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Empathy and Executive Functioning in Children with Attention-Deficit/Hyperactivity Disorder

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Empathy and Executive Functioning in Children with Attention-Deficit/Hyperactivity Disorder

by

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Abstract

The current study investigated the relationship between levels of empathy and executive functioning (EF; specifically attention, inhibition, working memory) in children with and without Attention-Deficit/Hyperactivity Disorder (ADHD). Children with ADHD often experience impairments in EF. In addition to EF challenges, socioemotional deficits are frequently reported in these children. Successful social interaction relies on a child's ability to understand the minds of other individuals, a term referred to as social cognition. The present study focused on empathy, one particular component of social cognition. Previous research exploring empathy has identified both an affective and a cognitive factor, which are now considered to be separate components of empathy. Explorations of empathy in children with ADHD have revealed mixed findings, with some studies reporting no differences in the empathy levels of children with and without ADHD. In contrast, a number of other studies have found impaired empathy in individuals with ADHD. The results of recent studies in developmental psychology point to an association between EF and social cognition. The present study included a final sample of 45 children, 20 with ADHD and 25 typically developing (TD), between the ages of 8 and 12 years. The Comprehensive Executive Function Inventory – Parent Report (CEFI-PR) was used to measure attention, inhibition, and working memory, and the Interpersonal Reactivity Index (IRI) was used to assess cognitive, affective, and total empathy. Overall, the present study demonstrated that children with ADHD have significantly lower levels of self-reported cognitive empathy when compared to TD children. The same pattern was observed in total empathy. No such differences were found in affective empathy scores. The study also confirmed that children with ADHD perform lower than TD children on EF measures of attention, inhibition, and working memory. Finally, the current study demonstrated a significant positive correlation

between both total and cognitive empathy and the EFs of attention, inhibitory control, and working memory across all participants.

Keywords: Attention-Deficit/Hyperactivity Disorder, Empathy, Executive Functioning, Children

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List of Abbreviations

ACC	Anterior Cingulate Cortex
ADHD	Attention-Deficit/ Hyperactivity Disorder
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
CD	Conduct Disorder
CEFI-PR	Comprehensive Executive Function Inventory – Parent Report
Conners-3 PR	Conners Rating Scale – 3rd Edition, Parent Report
CU	Callous-Unemotional
DBD	Disruptive Behaviour Disorder
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
EF	Executive Functioning
fMRI	Functional Magnetic Resonance Imaging
IRI	Interpersonal Reactivity Index
MNs	Mirror Neurons
ODD	Oppositional Defiant Disorder
PAM	Perception-Action Model
PFC	Prefrontal Cortex
ST	Simulation Theory
TD	Typically Developing
ToM	Theory of Mind
VSWM	Visuospatial Working Memory
WASI-II	Wechsler Abbreviated Scale of Intelligence – Second Edition

Chapter 1: Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most commonly diagnosed childhood neurodevelopmental disorders and is characterized by developmentally inappropriate levels of inattention and hyperactivity/impulsivity (American Psychiatric Association [APA), 2013]. In addition to the core symptoms, ADHD is also frequently accompanied by impairments in executive functioning (EF), including inhibition and working memory (Barkley, 2006). Social functioning impairments and interpersonal difficulties have also been identified, and 52% to 82% of children with ADHD report social problems (Staikova et al., 2013). While these social problems have typically been attributed to impulsivity, inattention, and comorbid problems, the results of research exploring these explanations has been inconsistent (Staikova et al., 2017). Although the social functioning impairments of children with ADHD are well-documented, the mechanisms underlying these deficits are not well understood (Maoz et al., 2017). Upon consideration of the long-term consequences associated with impaired peer functioning, the identification of possible underlying mechanisms associated with the social difficulties experienced by children with ADHD is critical (Kofler et al., 2011).

Successful social interaction is dependent on a child's ability to understand the minds of other individuals, a term referred to as social cognition (Uekermann et al., 2010). The present study will focus on one particular element of social cognition, empathy, in children with ADHD. Empathy plays a key role in social functioning, facilitating prosocial behaviour and contributing to the development of morality (Malti, Gummerum, & Buchmann, 2007). Studies exploring the factor structure of empathy have consistently revealed both an affective and a cognitive factor, which are now considered to be separate components of empathy (Bensalah, Caillies, & Anduze, 2016). Cognitive empathy refers to the capacity to adopt another person's point of view, while

affective empathy relates to the ability to experience another person's affective reactions (Decety & Ickes, 2011). The concept of cognitive empathy is closely associated with theory of mind (ToM; Walter, 2012). Explorations of empathy in children with ADHD have revealed mixed findings, with some studies reporting no differences in the empathy levels of children with and without ADHD (Gumustas, Yilmaz, Yulaf, Gokce, & Sabuncuoglu, 2017; Kilic & Ay, 2016). In contrast, a number of other studies have found impaired empathy in individuals with ADHD (Braaten & Rosen, 2000; Demurie et al., 2011; Dyck, Ferguson, & Shochet, 2001; Marton, Wiener, Rogers, Moore, & Tannock, 2009).

The results of recent studies in developmental psychology point to an association between EF and social cognition, and previous research has investigated the association between social functioning impairments and limitations in EF resources (Decety & Lamm, 2006; Eslinger, Moore, Anderson, & Grossman, 2011). Previous research has investigated the association between impaired empathy and deficits in EF (Eslinger, Moore, Anderson, & Grossman, 2011). In addition, given the association between cognitive empathy and ToM, and the relationship between ToM and the executive functions of inhibition, working memory, and attention in children with ADHD (Pineda-Alhucema, Aristizabal, Escudero-Cabarcas, Acosta-Lopez, & Velez, 2018), it is hypothesized that these same executive functions will play a role in empathy levels in children with ADHD.

The purpose of the present study was to investigate the relationship between levels of empathy and EF (specifically attention, inhibition, and working memory) in children with and without ADHD. Understanding the relationship between social functioning impairments and related factors in children with ADHD could inform future intervention efforts and provide a better understanding of the social challenges experienced by these children. The following

section will provide the most current literature on ADHD, empathy, the association between empathy and ADHD, and empathy and EF.

Chapter 2: Literature Review

Attention-Deficit/Hyperactivity Disorder (ADHD)

ADHD is a neurodevelopmental disorder characterized by developmentally inappropriate levels of inattention and hyperactivity/impulsivity (American Psychiatric Association [APA], 2013). Inattentive symptoms may include difficulty sustaining focus, a lack of persistence, and wandering off task. Hyperactivity may include excessive motor activity, fidgeting, or talking. Impulsivity may manifest behaviorally as thoughtless action seemingly without forethought (APA, 2013). ADHD is one of the most commonly diagnosed childhood neurodevelopmental disorders, with a global prevalence rate between 2% and 7% (Sayal et al., 2017). In Canada, data obtained from the National Longitudinal Survey on Children and Youth revealed a prevalence rate of 2.6% in children between three and nine years of age (Brault & Lacourse, 2012). ADHD is more commonly diagnosed in males, and females are more likely to present with predominantly inattentive symptoms (APA, 2013).

Diagnostic features. To receive a diagnosis of ADHD, an individual must exhibit a persistent pattern of inattentive and/or hyperactive/impulsive symptoms that have endured for at least six months. Additionally, there must be clear evidence that these symptoms interfere with social, academic, or occupational functioning and have been present prior to the age of 12 years. Manifestations of the disorder must occur in more than one context (i.e., home and school), although symptoms will vary across settings (APA, 2013).

Specifiers. The *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-5; APA, 2013) divides ADHD into the following subtypes: predominantly hyperactive (ADHD-HI), predominately inattentive (ADHD-I), and combined (ADHD-C). A diagnosis of ADHD-HI can be given if six or more symptoms of hyperactivity-impulsivity and less than six

inattentive symptoms are present. Similarly, ADHD-I is characterized by a persistent pattern of six or more inattentive symptoms with less than six hyperactive-impulsive symptoms. A diagnosis of ADHD-C can be given if the diagnostic criteria for both ADHD-HI and ADHD-I have been met over the previous six months. The degree and severity of symptomatology differs between individuals and may present as mild (presentation of few symptoms in excess of the diagnostic requirements and minor functional impairments), moderate (impairments and symptoms slightly higher than mild, but less than severe), or severe (most, if not all, symptoms listed in the diagnostic criteria resulting in significant functional impairments; APA, 2013).

Development and Course. ADHD is both heritable (Stergiakouli et al., 2015) and influenced by environmental factors, including prenatal exposure, nutrition, heavy metal/chemical exposures, and lifestyle and psychosocial factors (Froehlich et al., 2011). A review of the molecular genetics of ADHD estimates the heritability to be approximately 75%, with the remaining 25% largely attributed to environmental variables (Park et al., 2014). The interplay of the genetic and environmental factors contributing to the expression of ADHD has been the subject of study, and recent work supports the notion of a developmental perspective, portraying ADHD as a multi-factorial disorder with multiple causal pathways (Park et al., 2014).

Early life. Although ADHD is typically identified during elementary school years (APA, 2013), there is a growing trend towards diagnosis in preschoolers (Posner et al., 2007). In recent years, research has moved towards the identification of early factors associated with ADHD trajectories, and the notion of early interventions to alter symptom trajectories is being queried (O'Neill, Rajendran, Mahbubani, & Haperin, 2017). However, the diagnosis of ADHD in preschool-aged children represents a topic of controversy (Davis et al., 2019), as little guidance is provided when distinguishing between typical preschool inattention, hyperactivity, and

impulsivity, and symptoms of ADHD (Egger, Kondo, & Angold, 2006). In addition, there is significant variability in the developmental trajectories of preschool-aged children with elevated levels of inattention and hyperactivity/impulsivity, and many of these children do not meet criteria for a diagnosis of ADHD later in life (O'Neill, Rajendran, Mahbubani, & Haperin, 2017). Nevertheless, research suggests that ADHD can be reliably diagnosed in children as young as three years old (Abikoff et al., 2007). Previous research suggests that the prevalence of ADHD among preschool children ranges from 2 to 7.9%, with the most common being the combined and hyperactive/impulsive subtypes (Egger, Kondo, & Angold, 2006). Although poor inhibitory control, short attention spans, and high activity levels are common in preschool children, these symptoms are more prominent in children with ADHD, and may result in physical injury, unmanageable behavior, and poor performance (Posner et al., 2007). To distinguish between typical preschool inattention, activity, and impulsivity and ADHD symptoms, Egger and colleagues (2006) considered the prevalence of these symptoms in preschool-aged children. In a review of the literature they noted that while the presence of one or two ADHD symptoms is developmentally appropriate, multiple ADHD symptoms is considered to be outside the normal range for preschool-aged children. When considering the pattern of symptoms, the predominantly hyperactive subtype is more commonly diagnosed in this population, while the predominantly inattentive subtype is rare. When considered in conjunction with the tendency for hyperactive symptoms to decrease with age, this pattern of presentation may reflect a developmental pattern in early childhood (Cherkasova, Sulla, Dalena, Pondé, & Hechtman, 2013).

School years. As previously mentioned, most ADHD diagnoses are made during the elementary school years (Cherkasova, Sulla, Dalena, Pondé, & Hechtman, 2013). Symptoms are

often identified as a result of academic challenges and/or classroom disturbances. It is most frequently teachers who make the initial referral for an ADHD assessment, as the structured nature of the school environment is often challenging for children with inattention, hyperactivity, and impulsivity, and may result in the development of problematic behaviours in the classroom (Topkin, Roman, & Mwaba, 2015). Children with hyperactive/impulsive or combined presentations may be identified with problematic behaviours before those with inattentive presentations, and these children are often recognized when academic expectations increase (i.e., around fourth grade; Felt, Biermann, Christner, Kochhar, & Harrison, 2014). During development, symptoms of ADHD often fluctuate, and may be displayed differently at different times. Generally, as children develop, there is a tendency for symptoms of hyperactivity and impulsivity to decrease. However, the pattern of symptom severity for inattentive symptoms is less clear, with some studies reporting these symptoms as constant, and others as increasing (Döpfner et al., 2015). This may reflect a developmental pattern and/or challenges identifying and measuring inattention in early childhood (Barkley, 2006).

Adolescence and adulthood. A considerable percentage of children diagnosed with ADHD remain impaired in adulthood, and approximately two-thirds of children continue to exhibit either the full diagnostic criteria or subthreshold levels of the symptoms (Cherkasova, Ponde, & Hechtman, 2012). Although signs of hyperactivity are less common, symptoms of inattention, restlessness, and impulsivity show greater persistence (APA, 2013). When compared to controls, adults with ADHD typically have poor long-term outcomes in academic achievement, occupational performance, relationships, traffic violations, and psychiatric comorbidities (Barkley et al., 2008).

Comorbidities. Symptoms of ADHD often do not present in isolation, but instead may coexist alongside a wide range of concurrent psychiatric disorders contributing to the psychopathological status of children with ADHD (Reale et al., 2017). An analysis of data from the 2007 National Survey of Children's Health indicated that in children with ADHD between 6 and 17 years of age, 33% had one comorbidity, 16% had two, and 18% had three or more (Larson, Russ, Kahn, & Halfon, 2011). The prevalence of comorbid psychiatric disorders accompanying ADHD ranges from 40 to 80%, with rates slightly higher in clinically referred children (67-87%). Frequently co-occurring disorders include: oppositional defiant disorder (ODD; 50-60%), conduct disorder (CD; 20-50% in children and 40-50% in adolescents), depression (16-26%) and anxiety (10-40%) disorders, bipolar disorders (11-75%), tic disorders (20%), obsessive compulsive disorders (6-15%), and autism spectrum disorders (ASD; 65-80%; Reale et al., 2017). Learning difficulties are also commonly associated with ADHD, with over 45% of children exhibiting accompanying impairments in reading, spelling, and/or arithmetic, and comorbid learning disorders reported in 25 to 40% of children with ADHD (DuPaul, Gormley, & Laracy, 2013). Additional comorbidities include social problems and sleep disturbances (Reale et al., 2017).

Executive function in children with ADHD. Executive functioning is a blanket term that refers to top-down, higher-order cognitive abilities that enable independent, goal-directed behaviour (Lezak, 1995). There are a number of specific domains under the umbrella of executive functions, including inhibition, initiation, working memory, switching, attention, planning, problem-solving, and self-regulation (Lezak, 2004). There is strong empirical evidence supporting the link between ADHD and deficits in a number of executive functions (Barkley, 2006), and recent research has revealed an association between early neuropsychological deficits

and ADHD symptoms later in life (Sjöwall, Bohlin, Rydell, & Thorell, 2017). Evidence further suggests that structural and functional brain changes are associated with the neuropsychological features implicated in ADHD. The strongest evidence has been found for the relationship between ADHD and deficits in EF, including inhibition and working memory (Barkley, 2006). Theories of ADHD suggest that deficits in EF represent a prominent feature of ADHD, and a meta-analysis found that EF challenges are significantly associated with ADHD. However, this same meta-analysis also determined that deficits in EF do not appear to be a necessary and sufficient cause of ADHD symptoms, but instead represent one of several difficulties (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). The following section details the association between ADHD and three domains of EF of specific interest to the present study: attention, inhibition, and working memory.

Attention. When considered as an EF, the term attention refers to "several different capacities or processes that are related aspects of how the organism becomes receptive to stimuli and how it may begin processing incoming or attended-to excitation, whether internal or external" (Lezak, 1995, pp 39). Within research examining attention in children with ADHD, four key components are typically considered: *orienting/alertness*, *selective/focused attention, divided attention*, and *vigilance/sustained attention*. There is evidence to suggest that children with ADHD may not be impaired in the *orienting/alertness* component of attention (i.e., the ability to increase activation in response to a high priority stimulus; Rapport, Orban, Kofler, & Friedman, 2013), and research suggests that they have comparable abilities when orienting to a high priority stimulus when compared to control participants (Huang-Pollock, Nigg, & Halperin, 2006). With regards to *selective/focused attention* (i.e., the ability to direct attention to relevant stimuli while ignoring irrelevant stimuli) and *divided attention* (i.e., the ability to attend to

multiple tasks simultaneously), results of research has been mixed, with some studies reporting stronger, comparable, and worse performance in children with ADHD when compared to typically developing children (Rapport et al., 2013).

With respect to the fourth component of attention, results of a number of studies have revealed that children with ADHD may experience deficits in *vigilance/sustained attention* (Rapport et al., 2013). *Sustained attention* (sometimes referred to as vigilance) refers to the ability to maintain the focus of attention over a prolonged period of time (Wang et al., 2013). Previous research has consistently revealed deficits in sustained attention in children with ADHD (Christakou et al., 2013). Sustained attention is often measured using continuous performance tasks, on which children with ADHD reveal higher error rates of omission and commission, slower response times, and greater response variability when compared to healthy controls. Studies using functional magnetic resonance imaging (fMRI) have also examined the underlying processes of sustained attention in individuals with ADHD and have revealed atypical activation in several brain regions, including the cerebellum, anterior cingulate cortex (ACC), ventrolateral/inferior prefrontal cortex (PFC), and striato-thalamic regions (Wang et al., 2013). For the purposes of the present study, the concept of attention is conceptualized as how well a child can avoid distractions, sustain attention, and concentrate on tasks (Naglieri & Goldstein, 2013).

Inhibition. Inhibition refers to an individual's ability to deliberately suppress or interrupt an emotional, cognitive, or behavioural response (Schachar, Mota, Logan, Tannock, & Klim, 2000). Inhibition is considered vital to EF, and contributes to the regulation of attention, thoughts, emotions, and behaviours (Martínez, Prada, Satler, Tavares, & Tomaz, 2016). Barkley (2006) argues that hypoactivity of the behavioural inhibition system serves as the foundation for

the attentional difficulties observed in individuals with ADHD and proposed a model naming inhibition as the basis of the neuropsychological skills that control behaviour (Barkley, 1997). Inhibition is thus considered to be a key construct in the conceptualization of ADHD, and evidence from multiple sources points to a deficit in inhibition in individuals with ADHD (Woltering, Liu, Rokeach, Tannock, 2013). Furthermore, longitudinal studies have demonstrated an association between inhibition in early childhood and ADHD symptoms later in life (Sjöwall et al., 2017). Evidence suggests that the deficits in inhibition observed in individuals with ADHD are associated with structural and functional differences in neural networks (Mulligan et al., 2011).

Theoretical causal models regarding the development of ADHD point to deficits in inhibition as the basis of secondary impairments in cognitive-control mechanisms related to inattentive, hyperactive, and impulsive behaviours (Barkley, 1997). Inhibitory control deficits are further hypothesized to be the consequence of structural and functional irregularities in prefrontal brain circuitry. This notion has prompted a number of behavioural and functional neuroimaging studies over the past two decades (Ma, van Duijvenvoorde, & Scheres, 2016), including single-photon emission computed tomography, positron emission tomography, fMRI, event-related brain potentials, and magnetoencephalography studies (Martínez et al., 2016). The results of these studies suggest that the deficit in inhibitory control observed in individuals with ADHD is accompanied by abnormal neural activity. Specifically, researchers have reported altered structural and functional connectivity in both frontostriatial and frontoparietal neural networks (Castellanos & Proal, 2012), hypoactivation in the frontoparietal networks (Cortese et al., 2012), as well as abnormal gray matter volumes in the ACC, prefrontal, and parietal areas (Nakao, Radua, Rubia, & Mataix-Cols, 2011).

Impaired behavioural control is characteristic of individuals with ADHD and has been demonstrated in numerous laboratory tasks measuring response time and inhibitory control (i.e., go/no-go tasks and stop signals tasks). These tasks typically require individuals to quickly respond to *go* targets and inhibit a response when presented with a *stop* target. Success on these tasks thus requires an unanticipated demonstration of inhibitory control. However, real-world events requiring the inhibition of a response are often prefaced by environmental cues indicating the adaptive behaviour in a given context. These cues have the potential to promote behavioural control by preparing the individual to inhibit a response through the reduction of the information that must be processed. A recent study found that, when compared to controls, individuals with ADHD were less sensitive to predictive cues and that cueing did not prevent inhibitory deficits in these individuals. Taken together, the results suggest that individuals with ADHD have difficulty regulating their behaviour in response to environmental cues, resulting in inappropriate behaviour in various domains of functioning (Roberts, Milich, & Fillmore, 2016). This deficit is particularly prominent in the social domain, and evidence suggests that inhibitory control deficits may impede the consideration of the mental states of others (i.e., ToM) due to an inability to suppress irrelevant stimuli, contributing to socioemotional difficulties (Berenguer et al., 2017).

Working memory. Working memory refers to the limited capacity system that temporarily processes and stores both verbal and spatial information (Baddeley, 2003). The ability to maintain and manipulate information in working memory relies on intact functioning of the PFC, and is implicated in a range of cognitive activities, including reasoning and problem-solving (Klingberg, Forssberg, & Westerberg, 2002), as well as reading and arithmetic (Barkley, 1997). Working memory has also been demonstrated to be vital in reducing distractions from extraneous stimuli and may be associated with greater distractibility in individuals with ADHD

(Westerberg, Hirvikoski, Forssberg, & Klingberg, 2004). Working memory represents a critical construct in models of ADHD; although differences among the models largely reflect two schools of thought. While some believe working memory deficits play a central role in the expression of ADHD symptomatology, others consider deficits in working memory as a result of underdeveloped inhibitory processes (Rapport, Alderson, Kofler, Sarver, Bolden, & Sims, 2008). Despite a lack of consensus regarding the role of working memory, deficits in this realm represent a core impairment in individuals with ADHD, and neuroimaging data suggests the presence of structural and functional abnormalities, with the greatest deficiencies observed in visuospatial working memory (VSWM; van Ewijk et al., 2015).

Neuroimaging research investigating the cognitive processes implicated in working memory functioning in individuals with ADHD has been relatively sparse when compared with that of inhibitory control. In spite of this disparity, neuroimaging data suggests the presence of structural and functional abnormalities consistent with working memory deficits in individuals with ADHD. Specifically, individuals with ADHD demonstrate abnormal caudate activation (Roman-Urrestarazu et al., 2016), as well as reduced activation in the ventrolateral PFC (Gu et al., 2018).

Similarly, VSWM-related brain activation implicates a widespread neural network. When compared to typically developing (TD) controls, individuals with ADHD demonstrate greater activation in the left inferior frontal gyrus and the lateral frontal pole, as well as reduced activation in the pars triangularis and increased activation in the pars opercularis, regions within the right inferior frontal cortex. Taken together, these results suggest that individuals with ADHD have impairments in the recruitment of left inferior frontal brain regions as VSWM-task difficulty increases (van Ewijk et al., 2015).

Social challenges. In addition to EF impairments, socioemotional deficits are frequently reported in children with ADHD (Nijmeijer et al., 2008; Uekermann et al., 2010). Although social problems are not considered to be a core diagnostic feature of ADHD, many of these children experience impairments in this area of functioning. For children with ADHD, impairments in the formation and maintenance of peer relationships often begins in childhood and may persist through adolescence and into adulthood (Kofler et al., 2011).

Children with ADHD frequently exhibit impaired peer functioning, which often results in peer rejection and social isolation (De Boo & Prins, 2007; Hinshaw, 2002; Hoza et al., 2005). Although impaired social functioning is not apparent in the self-reports of children with ADHD, parent, teacher, and peer reports suggest that these children have fewer friends, are more rejected by their peers, and engage in a reduced range of social activities (Aduen et al., 2018). Children with ADHD have been shown to be less popular, less competent (Kofler et al., 2011), less liked, less accepted, and more likely to be rejected by their peers (Sayal et al., 2017). One study reported that children with ADHD are often rejected within 30 minutes of the onset of an interaction (De Boo & Prins, 2007). These difficulties may be a result of inappropriate social behaviors, including frequently interrupting and not listening to others (Guevremont & Dumas, 1994). Observational studies are consistent with these findings, suggesting that during peer interactions children with ADHD make more command statements, demands, and respond more negatively, prompting a negative reaction from both their peers and parents (Kofler et al., 2011). Additionally, when compared to TD children, children with ADHD are characterised as more intrusive and less competent socially and have fewer reciprocal dyadic friendships. Social problems in children with ADHD as associated with negative long-term outcomes, including

depression (Humphreys, Galán, Tottenham, & Lee, 2016), as well as substance abuse, conduct problems, and academic failure (Mikami & Hinshaw, 2006).

Social cognition. Successful social interaction is dependent on a child's ability to understand the minds of other individuals, a term referred to as social cognition. Social cognition is not a unitary construct, but includes a number of abilities, including ToM, humour processing, empathy (Uekermann et al., 2010), emotion recognition, social knowledge, social perception, and attributional style (Green et al., 2008). In an early study investigating the rate of autistic symptoms in a sample of children with ADHD (aged 5-15 years, 95.9% male), impairments in social interaction were commonly reported, and 85.7% of parents indicated that their child demonstrated a lack of awareness for the feelings of others (Clark, Feehan, Tinline, & Vostanis, 1999). In order to examine cooperative social behaviour (including emotional understanding), Downs and Smith (2004) compared children with ASD to TD children and children with ADHD/ODD. Results suggest that children with ADHD/ODD demonstrate more impaired emotional understanding than both comparison groups (Downs & Smith, 2004). To further investigate emotional understanding in boys with ADHD, Yuill and Lyon (2007) designed a study in which participants were asked to make inferences about emotions using facial expressions. The boys with ADHD revealed a selective difficulty in processing information about the facial expression of emotions. Results also suggest a discrepancy between the ability to match an emotion to a facial expression and the ability to match an emotion to the appropriate situation (Yuill & Lyon, 2007).

The social problems observed in children with ADHD have been attributed to a performance, rather than a knowledge, deficit; that is, they appear to have the knowledge of social rules, but not the ability to apply them consistently (Kofler et al., 2011). While these social

problems have typically been attributed to impulsivity, inattention, and comorbid problems, the results of research exploring these explanations has been inconsistent (Staikova et al., 2017). Although the social functioning impairments of children with ADHD are well-documented, the mechanisms underlying these deficits are not well understood (Maoz et al., 2017). Upon consideration of the negative long-term outcomes associated with the social problems observed in children with ADHD, the identification of possible processes relating to these impairments is imperative.

The present study will focus on one particular element of social cognition, empathy, in children with ADHD.

Empathy

Definition of empathy. Empathic concern plays a key role in social functioning, facilitating prosocial behaviour and contributing to the development of morality (Malti, Gummerum, & Buchmann, 2007). Generally speaking, empathy refers to the response of one individual to the observed experiences of another (Davis, 1994). Although the notion of *empathy* has an extensive history, a concrete definition has yet to be established (Cuff, Brown, Taylor, & Howat, 2016). In a recent review, Cuff and colleagues (2016) evaluated current definitions to develop a new conceptualization of empathy. Through this review, a total of 43 formal and informal conceptual definitions of empathy were identified. An examination of the similarities and differences among the definitions revealed eight themes critical to the conceptualization of empathy. These themes included: 1) there are key differences between empathy and similar concepts (e.g., sympathy); 2) empathy includes both a cognitive and an affective component; 3) the emotions of the individual and the other are distinct; 4) empathy can be evoked by other stimuli (e.g., imagination); 5) the distinction of the self and the other is maintained during an empathetic response; 6) empathy is both a trait and a state; 7) empathy does not include a

behavioural consequence; and 8) empathy is both an automatic and a controlled process (i.e., a state of mind that can be controlled or modified). Based on these conclusions, the authors present the following definition of empathy: "empathy is an emotional response (affective), dependent upon the interaction between trait capacities and state influences. Empathic processes are automatically elicited but are also shaped by top-down control processes. The resulting emotion is similar to one's perception (directly experienced or imagined) and understanding (cognitive empathy) of the stimulus emotion, with recognition that the source of the emotion is not one's own" (Cuff et al., 2016, pp 7).

Models of empathy. In 2002, Stephanie Preston and Frans de Waal published a review in which they presented five key findings on empathy, specifically, a positive association between empathy and familiarity, learning, similarity, past experience, and salience. As a result of these findings, the authors proposed a Perception-Action Model (PAM) to explain empathy, in which an autonomic and somatic response is automatically activated by the observation and perception of another's affective state. This model is supported by the Simulation Theory (ST; Preston & de Waal, 2002), one of two conflicting theoretical explanations proposed to explain the cognitive mechanisms underlying our understanding of other's behaviour.

The ST proposes that our ability to understand other people's behaviour stems from the capacity to adopt their perspective through tracking and/or matching. This perspective is supported by the discovery of mirror neurons (MNs), a class of neurons in the macaque monkey premotor cortex. MNs discharge when a recorded monkey performs a particular goal-related motor action while observing another individual performing the same action. These neurons are hypothesized to form a cortical system that matches execution and observation of motor acts.

Evidence suggests that a comparable system exists in humans and may be the basis of our ability to form a ToM (Gallese & Goldman, 1998).

Alternatively, ToM theorists propose that the attribution of theoretical mental states to others occurs in order to form a system to understand, predict, and explain the behaviours of others – a *theory* of mind (Decety & Ickes, 2011). The critical difference between ToM and ST perspectives is that while ToM identifies our understanding of other's behaviour as a theoretical activity, ST portrays this understanding as an attempt to replicate the mental state of another person via neural networks (Gallese & Goldman, 1998). These notions extend to our understanding of empathy as well. There is general consensus that the experience of empathy may be triggered in different ways, resulting in either an automatic tendency to simulate the emotions of another individual (bottom-up processing; Preston & de Waal, 2002) or the mental simulation and adoption of the feelings of another (top-down processing; Decety & Jackson, 2006). Following this line of reasoning, Shamay-Tsoory, Aharon-Peretz, and Perry (2009) investigated whether emotional empathy (implicating the mirror neuron system) and cognitive empathy are independent of one another. Results of the study suggest the presence of two empathetic systems: an early mirroring system and a more advanced system involving the cognitive understanding of the mental states of others. Along a similar line, upon consideration of the cognitive and emotional components of empathy, it has been proposed that cognitive empathy may involve a higher degree of ToM processing, while affective empathy may implicate simulation processing (Decety & Ickes, 2011).

As previously mentioned, the PAM of empathy (Preston & De Waal, 2002) suggests that empathy occurs automatically in response to the emotional state of another individual and is unaffected by cognitive load (Preston & De Waal, 2002). However, other research suggests that

the experience of empathy can be disrupted by other cognitive processes (i.e., attention; Gu & Han, 2007). One study found that cognitive load reduces the subjective experience of empathy and decreases neural responses in core empathy regions. These results challenge the assumptions of the PAM and suggest that the experience of empathy is not entirely automatic (Morelli & Lieberman, 2013).

In line with previous research, the present paper adheres to the notion that the experience of empathy is not automatic but affected by other cognitive processes. Specifically, in agreement with Decety and Ickes (2011), the research objectives of the present paper operate under the assumption that cognitive empathy involves a higher degree of ToM processing, while affective empathy implicates simulation processing. As such, it is hypothesized that the experience of cognitive empathy will be associated with other cognitive processes, such as EF.

Empathy development. Hoffman's theory of empathy (Hoffman, 1975, 1984, 2000) posits that the capacity for true empathy emerges during the second year of life, preceded by a rudimentary form of empathy referred to as empathic distress (Hoffman, 1975, 1984, 2000). According to this theory, infants are born with the ability to experience empathy. As infants are not yet able to perceive themselves as separate entities from others, the distress of others is perceived as the infant's own distress, thus limiting them to self-focused empathic distress during the first year of life. It is not until the second year that infants begin to possess the ability to differentiate the self from others, facilitating other-oriented empathy and early prosocial behaviour. Studies of early empathy development have revealed that when exposed to the distress cries of another infant, newborns typically respond with a self-distress reaction (i.e., crying). This contagious crying response, labelled reflexive or reactive crying (Zahn-Waxler et al., 1992), is not limited to the newborn period and has also been observed in infants 1-, 3-, 6-,

and 9-months of age. However, evidence from a study conducted by Roth-Hanania, Davidov, and Zahn-Waxler (2011) suggests that by 8-to 10-months infants possess affective and cognitive components of early empathy, as expressed through facial, vocal, or gestural-postural expressions of concern, as well as attempts to understand the distress.

During the second year of life, the results of developmental studies suggest that young children demonstrate rudimentary other-oriented distress, reflected in expressions of concern (through facial expressions, vocalizations, etc.), attempts to understand the victim's experience, and prosocial behaviour (attempts to help or comfort the distressed individual; Roth-Hanania, Davidov, & Zahn-Waxler, 2011). As development progresses, children continue to make gains in empathic responding, especially in the realm of cognitive empathy. An investigation of the genetic and environmental contributions to empathy suggests that empathic responding is a relatively stable trait across development (Knafo, Zahn-Waxler, Van Hulle, Robinson, & Rhee, 2008). However, evidence suggests that the different facets of empathy (i.e., cognitive and affective) do not follow the same development trajectory (Decety & Svetlova, 2012). While affective empathy emerges early in development and remains relatively stable, cognitive empathy develops in line with ToM understanding (Imuta, Henry, Selcuk, & Slaughter, 2016; Uzefovsky & Knafo-Noam, 2017).

Empathy vs. other concepts. Although the concept of empathy is often equated with the notions of *compassion* or *sympathy*, these terms are not considered to be synonymous. It has been suggested that the latter two concepts are characterized by the motivation to alleviate the suffering of another (prosocial motivation), while affective empathy occurs in the absence of prosocial behaviour (Walter, 2012). An alternative distinction equates empathy with "feeling *as* the other" and sympathy with "feeling *for* the other" (Hein & Singer, 2008, pp 157). In the

instance that empathic arousal leads to concern focused on the other person, this distress is referred to as *empathic concern* or *sympathy*. However, if the focus of concern shifts to the self, manifesting as experiences of anxiety or disturbance, this phenomenon is labelled *personal distress* or *empathic distress* (Roth-Hanania, Davidov, & Zahn-Waxler, 2011). Finally, evidence suggests that compassion and empathy activate different neural networks, the former implicating areas involved in positive affect (e.g., ventral striatum; Kanske, Böckler, Trautwein, & Singer, 2015).

Cognitive vs. affective empathy. Studies exploring the factor structure of empathy have consistently revealed both an affective and a cognitive factor, which are now considered to be separate components of empathy (Bensalah, Caillies, & Anduze, 2016). Cognitive empathy refers to the capacity to adopt another person's point of view (i.e., "I *understand* what you feel"), while affective empathy relates to the ability to experience another person's affective reactions (i.e., "I *feel* what you feel"; Decety & Ickes, 2011; Wlodarski, 2015). Individuals with well-developed empathy are able to simultaneously understand how another individual is feeling (cognitive empathy) and experience his/her emotions (affective empathy; Vachon & Lynam, 2016). The key difference distinguishing cognitive empathy from affective/emotional empathy is that while the former entails an understanding of another person's perspective (e.g., why someone else is crying), the latter also requires the ability to share in this perspective (Mehrabian & Epstein, 1972).

Cognitive empathy, the capacity to understand the emotions of another, may appear in the absence of an affective response (e.g., when motivating people; Walter, 2012) and has been hypothesized to involve conscious emotional processing, including perspective taking, mentalizing, emotional recognition, and imagination (Smith, 2006). Challenges with this

dimension of empathy may manifest as an inability to determine and describe the emotional state of another (Wlodarski, 2015). The concept of cognitive empathy is associated with ToM (Walter, 2012), and the terms ToM and cognitive empathy have been used interchangeably (Grove, Baillie, Allison, Baron-Cohen, & Hoekstra, 2014). The experience of cognitive empathy relies on the ability to attribute an emotional state to another individual, and therefore is hypothesized to activate the same mechanisms underlying ToM understanding (Eres, Decety, Louis, & Molenberghs, 2015). ToM is a complex component of social cognition, characterized by the ability to attribute mental states (beliefs, desires, thoughts, intentions) to oneself and others, as well as the capacity to understand and predict the behaviour of others based on their mental state (Premack & Woodruff, 1978). A consideration of the affective states of others is, therefore, referred to as affective ToM, a term that is conceptually tantamount to cognitive empathy (Walter, 2012). However, recent research in psychology and neuroimaging suggests that cognitive empathy and ToM are distinct processes (Eres et al., 2015), and evidence from brain imaging studies suggests that empathy and ToM engage overlapping but distinct neural networks. More specifically, results suggest that although networks involved in reasoning about the mental states of others are implicated in both empathy and ToM, empathy requires the activation of additional networks involved in the processing of emotions (Völlm et al., 2006). Although cognitive empathy and ToM seem to be theoretically related, affective empathy appears to be independent of ToM understanding.

Contrary to cognitive empathy, affective empathy is believed to involve unconscious processing, including the shared experience of emotions such as emotional contagion, affective responsiveness, and personal distress (Hooker, Verosky, Germine, Knight, & D'Esposito, 2010). In other words, affective empathy refers to the subjective experience of the emotions of another

person (Eres et al., 2015). For example, the experience of affective empathy is akin to the feeling of distress when someone is hurt. Deficiencies in this facet of empathy may manifest as an inability to feel the emotion of another, while maintaining the ability to discern and describe the emotion (Wlodarski, 2015). The notion of affective empathy includes the following characteristics: it is a) an affective state, b) elicited by the inferred/perceived affective state of another, c) analogous to the other's affective state, d) directed towards the other, and e) includes a cognitive interpretation of the other's affective state that includes self-other distinction, perspective taking, and an understanding of the causal association between the other's affective state and the self (Walter, 2012). Accordingly, the unconscious experience of the emotional state of another individual suggests a self-other distinction, as well as an appreciation for where/what the emotional response stemmed from (Eres et al., 2015). In addition to affective empathy, there exists more basic affective responses to the emotional states of others. These include: a) emotional mimicry, the synchronism of emotional response/expression, b) emotional contagion, the experience of emotion as a result of association (i.e., the automatic adoption of the emotions of another), and c) personal distress, a self-centered negative affective response to the state of others (Walter, 2012). Affective empathy differs from emotional mimicry and contagion however, as the latter two are automatic responses absent of the self-other distinction (Eres et al., 2015).

Empathy and ADHD

Deficits in empathetic responding are common in young children (Piaget, 1962), and empathetic thoughts and actions evolve as children develop ToM. Neurological research suggests that deficits in a number of brain regions in individuals with ADHD may be linked to reduced empathy levels (Conway, 2015). However, explorations of empathy in children with ADHD

have revealed mixed findings, with some studies reporting no differences in the empathy levels of children with and without ADHD (Kilic & Ay, 2016; Gumustas, Yilmaz, Yulaf, Gokce, & Sabuncuoglu, 2017). In contrast, a number of studies have found impaired empathy in individuals with ADHD (Braaten & Rosen, 2000; Demurie et al., 2011; Dyck, Ferguson, & Shochet, 2001; Marton et al., 2009). In one such study, empathy was examined directly through an empathy response task and self- and parent reports of emotion. Results of the study suggest that when compared with TD boys, boys with ADHD were less likely to match their emotion with the emotion of a child in a story and provided less character-centered interpretations when describing the character's emotion. These results suggested that boys with ADHD were less empathetic than those without ADHD (Braaten & Rosen, 2000). Similar deficits were reported by Dyck and colleagues (2001) in a study that revealed that when compared to children with no psychological disorder, children with ADHD revealed pronounced empathic ability deficits.

In order to further compare empathy in children with ADHD and healthy controls, participants completed both a self-report measure (Interpersonal Reactivity Index, IRI), as well as the "faux-pas" recognition task. The results of these measures suggest that children with ADHD exhibit lower levels of self-reported empathy. However, scores on the Personal Distress subscale of the IRI did not differ between groups, and the authors interpreted this discrepancy to reflect an impairment in predominantly the cognitive domain of empathy, rather than the affective component (Maoz, Gvirts, Sheffer, & Bloch, 2017). These findings build on previous research examining differences in the cognitive and affective components of empathy. In one study examining affective empathy in response to distress and sadness, teachers reported deficits in affective empathy in 6- to 7-year-old children with disruptive behaviour disorder (DBD), ADHD, and DBD+ADHD. However, these same impairments were not reported by parents of

children with ADHD. The authors suggest that impaired empathic responding in the affective domain may be limited to socially demanding settings, such as school (Deschamps, Schutter, Kenemans, & Matthys, 2015). One additional study investigated cognitive and emotional empathy in boys with ADHD-I, ADHD-C, CD, and a control group. Contrary to the results of Maoz et al., 2017, deficits in emotional (affective) empathy were observed in children with ADHD-C and CD only (Schwenck et al., 2011).

Findings regarding social-cognitive difficulties in children with ADHD are complicated by the tendency of these children to view themselves as *not* having social challenges (Barkley, 2014). Marton and colleagues (2009) found that although children with ADHD did not report themselves to be less empathetic than their TD peers, the opposite pattern emerged in the reports of their parents. However, this discrepancy was explained by the presence of co-occurring oppositional and conduct problems in the ADHD group. Additionally, the researchers found that, when compared to TD children, children with ADHD have poorer social perspective taking abilities. These children were found to apply less advanced social perspective taking when asked to define problems, identify feelings, and evaluate outcomes. In an additional study, when given an empathy questionnaire (IRI), parents of adolescents with ADHD reported their children to be less able to take the perspective of someone else and to experience feelings of compassion for others. However, when asked to complete a self-report, the adolescents with ADHD did not report significantly different scores when compared to their TD counterparts (Demurie, Corel, & Roeyers, 2011). These results mirror those of Marton and colleagues (2009).

In contrast to the previous studies noting differences in empathy in children with and without ADHD, other studies have found that children with ADHD perform similarly to TD children, challenging the idea of an empathy deficit in ADHD. Unlike previous studies, Kilic and

Ay (2016) found no effect of ADHD on Basic Empathy Scale scores among adolescents; although comorbid ODD was associated with lower empathy scores on both the Basic Empathy Scale and a measure of emotional empathy (Kilic & Ay, 2016). It is important to note that, within clinical psychology, the association between ADHD and empathy has heavily relied on callous-unemotional (CU) traits as a proxy for low levels of empathy. A recent meta-analysis revealed that, although the link between ADHD and empathy/CU traits is strongly related to co-occurring conduct problems, only a small association (d = .25) remains once conduct problems are accounted for (Graziano & Garcia, 2016).

In conclusion, there have been mixed findings regarding empathy in children with ADHD. While the results of some studies report no differences in the empathy levels of children with and without ADHD, a number of studies have found impaired empathy in individuals with ADHD. In addition, results from previous research examining differences in the cognitive and affective components of empathy have also been mixed, with two studies reporting deficits in affective empathy, and a third reporting greater impairment in the cognitive domain. Finally, several studies have reported a discrepancy between self- and parent-reported empathy levels, with parents reporting decreased empathy levels and children with ADHD reporting similar levels as their typically-developing counterparts. As previously mentioned, the PAM of empathy suggests that empathy occurs automatically in response to the emotional state of another individual and is unaffected by cognitive load (Preston & De Waal, 2002). However, other research suggests that the experience of empathy can be disrupted by other cognitive processes (Gu & Han, 2007). Following this line of reasoning, it has been proposed that empathy is supported by other higher-level cognitive abilities, including executive functions (Decety, 2011).

Empathy and Executive Functioning

Social cognition is supported by other higher-level cognitive abilities, including executive functions, and it has been hypothesized that these PFC capacities are built on a foundation of phylogenetically older social and emotional abilities (Decety, 2011). While some researchers have argued for the importance of cognitive processing and top-down control in the experience of empathy, others stress the importance of bottom-up processing, particularly in the experience of affective empathy (Singer & Lamm, 2009). In Decety and Lamm's model (2006), bottom-up processing supports the sharing of emotions (i.e., affective empathy), while EFs in the PFC and cingulate cortex support the modulation of emotion and cognition through self-regulation and selective attention, all the while continually being updated by bottom-up information.

Children with ADHD frequently exhibit impaired peer functioning, which often results in peer rejection and social isolation. For these children, deficits in forming and maintaining relationships often appear during childhood, frequently continuing into adolescence (Bagwell et al., 2001). Upon consideration of the long-term consequences associated with impaired peer functioning, the identification of possible underlying mechanisms associated with the social difficulties experienced by children with ADHD is critical (Kofler et al., 2011). Research in developmental psychology points to an association between EF and social cognition, particularly the capacity to understand the mental states of the self and others. Increasing evidence suggests a developmental link between ToM understanding and self-control around age four (Decety & Lamm, 2006). Following this line of reasoning, it has been suggested that the social-cognitive impairments observed in individuals with ADHD may be related to neurocognitive deficits (Groen et al., 2017).

As previously mentioned, social cognition is not a unitary construct but includes a number of abilities, including empathy. The ability to identify the affective state of another individual is considered to be a precursor to empathy (Jackson, Meltzoff, & Decety, 2005). This perception of emotion requires the ability to retain stimuli in working memory, switch between emotional tone and semantic content, and inhibit task irrelevant information (Uekermann et al., 2010). To trigger emotional contagion and, subsequently, the experience of empathy, attention, inhibitory control, and other EF processes are necessary (Singer & Lamm, 2009).

Previous research has investigated the association between social functioning impairments and limitations in EF resources. In a study examining the relationship between social and executive resources and empathic limitations in individuals with frontotemporal dementia, results indicated an association between a decline in both cognitive (i.e., perspective taking) and affective (i.e., emotional) empathy and EF. These results suggest that cognitive resources may be shared by both social-interpersonal and EF processes (Eslinger, Moore, Anderson, & Grossman, 2011).

As previously mentioned, there are a number of specific domains under the umbrella of executive functions including inhibition, initiation, working memory, switching, attention, planning, problem-solving, and self-regulation (Lezak, 2004). A recent systematic review found that the executive functions of attention, inhibition, and working memory were associated with ToM in ADHD (Pineda-Alhucema, Aristizabal, Escudero-Cabarcas, Acosta- Lopez, & Velez, 2018). Upon consideration of the relationship between ToM and empathy, it is hypothesized that these same executive functions will play a role in empathy levels in children with ADHD. The following sections detail the association between empathy and these three specific domains of EF: attention, inhibition, and working memory.

Attention and empathy. It has been hypothesized that for a child to experience empathy he or she must first be paying attention to another individual's emotional state. In Decety and Lamm's (2006) model of empathy, the sharing of emotions implicates bottom-up processes, while executive functions in the prefrontal and cingulate cortex regulate the cognitive and emotional components of empathy. This top-down regulation is continually updated and modulated by bottom-up information. Results from fMRI studies support this notion of top-down regulation of empathy. For example, in one study participants who were exposed to images of painful scenarios revealed activation in parts of the pain matrix. However, when told to count the number of hands in an image, the same activation patterns were not observed. Thus, in a condition in which participants' attention was diverted, empathic responses differed, suggesting that the way in which an individual attends to the emotions of another modulates the subsequent empathic response (Gu & Han, 2007). To the author's knowledge no studies exist examining the association between empathy and the EF of attention in children with ADHD. In line with the results of Gu and Han (2007), it is hypothesized that a positive correlation will exist between attention and empathy in children with ADHD.

Inhibition and empathy. Deficits in inhibitory control impact a child's ability to perceive another individual's point of view and to express emotions and feelings (Pineda-Alhucema et al., 2018). Research suggests that the ability to understand what another individual is feeling and the experience of how another would feel in that situation activate different mechanisms of perspective taking. Specifically, while the former induces feelings of empathic concern, the latter prompts both empathic concern and personal distress (Lamm, Batson, & Decety, 2007). Research in cognitive neuroscience suggests that both the perspective of the self and the adoption of the perspective of the other results in the activation of common neural

circuits. However, the latter activates areas of the frontal cortex involved in executive control (Decety & Lamm, 2006). Recent neurological evidence points to an *empathy circuit*, which is hypothesized to include the amygdala, ACC, and the anterior insula (AI; Honigsbaum, 2013). Recent research on ADHD connects symptoms of impulsivity and poor impulse control with deficits in these same brain regions (Hulvershorn et al., 2014). In addition, impaired inhibitory control has been linked to the right anterior attention network and is associated with reduced cortical thickness in the ACC (Bledsoe et al., 2013). It has been proposed that reduced levels of empathy may be associated with deficits in inhibitory control observed in individuals with ADHD (Barkley, 1994). According to Barkley's model (1997), children with ADHD may exhibit deficits in social perspective taking as a result of their inability to delay their initial emotional reaction in order to consider the perspectives of others (Barkley, 2014).

Previous research using behavioural measures has linked empathy with emotion regulation processes, including effortful control. Effortful control refers to an individual's ability to activate a subdominant response while inhibiting a dominant response (Rothbart & Bates, 1998; 2006), and includes inhibitory control, motor control, and the focusing of attention (Murray & Kochanska, 2002). While effortful control constitutes a number of the EF features of cognitive control, executive control is considered to be a narrower construct when compared to EF (Nigg, 2017). Although EF and effortful control are conceptually similar, inhibitory control represents a key process in both. Research investigating the relationship between effortful control or, more broadly, EF, and empathy has revealed conflicting findings. In one study, no association was found between empathy and EF in TD children (Hughes, White, Sharpen, & Dunn, 2000). However, other studies have revealed a positive relationship between children's empathy and effortful control (Eisenberg et al., 1996; Guthrie et al., 1997; Rothbart, Ahadi, &

Hershey, 1994; Valiente et al., 2004), where greater levels of empathy are linked to greater levels of control. These findings are not limited to children, as results of an additional study linked deficits in inhibitory control to reduced empathy in older adults (Bailey & Henry, 2008).

To the author's knowledge, however, no studies exist investigating the association between empathy and inhibitory control in children with ADHD. As empathy represents an element of social cognition that relies on mechanisms related to ToM, it is hypothesized that a positive correlation will exist between inhibitory control and empathy in these children.

Working memory and empathy. A recent literature review examined current research investigating the relationship between working memory deficits and social functioning in children with ADHD (Fried, Abrams, Hall, Feinberg, Pope, & Biederman, 2017). An association between deficits in visual-spatial working memory and social impairment in youth with ADHD was reported in three articles (Bunford et al., 2015; Kofler et al., 2011; Tseng & Gau, 2013). Specifically, working memory processes were found to contribute to symptoms of inattention and hyperactivity/impulsivity, which negatively influenced social interactions (Kofler et al., 2011). Similarly, in another study ADHD youth with social problems performed more poorly on measures of EF, including working memory (Tseng & Gau, 2013). Finally, a recent systematic review found a positive correlation between working memory and ToM (Pineda-Alhucema et al., 2018). Given the relationship between ToM and empathy, it is hypothesized that a similar association will exist between empathy and working memory in children with ADHD.

Current Study

As noted, children with ADHD frequently exhibit impairments in EF, including inhibition and working memory (Barkley, 2006). In addition, previous studies have compared levels of empathy in children with ADHD and TD controls. However, there are no published

studies investigating the relationship between EF and empathy in children with ADHD. The current study examined the association between the executive functions of attention, inhibition, and working memory, and empathy.

As previously mentioned, in addition to the core symptoms, children with ADHD often report social problems. Although the social functioning impairments of children with ADHD are well-documented, the mechanisms underlying these deficits are not well understood (Maoz et al., 2017). Successful social interaction is dependent on a child's ability to understand the minds of other individuals, a term referred to as social cognition. Social cognition is not a unitary construct, but includes a number of abilities, one of which is empathy (Uekermann et al., 2010). Studies exploring the factor structure of empathy have consistently revealed both an affective and a cognitive factor, which are now considered to be separate components of empathy (Bensalah, Caillies, & Anduze, 2016).

Research in developmental psychology points to an association between EF and social cognition (Decety & Lamm, 2006). It has been hypothesized that the social cognition impairments observed in individuals with ADHD may be associated with cognitive abilities, including EF, and previous research has investigated the association between impaired empathy and deficits in EF (Eslinger, Moore, Anderson, & Grossman, 2011). In addition, given the association between cognitive empathy and ToM and the relationship between ToM and the executive functions of inhibition, working memory, and attention in children with ADHD (Pineda-Alhucema, Aristizabal, Escudero-Cabarcas, Acosta- Lopez, & Velez, 2018), it is hypothesized that these same executive functions will play a role in empathy levels in children with ADHD. The purpose of the present study was to investigate the relationship between levels

of empathy and EF (specifically inhibition, working memory, and attention) in children with and without ADHD.

Research Questions

The current study examined the following research questions:

1. *What are the levels of cognitive and affective empathy in children with and without ADHD?* Based on previous findings it is hypothesized that children with ADHD will demonstrate lower levels of self-reported cognitive empathy when compared to children without ADHD. A number of studies have found deficits in empathic responding in individuals with ADHD (Braaten & Rosen, 2000; Demurie et al., 2011; Downs & Smith, 2004; Dyck, Ferguson, & Shochet, 2001; Marton et al., 2009; Yuill & Lyon, 2007). Among existing studies examining empathy and ADHD are those investigating differences in the cognitive and affective components of empathy. While earlier studies have found deficits in the affective component of empathy (Deschamps, Schutter, Kenemans, & Matthys, 2015; Schwenck et al., 2011), evidence from a more recent study suggests that the impairment in empathy in children with ADHD occurs primarily in the cognitive domain (i.e., perspective taking; Maoz et al., 2017). As previously mentioned, cognitive empathy and ToM appear to be conceptually related. As a number of studies suggest that children with ADHD experience difficulties with ToM understanding (Bora & Pantelis, 2016; Mary et al., 2016; Uekermann et al., 2010), it is theorized that children with ADHD will experience similar difficulties in the cognitive component of empathy. In line with these findings, it is hypothesized that children with ADHD will demonstrate impaired cognitive empathy and comparable affective empathy when compared to children without ADHD.

2. *Do children with ADHD demonstrate deficits in the EF domains of inhibition, working memory, and attention when compared to TD controls?* Based on the current literature, deficits in EF do not appear to be a necessary and sufficient cause of ADHD symptoms, but instead represent one of several difficulties (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Evidence from multiple sources points to a deficit in inhibition in individuals with ADHD (Woltering, Liu, Rokeach, Tannock, 2013), and neuroimaging data suggests the presence of structural and functional abnormalities consistent with working memory deficits in individuals with ADHD (Roman-Urrestarazu et al., 2016; Gu et al., 2018). As such, the current study hypothesizes that children with ADHD will demonstrate weaker abilities in the areas of inhibition, working memory, and attention when compared to TD controls.
3. *What is the relation between EF (inhibition, working memory, and attention) and empathy in children with ADHD and TD children?* It has been proposed that empathy is supported by other higher-level cognitive abilities, including executive functions. (Decety, 2011). Following this notion, for an individual to experience empathy he or she must first be paying attention to another individual's emotional state. In order to trigger emotional contagion and, subsequently, the experience of empathy, attention, inhibitory control, and other EF processes are necessary (Singer & Lamm, 2009). As outlined above, deficits in aspects of EF (i.e., inhibitory control and working memory) have been linked to ToM impairments. In addition, research points to a link between working memory and empathy, and deficits in working memory have been associated with social functioning impairments in children with ADHD. The current study hypothesized that inhibitory control, working memory, and attention might be significantly associated with empathy, which requires the ability to attend to the emotional response of another and shift between one's own and another's perspective,

inhibiting one's own emotional response, and managing multiple information streams. In accordance with these notions we hypothesized that scores on measures of attention, inhibitory control, and working memory would be positively correlated with parent-reported empathy levels in children with ADHD. Following the same line of reasoning, it is hypothesized that scores on measures of attention, inhibitory control, and working memory will be positively correlated with overall parent-reported empathy levels in children without ADHD. In addition, in agreement with Decety and Ickes (2011), the research objectives of the present paper operate under the assumption that the cognitive component of empathy involves a higher degree of ToM processing, while the affective component implicates simulation processing. As such, it was further hypothesized that the experience of cognitive empathy specifically would be associated with attention, inhibitory control, and working memory.

Chapter 3: Methodology

This study is a part of a larger project investigating social-cognitive abilities in children with ADHD. Only the details relevant to the present study are discussed.

Participants

A total of 20 children with ADHD (45.0% female, 55.0% male) and 26 TD children (38.5% female, 61.5% male) participated in the study. The mean age of the children with ADHD was 10.63 years (*SD* = 1.28). The mean age of the TD control participants was 10.08 years (*SD* = 1.27). There was no significant age difference between the two groups, $t(44) = 1.418$, $p = .163$. In addition, a Chi-square test revealed no significant effect of gender X^2 (2, N = 44) = .199, p= .655. Participants in the ADHD group received a diagnosis of ADHD from a medical professional prior to participation in the study.

Participant recruitment. Participants were recruited through the use of posters distributed on the University of Calgary campus, local coffee shops, city recreation centres, and public libraries. In addition, community partners (including Learning Disabilities Association of Alberta, CanLearn Society, and Foothills Academy) circulated information about the research study. Posts detailing the study were also made by the Strengths in ADHD Research Group Facebook account. As this study is part of a larger project, multi-city recruitment was possible, and posters were also distributed in local coffee shops, recreation centres, and public libraries in Ottawa, Ontario, and Regina, Saskatchewan. As compensation for their time, participants were given the choice of a $25 gift card (e.g., iTunes, Chapters, Toys R Us), as well as a small gift (value under $5). Parking expenses were also covered.

Inclusion criteria. Prior to participation, a 10- to 15-minute pre-screening phone interview was conducted to determine whether the child met criteria to participate in the study.

At this time information was gathered regarding additional medical, health, and/or learning diagnoses (Table 1). Inclusion criteria for participation in the ADHD participant group included being between the ages of 8 and 12 years with a previous diagnosis of ADHD. Children in this age range without a diagnosis of ADHD were eligible to participate in the TD control participant group. In addition, t-scores for the Inattention and Hyperactivity/Impulsivity scales of the Conners Rating Scale – 3rd Edition, Parent Report (Conners-3 PR) served as inclusionary criteria for participation in the ADHD group. Specifically, in addition to a previous diagnosis, participants in the ADHD group were required to have a t-score equal to or above 70 on one of the scales and equal to or above 65 on the second. However, it is important to note that a number of the participants in the ADHD group were receiving medication at the time of testing. As the Conners-3 PR assesses current functioning, the t-scores of these participants may be lower than the previously specified criteria. Therefore, if the participant has received a diagnosis of ADHD and is currently taking medication, he/she was included in the study. When compared to the TD groups, the ADHD group had significantly greater symptoms on both the Hyperactivity/Impulsivity scale, $t(34.41) = 7.416$, $p < .001$, and Inattention scale, $t(29.77) = 9.64$, $p < .001$.

Additionally, all participants were required to be able to fluently speak, write, and read English. In order to ensure comprehension, Average or Above Average FSIQ scores (i.e., standard score of 80 and above) were also considered as inclusionary criteria for participation, as determined using scores obtained on the Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II). No significant differences were noted between the ADHD and the TD participants on FSIQ $t(43) = 7.30$, $p = .469$. Finally, due to the nature of the measures used in the study, children were only invited to participate if they did not have any major hearing or

vision challenges. Similarly, children were only included in the study if they did not exhibit gross motor difficulties (e.g., cerebral palsy) or ASD, due to the neurological overlaps with ADHD.

Table 1.
Demographic Information

Variable	Category	ADHD				Control			
		n	*%*	*M*	*SD*	*n*	*%*	*M*	*SD*
Age		---	---	10.63	1.28	---	---	10.33	1.29
Gender	Male	11	55	---	---	16	61.5	---	---
	Female	9	45	---	---	10	38.5	---	---
Ethnicity	Caucasian	18	90	---	---	15	57.7	---	---
	African	0	0	---	---	1	3.8	---	---
	Aboriginal	0	0	---	---	2	7.7	---	---
	East Indian	0	0	---	---	1	3.8	---	---
	Mixed/ Multiple	2	10	---	---	0	0	---	---
	Other	0	0	---	---	1	3.8	---	---
Second Language	French	2	10	---	---	2	7.7	---	---
	Other Language	1	5	---	---	4	15.4	---	---
	None	17	85	---	---	20	76.9	---	---
Family Structure	Lives with both parents	15	75	---	---	23	88.5	---	---
	Lives with one parent full-time	1	5	---	---	2	7.7	---	---
	Lives with one parent but sees other	1	5	---	---	1	3.8	---	---
	Other	3	15	---	---	0	0	---	---
	Not indicated	0	0	---	---	0	0	---	---
Highest Level of Education (Mother)	Less than High School	0	0	---	---	0	0	---	---
	Some High School	0	0	---	---	0	0	---	---
	High School Diploma	0	0	---	---	0	0	---	---
	Some College/University	5	25	---	---	2	7.7	---	---
	College Diploma	5	25	---	---	3	11.5	---	---
	Undergraduate Degree	8	40	---	---	11	42.3	---	---
	Graduate Degree	1	5	---	---	9	34.6	---	---
	Other	1	5	---	---	1	3.8	---	---
	Not indicated	0	0	---	---	0	0	---	---
Highest Level of Education (Father)	Less than High School	0	0	---	---	0	0	---	---
	Some High School	1	5	---	---	0	0	---	---
	High School Diploma	3	15	---	---	3	11.5	---	---
	Some College/University	4	20	---	---	3	11.5	---	---
	College Diploma	4	20	---	---	4	13.8	---	---
	Undergraduate Degree	3	15	---	---	8	30.8	---	---
	Graduate Degree	3	15	---	---	7	26.9	---	---

	Other	0	0	---	---	1	3.8	---	---
	Not indicated	2	10	---	---	0	0	---	---
Medication	On Medication	16	80	---	---	0	0	---	---
Status	Vivanse	1	5	---	---	0	0	---	---
	Concerta	5	25	---	---	0	0	---	---
	Biphentin	6	30	---	---	0	0	---	---
	Methylphenidate/ Ritalin	1	5	---	---	0	0	---	---
	Combination of medication	3	15	---	---	0	0	---	---
Additional	Learning Disability	1	5	---	---	0	0	---	---
Diagnoses	(Math)								
	Learning Disability (Reading)	2	10	---	---	0	0	---	---
	Learning Disability (Not Specified)	2	10	---	---	0	0	---	---
	Anxiety	2	10	---	---	1	3.8	---	---
	Oppositional Defiant Disorder	1	5	---	---	0	0	---	---
	Oppositional Defiant Disorder and Anxiety	1	5	---	---	0	0	---	---
	Other	3	15	---	---	0	0	---	---
WASI-II	FSIQ	---	---	108.63	12.16	---	---	106.08	11.16
Conners 3-PRS	Hyperactivity/ Impulsivity Index	---	---	76.70	13.00	---	---	51.69	9.86
	Inattention Index	---	---	76.55	11.04	---	---	49.50	6.79

Measures

To increase validity for this study, data was collected from multiple sources, including parents and children. As the current student was part of a larger project, only measures relevant to the present study will be included.

Parent measures. Each participant's parent/guardian completed a demographic questionnaire as well as standardized assessment measures. Measures included the Conners Rating Scale – 3rd Edition, Parent Report (Conners-3 PR; Conners, 2008) and the Comprehensive Executive Function Inventory – Parent Report (CEFI-PR; Naglieri & Goldstein, 2013).

Conners Rating Scale – 3rd Edition, Parent Report (Conners-3 PR; Conners, 2008). The Conners-3 PR (Conners, 2008) was included to confirm ADHD diagnosis and symptoms for children in the ADHD participant group. The measure includes 43 items designed to measure symptoms associated with ADHD and comorbid problems in children between six and 18 years of age. The Conners-3 PR includes both content scales (Inattention, Hyperactivity/Impulsivity, Learning Problems/EF, Aggression, Peer Relations, and Family Relations) as well as symptom scales based on diagnostic criteria in the APA's *Diagnostic and Statistical Manual, 5th Edition (DSM-5;* APA, 2013). Parents are asked to rate statements regarding their child over the past month according to a 4-point Likert-type scale. A 0 corresponds to a response of *not at all*, a 1 to a response of *just a little true*, a 2 to *pretty much true*, and a 3 to *very much true*. The Conners-3 PR has demonstrated good reliability and validity, and the internal consistency (r = .85 to .94) and test-retest reliability (r = .72 to .98) are well within the acceptable range (Conners, 2008).

The Comprehensive Executive Function Inventory – Parent Report (CEFI-PR; Naglieri & Goldstein, 2013). The CEFI-PR was included to measure key areas of EF, including

attention (how well a child can avoid distractions, sustain attention, and concentrate on tasks; i.e., "pay attention for a long time?"), *emotion regulation* (control and management of emotions; i.e., "stay calm when handling small problems?"), *flexibility* (a child's ability to adapt to circumstances; i.e., "solve a problem in different ways?"), *inhibitory control* (a child's control over behaviour/impulses; i.e., "think before acting?"), *initiation* (a child's ability to begin a task without being prompted; i.e., "start something without being asked?"), *organization* (a child's ability to manage work, personal effects, or multiple tasks; i.e., "complete one task before starting a new one?"), *planning* (a child's ability to develop and implement strategies to complete tasks; i.e., "know what to do first?"), *self-monitoring* (a child's self-evaluation of his/her behaviour; i.e., "keep track of time?"), and *working memory* (how well a child can keep information in mind that is important for knowing what to do and how to do it; i.e., "remember how to do something?"; Naglieri & Goldstein, 2013). The CEFI-PR is a standardized rating scale designed for use with children ages 5 to 18 years old. Completion of the CEFI-PR provides a full-scale EF score, as well as nine subtest scores, including Attention, Emotion Regulation, Flexibility, Inhibitory Control, Initiation, Organization, Planning, Self-Monitoring, and Working Memory. The CEFI includes three forms, of which only the Parent Report was used (ages five to 11 or 12 to 18, depending on the age of the child). The questionnaire is composed of 100 items scored according to a 6-point Likert-type scale (*Never, Rarely, Sometimes, Often, Very Often, Always*). Parents are directed to consider behaviours observed over the previous four weeks when responding to each item.

Exploratory Factor Analysis and congruence analysis of the CEFI identified a unidimensional factor structure in line with the nine subcomponents originally proposed by the authors. The parent report has demonstrated good internal consistency on both the full scale and

subtest scores, .97 to .99 and greater than .85 (with the exception of Flexibility and Self-Monitoring), respectively. Test-retest reliability for the full-scale scores resulted in scores of .80 or higher, and interrater reliability was strong for both the full scale (.88) and subtest (.73 to .86) scores (Climie, Cadogan, & Goukon, 2014).

Child measures. Child participants completed a number of standardized measures. Measures included the Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II; Wechsler, 2011) and the Interpersonal Reactivity Index (IRI; Davis, 1983).

Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II; Wechsler, 2011). In order to ensure adequate comprehension of the questions posed, the WASI-II was included to determine whether participants were functioning at an age appropriate level. The WASI-II, an abbreviated measure of cognitive intelligence, was administered to all children in the sample. The WASI-II is composed of four subtests: Vocabulary (measures word knowledge and verbal concept formation), Similarities (measures verbal concept formation and reasoning), Block Design (measures the ability to analyze and synthesize abstract visual stimuli), and Matrix Reasoning (measures fluid intelligence, broad visual intelligence, classification and spatial ability, knowledge of part–whole relationships, simultaneous processing, and perceptual organization). The former two subtests contribute to the Verbal Comprehension Index (VCI; a measurement of verbal ability), while the latter two subtests form the Perceptual Reasoning Index (PRI; a measurement of nonverbal reasoning and problem-solving). A Full-Scale IQ (FSIQ) score is determined using a combination of all four subtests. The WASI-II is a commonly used measure that has demonstrated good reliability, test-retest stability, and construct validity. The standardization sample included 2,300 individuals representative of the population in terms of sex, age, race/ethnicity, geographic region, and educational level. In the child sample, internal

consistency coefficients for the subtest scores ranged from good to excellent (.87 to .91), while internal consistency coefficients for the composite scores all fell within the excellent range (.92 to .96). In terms of test-retest stability, subtests revealed acceptable to excellent (.79 to .90) stability coefficients, while composites exhibited good to excellent (.87 to .95) coefficients. The validity of the WASI-II is supported by strong interrelationships across all the subtests and composites. Concurrent validity was evaluated through a comparison with other measures assessing similar constructs. More specifically, correlations between the WASI-II and the WASI, WAIS-IV, and WISC-IV were acceptable to excellent (.71 to .92; McCrimmon & Smith, 2013).

Interpersonal Reactivity Index (IRI; Davis, 1983). The IRI is a 28-item self-report questionnaire designed to measure both cognitive and affective components of empathy. These items are further divided into four subscales, each comprising seven different items. The *Perspective Taking* (PT) subscale measures the tendency to adopt another person's psychological position/point of view (i.e., "I sometimes try to understand my friends better by imagining how things look from their perspective"). The *Empathic Concern* (EC) subscale measures the tendency to experience feelings of sympathy and concern for others ("other-oriented feelings"; i.e., "When I see someone being taken advantage of, I feel kind of protective towards them"). The *Personal Distress* (PD) subscale measures feelings of unease and anxiety in response to tense interpersonal settings (i.e., "I sometimes feel helpless when I am in the middle of a very emotional situation"). The final IRI subscale, the *Fantasy* (F) subscale, measures the tendency to imagine oneself experiencing the feelings and actions of fictitious characters in books, movies and plays (i.e., "After seeing a play or movie, I have felt as though I were one of the characters"). Each item is scored on a 5-point Likert scale, ranging from "Does not describe me well' to "Describes me very well" (Davis, 1983).

This questionnaire was chosen for the current study because it is the most commonly used psychometric tool in the measurement of empathy. The IRI was initially presented as a multidimensional measure (Davis, 1983), and its structure was later validated through the identification of four factors that map onto the original scale (Carey, Fox, & Spraggins, 1988). Subsequent studies (Cliffordson, 2001; Hawk et al., 2013) have proposed a hierarchical model to describe the structure of the scale, supporting the presence of a general empathy second-order factor in addition to the original four-factor model. An additional study (Pulos et al., 2004) also identified a second-order empathy factor, however only three of the four subscales (PT, F, and EC) loaded onto this factor.

Within the realm of empathy research, recent work has attempted to distinguish cognitive and affective empathy, and the IRI has been adapted to measure this two-factor model. In line with previous studies that have used the IRI in ASD research (e.g., Bos & Stokes, 2018; Brouns et al., 2013; Rueda et al., 2015; Trimmer, McDonald, & Rushby, 2017), only two of the four subscales were selected for analysis in the present study. Specifically, the PT subscale was selected as a measure of cognitive empathy, while the EC subscale was chosen to measure affective empathy. The PT and EC subscales are believed to be the two most pure measures of AE and CE, while the F and PD subscales are considered to measure broader psychological constructs (Parkinson & Wheatley, 2012). In order to examine empathy overall, a total score was created by combining scores on the PT and EC subscales.

Procedure

As this study is part of a larger project, only measures relevant to the present study will be included in the discussion of study procedure. Prior to participation in the study a 10- to 15-minute pre-screening phone interview was conducted to determine whether the child met criteria

to participate in the study. For participants located in Calgary, Alberta, study sessions were conducted in a confidential space designed for research purposes on the University of Calgary campus. For participants located in Ottawa, Ontario and Regina, Saskatchewan, study sessions were conducted in confidential spaces (e.g., reserved office space, public library rooms). Once parent/guardian consent and child assent for participation had been established, parents/guardians were provided with questionnaire packages that included the demographic questionnaire, the Conners-3 PR, and the CEFI-PR, as well as measures relevant to the larger project. Parents/guardians completed these measures while the child worked one-on-one with the researcher. During this time the researcher administered the WASI-II and the IRI, as well as other measures pertinent to the larger project. With the exception of the WASI-II, all measures were administered in random order. Children were offered breaks and snacks when appropriate, as deemed by the researcher. Once all measures had been completed participants were given the choice of a $25 gift card (e.g., iTunes, Chapters, Toys R Us), as well as a small gift (value under $5). The present study was approved by the Conjoint Faculties Research Ethics Board (CFREB) at the University of Calgary.

Chapter 4: Results

A total of 46 children participated in the study (41.3% female, 58.7% male). Participants included 20 children with ADHD and 26 TD children. Parents/guardians completed the Conners-3 PR and the CEFI-PR while the researcher administered the WASI-II and the IRI to the child participants. To begin, cases with more than 20% of missing responses were removed from the data set via listwise deletion. At this stage, one TD participant was removed from the analysis, resulting in final numbers of 20 in the ADHD group and 25 in the TD group. Normality of the data was then determined through an analysis of histograms, Q-Q plots, skewness, and kurtosis. This assessment showed that the data are approximately normally distributed. Similarly, the Shapiro-Wilk's test confirmed that the data are likely normally distributed. Levene's test was used to evaluate the homogeneity of variance, which indicated that the population variances are equal for both groups. Finally, standardized values were created to evaluate the presence of extreme outliers. All standardized values were within the normal range (i.e., +/- 3.29; Tabachnick & Fidell, 2013), and no extreme outliers were identified. An alpha level of .05 was applied to all statistical tests.

Research Question One

The first research question investigated the levels of cognitive and affective empathy in children with and without ADHD. An independent samples t-test was conducted to compare children with ADHD and TD children on measures of cognitive and affective empathy, as well as total empathy score. As previously mentioned, the data from the two groups were sufficiently normal and the assumption of homogeneity of variances was tested and satisfied via Levene's test for equality of variance (i.e., the test was non-significant, indicating homogeneity of variance). As multiple analyses were conducted, the Bonferroni correction was used to limit the

chance of a Type I error (i.e., rejecting a true null hypothesis), resulting in a *p* value of .02 (α_B = α/k, α = .05 and k equal to the number of comparisons; Abdi, 2007). Results of the t-test revealed a significant difference in total empathy scores, with children with ADHD (*M* = 30.30, *SD* = 6.21) scoring significantly lower than TD children (*M* = 34.72, *SD* = 6.03), *t*(43) = -2.41, *p* = .02. There was no significant difference in affective empathy scores between children with ADHD (*M* = 18.35, *SD* = 3.22) and TD children (*M* = 19.16, *SD* = 3.72), *t*(43) = -.77, *p* = .45. However, there was a significant difference in cognitive empathy, with children with ADHD (*M* = 11.95, *SD* = 4.59) performing significantly lower than TD children (*M* = 15.56, *SD* = 4.87), *t*(43) = -2.53, *p* = .02 (See Table 2).

Table 2.
Empathy in Children with and without ADHD

	ADHD (*n* = 20)		TD (*n* = 25)			
Variable	*M*	SD	*M*	SD	*t*	Cohen's *d*
Total Empathy	30.30	6.21	34.72	6.03	–2.41*	–0.72
Affective Empathy	18.35	3.22	19.16	3.72	–0.77	–0.23
Cognitive Empathy	11.95	4.59	15.56	4.87	–2.53*	–0.76

* indicates $p < .05$

Research Question Two

In order to examine potential executive function deficits an independent samples t-test was conducted to compare children with ADHD and TD children on measures of attention, inhibitory control, and working memory. Again, the data from the two groups were sufficiently normal and Levene's test was found to be non-significant, denoting homogeneity of variance. As noted in research question one, due to the fact that multiple analyses were conducted, the Bonferroni correction was used, resulting in a *p* value of .02 (α_B = α/k, α = .05 and k equal to the

number of comparisons; Abdi, 2007). Overall, children with ADHD performed lower than TD children on all measures of EF. Specifically, there was a significant difference in attention scores, with children with ADHD (M = 86.15, SD = 8.36) performing lower than the TD children (M = 108.52, SD = 8.73), $t(43) = -8.70$, $p < .001$. Likewise, significantly lower inhibitory control was demonstrated in the ADHD group (M = 84.80, SD = 11.22), compared to the TD group (M = 109.52, SD = 10.49), $t(43) = -7.62$, $p < .001$. Similarly, lower performance in working memory was observed in the ADHD group (M = 82.35, SD = 13.20), when compared to the TD group (M = 107.28, SD = 8.85), $t(43) = -7.57$, $p < .001$ (see Table 3).

Table 3.
Attention, Inhibitory Control, and Working Memory in Children with and without ADHD

	ADHD (n = 20)		TD (n = 25)			
Variable	*M*	SD	*M*	SD	*t*	Cohen's *d*
Attention	86.15	8.36	108.52	8.73	-8.70*	-2.62
Inhibitory Control	84.80	11.22	109.52	10.49	-7.62*	-2.28
Working Memory	82.35	13.20	107.28	8.85	-7.57*	-2.22

* indicates $p < .001$

Research Question Three

The third research question sought to determine the relation between EF (inhibition, working memory, and attention) and empathy in children with ADHD and TD children. This association was examined across all participants, irrespective of group membership. Pearson correlations were conducted with total empathy, cognitive empathy, affective empathy and the different EF subscales (see Table 4). The results showed a significant positive correlation between total empathy and attention (r = .38, p = .01), inhibitory control (r =.36, p =.02), and working memory (r =.33, p = .03). The same pattern was observed in the correlations between cognitive empathy

and attention (r = .38, p = .01), inhibitory control (r = .36, p = .02), and working memory (r = .36, p = .01). No significant correlations between affective empathy and EF were observed.

Table 4
Pearson Correlations between Empathy and EF in Children with ADHD and TD Children

Executive Function	Total Empathy	Cognitive Empathy	Affective Empathy
Attention	r = .38 p = .01*	r = .38 p = .01*	r = .16 p = .29
Inhibitory Control	r = .36 p = .02*	r = .36 p = .02*	r = .14 p = .37
Working Memory	r = .33 p = .03*	r = .36 p = .01*	r = .08 p = .62

* indicates $p < .05$

To investigate the influence of ADHD on these associations, partial correlations were conducted with total empathy, cognitive empathy, affective empathy and the different EF subscales to determine the degree of association while controlling for ADHD (see Table 5). No significant correlations between empathy and EF were observed (see Table 5).

Table 5
Partial Correlations between Empathy and EF in Children with ADHD and TD Children

Executive Function	Total Empathy	Cognitive Empathy	Affective Empathy
Attention	r = .19 p = .22	r = .16 p = .31	r = .11 p = .46
Inhibitory Control	r = .15 p = .32	r = .14 p = .36	r = .07 p = .64
Working Memory	r = .11 p = .50	r = .15 p = .33	r = -.02 p = .91

In order to further examine the influence of ADHD on the association between executive functioning and empathy, Fisher's Z-test was used to compare the correlation coefficients before and after controlling for ADHD (i.e., comparing the bivariate correlations with the partial

correlations). As all z-scores were between +/- 1.96, there are no significant differences between the correlations before and after controlling for ADHD (Table 6).

Table 6
Fischer's Z-test comparing Bivariate Correlations and Partial Correlations of Empathy and EF in Children with ADHD and TD Children

Variable	Bivariate	Partial	Z
Cognitive Empathy & Attention	r = .38 p = .01	r = .16 p = .31	1.08 p = .28
Cognitive Empathy & Inhibitory Control	r = .36 p = .02	r = .14 p = .36	1.07 p = .28
Cognitive Empathy & Working Memory	r = .36 p = .01	r = .15 p = .33	1.06 p = .29
Total Empathy & Attention	r = .38 p = .01	r = .19 p = .22	.97 p = .33
Total Empathy & Inhibitory Control	r = .36 p = .02	r = .15 p = .32	.99 p = .32
Total Empathy & Working Memory	r = .33, p = .03	r = .11 p = .50	1.06 p = .29

Chapter 5: Discussion

The purpose of the present study was to investigate the relationship between levels of empathy and EF (specifically inhibition, working memory, and attention) in children with and without ADHD. Specifically, the current study sought to answer the following three research questions: (1) What are the levels of cognitive and affective empathy in children with and without ADHD? (2) Do children with ADHD demonstrate deficits in the EF domains of inhibition, working memory, and attention when compared to TD controls? (3) What is the relation between EF (inhibition, working memory, and attention) and empathy in children with ADHD and TD children?

Overall, the present study demonstrated that children with ADHD have significantly lower levels of self-reported overall empathy and cognitive empathy when compared to TD children. No such differences were found in affective empathy scores. The study also confirmed that children with ADHD perform lower than TD children on EF measures of attention, inhibition, and working memory. Finally, the current study demonstrated a significant positive correlation between both overall and cognitive empathy and the EFs of attention, inhibitory control, and working memory across all participants. To the best of the author's knowledge, this study represents the first attempt to investigate the relation between empathy and EF in children with ADHD. The following sections will outline the results and implications of the findings in more detail.

Research Question One

The first research question examined differences in cognitive and affective empathy in children with and without ADHD. In order to supplement the present understanding of any empathetic deficits, a consideration of overall empathy was also included. The present study

conceptualized empathy as comprising two domains: cognitive and affective empathy. It was hypothesized that, in line with previous research (i.e., Maoz et al., 2017), children with ADHD would demonstrate lower levels of self-reported cognitive empathy when compared to children without ADHD. As previously mentioned, cognitive empathy and ToM appear to be conceptually related. As a number of studies suggest that children with ADHD experience difficulties with ToM understanding (Bora & Pantelis, 2016; Mary et al., 2016; Uekermann et al., 2010), it is therefore conceivable that children with ADHD would experience similar difficulties in the cognitive component of empathy. In addition, it was hypothesized that children with ADHD and TD would not differ significantly in affective empathy scores.

The results of the present study support the notion of two components of empathy in children with ADHD. Further, the hypothesis of the current study was supported, as there was a significant difference in cognitive empathy, with children with ADHD scoring significantly lower than TD children on a self-report measure. No such difference was noted in affective empathy scores. The absence of a difference in affective empathy between children with ADHD and TD children runs contrary to previous research finding a deficit in the affective component of empathy in children with ADHD (Deschamps, Schutter, Kenemans, & Matthys, 2015; Schwenck et al., 2011). In addition, results of the present study revealed significantly lower scores in total empathy in children with ADHD, suggesting an overall empathetic deficit when compared to their TD counterparts. These findings mirror those of previous studies finding deficits in individuals with ADHD in overall empathic responding (Braaten & Rosen, 2000; Demurie et al., 2011; Marton et al., 2009;).

The findings of intact affective empathy and impaired cognitive empathy in children with ADHD may be influenced by several factors. Previous research investigating empathy levels in

children with ADHD has primarily relied on parent and teacher reports. A recent study using self-reported parameters of empathy found that, when compared to TD children, those with ADHD reported lower levels of empathy in predominantly the cognitive domain (Maoz et al., 2017). While the results of the present study suggest that children with ADHD are not impaired in affective empathy, evidence of this may not be readily apparent (i.e., as shown in parent and teacher reports). As children with ADHD reported significantly lower scores than TD children in cognitive empathy, this result suggests they may have difficulty understanding the emotions and perspectives of others. As such, these children may not act as expected in response to the emotional experience of another. However, the results of the present study suggest that when they are given the necessary information to understand the perspective of another, their levels of affective empathy are comparable to their typically-developing counterparts. As the empathetic deficit appears to be primarily associated with the cognitive domain of empathy, once the situation is understood an appropriate affective response can follow (Rogers et al., 2007). In addition, the results of the self-report measure of empathy suggest that children with ADHD are aware of their challenges with perspective-taking. This self-awareness may have the potential to play a supportive role in targeted intervention, facilitating social skill development through an awareness of specific challenges.

The absence of a difference in affective empathy scores between children with ADHD and TD children is complicated by challenges in the measurement of affective empathy. Previous research suggests that children's self-reports of affective empathy do not coincide with their prosocial behaviour and are influenced by factors such as demand characteristics and the experimenter's gender (Dadds et al., 2008). In addition, the nature of the IRI may introduce a response bias that complicates the measurement of affective empathy. Items in the IRI designed

to measure affective empathy require the use of cognitive empathy in order to respond. Consequently, an impairment in cognitive empathy would therefore influence responding on affective items, leading to a lower performance in this domain. Therefore, although the IRI may be effective in the measurement of cognitive empathy, the affective empathy scores may not be valid (Chrysikou & Thompson, 2016). Thus, the results of the present study should be considered in conjunction with these limitations. Specifically, although the results pertaining to cognitive empathy may be valid, an understanding of affective empathy in children with ADHD requires further investigation. In order to overcome these challenges, future studies should include a performance measure of affective empathy.

Overall, results of the present study suggest that when compared to TD children, children with ADHD may have more difficulty accurately understanding and predicting the emotions of others (cognitive empathy) but are comparable in their emotional responsiveness to the emotional state of another (affective empathy). This empathetic profile may result in the experience of the emotions of another without the cognitive understanding necessary to promote prosocial behaviour (Smith, 2009). Future research should continue to investigate the nature of the deficit in cognitive empathy in children with ADHD in order to better inform interventions supporting the improvement of peer relationships and social skills through the inclusion and development of empathy-induced prosocial behaviour.

Research Question Two

The purpose of the second research question was to investigate EF deficits in children with ADHD. Specifically, the current study explored whether children with ADHD demonstrate deficits in the EF domains of attention, inhibition, and working memory when compared to TD controls. There is strong empirical evidence supporting the link between ADHD and deficits in a

number of executive functions (Barkley, 2006). As such, it was hypothesized that, when compared to TD children, children with ADHD would demonstrate weaker abilities in the areas of inhibition, working memory, and attention. Overall, children with ADHD performed lower than TD children on all measures of EF. Based on the findings of the present study, the executive functions of attention, inhibition, and working memory appear to represent specific areas of difficulty in children with ADHD, when compared to TD children. Upon consideration of the evidence linking ADHD with deficits in these areas, the results of the present study suggest that the sample is indeed representative of the ADHD population, increasing generalizability of the findings.

As previously mentioned, EF deficits are commonly observed in children with ADHD. The results of the present study confirm that the participants in the ADHD sample experience difficulties in the parent-ratings of attention, inhibition, and working memory. Deficits in these areas have been associated with poor social outcomes in the ADHD population, and previous research has examined the effects of the interaction between ADHD and EF deficits on social challenges. For example, previous research has revealed an association between social problems and a number of EF tasks (Kofler et al., 2011). The present study showed challenges in three specific domains of EF believed to affect social ability. In terms of attention, inattention may impact a child's ability to pay attention to important social signals, impacting interpretation of the situation (Mary et al., 2016). Similarly, challenges with impulsive responding accompanying deficits in inhibitory control may interrupt processing of pertinent social information (Charman, Carroll, & Sturge, 2001). Working memory is also believed to be vital to successful social interaction, impacting a child's ability to store and recall social cues and process social information (Kofler et al., 2011). In addition, successful social interactions depend in part on a

child's ability to understand the minds of other individuals, a term referred to as social cognition (Uekermann et al., 2010). As empathy represents one vital element of social cognition, it is likely that these EFs also play a role in empathy.

Research Question Three

The third research question sought to determine the relation between EF (attention, inhibition, and working memory) and empathy in children with ADHD and TD children. As previously mentioned, the PAM of empathy (Preston & De Waal, 2002) suggests that empathy occurs automatically in response to the emotional state of another individual and is unaffected by cognitive load (Preston & De Waal, 2002). However, other research suggests that the experience of empathy can be disrupted by other cognitive processes (i.e., attention; Gu & Han, 2007). These results challenge the assumptions of the PAM and suggest that the experience of empathy is not entirely automatic (Morelli & Lieberman, 2013).

Following this line of reasoning, it has been proposed that empathy is supported by other higher-level cognitive abilities, including executive functions (Decety, 2011). As such, inhibitory control, working memory, and attention were hypothesized to be significantly associated with empathy, which requires the ability to attend to the emotional response of another and shift between one's own and another's perspective, inhibiting one's own emotional response, and managing multiple information streams. In accordance with these notions, it was hypothesized that parent-reported scores on measures of attention, inhibitory control, and working memory would be positively correlated with self-reported empathy levels. More specifically, in agreement with Decety and Ickes (2011), the research objectives of the present paper operated under the assumption that the cognitive component of empathy involves a higher degree of ToM processing, while the affective component implicates simulation processing. As such, it was

further hypothesized that the experience of cognitive empathy specifically would be associated with other cognitive processes (i.e., EF). Consistent with this hypothesis, the results showed a significant positive correlation between cognitive empathy and the EFs of attention, inhibitory control, and working memory. No other significant correlations between empathy and EF in the ADHD or TD groups was observed. However, when the association between empathy and EF was examined while controlling for ADHD, the correlations between empathy (cognitive and overall) and attention, inhibitory control, and working memory were no longer significant. A follow-up comparison of the bivariate and partial correlations revealed that the differences were not significant, suggesting that ADHD is not the differentiating variable driving the association between empathy and EF.

Results of the present study therefore suggest that there exists a small positive relationship between attention, inhibitory control, and working memory with both overall and cognitive empathy. To the best of the author's knowledge, this study represents the first attempt to investigate the relation between empathy and EF in children with ADHD. In line with previous research, results of the present paper give weight to the notion that the experience of empathy is not automatic but affected by other cognitive processes. More generally, results from the present study suggest that resources may be shared between social-interpersonal and executive processing, as has been previously demonstrated in individuals with frontotemporal dementia (Eslinger, Moore, Anderson, & Grossman, 2011). In addition, a previous review of the research suggests that the executive functions of inhibition, working memory, and attention are associated with ToM in individuals with ADHD (Pineda-Alhucema, Aristizabal, Escudero-Cabarcas, Acosta- Lopez, & Velez, 2018). In light of the relationship between ToM and cognitive empathy, it was hypothesized that these same executive functions would play a role in

the cognitive empathy levels of children with ADHD. The results of the present study confirm this notion, identifying inhibitory control, working memory, and attention as specific EFs associated with cognitive empathy in children.

Attention. There was limited prior research investigating the association between EF and empathy. It has been hypothesized that for a child to experience empathy he or she must first be paying attention, and the association between cognitive empathy and attention has been previously supported in current empathy literature. For example, in one study participants who were exposed to images of painful scenarios revealed activation in parts of the pain matrix. However, when told to count the number of hands in an image, the same activation patterns were not observed. Thus, in a condition in which participants' attention was diverted, empathic responses differed, suggesting that the way in which an individual attends to the emotions of another modulates the subsequent empathic response (Gu & Han, 2007). Results of the present study support the notion that, in order to respond empathetically children must first be able to demonstrate the attentional capacity required to identify and interpret socially relevant cues. It is important to note a critical difference between the results of the present study and those obtained by Gu and Han (2007). While the latter employed a behavioural task, the present study used both self-report and parent-report rating scales. As such, the two studies examined attention and empathy in different ways and had different attentional and empathetic requirements for participants. As previously mentioned, the social problems exhibited by children with ADHD have been attributed to a performance, rather than a knowledge, deficit; that is, they appear to have the knowledge of social rules but not the ability to apply them (Kofler et al., 2011). While the results of Gu and Han (2007) point to a performance deficit for children with ADHD in the

realm of empathy, the present study points to a knowledge deficit as well, supporting the notion of congruence in what they know and how they act.

Inhibitory control. In addition to attention, the experience of empathy also requires the inhibition of one's own emotional response. The notion of an association between inhibitory control and empathy is not entirely novel, and it has been proposed that reduced levels of empathy may be associated with deficits in inhibitory control observed in individuals with ADHD (Barkley, 1994). According to Barkley's model (1997a), children with ADHD may exhibit deficits in social perspective taking as a result of their inability to delay their initial emotional reaction in order to consider the perspectives of others (Barkley 2014). Deficits in inhibitory control impact a child's ability to perceive another individual's point of view and to express emotions and feelings (Pineda-Alhucema et al., 2018) and recent research on ADHD connects symptoms of impulsivity and poor impulse control with deficits in the same brain regions implicated in the "empathy circuit" (Hulvershorn et al., 2014). Although there is a lack of research regarding the relation between cognitive empathy and inhibitory control, the concept of cognitive empathy is closely associated with ToM (Walter, 2012), an area with a stronger research basis. Performance on ToM tasks has been linked to inhibitory control in TD children (Carlson & Moses, 2001; Carlson et al., 2002; Flynn et al., 2004; Flynn, 2007), and recent evidence suggests a relationship between ToM deficits and inhibitory control impairments in children with ADHD (Mary et al., 2015; Ozonoff & McEvoy, 1994; Sabbagh et al., 2006). The results of several studies suggest that on ToM tasks requiring inhibition, children with ADHD performed poorer than their TD counterparts (Sodian, Hulsken, & Thoermer, 2003; Yang, Zhou, Yao, Su, & McWhinnie, 2009). The results of the present study extend these findings to

cognitive empathy specifically, confirming that a small positive relationship exists between inhibitory control and cognitive empathy.

Working memory. Finally, results of the present study point to an association between working memory abilities and cognitive empathy levels. Although there is little research to date on this relation, a systematic review investigating ToM found a positive correlation between working memory and ToM in two studies (Pineda-Alhucema et al., 2018). Similarly, results of the present study indicate a small positive relationship between cognitive empathy and working memory, suggesting that the ability to maintain and manipulate information regarding the perspective of another person in working memory is linked to the capacity to adopt that person's point of view (i.e., cognitive empathy). Furthermore, it appears that the importance of working memory extends beyond cognitive empathy to support the overall experience of empathy.

Based on the results of the first research question, children with ADHD have significantly lower levels of self-reported cognitive empathy when compared to TD children. Similarly, the second research question confirmed that children with ADHD perform lower than TD children on EF measures of inhibition, working memory, and attention. Finally, results from the third research question indicate a small positive relationship between attention, inhibitory control, and working memory with cognitive empathy across all participants. However, when the relation between empathy and EF was examined while controlling for ADHD, the correlations between cognitive and total empathy and attention, inhibitory control, and working memory were no longer significant. A follow-up comparison of the bivariate and partial correlations revealed that the differences were not significant, suggesting that ADHD is not driving the association between empathy and EF. With the exception of an ADHD diagnosis, children in the ADHD group and those in the TD group were more similar than different across the majority of

demographic variables collected (Table 1). Upon consideration of the above information, it seems that TD children have an advantage over children with ADHD in their expression of cognitive empathy that may be due to their stronger performance on EF measures, and unrelated to the presence of ADHD symptoms.

Limitations

Sample Limitations. While the current study contributes to the existing body of knowledge concerning empathy and ADHD, the results should be considered within the context of some limitations. In the present study several sample characteristics limited the findings. First, the relatively small sample size (N = 45) impacted the findings, as the statistical power of the analyses was limited. More specifically, a smaller sample size decreases the likelihood that a significant association will be found (Tabachnick & Fidell, 2013). Post hoc power analyses using the program *G*Power* revealed that the sample size was sufficient to detect effects with greater than 0.90 power, with the exception of cognitive and total empathy scores. Specifically, post hoc power analyses resulted in power values of 0.70 and 0.65, respectively. Therefore, a larger sample size is recommended to strengthen the findings of the present study.

The composition of the sample also limited the findings. The families that participated in the present study characterize a subgroup of the population with unique motivations to participate in research studies (i.e., potentially more educated, higher SES, etc.), and it is possible that these characteristics confounded between-group effect estimates. In addition, due to the small sample size, the varying presentations of ADHD were combined into one group, with the ADHD group including children with ADHD-HI, ADHD-I, and ADHD-C. Differences in empathetic functioning may exist between the three subtypes within ADHD, and previous research suggests that children with ADHD-C experience more severe impairments in social

functioning (Maoz et al., 2013). As the present study considered the three presentations as a whole, unique differences between the presentations may have confounded the results. Future research should consider the differences in empathic responding across the three presentations.

In addition, the current study included children with ADHD as well as a number of comorbid diagnoses, including learning disabilities, anxiety, and ODD. As the presence of comorbidities often augments the social difficulties experienced by children with ADHD (Wehmeier, Schacht, & Barkley, 2010), it is possible that the results of the present study could be better explained by the co-occurrence of an additional neurodevelopmental disorder. Although research investigating empathy and ADHD with an emphasis on comorbidity is limited, some studies have examined the influence of behaviour problems on empathy in children with ADHD. Marton and colleagues (2009) found that although children with ADHD did not report themselves to be less empathetic than their TD peers, the opposite pattern emerged in the reports of their parents. This discrepancy was explained by the presence of co-occurring oppositional and conduct problems in the ADHD group. These results suggest that the deficits in empathy may be related to conduct and oppositional problems rather than ADHD itself. As the present study did not take into account the influence of comorbidity on empathy in children with ADHD, which may have led to a biased understanding. To overcome this limitation, future studies may wish to investigate the contribution of comorbidities on empathy in children with ADHD. Finally, as the sample size was limited to 45 children the present study did not have the power to investigate potential sex differences in empathy in children with and without ADHD. Previous research suggests that girls may be more empathetic than boys (Marton et al., 2009), and it's possible that this tendency may have influenced the results of the present study. Future research should explore potential sex differences in empathy levels in children with ADHD.

Challenges of Measuring Empathy. The measurement of empathy is challenging for several reasons. First, a universal definition of empathy has yet to be established, and the lack of a consensus has affected measurement and interpretation (Dohrenwend, 2018). For example, some authors view empathy as cognitive, others as affective, and others as multidimensional (Dohrenwend, 2018). It is not yet known whether empathy is best measured as a unidimensional or multidimensional construct (Neumann et al., 2015). As previously mentioned, in a recent review, Cuff and colleagues (2016) evaluated current definitions of empathy and identified a total of 43 formal and informal conceptual definitions of empathy. In this same review, the authors identified eight themes common to the definition of empathy. For the purposes of the present study, the following definition was adopted, based on the eight themes: "empathy is an emotional response (affective), dependent upon the interaction between trait capacities and state influences. Empathic processes are automatically elicited but are also shaped by top-down control processes. The resulting emotion is similar to one's perception (directly experienced or imagined) and understanding (cognitive empathy) of the stimulus emotion, with recognition that the source of the emotion is not one's own" (Cuff et al., 2016, pp 7). However, due to the fact that the current body of knowledge regarding empathy has been established from the basis of distinct definitions of empathy, and that different empathy measures are based on different definitions of empathy, future research solidifying the definition of empathy and establishing reliable and valid means of measurement is critical.

Self-Report Challenges. Although the results of the present study suggest that children with ADHD may be aware of their own empathetic challenges, other possibilities should be considered. In addition to the previously mentioned challenges, the measurement of empathy is further complicated by response bias. Since being empathetic is typically considered a socially

desirable trait, self-report measures of empathy are disposed to presentation bias, as the measures are not objectively measuring empathy, but rather how empathetic children view themselves to be (Neumann et al., 2015). In addition, the self-reporting of empathy is inherently subjective. Findings regarding social-cognitive difficulties in children with ADHD are complicated by the tendency of these children to view themselves as *not* having social challenges (Barkley, 2014, pp 571). Previous studies suggest that, when compared to their TD peers, children with ADHD report higher levels of social skills (Hoza, Waschbuschm Pelham, Molina, & Milich, 2000) and perceive themselves to be equally liked by their peers (Hoza, Pelham, Dobbs, Owens, & Pillow, 2002); although the opposite pattern emerges in the reports of parents and teachers (Barkley, 2014, pp 571). It is not clear whether this *positive illusory bias* exists as a way to offset feelings of inadequacy, serving a self-protective function, as a result of impaired self-monitoring, or a combination of factors (Owen et al., 2007). In order to overcome some of these challenges, future studies investigating empathy in children with ADHD should include a social desirability scale and/or performance-based measures.

Challenges with the IRI. As the present study has adopted a multidimensional view of empathy, the IRI was selected to measure self-reported empathy. As previously mentioned, the IRI is the most commonly used psychometric tool in the measurement of empathy and has been adapted in recent years to measure a two-factor model of empathy, with a cognitive and an affective domain. Specifically, the Perspective Taking and Fantasy subscales have been combined into a cognitive empathy factor while the Empathic Concern and Personal Distress subscales form the affective empathy factor. However, a recent examination of the validity of this structure revealed poor model fit, suggesting that the two-factor model does not represent a valid measurement of cognitive and affective empathy (Chrysikou & Thompson, 2016). To

examine cognitive and affective empathy as separate elements, individual subscales were used. In line with previous studies that have used the IRI in ASD research (e.g., Bos & Stokes, 2018, Brouns et al., 2013, Rueda et al., 2015, Trimmer, McDonald, & Rushby, 2017), only two of the four subscales were selected for analysis of cognitive and affective empathy as separate constructs. Specifically, the Perspective Taking subscale was used to measure cognitive empathy, while the Empathic Concern subscale was used as an index of affective empathy. It is important to note that although it has yet to be determined whether the Perspective Taking and Empathic Concern subscales accurately measure cognitive and affective empathy (Chrysikou & Thompson, 2016), previous research supports the use of these subscales as indicators of cognitive and affective empathy (Cox et al., 2012). Despite the limitations associated with the IRI, it was selected for use in the present study as it remains the most widely used measure of empathy (Hall & Schwartz, 2019).

Implications

Children with ADHD frequently experience impairments in EF (Barkley, 2006) and social functioning (Staikova et al., 2013). Upon consideration of the long-term consequences associated with impaired peer functioning, the identification of possible underlying mechanisms associated with the social difficulties experienced by children with ADHD is critical (Kofler et al., 2011). Evidence from a recent study suggests that children with ADHD experience an impairment in empathy in primarily the cognitive domain (i.e., perspective taking; Maoz et al., 2017). The results of the present study parallel these findings. Specifically, in the present study children with ADHD reported significantly lower scores in cognitive empathy, suggesting that they have difficulty understanding the emotions and perspectives of others. However, as they did not differ significantly in their levels of affective empathy, the results of the present study

suggest that when they are given the necessary information to understand the perspective of another, their levels of affective empathy are comparable to their typically-developing counterparts. Although the results of the present study may be statistically significant, a consideration of the clinical relevance of the results is necessary. While the difference in cognitive empathy between children with ADHD and TD children was statistically significant, the effect size suggests that this difference is clinically meaningful as well. More specifically, the clinical importance of the difference in cognitive empathy may be manifested in differences in prosocial and helping behaviours. Well-developed empathy is associated with prosocial behaviour and positive relationships, and a recent meta-analysis suggests that empathy can be trained through intervention (Teding van Berkhout, & Malouff, 2016). In one study the use of role-playing was associated with increases in empathy (Goldstein & Winner, 2012). Results of the present study support the notion of a deficit in cognitive empathy and perspective-taking in children with ADHD, giving weight to the notion that role-playing may positively impact empathetic abilities. An additional study revealed gains in empathy as a result of a conversational intervention, which included dialogues on emotional understanding (Ornaghi, Brockmeier, & Grazzani, 2014). Again, the results of the present study suggest that by holding conversations around emotional understanding and providing the necessary information to understand the perspective of another, cognitive empathy is supported, facilitating adequate levels of affective empathy. Future research should continue to investigate the impairment in cognitive empathy in children with ADHD in order to better inform interventions supporting the improvement of peer relationships and social skills through the inclusion and development of empathy-induced prosocial behaviour. In addition, the knowledge that select EFs may be

associated with cognitive empathy may be used to guide intervention strategies to ensure success.

Part of the role of a school psychologist is to work with teachers and families to create supportive environments to foster social and emotional development in children. Understanding the relationship between social functioning impairments and related factors in children with ADHD could inform future intervention efforts and provide a better understanding of the social challenges experienced by these children. In line with a strengths-based approach, deeper knowledge of the connection between EF challenges and social problems will allow school psychologists to highlight and build upon the empathetic profile of children with ADHD in order to support their peer functioning.

Future Directions

The current study aimed to understand levels of empathy and EF (specifically attention, inhibition, and working memory) in children with and without ADHD. Although the results provide some information regarding empathy, EF, and their association, additional research is necessary to further develop the present body of knowledge. In particular, future studies employing a longitudinal design would contribute to the present understanding of the developmental trajectory of empathy in children with ADHD. For example, previous evidence suggests that, compared to the cognitive route, the affective route of empathy develops earlier and is unaltered by aging (Stietz, Jauk, Krach, & Kanske, 2019). A deeper understanding of the factors that influence the development of empathy could inform early intervention efforts, and lifespan developmental research is encouraged.

In addition, although it was not analyzed in the present study, future research should investigate the role of gender and its association with EF and empathy in children with ADHD.

Existing literature suggests that girls are more empathetic than boys, and this finding has been replicated in children with ADHD (Marton et al., 2009). Future research should explore potential sex differences in empathy levels in children with ADHD. Similarly, future studies may wish to investigate the contribution of comorbidities on empathy in children with ADHD. Finally, differences in empathy levels may exist between the three subtypes within ADHD, and previous research suggests that children with ADHD-C experience more severe impairments in social functioning (Maoz et al., 2013). As the present study considered the three presentations as a whole, unique differences between the presentations may have confounded the results. Future research should consider the differences in empathic responding across the three presentations.

As previously mentioned, a recent meta-analysis suggests that empathy can be trained through intervention (Teding van Berkhout, & Malouff, 2016). However, before empathy can be taught, it first needs a precise definition. At this point in time, a universal definition of empathy has yet to be established, and the lack of a consensus has negatively affected measurement and interpretation (Dohrenwend, 2018). Due to the fact that the current body of knowledge regarding empathy has been established from the basis of distinct definitions of empathy, and that different empathy measures are based on different definitions of empathy, future research solidifying the definition of empathy and establishing reliable and valid means of measurement is critical.

In order to overcome some of the challenges associated with self-report empathy scales, future studies investigating empathy in children with ADHD should include a social desirability scale. In addition, future investigations may be strengthened by the addition of multi-informant assessments, behavioural tasks, and/or the recording of physiological responses during experimental tasks designed to elicit empathy. While the results of the present study are strengthened by the use of both self- and parent-reports, the inclusion of performance-based

measures in future studies is recommended. Concerning EF, previous research suggests that rating and performance-based measures of EF may provide different information (Toplak, West, & Stanovich, 2013), and the inclusion of a performance-based measure of EF may enrich future investigations. Similarly, to address the aforementioned challenges associated with the measurement of affective empathy, future studies should include a performance-based measure of affective empathy. This information could contribute to a deeper understanding of the experience and expression of affective empathy in children with ADHD.

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APPENDIX A
Pre-Screener Questionnaire

Pre-screening Questionnaire (Administered over phone)

Thank you for your interest in the **Theory of Mind and ADHD study**. In order to determine whether your child is able to participate in this study, we have some questions for you now which will take approximately 5 minutes to complete. Is this a good time to complete our pre-screening questionnaire?

***ASSIGNED ID: _____ Sibling participant ID (if applicable): _____**

DATE BOOKED for session: _____

Name of researcher: ___ _____ Date of questionnaire: _____

Name of individual completing this questionnaire: _____

Where did you hear about us? _____

Relationship to child: _____

Phone Number: _____ E-mail address: _____

Child's full name: _____ Gender: _____

Child's date of birth: Age: _____

What are the living arrangements for this child? (e.g., lives with both parents, one parent)
If doesn't live with both parents, what is custody arrangement? _____
If joint custody, is other parent aware of this study? Will you be able to get a consent form signed by them as well? Y N

Child's primary language: _____
If English is not first language, is the child fluent in English? Yes No

Does your child have a diagnosis of ADHD? No
If so, do you know if a specific subtype was provided? _____
Who provided the diagnosis? Profession: _____

When was this diagnosis made? _____

Has your child received any other mental health or learning diagnoses? Yes No

If so, what other diagnosis does your child have or has had and when were they diagnosed?

_____

_____

_____

Has your child ever had a psychological assessment? yes no

If so, when was the last time an assessment was completed? _____ (date)

Are you planning on having your child undergo a psychological assessment? Yes No

If so, when (e.g., next 3 months)? _____

Does your child suffer from any of the following medical conditions:

Epilepsy:	Yes	No
Gross motor difficulties:	Yes	No
Major hearing or vision problems:	Yes	No
Autism Spectrum Disorder:	Yes	No

Is your child currently taking medication for attentional concerns? Yes No

If yes, what medication? _____

What dosage? _____

What is the medication schedule for your child (e.g., daily: in the morning and at night; daily: only in the morning and not on weekends)? _____

_____

********** **For office use only** **********

Based on these questions:

Does the child meet inclusionary criteria to participate in this study? Yes No

If so, in what group? ADHD Control

Is the child needed based on age, gender, or comorbidity needs at this time? Y / N

APPENDIX B
Demographic Questionnaire

Participant Questionnaire - parent

****** Please note: This page will be removed from the participant package and will not be kept with any other information******

Demographic Questionnaire

Today's date: _____

Your Name: _____ Relationship to child: _____

Child's Name: _____ Child's birth date: _____

Gender: Male Female

Current Grade: _____

Phone Number: _____ Email address: _____

Would you be willing to be contacted about opportunities for follow-up data collection? (please note that you would be provided with detailed information and have the opportunity to consent to any follow-up data collection prior to participation)

____ Yes, please contact me about future opportunities for follow-up participation

____ No, I would not like to be contacted about follow-up participation opportunities

FAMILY INFORMATION

Mother:

Biological Parent? Yes No Step-parent? Yes No

Age: _____ Occupation: _____

Highest level of education (please circle):

Graduate degree Undergraduate Degree College Diploma Some College/University

High School Diploma Some high school Less than high school

Other: _____

Father:

Biological Parent? Yes No Step-parent? Yes No

Age: _____ Occupation: _____

Highest level of education (please circle):

Graduate degree Undergraduate Degree College Diploma Some College/University

High School Diploma Some high school Less than high school

Other: _____

Ethnicity: With which group(s) listed below does your child most identify? (circle)

Caucasian Asian African American Aboriginal East Indian

Other: _____

Please identify which is most accurate for your child:

a) Lives with both parents in one home
b) Lives with one parent full-time
c) Lives primarily with one parent but sees other parent
   How often does he/she see other parent? _____
d) Other (please describe): _____

How long has this living arrangement been in place? _____

LANGUAGE

What language(s) do you speak at home? Please check all that apply.

_____ English
_____ French
_____ Other (please specify all others) _____

What language(s) is your child instructed at school? Do not count language classes (e.g., one French lesson per week). Please check all that apply.

_____ English
_____ French
_____ Other (please specify all others) _____

Would you consider your child to be fluently bilingual (trilingual etc)? YES NO
Is your child able to FLUENTLY:

	Speak	Understand	Read	Write
English				
French				
Other _____				
Other _____				

FAMILY HISTORY

Not including this child, has anyone in his/her immediate family (e.g., biological or step/adoptive-parents and siblings) experienced:

ADHD Yes No If yes, who?
_____

Learning Disability Yes No If yes, who?
_____

Depression Yes No If yes, who?
_____

Anxiety Yes No If yes, who?
_____

Oppositional Defiant Disorder or Conduct Disorder
Yes No If yes, who?
_____

Autism Spectrum Disorder Yes No If yes, who?
_____

Are there any other significant mental health problems within your immediate family? Yes No

If yes, please describe:

_____

CHILD PHYSICAL & MENTAL HEALTH HISTORY

Illnesses & Medications

Does your child currently suffer from any chronic medical conditions (e.g., asthma)? Yes No

If yes, please list: _____

Is your child currently on any regular medication? Yes No

(please describe, including name, dosage, frequency):

_____

If yes, for what purpose was this medication prescribed? _____

For how long have they been on this medication? _____

Mental Health

Has your child received an ADHD diagnosis? Yes No

If yes, when? _____

By whom? Pediatrician/family doctor Psychologist Psychiatrist Other: _____

Has your child received any other mental health or learning diagnoses (e.g., learning disability, anxiety, autism, oppositional defiant disorder)? Yes No

If yes, please list: _____ When? _____

By whom? Pediatrician/family doctor Psychologist Psychiatrist Other: _____

Has your ever child received a psychological/psychoeducational assessment? Yes No

If yes, when? _____

For what purpose?

_____

Has your child ever had psychological counseling or therapy? Yes No

If yes, when? _____

For what purpose?

_____

CURRENT FUNCTIONING

Does your child have a close and positive relationship with any non-parental adults? (e.g., grandparent, coach, teacher, etc.) Yes No

If yes, who? _____

Friendships

Are there children in your child's class with whom he/she plays? Yes No

Are there children in the neighbourhood with whom this child could play? Yes No

Does your child have a best friend? (do not include siblings) Yes No

About how many close friends does your child have? None 1 2-3 4+

Outside of school hours, about how many times a week does your child spend time with friends?

Less than 1 1-2 3+

Does your child report being teased by peers at school? Yes No

Has your child ever reported being bullied at school? Yes No

Do you believe your child bullies other children at school? Yes No

How well does this child:	Very Poorly	Poorly	Average	Well	Very Well	Not Applicable
Get along with other kids?						
Behave with his/her parents?						
Behave with his/her teacher?						
Get along with his/her siblings?						
Play alone?						

Complete chores alone?						
Complete school work alone?						

For each of the following, please rate the proportion of this child's peers that:

	Very few (less than 25%)	**Some** (between 25-50%)	**About half** (50%)	**Many** (between 50-75%)	**Almost all** (more than 75%)
Like or accept him/her					
Dislike or reject him/her					
Ignore him/her					

Recreation/Interests:

Does your child enjoy playing with other children? Yes No

Please list the activities your child most likes to take part in with others (e.g., soccer, video games, bike riding):

_____

Does your child enjoy playing alone? Yes No

Please list your child's favourite solitary hobbies and activities (e.g., musical instrument, crafts, video games, reading): _____

Please list any organizations, clubs, teams, or groups your child belongs to, and for each, please indicate if this is a group or individual activity:

_____ Group Individual

_____ Group Individual

_____ Group Individual

During the school year, approximately how many days per week are spent participating in extracurricular activities? None 1-2 3-4 5+

EDUCATION

What grade is your child currently enrolled in? _____

Has your child been retained a grade in school? Yes No

If yes, when & why? _____

Has your child skipped a grade in school? Yes No

If yes, when & why? _____

Has your child changed schools? Yes No

If yes, when & why? _____

Does your child currently have an Individual Program Plan in place at school? Yes No

Does your child currently receive any special education services at his/her school? Yes No

If yes, what type of services (e.g., academic, social-emotional)? _____

_____

Hours/week: _____

Does your child enjoy going to school? Mostly/Always Sometimes Rarely/Never

Please rate your child's current academic performance:

	Significantly Below Grade Level	Somewhat Below Grade Level	At Grade Level	Somewhat Above Grade Level	Significantly Above Grade Level
Math					
Reading					
Writing					
Social Studies					
Science					
Art					
Phys Ed					
Overall					

APPENDIX C
Recruitment Email Script

Email Script for Previous Participants

The following email script will be sent to previous participants to recruit interest participants:

You and your child previously participated in one of our research projects, thank you for your participation! We are currently working on another research project and were wondering if you would be interested in participating again. The purpose of our current research project is to examine the relationships between the theory of mind abilities, executive functioning, emotional intelligence and social skills of children with ADHD. This study has been approved by the University of Calgary Conjoint Faculties Research Ethics Board.

If you choose to participate in this research project and you are determined to be eligible based on a brief pre-screening questionnaire, which we can do over the phone, you and your son/daughter will visit the University of Calgary for one session of 2-3 hours. Within this session, your child will work one-on-one with a researcher to complete puzzle-based and problem-solving activities as well as several questionnaires. While the researcher is working with your child, you will be asked to complete a questionnaire that asks about your family and your child's history, as well as questionnaires that asks you about your child's behaviour.

It is expected that the information collected in this study will provide us with a better understanding of how theory of mind, emotional intelligence, social skills, and executive functioning are related in children with ADHD. An understanding of the relationships between each of these abilities can be beneficial with designing effective interventions that increase social relations and school engagement.

Participation in this study is completely voluntary and confidential. In exchange for your participation, your family will receive a $10 gift card as an acknowledgement of your time.

If you are interested in participating in this study or would like more information please contact us at:

(403) 210-6726, adhdkids@ucalgary.ca

APPENDIX D
Informed Consent Form

Study Coordinators:

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Supervisor:

Dr. Emma A. Climie, Werklund School of Education

Title of Project:

Theory of Mind and ADHD

Sponsor:

Carlson Family Research award in ADHD

This consent form, a copy of which has been given to you, is only part of the process of informed consent. If you want more details about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

The University of Calgary Conjoint Faculties Research Ethics Board has approved this research study.

Participation is completely voluntary, and confidential

Purpose of the Study

The purpose of this study is to examine the theory of mind abilities, executive functioning, emotional intelligence, social skills, and sleep habits of children with ADHD. Theory of mind is the ability to understand and explain the behaviours of others using their mental state (e.g., beliefs and desires). Executive functioning refers to higher order cognitive abilities, such as planning and organization. Emotional intelligence is the ability to be aware of and express one's emotions. Empathy refers to the ability to understand and share the feelings of others. Children with ADHD who have strong skills in these social cognitive areas will provide valuable insight relating to ways these skills may be fostered among those who are continuing to develop these abilities. An understanding of the relationships between each of these abilities can be beneficial with designing effective interventions that increase social relations and

school engagement. An understanding of the relationships between each of these abilities can be beneficial with designing effective interventions that increase social relations and school engagement.

What Will I Be Asked To Do?

The study will involve your son/daughter's completion of puzzle-based and problem-solving tasks as well as several questionnaires addressing their social skills and emotions. Your son/daughter will be encouraged to express their need for breaks throughout the study. You, the parent, will be given a demographics questionnaire relating to your child's medical history and family background. Parents will also be given several questionnaires that involve answering questions regarding their child's behavior.

Participation in the study is completely voluntary, and both the parent and adolescent may withdraw from the study at any time without penalty. Participants will still receive a $10 gift card as appreciation

What Type of Personal Information Will Be Collected?

Should you agree to participate, you will be asked to provide personal information including your and your child's gender, age, family history, your child's physical and mental health history, information on your child's primary/secondary language abilities, and information on your child's education/academic background. Given the personal nature of the information being collected, you may opt out of answering any question. Your contact information will be collected, and you will have the opportunity to indicate your interest in being contacted for participation in future studies with the Strengths in ADHD research group. Should you decide to provide your contact information, it will be kept separate and will be added to the participant pool for future studies.

Are there Risks or Benefits if I Participate?

There are no foreseeable physical risks to you or your child should you choose to participate in this study. Given that participation involves completion of questionnaires, puzzle-based, and problem-solving tasks, there is the possibility that your child may experience fatigue and/or minor emotional stress/worry if your child tends to get anxious during tests. The opportunity to take breaks will be provided throughout the study as needed.

As recognition for you and your child's time and efforts, a $10 gift card will be given to you as a token of appreciation. This gift card will be provided even if you choose to withdrawn from the study.

What Happens to the Information I Provide?

Participation in the study is completely voluntary and confidential. You are free to discontinue participation at any time during the study. Should you decide to withdraw participation from the study, any data collected will be destroyed and will not be used in any data analyses. Only the research study coordinators Christina Gray, Kelsey Friesen, Tessa Ritchie, and their supervisor Dr. Emma Climie will have access to the information collected through the study. To ensure confidentiality of your participation, an identification number will be assigned to your child and all study materials will be labelled with the assigned number. Only group information will be summarized for any presentation or publication of results. All questionnaires and study materials are kept in a locked cabinet in a locked lab

space. The anonymous data will be stored for 10 years on a password-protected computer, at which time, hard copies of data and the electronic datasets will be shredded and permanently erased.

Signatures

Your signature on this form indicates that 1) you understand to your satisfaction the information provided to you about your participation in this research project, and 2) you agree to participate in the research project.

In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You may opt out of answering any questions involved in the study. You are free to withdraw from this research project at any time. You should feel free to ask for clarification or new information throughout your participation.

I, the parent/guardian, consent to my participation in the present study:

Parent/Guardian Participant's Name: (please print) _____

Parent/Guardian Signature: _____ Date: _____

I, the parent/guardian consent to my child's participation in the present study:

Child Participant's Name: (please print) _____ Parent/Guardian Signature: _____

Date: _____

Researcher's Name: (please print) _____

Researcher's Signature: _____ Date: _____

Questions/Concerns

If you have any further questions or want clarification regarding this research and/or your participation, please contact the researchers at adhdkids@ucalgary.ca or Dr. Emma A. Climie eaclimie@ucalgary.ca 403.220.7770.

If you have any concerns about the way you've been treated as a participant, please contact the Research Ethics Analyst, Research Services Office, University of Calgary at (403) 220-6289/220-4283; email cfreb@ucalgary.ca. A copy of this consent form has been given to you to keep for your records and reference. The investigator has kept a copy of the consent form.

APPENDIX E
Verbal Assent Script

Child Participant Assent Form

Project Title: Theory of Mind in Children with ADHD
Principal Investigator: Dr. Emma A. Climie

We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about your thoughts and feelings, your experiences, social skills, and theory of mind. Theory of mind is an ability where you understand that others have different beliefs and ideas than your own. You are being asked to join the study because we want to figure out how you understand other's beliefs and ideas and how you get along with your friends. We are trying to understand this ability in children your age and older.

If you agree to join this study, you will be asked to complete a number of tasks with the researcher. These tasks include questionnaires and puzzle-like activities. Some of the questions will ask about your friendships, sleep, and emotions. There are no right or wrong answers for many of the questions, we just want to hear about your life and experiences. You will only be asked to do each task once during your visit today. In total, all of these tasks for the study should take between 2 to 3 hours. If your parents agree to participate, they will be sharing information about you and your family with us.
Some possible risks of participating include that you may feel tired after thinking and working on some of the more difficult puzzle-like tasks and some of the questionnaires may feel boring to complete. There will be opportunities to take breaks during your participation if you feel tired.
We expect that the study will help you by allowing you to reflect on your thoughts, feelings, and experiences. The puzzles-like tasks can be fun to do, and you may enjoy your participation in the study. We expect that through the study we may learn something that will help other children with ADHD with their social skills and friendships. Overall, this study will help us learn more about social skills and theory of mind in children your age with and without ADHD.

You do not have to join this study. It is up to you. You can say okay now. You can also say no. If you say okay and then you change your mind later. If you want to stop, then all you have to do is tell us you want to stop. No one will be mad at you if you don't want to be in the study or if you join the study and then change your mind later and stop.
Before you say yes or no to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell the researcher that you have a question.
We will also talk to your parents about this study. You can talk this over with them before you decide.

Would you like to be in this research study?

_____ Yes, I will be in this research study. _____ No, I don't want to do this.

_____	_____	_____
Child's name	Signature of the child	Date
_____	_____	_____
Researcher who received assent	Signature	Date

APPENDIX F

Debrief Form

Thank you for your participation in the Theory of Mind and ADHD study. The present study aims to examine the theory of mind abilities, executive functioning, emotional intelligence and social skills of children with ADHD. Theory of mind is the ability to understand and explain the behaviours of others using their mental state (e.g., beliefs and desires). Executive functioning refers to higher order cognitive abilities, such as planning and organization, and emotional intelligence is the ability to be aware of and express one's emotions. Empathy, or the ability to understand and share the feelings of others, is closely related to emotional intelligence. Sleep impacts a child's functioning in number of ways and has the potential to impact a child's social functioning. We are collecting data from participants with a diagnosis of ADHD and participants without a diagnosis of ADHD to compare theory of mind abilities, executive functioning, emotional intelligence, social skills, and sleep between groups.

Children with Attention-Deficit/Hyperactivity Disorder (ADHD) often face difficulties with executive functioning that impact their social interactions with others. These difficulties stem from challenges with emotion regulation and behaviours that may negatively impact peer interactions (e.g., hyperactivity/impulsivity leading to frequently interrupting peers; distractibility when playing and talking with peers). Despite these characteristic difficulties associated with ADHD, some children with ADHD have strong social skills and close peer relationships. Children with strong skills in these areas will provide valuable insight relating to ways these skills may be fostered among those who are continuing to develop these abilities. An understanding of the relationships between each of these abilities can be beneficial with designing effective interventions that increase social relations and school engagement.

Please feel free to contact the primary researchers, Christina Gray, at cgray@ucalgary.ca, Kelsey Friesen at kfriesen@ucalgary.ca, Tessa Ritchie at tessa.ritchie1@ucalgary.ca, or Dr. Emma Climie at eaclimie@ucalgary.ca if you have any questions regarding this study.