injection Drug Use: ☐ Yes ☐ No

TREATMENT HISTORY

Previous Treatment Attempt(s) ☐ No ☐ Yes (Please complete the information below)

Name of Facility	Date	Completed
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
How long were you clean/sober after treatment:		
What do you identify as the reasons for returning to drinking/drug using:		

Appendix B: Family Health History Questionnaire

Time 1 Questions

These questions will ask about yourself and your family. This information will allow us to better understand problems that may occur early in life, and may help others in the future. Some of these questions ask about sensitive topics and some people may feel uncomfortable with these questions. You do not have to answer any question that you don't want to.

1. How old are you?	AGE: _____
2. Where were you born? (community and province)	BIRTH PLACE: _____
3. What was your biological sex determined at birth?	Male Female Intersex Other: _____
4. What is your gender identity? (ie: your own personal experience of gender)	Male Female Transgender woman Transgender man Gender queer or nonbinary Unsure Other (please specify): _____
5. Do you self-identify as Indigenous?	1= YES 2= NO
6. If YES, what band, reserve, or community are you affiliated with?	NAME: _____ DOES NOT APPLY
7. How far did you get in school?	1= Didn't go to school/Lower than grade 6 2= Elementary (Grade 6) 3= Middle School (Grade 8) 4= Some high school 5= High school graduate or GED 6= Some college or technical school 7= University Degree (Bachelor) 8= Professional Degree (Master's or PhD)
8. What is your current marital status? Are you now:	1= Married 2= Common Law (not married but living together) 3= In a serious relationship 4= Widowed 5= Separated 6= Divorced 7= Single/Not in a serious relationship
9. How many times have you been married?	1= 1 2= 2 3= 3 4= 4 or more 5= Never married

10. How old were you when you were first married?	AGE: _____
11. Prior to treatment at ARTC, what was your living situation?	1= Living Alone 2= With spouse/partner 3= With roommates/friends 4= With parents/ other family 5= No permanent resident 6= None of the above, my living status is: _____
12. Where do you anticipate living after ARTC?	1= Living Alone 2= With spouse/partner 3= With roommates/friends 4= With parents/ other family 5= No permanent resident 6= None of the above, my living status is: _____
13. What is your current annual income?	1= < $10 000 2= <$10 001 to $19 999 3= $20 0000 to $29 999 4= $30 000 to $39 999 5= $40 000 to $60 000 6= > than $60 000
14. Which of the following best describes your employment status before coming to ARTC?	1= Full time (35 hours or more) 2= Part-time (1-34 hours) 3= Student 4= Sick leave 5= Unemployed looking for work 6= Unemployed not looking for work 7= Retired 8= Disability (ODSP, OW) 9= Home/parenting
15. During the 30 days prior to entering treatment at ARTC, how many days did you miss work due to stress or feeling depressed?	# of days _____ DOES NOT APPLY
16. During the 30 days prior to entering treatment at ARTC, how many days of work did you miss due to poor physical health?	# of days _____ DOES NOT APPLY
17. Have you ever attended a residential school?	1= YES 2= NO

18. If so, what age did you attend and for how many years?	AGE _____ Years attended _____

Childhood & Family Questions

19. For most of your childhood, did your family own their own home?	1= YES 2= NO
20. During your childhood, how many times did you move residences, even in the same town/community?	# of times _____
21. How old was your mother when you were born?	AGE: _____
22. How much education does/did your mother have?	1= Didn't go to school/Lower than grade 6 2= Elementary (Grade 6) 3= Middle School (Grade 8) 4= Some high school 5= High school graduate or GED 6= Some college or technical school 7= University Degree (Bachelor) 8= Professional Degree (Master's or PhD) 9= DON'T KNOW/ DOES NOT APPLY
23. How much education does/did your father have?	1= Didn't go to school/Lower than grade 6 2= Elementary (Grade 6) 3= Middle School (Grade 8) 4= Some high school 5= High school graduate or GED 6= Some college or technical school 7= University Degree (Bachelor) 8= Professional Degree (ie: MA) 9= DON'T KNOW/ DOES NOT APPLY

Tobacco Use

37. Have you smoked at least 100 cigarettes in your life?	1= YES 2= NO
38. How old were you when you began to smoke cigarettes fairly regularly?	AGE: _____
39. Do you smoke cigarettes now or chew tobacco?	1= YES 2= NO
40. If yes, on average, how many cigarettes per day do you smoke?	# of cigarettes: _____ DOES NOT APPLY
41. If you used to smoke cigarettes but don't smoke now, about how many cigarettes a day did you smoke?	# of cigarettes: _____ DOES NOT APPLY
42. How old were you when you quit?	AGE: _____

	DOES NOT APPLY
43. During your first 18 years of life did your father smoke?	1= YES 2= NO 3= DON'T KNOW/DOES NOT APPLY
44. During your first 18 years of life did your mother smoke?	1= YES 2= NO 3= DON'T KNOW/DOES NOT APPLY

Substance Use

49. How old were you when you had your first drink of alcohol, other than a few sips?	AGE: _____ NEVER DRANK
During each of the following age intervals, what was your usual number of drinks of alcohol per week? Remember, 1 standard alcoholic drink= ne bottle of beer, one cooler, one small (4-ounce) glass of wine, or one shot/ mixed drink containing an ounce of hard liquor.	
50. AGE 12 to 14	1=None 2=Less than 6 per week 3=7-13 per week 4=14 or more per week
51. AGE 15 to 18	1=None 2=Less than 6 per week 3=7-13 per week 4=14 or more per week
52. AGE 19 to 29	1=None 2=Less than 6 per week 3=7-13 per week 4=14 or more per week
53. AGE 30 to 39	1=None 2=Less than 6 per week 3=7-13 per week 4=14 or more per week
54. AGE 40 to 49	1=None 2=Less than 6 per week 3=7-13 per week 4=14 or more per week
55. AGE 50 and older	1=None 2=Less than 6 per week 3=7-13 per week 4=14 or more per week
56. In the 30 days prior to entering treatment at ARTC, did you drink any alcohol?	1= YES 2= NO
57. In the 30 days prior to entering treatment at ARTC, how many <u>days per week</u> did you drink any alcoholic beverages on average?	DOES NOT APPLY # of days per week: _____
58. On the days when you drank, about how many <u>drinks per day</u> did you have on average?	DOES NOT APPLY

	# of drinks per day: _____
59. How many times during the past month did you have more than 5 drinks at one occasion?	# of times: _____
60. In the 30 days prior to entering treatment at ARTC, how many times have you driven when you've had perhaps too much to drink?	# of times: _____
61. In the 30 days prior to entering treatment at ARTC, how many times did you ride in a vehicle drive by someone who had been drinking?	# of times: _____

Family Alcohol Use

62. During your first 18 years of your life, did you live with anyone who was a problem drinker or alcohol?	1= YES 2= NO
63. Who? *Check all that apply:*	o Father o Mother o Brothers o Sisters o Other Relatives: _____ o Other non-relatives: _____ # of CIRCLES CHECKED: _____
64. Have you ever been married to someone (or lived with someone as if you were married) who was a problem drinker or alcoholic?	1= YES 2= NO

Substance Use

65. Have you ever used street drugs? *(ie: Marijuana, cocaine, speed, LSD, heroin)*	1= YES 2= NO
66. If yes, how old were you the first time you used them?	AGE: _____
67. About how many times have you used street drugs?	0=0 1=1-2 2=3-10 3=11-25 4=26-99 5=100+
68. Have you ever considered yourself to be addicted to street drugs?	1= YES 2= NO

To your best knowledge, have you been diagnosed or received treatment for any of the following?

66. Depression (Major Depression, Dysthymia)	1= YES 2= NO
67. Anxiety (Generalized Anxiety, Fear of Public Spaces, Social Anxiety)	1= YES 2= NO

68. Eating Concerns (Anorexia, Bulimia, Binge Eating)	1= YES	2= NO
69. Bi-polar Disorders	1= YES	2= NO
70. Schizophrenia or Psychosis	1= YES	2= NO
71. Post-Traumatic Stress Disorder/Trauma	1= YES	2= NO
72. Substance Use Disorder	1= YES	2= NO
73. Attention-Deficit Hyperactivity Disorder	1= YES	2= NO
74. Fetal Alcohol Spectrum Disorder	1= YES	2= NO
75. Learning Disability	1= YES	2= NO
76. Personality Disorder (ie: Borderline Personality Disorder)	1= YES	2= NO

Appendix C: Family Health History Questionnaire

Time 2 Questions

These questions will ask about yourself and your family. This information will allow us to better understand problems that may occur early in life, and may help others in the future. Some of these questions ask about sensitive topics and some people may feel uncomfortable with these questions. You do not have to answer any question that you don't want to.

The next questions ask about the first 18 years of your life, and about family members in your household.

1. Did you live with anyone who used street drugs?	1= YES 2= NO
2. Did your mom ever drink alcohol when she was pregnant with you	1= YES 2= NO 3= DON'T KNOW
3. Were your parents ever separated or divorced?	1= YES 2= NO
4. Did you ever live with a step father?	1= YES 2= NO
5. Did you ever live with a stepmother?	1= YES 2= NO
6. Did you ever live in a foster home?	1= YES 2= NO
7. If yes, at what age were you first placed in foster care?	AGE: _____
8. If yes, how many foster family placements did you have during your childhood?	# of placements: _____
9. If yes, what age was your last foster family placement?	AGE: _____
10. Did you ever run away from home for more than one day?	1= YES 2= NO
11. Did your brothers or sisters run away from home for more than one day	1= YES 2= NO
12. Was anyone in your household depressed or mentally ill?	1= YES 2= NO
13. Did anyone in your household attempt suicide?	1= YES 2= NO
14. Did anyone in your household go to prison?	1= YES 2= NO
15. Did anyone in your household commit a serious crime?	1= YES 2= NO

Sometimes physical blows occur between parents. While you were growing up, in the first 18 years of your life, how often did your mother's partner (ie: father/stepfather/boyfriend) do any of these things to your mother (or stepmother)?

16. Push, grab, slap, or throw something at her?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often

17. Kick, bite, hit her with a fist, or hit her with something hard?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often
18. Repeatedly hit her over at least a few minutes?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often
19. Threaten her with a knife or gun to hurt her?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often

While you were growing up, during the first 18 years of your life, how true were each of the following statements?

20. You didn't have enough to eat.	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
21. You knew there was someone to take care of you and protect you	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
22. People in your family called you things like "lazy" or "ugly"	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
23. Your parents were too drunk or high to take care of the family?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
24. There was someone in your family who helped you feel important or special?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
25. You had to wear dirty clothes?	1= Never true 2= Rarely true 3= Sometimes true

	4= Often true 5= Very often true
26. You felt loved?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
27. You thought your parents wished you had never been born?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
28. People in your family looked out for each other?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
29. You felt that someone in your family hated you?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
30. People in your family said hurtful or insulting things to you?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
31. People in your family felt close to each other?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
32. You believe that you were emotionally abused?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
33. There was someone to take you to the doctor if you needed it?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true
34. Your family was a source of strength and support?	1= Never true 2= Rarely true 3= Sometimes true

	4= Often true 5= Very often true
35. Your family did not send you to school, even when it was available?	1= Never true 2= Rarely true 3= Sometimes true 4= Often true 5= Very often true

Sometimes parents or other adults hurt children. While you were growing up, during the first 18 years of your life, how often did a parent, step-parent or adult living in your home:

36. Swear at you, insult you, or put you down?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often
37. Threaten to hit you or throw something at you, but didn't do it?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often
38. Actually push, grab, shove, slap you, or throw something at you?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often
39. Hit you so hard that you had marks or were injured?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often
40. Act in a way that made you afraid that you might be physically hurt?	1= Never 2= Once, twice 3= Sometimes 4= Often 5= Very often

Some people, while growing up in their first 18 years of life, had a sexual experience with an adult or someone at least five years older than themselves. These experiences may have involved a relative, family friend, or stranger.

41. During the first 18 years of your life, did an adult, older relative, family friend, or stranger ever sexually abuse you? This can include an adult touching your body in a sexual way, having you touch their body in a sexual way, attempting to have any type of sexual intercourse (oral, anal, or vaginal) with you, or having sexual intercourse with you.	1= YES 2= NO

42. If yes, the first time this happened, how old were you?	AGE: _____
43. About how many times did this happen to you?	# of times: _____ DOES NOT APPLY

As an adult, (age 19 or older), did:

44. Anyone ever force or threaten you with harm in order to have sexual contact, such as touching your sexual parts or trying to have intercourse with you?	1= YES 2= NO

Appendix D: Comprehensive Executive Function Inventory (CEFI) – Adult Self Report

CEFI ADULT ™ SELF-REPORT FORM

Jack A. Naglieri, Ph.D. & Sam Goldstein, Ph.D.

6863981

Name/ID: _____

INSTRUCTIONS: Read each statement that follows the phrase, ***"During the past four weeks, how often did you...,"*** then circle the letter under the word that tells how often it happened. Read each question carefully, then mark how often it happened in the ***past four weeks***. Answer every question without skipping any. If you want to change your answer, put an X through it and circle your new choice. Be sure to answer every question.

During the past four weeks, how often did you...	Never	Rarely	Sometimes	Often	Very Often	Always
1. show self-control?	N	R	S	O	V	A
2. have trouble finding things?	N	R	S	O	V	A
3. maintain self-control?	N	R	S	O	V	A
4. plan ahead?	N	R	S	O	V	A
5. remember many things at one time?	N	R	S	O	V	A
6. know when a task was completed?	N	R	S	O	V	A
7. come up with different ways to solve problems?	N	R	S	O	V	A
8. pay attention for a long time?	N	R	S	O	V	A
9. have trouble solving problems?	N	R	S	O	V	A
10. start tasks easily?	N	R	S	O	V	A
11. get upset?	N	R	S	O	V	A
12. get things done efficiently?	N	R	S	O	V	A
13. think of the consequences before acting?	N	R	S	O	V	A
14. pay attention during a boring task?	N	R	S	O	V	A
15. forget to do things?	N	R	S	O	V	A
16. know what to do first?	N	R	S	O	V	A
17. stay calm when handling small problems?	N	R	S	O	V	A
18. like everyone you met?	N	R	S	O	V	A
19. accept a different way of doing things?	N	R	S	O	V	A
20. need others to tell you to get started on things?	N	R	S	O	V	A
21. work neatly?	N	R	S	O	V	A
22. have trouble listening to instructions?	N	R	S	O	V	A
23. keep all your commitments?	N	R	S	O	V	A
24. remember instructions with many steps?	N	R	S	O	V	A
25. keep track of time?	N	R	S	O	V	A
26. prepare for upcoming events?	N	R	S	O	V	A
27. find it hard to control your emotions?	N	R	S	O	V	A
28. get things done on time?	N	R	S	O	V	A
29. respond thoughtfully?	N	R	S	O	V	A
30. fail to put plans into action?	N	R	S	O	V	A
31. work well in a noisy environment?	N	R	S	O	V	A
32. hold several ideas in memory?	N	R	S	O	V	A
33. have trouble judging how long it takes to do something?	N	R	S	O	V	A
34. react with the right level of emotion?	N	R	S	O	V	A
35. start something without being asked?	N	R	S	O	V	A
36. pay attention to details?	N	R	S	O	V	A
37. have good thoughts about everyone?	N	R	S	O	V	A
38. notice your mistakes?	N	R	S	O	V	A
39. think through your decisions?	N	R	S	O	V	A
40. manage frustration?	N	R	S	O	V	A

Continued on the next page...

6863981

CEFI ADULT ™ SELF-REPORT FORM

Jack A. Naglieri, Ph.D. & Sam Goldstein, Ph.D.

6863981

Name/ID: _____

During the past four weeks, how often did you...	Never	Rarely	Sometimes	Often	Very Often	Always
41. change your behavior as needed?	N	R	S	O	V	A
42. need others to tell you to do things?	N	R	S	O	V	A
43. manage time effectively?	N	R	S	O	V	A
44. have trouble waiting your turn?	N	R	S	O	V	A
45. concentrate while reading?	N	R	S	O	V	A
46. get bothered by something?	N	R	S	O	V	A
47. follow instructions well?	N	R	S	O	V	A
48. learn from past mistakes?	N	R	S	O	V	A
49. solve problems creatively?	N	R	S	O	V	A
50. become upset in new situations?	N	R	S	O	V	A
51. compromise when needed?	N	R	S	O	V	A
52. appear motivated?	N	R	S	O	V	A
53. organize your thoughts well?	N	R	S	O	V	A
54. have trouble waiting to get what you wanted?	N	R	S	O	V	A
55. notice how your actions affected others?	N	R	S	O	V	A
56. make a mistake?	N	R	S	O	V	A
57. remember important things?	N	R	S	O	V	A
58. respond calmly to delays?	N	R	S	O	V	A
59. consider other points of view?	N	R	S	O	V	A
60. get distracted?	N	R	S	O	V	A
61. organize tasks well?	N	R	S	O	V	A
62. have a bad day?	N	R	S	O	V	A
63. ask for help when needed?	N	R	S	O	V	A
64. resist change?	N	R	S	O	V	A
65. think before acting?	N	R	S	O	V	A
66. stay on topic when talking?	N	R	S	O	V	A
67. keep goals in mind when making decisions?	N	R	S	O	V	A
68. make careless errors?	N	R	S	O	V	A
69. come up with a new way to reach a goal?	N	R	S	O	V	A
70. get upset when plans were changed?	N	R	S	O	V	A
71. start a task without help?	N	R	S	O	V	A
72. appear disorganized?	N	R	S	O	V	A
73. think before speaking?	N	R	S	O	V	A
74. tell a fib?	N	R	S	O	V	A
75. fix your mistakes?	N	R	S	O	V	A
76. forget where you put things?	N	R	S	O	V	A
77. make good decisions?	N	R	S	O	V	A
78. control emotions when under stress?	N	R	S	O	V	A
79. react well to new demands?	N	R	S	O	V	A
80. take initiative?	N	R	S	O	V	A

Thank you for completing this form!

MHS

6863981

Appendix E: Depression-Anxiety-Stress Scale 21

Depression-Anxiety-Stress Scale 21

DASS21 :

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree, or a good part of time
3 Applied to me very much, or most of the time

1	I found it hard to wind down	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I found it difficult to work up the initiative to do things	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I experienced trembling (eg, in the hands)	0	1	2	3
8	I felt that I was using a lot of nervous energy	0	1	2	3
9	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting agitated	0	1	2	3
12	I found it difficult to relax	0	1	2	3
13	I felt down-hearted and blue	0	1	2	3
14	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15	I felt I was close to panic	0	1	2	3
16	I was unable to become enthusiastic about anything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life was meaningless	0	1	2	3

Appendix F: PTSD Checklist for DSM-5

Instructions: Below is a list of problems that people sometimes have in response to a very stressful experience. Please read each problem carefully and then circle one of the numbers to the right to indicate how much you have been bothered by that problem in the past month.

In the past month, how much were you bothered by:	**Not at all**	**A little bit**	**Moderately**	**Quite a bit**	**Extremely**
1. Repeated, disturbing, and unwanted memories of the stressful experience?	0	1	2	3	4
2. Repeated, disturbing dreams of the stressful experience?	0	1	2	3	4
3. Suddenly feeling or acting as if the stressful experience were actually happening again (as if you were actually back there reliving it)?	0	1	2	3	4
4. Feeling very upset when something reminded you of the stressful experience?	0	1	2	3	4
5. Having strong physical reactions when something reminded you of the stressful experience (for example, heart pounding, trouble breathing, sweating)?	0	1	2	3	4
6. Avoiding memories, thoughts, or feelings related to the stressful experience?	0	1	2	3	4
7. Avoiding external reminders of the stressful experience (for example, people, places, conversations, activities, objects, or situations)?	0	1	2	3	4
8. Trouble remembering important parts of the stressful experience?	0	1	2	3	4
9. Having strong negative beliefs about yourself, other people, or the world (for example, having thoughts such as: I am bad, there is something seriously wrong with me, no one can be trusted, the world is completely dangerous)?	0	1	2	3	4
10. Blaming yourself or someone else for the stressful experience or what happened after it?	0	1	2	3	4
11. Having strong negative feelings such as fear, horror, anger, guilt, or shame?	0	1	2	3	4
12. Loss of interest in activities that you used to enjoy?	0	1	2	3	4
13. Feeling distant or cut off from other people?	0	1	2	3	4
14. Trouble experiencing positive feelings (for example, being unable to feel happiness or have loving feelings for people close to you)?	0	1	2	3	4
15. Irritable behavior, angry outbursts, or acting aggressively?	0	1	2	3	4
16. Taking too many risks or doing things that could cause you harm?	0	1	2	3	4
17. Being “superalert” or watchful or on guard?	0	1	2	3	4
18. Feeling jumpy or easily startled?	0	1	2	3	4
19. Having difficulty concentrating?	0	1	2	3	4
20. Trouble falling or staying asleep?	0	1	2	3	4

Appendix G: Drinking & Substance Use Motives Questionnaire

Below is a list of reasons people sometimes give for drinking alcohol or using drugs. Thinking of all the times you drink alcohol or use drugs, how often would you say that you drink/use for each of the following reasons?

Please respond based on how you usually have felt or behaved **over the past several years**.	Almost never/ Never	Some of the time	Half of the time	Most of the time	Almost always/ Always
1. As a way to celebrate	1	2	3	4	5
2. To relax	1	2	3	4	5
3. Because I like the feeling	1	2	3	4	5
4. Because it is what most of my friends do when we get together	1	2	3	4	5
5. To forget my worries	1	2	3	4	5
6. Because it is exciting	1	2	3	4	5
7. To be social	1	2	3	4	5
8. Because I feel more self-confident or sure of myself	1	2	3	4	5
9. To get a high	1	2	3	4	5
10. Because it is customary on special occasions	1	2	3	4	5
11. Because it helps me when I am feeling nervous	1	2	3	4	5
12. Because it's fun	1	2	3	4	5
13. Because it makes a social gathering more enjoyable	1	2	3	4	5
14. To cheer me up when I'm in a bad mood	1	2	3	4	5
15. To be liked	1	2	3	4	5
16. To numb my pain	1	2	3	4	5
17. Because it helps me when I am feeling depressed	1	2	3	4	5
18. So that others won't kid me about not using	1	2	3	4	5
19. To reduce my anxiety	1	2	3	4	5
20. To stop me from dwelling on things	1	2	3	4	5
21. To turn off negative thoughts about myself	1	2	3	4	5
22. To help me feel more positive about things in my life	1	2	3	4	5
23. To stop me from feeling so hopeless about the future	1	2	3	4	5
24. Because my friends pressure me to use	1	2	3	4	5
25. To fit in with a group I like	1	2	3	4	5
26. Because it makes me feel good	1	2	3	4	5

27. To forget painful memories	1	2	3	4	5
28. So I won't feel left out	1	2	3	4	5

Appendix H: Verbal Recruitment Script

There is a project happening here at Dilico that you might be interested in. It involves answering some questions about yourself. You would answer some questions today and then again about half way through treatment. Some of the questions are related to your childhood and may be personal or sensitive in nature. Are you interested in hearing more? If so, I can tell you more about it. Your decision to take part or not to take part in the project, or stop participating in project at any time, will **never** affect your access to services or supports at Dilico.

Appendix I: Information Letter

Dr. Christopher Mushquash
Department of Psychology
t: (807) 343-8239 f: (807) 346-7734
e: chris.mushquash@lakeheadu.ca

Study Information Letter:
Understanding Childhood Experiences and Relation to Substance Use for First Nations People

Principal Investigator: Dr. Christopher Mushquash, Lakehead University, in collaboration with Dilico Anishinabek Family Care
Email: chris.mushquash@lakeheadu.ca
Phone: (807) 343-8239
Student Investigators: Elaine Toombs and Jessie Lund, Lakehead University
Email: etoombs@lakeheadu.ca or jlund@lakeheadu.ca

Dear potential participant,

We invite you to take part in a research study being conducted by Dr. Christopher Mushquash, Elaine Toombs, and Jessie Lund, in partnership with Dilico Anishinabek Family Care. As someone seeking treatment for substance use, your experiences and perspectives may help us understand how childhood experiences may influence substance use across your lifetime.

Your participation in this study is voluntary and you may withdraw from this study at any time**. Your decision to take part or not to take part in the study, or to drop out of the study at a later time, will never affect your access to services or supports at Dilico Anishinabek Family Care.** You should discuss any questions you have about this study with Dr. Mushquash, Elaine Toombs, Jessie Lund, or your counsellor at Dilico. Please take as much time as you need to decide if you'd like to participate.

Purpose of this study
The purpose of this study is to understand how childhood experiences of trauma may influence substance use and other health outcomes for First Nations people.

Who can participate in this study?

You must be a current client at the Adult Residential Treatment Centre (ARTC) and aged 18 years or older to participate in this study.

Who will be conducting the research?
Dr. Christopher Mushquash, Elaine Toombs, Jessie Lund, and staff at Dilico Anishinabek Family Care will be conducting the research.

What will I be asked to do?
You will be asked to complete questionnaires with your individual counsellors at ARTC. Some of these questionnaires will be used for your treatment at ARTC and would be completed with your individual counsellor whether you agree to participate in this study or not (ie: for clinical purposes). Some questionnaires however will only be used for research purposes. If you consent to participant in this study, some information collected as part of your intake to ARTC (including prior treatment history, substance use history, and health history) will also be shared with study researchers. No identifying information (such as your birth date, home address, or health insurance information) will be shared. Additional questions will ask you about individual and family life experiences about substance use, addiction, health outcomes, and trauma. Some questions will ask about difficult experiences you may have had in your life, which may be difficult to answer or may cause distress. It will take approximately 90 minutes to complete these questions, which will be completed in two sessions. If you agree to participate, you will have the option to complete questions individually using pen and paper or have the questions read to you and you respond orally. You do not have to answer all questions and can skip questions that you are not comfortable answering.

What are the burdens and potential harms to participation?
There is a possibility that answering some of the questions may make you feel upset. There is a small burden of time associated with the completion of the assessment questions and program content. If you feel upset at any time completing the study, please contact your counsellor at ARTC as they can connect you with appropriate resources. If you have research related questions, please contact your Dr. Mushquash by phone at (807) 343-8239 or by email at chris.mushquash@lakeheadu.ca.

What are the potential benefits?
There are minimal individual benefits to participating in this study. You may find it satisfying to contribute to research programs and/or help First Nations communities understand how adverse childhood experiences may influence substance use.

Can I withdraw from the study?
This study is voluntary. You are free to withdraw from the study at any time, and free to remove your answers from the study, up until the point at which the study is complete (approximately December 2019). Your decision to take part or not to take part in the study, or to drop out of the study at a later time, will never affect your access to services or supports at Dilico Anishinabek Family Care.

How will my privacy be protected?
Anonymity: Your individual information will not appear in any reports or publications. All information will only be used when it is combined with other participants' information,

without your name or other information that would identify you. Several steps have also been taken to protect your confidentiality (see below).

Confidentiality: All information obtained is strictly confidential. The information you provide will only be accessed by designated members of the research team. All Dilico staff are trained to maintain your confidentiality and have signed confidentiality agreements.

Consistent with Lakehead University's policy on research data storage, paper copies of your information will be securely stored for 5 years after the completion of the study at Dilico. Your consent form will be stored separately from any collected data. These files will be stored in a locked filing cabinet in a locked office at Dilico, like all other client files. Electronic versions of de-identified data will be held for an indefinite period of time and will be kept in a password-protected USB drive in Dr. Mushquash's locked laboratory for a brief time and then will be held for 5 years at Dilico.

Electronic versions of the data will never include your name or contact information but will contain the following information about you: age, sex, ethnicity (i.e., self-reported ethnicity and country of birth), occupation, and nature of employment (e.g., full-time, part-time, etc.). Electronic information will be used by researchers at Lakehead University for a brief time and then stored at Dilico.

How can I receive a copy of the study results?
If you would like to receive a summary of study results, you can indicate this on the study consent form and provide your contact information. Individual results will not be made available to participants.

What if I have study questions or problems?
If you have any questions about this study or your participation, you may contact Dr. Mushquash by emailing chris.mushquash@lakeheadu.ca.

What are my research rights?
If you have any difficulties with, or wish to voice concern about, any aspect of your participation in this study, you may contact Lakehead University's Research Ethics Board for assistance at (807) 343-8283.

This study has been approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team please contact Sue Wright at the Research Ethics Board at 807-343-8283 or research@lakeheadu.ca.

Appendix J: Consent Form

Department of Psychology
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e: chris.mushquash@lakeheadu.ca

CONSENT FORM: **Understanding Childhood Experiences and Substance Use for First Nations People**

Agreement to Participate

1) **Study Purpose**: Dilico Anishinabek Family Care, in collaboration with Dr. Christopher Mushquash at Lakehead University, is doing this study to understand how childhood experiences of trauma may influence substance use and other health outcomes for First Nations people.

2) **Participation:** We are inviting clients of the Adult Residential Treatment Centre (ARTC) to participant in approximately an hour interview asking about individual and family life experiences about substance use, addiction, health outcomes, and trauma.

3) **Confidentiality:** All information given is private and we will not share your individual answers with anyone outside of the research team. All Dilico staff are trained to maintain participant confidentiality and have signed confidentiality agreements. Study information will be kept in locked cabinets at Dilico Anishinabek Family Care offices in Thunder Bay for 5 years, and then destroyed. Your consent form will be stored separately from any collected data. Electronic information will be password protected. All information that you provide will be combined with information from all the other people interviewed, so no one will know what you said specifically. We will never use your name in our reports or presentations.

4) **Benefits and Risks**: There are minimal benefits and risks to you during your study participation. Some people may find it satisfying to participate in research activities. There is a possibility that answering some of the questions or participating in this study may make you feel upset. If you do feel uncomfortable or upset during your participation, please tell your counsellor at ARTC as they can help support you and connect you with appropriate resources to help.

5) **Reporting:** When our study is complete, we will prepare a summary of findings. You will also be able to request a summary of results by contacting the research team. In collaboration with the project advisory, we may prepare additional reports for publication in order to share the information for the benefit of others working with First Nations people with substance use concerns. Again, as a participant in this study, we will never include your name – your confidentiality and privacy will always be respected.

6) **Further Information**: If you have questions about the study after the study is completed or wish to receive a copy of the study results, you can contact Dr. Christopher Mushquash by

telephone at (807) 343-8239 or by email at chris.mushquash@lakeheadu.ca. If you wish to speak to someone other than a researcher about the study, you may call the Lakehead University Research Ethics Board at (807) 343-8283.

7) **Confirmation of Agreement to Participate**: It is your choice if you would like to participate in this study. Your decision to take part, or not take part, will **never** affect the services you receive from Dilico Anishinabek Family Care.

a) I agree to the following:

- ✓ I have read and understand the information contained in the Information Letter
- ✓ I agree to participate
- ✓ I understand the risks and benefits to the study
- ✓ That I am a volunteer and can withdraw from the study at any time, and may choose not to answer any question
- ✓ That the data will be securely stored at Dilico for a minimum period of 5 years following completion of the research project
- ✓ I understand that the research findings will be made available to me upon request
- ✓ I will remain anonymous
- ✓ All of my questions have been answered
- ✓ By consenting to participate, I have not waived any rights to legal recourse in the event of research-related harm.

b) Would you like to receive a copy of the study results?

_____ Yes _____ No

If you would like to receive a copy of the results, please provide us with your contact information:

Mailing Address **Email Address**

Participant Name: _____ **Witness Name**: _____

Signature: _____ Signature: _____

Date: _____ Date: _____

Optional study information:

In order to understand more about how childhood experiences affect health outcomes for First Nations people, we would like to contact study participants again to ask other questions that relate to your overall health and wellbeing, including how biological stress hormones may influence overall health.

Would you like to be contacted to receive more information about these studies?

_____ Yes _____ No

To receive more information, please provide us with your contact information:

Mailing Address **Email Address** **Telephone Number**