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Effect of Sleep Quality on Theory of Mind in Children with ADHD

by

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Abstract

The current study explored the relationship between sleep quality and Theory of Mind (ToM) in children with Attention-Deficit/Hyperactivity Disorder (ADHD). Children with ADHD often have reduced sleep quality and increased daytime sleepiness than their typically developing peers. ToM is a skill that entails gaining another person's perspective through an understanding of their mental state. Current research has suggested that ToM may explain some of the social difficulties for children with ADHD. A sample of 46 children between the ages of 8 and 12 years were included, 21 of which had a diagnosis of ADHD. The Reading the Mind in the Eyes test (Child version) was used to assess ToM and the Children's Sleep Habits Questionnaire was used to examine quality of sleep. Children with ADHD had significantly greater sleep disturbances than the control group. Additionally, children with ADHD had greater daytime sleepiness, greater disturbances of sleep duration and greater sleep anxiety. Contrary to what was hypothesized, the current study did not find any difference between children with ADHD and control children on the ability to identify emotions through reading facial expressions. In addition, no relationship was found between sleep quality and ToM. The higher levels of sleep disturbances in children with ADHD, call for increased intervention to help improve sleep quality in children with ADHD, and develop targeted sleep interventions specific for children with ADHD.

Keywords: Theory of Mind, Sleep, Attention-Deficit/Hyperactivity Disorder, Children

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List of Abbreviations

ADHD	Attention-Deficit/ Hyperactivity Disorder
CSHQ	Children's Sleep Habits Questionnaire
Conners 3-PRS	Conners, 3rd Edition Parent Report Short Form
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
EEG	Electroencephalogram
EF	Executive Functioning
IQ	Intellectual Quotient
Non-REM	Non-Rapid Eye Movement
PLM	Periodic Leg Movement
REM	Rapid Eye Movement
RLS	Restless Leg Syndrome
RME	Reading the Mind in the Eyes test (Child)
ToM	Theory of Mind
WASI-II	Wechsler Abbreviated Scale of Intelligence – Second Edition

Chapter 1: Introduction

Children spend approximately 40% of their childhood asleep (Meltzer & Mindell, 2006). Many parents can attest to the impact of poor sleep on their child's behaviour, reflected in the chaos of a child who has not had a restful night. Concerns that children are not getting enough sleep are commonplace in modern society, but more recently researchers have begun to quantitatively analyze both the short and long-term consequences of a child not getting enough sleep (Cortese, Faraone, Konofal, & Lecendreux, 2009). Poor sleep quality can negatively impact a child's development as well as their day to day functioning (Bériault, et al., 2018). Children with Attention-Deficit/ Hyperactivity Disorder (ADHD) are a group that are often reported as having sleep problems (Bériault et al., 2018). ADHD is a childhood-onset neurodevelopmental disorder characterized by symptoms of inattention and impulsivity/hyperactivity that interfere with functioning or development (APA, 2013). Children with ADHD have a harder time getting to bed, falling asleep, staying asleep and more difficulty getting up in the morning, resulting in greater daytime sleepiness (Cortese, et al., 2009). The full extent of the impact of sleep deprivation on children with ADHD's daytime functioning is still not fully understood.

One daytime activity that has been examined in children with ADHD, is the building of friendships (Simoni, 2016). Children with ADHD often have more difficulty with social skills and peer relations (Hughes & Leekam, 2004). The difficulties with social skills may be a reflection of their failure to adapt to the normative patterns of peer behaviour resulting in greater interpersonal conflict and rejection by peers. Current research has suggested that Theory of Mind (ToM), may partially explain some of the social difficulties for children with ADHD (Pineda-Alhucema, Aristizabal, Escudero-Cabarcas, Acosta-López, & Vélez, 2018). ToM is a social cognitive skill that entails gaining another person's perspective through an understanding of their

mental state (Hughes & Leekam, 2004; Korucu, Selcuk, & Harma, 2017). Previous research has identified that poor sleep is negatively associated with poor performance on ToM tasks and other Executive Functioning (EF) skills in typically developing children (Tesfaye, Brown, Drouin, & Gruber, 2017). As 50-80% of children with ADHD experience sleep difficulties (Eyuboglu & Eyuboglu, 2018), the current research seeks to identify if sleep quality has an impact on ToM performance in children with ADHD.

Chapter 2: Literature Review

Sleep

Sleep is essential for all humans, and sleep deprivation has been linked to a number of health risks (Schotland & Sockrider, 2017). Commonly, when children are not getting enough sleep, there can be visible impacts on their learning, behavior, and mood. In young children, who spend up to 40% of their childhoods asleep, there may be changes in behaviour and increased irritability (Schotland & Sockrider, 2017). Thus far, research has supported the significant impact that sleep has on both physical and mental health (Pilcher & Huffcutt, 1996).

Despite the significant impact sleep deprivation has on a child's behaviour, sleep research has only recently been extended to the pediatric domain. Sleep is a universal human experience that is essential to life, yet there is vast variability in individual quality and quantity of sleep. The focus of this paper will be on the impact of poor sleep quality, specifically in a population that commonly struggles with sleep: children with Attention Deficit/ Hyperactivity Disorder (ADHD).

Sleep structure. Prior to examining sleep disturbances, it is important to understand the concept of sleep. Sleep is a "naturally re-occurring state characterized by reduced or absent consciousness, relatively suspended activity, and inactivity of nearly all voluntary muscles" (Kovash, 2013, p. 4). Sleep has been related to physical, social, emotional, and behavioural wellbeing in children. In the literature, what is referred to as "sleep health" are the specific characteristics and qualities of sleep which result in a restful and restorative night's sleep (Matricciani, Paquet, Galland, Short, & Olds, 2019)

Throughout a person's sleep there are cyclical processes occurring to ensure that the body is resting and recovering adequately. The 24-hour process of cycling between awake and asleep is

often referred to as a person's circadian rhythm. The sleep portion of this cycle can be differentiated by two types of sleep and four distinct stages, each uniquely important to healthy sleep (Cortese et al., 2009).

There are two types of sleep that occur on rotation throughout the night. The first type of sleep is Rapid Eye Movement (REM) sleep and the second type is Non-Rapid Eye Movement (non-REM) sleep. REM sleep occurs when a person's eyes dart back and forth whilst the body remains fully relaxed and motionless. During this stage, brain waves are much more active than in non-REM sleep (Cortese et al., 2009). REM sleep is distinguished from the other types of sleep through its unique desynchronized brain activity, in which brain waves are mixed low voltage frequencies. In healthy adults, REM sleep accounts for approximately 25% of total sleep time and is vital to daytime activities, providing energy to the body and brain (Kovash, 2013). At the beginning of the night, REM sleep lasts between 1 to 5 minutes, and becomes progressively longer as the sleep episode progresses. REM sleep is also when dreaming occurs, responsible for approximately 80% of vivid dreams that are recalled following the sleep episode. REM sleep is considered important for enhancing one's memory (Crick & Mitchison, 1983).

Non-REM sleep accounts for the other 75% of total sleep time and can be separated into four distinct stages. Stage one is defined by the disappearance of electroencephalogram (EEG) alpha patterns (awake behaviour) and the formation of theta waveforms paired with slow rolling eye movement. Stage one is the stage between awake and asleep, or a light sleep where the muscles in the body relax and brain activity begins to slow (Kovash, 2013).

Stage two is considered the first true non-REM stage of sleep when a person falls asleep. Stage two is defined by low-frequency, high amplitude discharges (k complexes) on a background of theta waves. K complexes are specific bursts of rapid activity and serve as

protection for the brain from awakening from sleep. At this time a person's breathing and heart rate become regular and the body temperature begins to drop (Kovash, 2013). Stages three and four are characterized as slow-wave, high amplitude and low frequency delta waveforms. Stages three and four are the deepest and most restorative stage of sleep. At this time, a person's breathing and heart rate drop and muscles become more relaxed, allowing for increased blood supply. Various hormones are released during these stages, including growth hormone which is responsible for growth and development of muscular, skeletal and nervous systems (Cortese et al., 2009; Kovash, 2013). On average, children get through 4 to 5 complete sleep cycles per night; however, sleep disturbances can impact the number, quality, and duration of the sleep stages (Grissom, Brubaker, Capdevila, Hawley, & Gozal, 2009).

As a child gets older, the ratio between the macro-stages of sleep (specifically non-REM and REM) changes. As the quantity of REM sleep decreases, the sleep cycles lengthen, and children begin to require less sleep (Astill et al., 2012). The sleep cycle is a neurological mechanism that can have significant consequences when it is disturbed (Astill et al., 2012). Adequate sleep is necessary for growth and development as well as psychological wellbeing. A variety of sleep disturbances in initiation and maintenance of a healthy sleep cycle are associated with increased social, emotional, and behavioural problems as well compromised school performance and increased medical visits (Roberts, Harper, Bistricky, & Short, 2019).

Importance of sleep. As noted above, children and infants spend a significant portion of their life asleep (Pilcher & Huffcutt, 1996). The American Thoracic Society recommends that children 6 to 12 years of age get between 9 and 12 hours of sleep a night (Schotland & Sockrider, 2017). Despite this recommendation, research indicates that school age children on average are getting one to three hours less than the recommended amount of sleep per night (Colten &

Altevogt, 2006). O'Brien (2011) suggested that between 25 and 40% of American children and adolescents have inadequate sleep that impacts their daily functioning. Researchers agree that sleep is vital for daytime functioning and neurocognitive performance at all ages (e.g., Astill, et al., 2012). For typically developing children, high quality sleep is associated with improved cognitive efficiency and increases in Intellectual Quotient (IQ) (Bruni et al., 2012). Further, getting enough sleep has been associated with greater quality of life, memory, learning, attention and behaviour (Schotland, & Sockrider, 2017).

Sleep research is complicated by the variability in sleep quality and quantity, from person to person and night to night. Further, there are significant individual differences in a person's responses to sleep loss (Marcus, 2008). Despite the complications, researchers generally agree that high quality sleep is associated with positive mental and biological outcomes (Marcus, 2008). Sleep hygiene refers to the behavioural habits and practices surrounding sleep routines that promote good sleep quality (LeBourgeois et al., 2005). Good sleep hygiene enhances the likelihood of adequate sleep duration, and full daytime alertness. Examples of good sleep hygiene include sleeping alone in a quiet setting or having a bedtime routine. For children, healthy sleep hygiene has an even greater importance, as it is during the school aged years that development and growth of physiological and mental functions peaks. A lack of sufficient sleep for school-aged children is associated with learning difficulties, mood, and behaviour problems (Marcus, 2008).When examining children with a variety of health problems, professionals have also found that poor sleep mechanisms can trigger, or exacerbate many of their diagnostic symptoms (Marcus, 2008).

Sleep challenges. Children's sleep has been diminishing, with an average loss of approximately three-quarters of a minute per year over the last century, for a cumulative loss of

75 minutes per night (Matricciani, Blunden, Rigney, Willians, Olds, & 2013). Irregular cycling between REM and non-REM sleep is associated with various sleep disorders (Colten & Altevogt, 2006). Sleep issues arise not only because of a decreased in time spent sleeping, but also with changes in the microstructure of sleep. Microstructure refers to the number of arousals associated with sleep disturbance. (Bruni et al., 2012; Príhodová, Paclt, Kemlink, & Nevsímalová, 2012). Often the microstructure of sleep is examined using cyclic alternating pattern (CAP) which is done with EEGs (Bruni et al., 2012). CAP measures arousal complexes (e.g., caused by night wakings or increased movement) that interrupt the theta and delta activities associated with non-REM. By measuring sleep disturbances subjectively researchers can thus infer the impact the disturbances have on the microstructure of sleep Greater inconsistencies within the microstructure of sleep, paired with increased arousal, have been associated with lowered sleep quality (Miano et al., 2019; Príhodová, et al., 2012).

Specific definitions of what qualifies as a sleep disturbance varies among studies. A sleep disturbance is an overarching term that includes difficulties initiating and maintaining sleep as well as disruption to the sleep-wake cycles (circadian rhythm), of sleep and sleep stages (Cortese et al., 2009). As well sleep disturbances include parasomnias which are partial awakenings during sleep caused by abnormal movements, behaviours, emotions, perceptions and dreams that occur throughout the sleep cycle (Kryger, Roth, & Dement, 2017).

There are eight specific types of sleep disturbances that are frequently examined in sleep quality research. Included in the eight types of sleep disturbances, are both behaviorally based sleep disturbances (e.g., changing beds during the night) as well as medical disturbances (e.g., obstructive sleep apnea). These eight subtypes include: bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night awakenings, parasomnias, sleep disordered breathing, and

daytime sleepiness (Cortese et al., 2009). The eight subtypes detailed below parallel the *International Classification for Sleep Disorders (ICSD;* American Academy of Sleep Medicine, 1990) that delineate the most common sleep disorders for children. The sleep disorders paralleled in the subtypes of sleep disturbances include two types of sleep disorders. The first are dyssomnias (intrinsic and extrinsic sleep disorders) which are represented through bedtime resistance, sleep onset delay, sleep duration, sleep anxiety and night wakings. The second type of disorder are parasomnias which are reflected in the sleep disordered breathing. Finally, the daytime sleepiness subtype is intended to reflect the consequences of the disorders listed above.

Although sleep disturbances are not intended to directly reflect the sleep disorders listed in the ICSD, for the purpose of statistics of prevalence, sex ratio and age of onset, the convention is that statistics for the sleep disorders themselves are reported (Owens, Spirito, & McGuinn, 2000). Dyssomnia is another term for sleep disorder, that can either produce insomnia (not enough sleep) or excessive sleepiness. (American Academy of Sleep Medicine, 1990). Dyssomnias either be intrinsic or extrinsic. Intrinsic dyssomnias, indicate that disorder originates from causes within the body's sleep-wake cycle. Extrinsic dyssomnias reflect that the sleep disorder originates from causes outside the body (e.g., needing to sleep in a bed with a parent). Parasomnias are disorders that intrude the sleep process but do not originate from the sleep-wake cycle (e.g., sleep walking; American Academy of Sleep Medicine, 1990).

Bedtime resistance. Bedtime resistance is defined as bedtime delay through behaviours such as refusal and stalling. Symptoms of bedtime resistance are often reported by parents as inconsistent bedtimes, difficulty sleeping alone, requiring a parent in the room to fall asleep or falling asleep in a parent or sibling's bed (Wilson, et al., 2015). Bedtime resistance is consistent with the ICSD identification of Sleep Onset Association Disorder. Sleep Onset Association

Disorder is an extrinsic dyssomnia that is mainly a disorder of childhood and includes difficulty with transitions to sleep, both at bedtime and after nighttime wakings. Prevalence is between estimated at 15% to 20% between the ages of 6 months and three years and decreases significantly after this time age. Gender differences indicate an increased incidence in males; however, studies vary with some suggesting no sex difference (American Academy of Sleep Medicine, 1990).

Sleep onset delay. Difficulty falling asleep is often reported as a sleep onset delay. Typically, children fall asleep within 20 minutes of going to bed, and anything longer, is considered to constitute a sleep onset delay, regardless of the etiology (Owens et al., 2000). Sleep onset delay is associated with a variety of conditions within the ICSD.

Night wakings. Night wakings refer to children getting up during the night. Most often, the quantity of night wakings as well as their duration are measured to analyze the degree of disruption night wakings have on a child's sleep. Night wakings also occur when children move to another person's bed (most often the parent) disrupting not only the child's sleep cycle, but also the parents' sleep (Owens et al., 2000). Night wakings symptomology also parallels the Sleep Onset Association Disorder similar to bedtime resistance in the ICSD (American Academy of Sleep Medicine, 1990).

Sleep duration. Sleep duration refers to the number of hours a child is sleeping, compared to the recommended amount. In addition, sleep duration examines the consistency between nights as well as whether parents feel their children are sleeping too little (Owens et al., 2000). Although the recommended amount of 9 to 12 hours is developmentally appropriate, each child is unique and subjective reports help account for the individuality of a child's sleep needs (Owens et al., 2000). Sleep duration is typically a reflection of adequate sleep hygiene and can be impacted by a

multitude of sleep disorders. In the ICSD, sleep duration follows similar symptomology of the Insufficient Sleep Syndrome, which -is an extrinsic dyssomnia. Insufficient Sleep Syndrome is characterized by frequent stalling or refusing to go to bed at an appropriate time. Often mild fears are associated with the disorder which when not addressed effectively, can extend the bedtime routine. Typically, prevalence in childhood is between 10% and 15% and begins once children are able to voice verbal demands; it decreases once children strive for greater independence. There are no known sex differences for the Insufficient Sleep Syndrome Disorder (American Academy of Sleep Medicine, 1990).

Sleep anxiety. Sleep anxiety refers to any anxiety's that is associated with sleep including fear of the dark, fear of sleeping alone, and difficulty sleeping away from home (Owens et al., 2000). Previous studies have found a high correlation between sleep anxiety and daytime sleepiness. Sleep anxiety is related to Adjustment Sleep Disorder, an extrinsic dyssomnia from the ICSD which refers to any sleep disturbance related to acute stress, conflict, or environmental change that results in emotional arousal. Children with this disorder are likely to present with insomnia. Epidemiologic studies suggest that up to one third of all adults will experience episodes of Adjustment Sleep Disorder each year. Prevalence and gender differences for Adjustment Sleep Disorder in children are not well established and thus preclude the drawing of any definitive conclusions (American Academy of Sleep Medicine, 1990).

Parasomnias. Parasomnias are defined as undesirable physical events or experiences that occur during sleep (Wilson et al., 2015). Examples of parasomnias include sleep walking, talking, restless movements, night terrors, and teeth grinding (Owens et al., 2000). Parasomnia's intrude upon the sleep process but are not directly disruptive of the sleep and wake states. Rather, parasomnias are undesired physical phenomena that occur primarily during sleep. Types of

parasomnia sleep disorders include confusional arousals, sleepwalking and sleep terrors (Owens, et al., 2000). Prevalence of confusional arousals (slow speech that is disoriented in space and time) is common in nearly every child under the age of five years and decreases with age. Prevalence of sleep walking is between 1% and 5% of the general population and occurs equally in each gender. Night terrors occurs more frequently in males than females and impacts approximately 3% of children (American Academy of Sleep Medicine, 1990). Sleep talking is also very common in childhood; however, it rarely creates a significant disturbance for others. If sleep talking does cause disruption for the sleeper, it commonly occurs in association with other sleep disorders such as sleep apnea syndrome; sleep talking is more common in males (American Academy of Sleep Medicine, 1990).

Sleep disordered breathing. Sleep disordered breathing ranges from snoring to snorts and gasps throughout the night to obstructive sleep apnea. Obstructive sleep apnea, an intrinsic dyssomnia, occurs when a child periodically stops breathing throughout the night due to their airway collapsing during sleep. During this time there is a lack of oxygen that causes the brain to wake up in order to tighten the airway muscles and restore waking levels of air intake. Consequently, sleep is continually interrupted over the course of the night. Although sleep disordered breathing is sometimes reported by parents, most often sleep studies or polysomnographic recordings are responsible for discovering such conditions (Wilson et al., 2015). Although sleep disordered breathing can occur during childhood, the most common age for treatment of the disorder is between the ages of 40 and 60 years. The life-long prevalence of obstructive sleep apnea is 4% for men and 2% for women (American Academy of Sleep Medicine, 1990).

Daytime sleepiness. Daytime sleepiness is often apparent in a child falling asleep during

inappropriate situations such as watching television, sitting in class, riding in a car, or even while talking to someone (Schotland & Sockrider, 2017). Further indications of daytime sleepiness can include difficulty getting out of bed in the morning, taking a long time to become alert as well as a negative mood first thing in the morning (Owens et al., 2000).

Impact of sleep disturbances. Current research looking at the impact of sleep loss and lowered sleep quality through neuroimaging studies suggests that some aspects of cognition may be more susceptible to the effects of sleep loss than others. Specifically, Killgore (2010) suggests that the more a cognitive process relies on emotion-processing networks (higher level thinking with emotional processing), the greater the impact sleep deprivation has on functioning. Due to the severity of the consequences of sleep loss, there is a significant amount of research dedicated to the impact of sleep loss on performance tasks for adults (e.g., driving). Despite the growing interest in the impact of sleep disturbance, including with children, the underlying mechanisms to connect the performance tasks to the responsible cognitive domains is still poorly understood (Jackson et al., 2013).

Jackson and colleagues (2013) determined that degraded attention may be responsible for a decline in working memory following sleep deprivation. In addition, a study that examined the effects of sleep deprivation on emotional regulation in healthy adults found that sleep deprivation correlates with reductions in positive emotionality and affect as well as increased negative emotions (Danielsson, MacDonald, Jansson-Frojmark, Linton, & Harvery, 2011). Therefore, there appear to be demonstrable consequences that sleep deprivation has an impact on daytime behaviour and specifically, attention and emotional control in typically functioning individuals. For example, social cognition may be one aspect of functioning that may be impacted by sleep.

Social Cognition

Social cognition is the ability to understand the mind of another person and is critical to successful social interactions (Uekermann, et al., 2010). Social cognition is a broad overarching term which refers to the underlying cognitive processes necessary for successful social interactions (Miranda, Berenguer, Rosello, Baixauli, & Colomer, 2017). Social cognition includes the ability to interpret social cues, body language, and prosody as well as the skill of perspective-taking, empathy and humour processing (Uekermann, et al., 2010).

Social information processing can be broken down into a series of steps through Dodge's social information-processing model first created in 1986. Initially, Dodge's model outlined four processing steps that are integral to social problem-solving, but has since distinguished six processing steps: (a) encoding of cues; (b) interpretation of cues; (c) clarification of goals; (d) response access or construction; (e) response decision; and (f) behavioural enactment (Crick & Dodge, 1994). The first two skills (encoding and interpretation) are those encompassed in social cognition and can be highly influenced by cognitive biases. An example of a social cognitive bias may be the false assumption of aggression or hostility attributed to a neutral comment, resulting in social problems (Crick & Dodge, 1994; Hutchins, Prelock, Morris, Benner, LaVigne, & Hoza, 2016; Ukermann, et al., 2010). Specifically, theory of mind (ToM) is one of the psychological processes that is represented by this broad construct and which focuses on the encoding and interpretation of cues (Crick & Dodge, 1994; Miranda et al., 2017).

Crick and Dodge's (1994) social information-processing model has been previously used not only to explain social problems, but more specifically social problems in children with ADHD. The social information-processing model will be discussed specifically in relation to ToM, as well as with respect to social problem solving in children with ADHD.

Theory of mind. There are several social-cognitive abilities that have a lasting influence on a child's long-term development and functioning within social relationships. ToM is the cognitive skill of being able to understand the beliefs, desires, thoughts and intentions of others (Korucu, Selcuk, & Harma, 2017). Further ToM can be used to predict or explain behaviour (Hutchins et al., 2016).

There are two primary types of ToM: Cognitive and Affective. Cognitive ToM refers to the ability to make inferences about other' beliefs, motivations, and thoughts. An example of cognitive ToM is a child trying to understand what a friend is thinking when they see a certain result on their test. The child might look at their face to gain clues about what the person may be thinking or imagine how they would react if they were given a similar grade. Affective ToM is the ability to infer what an individual is feeling (Kalbe et al., 2010). An example of affective is the child is trying to understand what a friend is feeling when they see a certain result on their test. The child now might again look at their face and try and how to imagine how they would be feeling if they had received a similar grade. Both aspects of ToM facilitate the ability to understand, explain, and predict others' behaviour (Demers & Koven, 2015). Affective ToM requires a more in depth understanding of emotions and their displays in human behaviour (Demers & Koven, 2015). Researchers have designed more ToM measures for children focusing on affective ToM than cognitive ToM, as being able to take perspective on each other's emotions is thought to be a more valid representation of the skill required for successful social interactions (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). It is important to note, however, that just as in the example of a child taking perspective of a friend reacting to their test, ToM frequently requires both cognitive and affective components at the same time.

The development of ToM is a normal part of social cognitive development that begins

between the ages of two and six years and continues to develop throughout early childhood and adolescence (McAlister & Peterson, 2013). ToM can be demonstrated in a laboratory setting through a false belief task: In these tasks children make the transition from identifying what an object actually is to what another individual might think that object is, requiring the understanding of their knowledge of the other person's individual mental state as different from their own (Doenyas, Yavuz, & Selcuk, 2018).

An example of a false belief task would be asking a child to watch a boy and a girl playing in a room. While the child is watching the children play, he or she is asked questions about the perspectives of the boy and the girl in question. For example, the boy who is playing goes to leave the room and he puts his toy in the drawer, but once he's out of the room the girl moves the toy into a second hiding spot. When the boy returns and wants his toy, the child watching is asked "where will the boy look for his toy". Most two- or three-year old's will fail false belief tasks, pointing to where the toy currently is (using his or her own personal perspective) but by the age of five years, most typically developing children are able to successfully complete these tasks and will point to where the boy thinks his toy is located (McAlister & Peterson, 2013). This task is an example of first order understanding of ToM, or an early developing form of ToM (Arslan, Taatgen, & Verbrugge, 2017).

Although historically false-belief tasks were the method of demonstrating the development of ToM, it has since been criticized, noting that children who are able to demonstrate the conceptual theory of ToM in a laboratory setting while watching as a third party may not yet be competent in applying this skill in a social context (Wellman, 2014). Therefore, ToM as a functional skill has been broken down into the stages of ToM development to explain the discrepancy between demonstrating a knowledge of perspective and applying perspective-

taking within social situations.

The ability to apply perspective-taking in social situations continues to develop as children have an increasing number of interactions with their peers (Doenyas et al., 2018). A first order ToM question asking where the boy will look for the toy, entails a question that requires the child to create a response taking into account one perspective (i.e., I think that you think…). First order ToM appears around four years of age in typically developing children.

Second order ToM understanding is the ability to understand what a person feels or believes regarding another person's feelings or beliefs (Lonigro, Baiocco, Baumgartner, & Laghi, 2017). Second order ToM understanding is a more advanced and complex skill which requires the child to successfully understand and reason through a complex social situation (Lapan & Boseovski, 2016). Given the previous example, a test of second order understanding would add that as the girl is hiding the toy, the boy walks by and sees her changing the location and the girl does not notice the boy walking by. Therefore, the girl has false belief about the boy's belief about the location of the toy. The child would then be asked where does the girl think that the boy will look for the toy? If children possess second order understanding, they would be able to state that the girl falsely thinks that the boy will look for the toy in the drawer. A second order ToM question asks where the girl thinks that the boy is going to look for the toy, requiring the child to take two perspectives into account when responding (i.e., I think that you think that she/he thinks…). Second order ToM is evident around eight years of age in typically developing children (Arslan et al., 2017).

Finally, third order ToM understanding increases the complexity of perspective-taking to 'I think that you think that he/she thinks that another person thinks…'. Third order ToM continues to develop from adolescence into later adulthood. An example of a third order question,

referencing the previous story would be “the boy thought that the girl thought that he, the boy, wanted the toy when the girl discovered what another girl wanted to do because the boy wanted to play alone with the toy with the girl” (Valle, Massaro, Castelli, & Marchetti, 2015).

These examples focus primarily on cognitive perspective-taking, focusing on thoughts and motivations. However, the same first, second, and third order ToM can be applied with affective ToM. In affective ToM rather than “I think that you think”, a question is targeted towards feelings and emotions requiring a response of “I think that you feel”. Measures designed to evaluated affective ToM are often used for assessing the development of ToM in children, however distinguishing the higher order of ToM (i.e. second and third order ToM) becomes more challenging (Baron-Cohen, et al., 2001). As can be seen through the early examples of cognitive ToM, both affective and cognitive ToM are closely tied together as rarely are thoughts and desires not influenced by emotions. A child looking for his or her toy might also experience emotions such as frustration, confusion, and sadness. Many false-belief tasks ask not only about what individuals may be thinking, but additionally what they may be feeling. Affective ToM requires the emotional vocabulary and knowledge to be able to interpret perspective-taking appropriately (Baron-Cohen, et al., 2001).

The early development of ToM is highly influenced by social settings. This skill can be seen as children begin to refer to their own mental states (their own thoughts, feelings etc.) within a social context (e.g., “I feel sad because someone took my toy”; Barreto, Osorio, Baptista, Fearon, & Martins, 2016). Once children enter school and begin regular interactions with a peer group, they are given more opportunities to learn and practice the integration of ToM within a social setting on a day-to-day basis. These early schooling experiences aid children in adapting to new social situations and understanding the perspective of others, directly utilizing their

developing ToM skills. Children with less developed ToM have difficulty navigating social situations, which may have long-term implications for their ability to positively integrate into their social and academic settings (O'Toole, Monks, & Tsermentseli, 2017). Although the opportunity for social interactions in early school tends to facilitate improvement in a child's social skills, this critical period in social development is heavily reliant on the development of social cognitive skills such as ToM. Children who do not develop the social cognitive skills at the same rate as their peers, may have negative social experiences in the early elementary years (McAlister and Peterson, 2013).

Theory of mind and executive functions. When examining the foundational development of ToM, there are major changes in the growth of social understanding in preschool children. Researchers have found a correlation between the development of socially appropriate behaviours and cognitive abilities (O'Toole, et al., 2017). These cognitive abilities include not only ToM but also Executive Functions (EF), which are also maturing during this same period of development (Korucu, Selcuk, Harma, 2017).

EFs are skills of higher order cognitive control which are required for goal-directed behaviour (O'Toole et al., 2017). It is the ability to control one's cognition, attention and behaviour through cognitive flexibility, shifting and entails skills such as inhibitory control and working memory (Diamond, 2013). There are several components to EF, but generally there are three broader components that are defined. The first component is working memory, which refers to the ability to monitor and update information in one's mind while carrying out another task (O'Toole et al., 2017). The second component is inhibition which is the ability to engage in an appropriate response by deliberately resisting a prepotent response (Hummer et al., 2010). The third component is cognitive flexibility. Cognitive flexibility is the ability to modify or shift

thought processes in response to a change in demands or goals (Hummer et al., 2010; Miyake et al., 2000) or the ability to simultaneously think about multiple things (Cartwright, 2002).

EF has been identified as having a strong to moderate correlation with ToM skills (Devine & Hughes 2014; O'Toole et al. 2017). The relationship between ToM and EF is bi-directional in nature; however, there has been found to be a stronger relationship between early EF development predicting subsequent ToM development (Doenyas, et al., 2018; Korucu et al., 2017). This relationship between EF and ToM suggests that for children to understand mental states and perspective-taking, they must be able to demonstrate higher order cognitive control in mental set shifting, and the maintenance and manipulation of information (Korucu et al., 2017).

The developmental progress of social cognitive skills becomes very apparent within a social context. ToM is related to social competence (Korucu, et al., 2017) as children are able to interpret and predict the behaviour of others as well as be able to consider the beliefs and desires of others as different than their own. Further, more advanced ToM skills are related to greater social competence and prosocial behaviour. This relationship between social skills and ToM can be explained through the development and coordination of perspective-taking and the ability to understand and predict others' thoughts and feelings in a social setting (Barreto et al., 2016).

The development of ToM and EF is associated with an increase in cognitive control, and self-monitoring actions can help increase the insight into other people's intentions and behaviours. ToM is a necessary skill for children to integrate successfully into social groups, as well as navigate social situations and ToM is a positive predictor of socializing skills (Tesfaye & Greuber, 2017). The ability to navigate social interactions facilitates the development of appropriate behaviours (Tesfaye & Greuber, 2017) which contributes to positive peer relationships, and academic success. Further, social interactions play a significant role in the

development of ToM, indicating a directional relationship between ToM and social competence (Bosacki, 2015). Such findings suggest that children who lack ToM skills are less able to form meaningful peer relations and may fall further behind in terms of social competence. One group who may exhibit challenges in this area are those with Attention-Deficit/Hyperactivity Disorder.

Attention-Deficit/Hyperactivity Disorder

Attention-Deficit/Hyperactivity Disorder (ADHD) is a childhood-onset neurodevelopmental disorder characterized by symptoms of inattention and impulsivity and/or hyperactivity that interfere with functioning or development (APA, 2013). According to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5; APA, 2013), ADHD has a prevalence of approximately 5% in school-aged children, making it one of the most common psychological disorders in childhood, with these problems often persisting into adulthood (American Psychological Association, 2013; Thapar & Cooper, 2015).

Diagnostic criteria. The initial signs of ADHD are often noted by parents when the child is a toddler. Often, the first symptoms can include displays of excessive motor activity. However, it is often challenging to distinguish hyperactive symptoms from typical development until early school years. ADHD begins in childhood and symptoms must be present before the age of 12 years for a clinical diagnosis. Specific symptoms that are characteristic to the disorder include inattention, hyperactivity, and impulsivity. *Inattention,* is characterized by frequently being off task and difficulty remaining focused, and becomes more impairing and noticeable by teachers and parents alike in the early schooling years (American Psychological Association, 2013). There are nine inattentive symptoms listed for ADHD including: (a) often fails to give close attention to detail; (b) often has difficulty sustaining attention; (c) often does not listen when spoken to directly; (d) often does not follow through on instructions and fails to finish schoolwork; (e) often

has difficulty organising tasks and activities; (f) often avoids or is reluctant to engage in tasks that require sustained mental effort; (g) often loses things; (h) is easily distracted; and (i) is often forgetful. *Hyperactivity,* which refers to excessive motor activity when not appropriate, can appear as excessive fidgeting, tapping or talking. *Impulsivity* refers to acting without thinking. There are nine noted hyperactivity/impulsivity symptoms: (a) often fidgets or taps, or squirms in seat; (b) often leaves seat when inappropriate; (c) often runs and climbs when inappropriate; (d) often unable to engage in activities quietly; (e) often "on the go" or "driven by a motor"; (f) often talks excessively; (g) often blurts out answer before question has been completed; (h) often has difficulty waiting turn; and (i) often interrupts (American Psychological Association, 2013).

There are three classifications of ADHD. The first presentation is *Inattentive*, where greater than six symptoms of inattention are present but fewer than six hyperactive/impulsive are present. The second presentation is *Hyperactive/Impulsive* requiring greater than six symptoms of hyperactive/ impulsive but fewer than six inattentive symptoms. The third classification is *Combined* presentation, in which six or more symptoms of both inattention and hyperactivity/impulsivity are present for a time period greater than six months. Symptoms must be present in more than one setting, such as both home and school; however, there is acknowledgment that context can influence how and which symptoms are being displayed (American Psychological Association, 2013).

The DSM-5 stipulates that a child must have at least six or more symptoms of inattention and/or hyperactivity/impulsivity present for at least six months to receive a diagnosis. In addition, the impairment must be to a degree that is not in line with developmental age and has a significant negative impact on social and academic or occupational activities. For individuals over the age of 17 years, the criteria for ADHD decreases to requiring five or more of the listed

symptoms (American Psychological Association, 2013).

Epidemiology. Several studies have examined the trends of ADHD rates in the population over time, and although there has been a steady increase in the rates of clinically diagnosed and treated ADHD, the rates of symptoms have been stable across time between 2004 and 2014 (Rydell et al., 2018). From an epidemiological perspective, ADHD is more frequent in boys than girls with a ratio of approximately 2:1 in children (American Psychological Association, 2013). Comorbidity with other disorders is also prevalent, with Oppositional Defiant Disorder, Conduct Disorder, Specific Learning Disorder, and Autism Spectrum Disorder being the most common. For girls, ADHD is often associated with more symptoms of inattention and internalizing symptoms while boys tend to present with more hyperactivity and externalizing symptoms (Rydell et al., 2018). The comorbid disorders are also more commonly internalizing (depression and anxiety) for girls whereas boys are more often diagnosed with comorbid disruptive disorders (Kok, Groen, Fuermaier, & Tucha, 2016).

Besides the core symptoms presented in the DSM-5. children with ADHD also display a range of cognitive, academic and EF deficits (APA, 2013). A meta-analysis of intellectual and neuropsychological performance in children with ADHD revealed that children perform significantly lower on intelligence tests when compared to a control group and that up to 80% of children with ADHD also have comorbid academic difficulties (Bridgett & Walker, 2006; Frazier, et al, 2004). The relatively low cognitive and academic results may not be a true reflection of children with ADHD's intelligence; rather, it may be an indication of how attention impacts testing and may result in underestimated functioning. A second study, examining the developmental progression of academic functioning, revealed that more than 20% of the children showed a relative decline in their standardized reading, spelling and arithmetic scores with 50%

displaying relative decline in one of the three areas. The researchers who published these data emphasized the importance of considering the individual trajectories of students when examining the developmental trajectories of children with ADHD (Murray, Robinson, & Tripp, 2017).

Theoretical foundations of ADHD. As noted above, ADHD is characterized by developmentally inappropriate levels of impulse control, attention and motor activities, all of which can be associated with deficient executive control (Ziegler, Pedersen, Mowinckel, & Biele, 2016). The subdomains of EF include working memory, inhibition and cognitive flexibility all of which have been identified as being potential areas of deficit in children with ADHD. Murray and colleagues (2017) examined EF in children with and without ADHD over a four-year period and found. Consistencies across development where children with ADHD's EF were either stable or improving over time, nevertheless remaining significantly behind their typically developing same-aged peers.

Evidence of deficits in EF can appear as difficulty with social appropriateness, making adaptive choices, motivation, initiation and sustained attention (Suchy, 2009). Researchers who are proponents for the Executive Functioning Theory of Attention Deficit/Hyperactivity Disorder suggest that the symptoms of ADHD are the result of primary deficits in the EF processes. A meta-analytic review of this theory suggests that executive dysfunction plays an important role of the neuropsychology of ADHD. Specifically, medium effect sizes were found on measures of response inhibition, vigilance, spatial working memory, and planning vis a vis ADHD symptomology. Despite this apparent relationship, the weaknesses in EF are neither sufficient nor necessary to account for all symptoms of ADHD (Willcutt et al., 2005). The deficits in EF remain relevant, however, particularly when examining the social deficits of children with ADHD.

ADHD and Social Cognition

For children with ADHD, there is thought to be deficient processing at each stage of the model of social information processing created by Dodge (1986). Specifically, with regard to the first two processing steps; encoding and interpretation of cues, children with ADHD who are often lacking the social cognitive skills such as perspective-taking, may display deficits in their ability to successful encoding and interpreting of social cues (Ukermann, et al., 2010).

Within Crick and Dodge's six step model (1994), the deficits in EF which have been presented above can be attributed to some of the social cognitive deficits seen in ADHD. The EF deficits present in those with ADHD impedes multiple steps of the social information processing model. Children with ADHD are at risk of misinterpreting social cues, and in turn have difficulty responding appropriately (Hutchins, Prelock, Morris, Benner, LaVigne, & Hoza, 2016). The ability to attend appropriately is also impacted in children with ADHD which is used in social situations to detect subtle features of social stimuli (encoding of cues). Further, appropriate inhibition needs to be directed to relevant rather than irrelevant information (response decision). The lack of appropriate attention that is characteristic of ADHD is associated with reduced accuracy, efficiency, and less complexity in the processing of social information (Crick & Dodge, 1994; Hutchins et al., 2016). A typically developing child will grow to develop ways of representing, organizing, and interpreting social information and social knowledge whereas one with ADHD will likely continue to struggle within these domains. It is hypothesized that this breakdown occurs as a result of EF deficits (Hutchins et al., 2016).

Aside from generalized social deficits, research continues to examine where the breakdown in social cognition occurs for children with ADHD, and which part of encoding and perception precisely is responsible. Current research has suggested that deficits in ToM may

partially explain these social skill deficits in children with ADHD (Feigenbaum, 2017).

ADHD and social challenges. The majority (52% to 82%) of children with ADHD have been found to struggle in social environments (Huang-Pollock, Mikami, Pfiffner, & McBurnett, 2009). Social impairments have been recognized by parents, teachers, and peers as early as the preschool years. Furthermore, children with ADHD are reported to have fewer reciprocal friendships than their typically developing peers (Mrug, et al., 2012). Despite increases in ADHD research, the developmental mechanisms responsible for the impairments in social functioning continue to be poorly understood (Staikova, Gomes, Tartter, McCabe, & Halperin, 2013).

There is some speculation that the long term consequences of peer rejection may include substance abuse, school dropout, delinquency, and academic problems in school-aged children (Greene, Biederman, Faraone, Sienna, & Garcia-Jetton, 1997) and subsequently develop into adult difficulties such as maintaining a job and higher divorce rates for adults with ADHD (Kuriyan et al., 2013). Studies have examined the long term impact of social impairment for individuals with ADHD, finding higher rates of depression and depressive symptoms (Eadeh, Bourchtein, Langerg, Eddy, Oddo, Molitor, & Evans, 2017).

The progression of social deficits across the lifespan for an individual with ADHD can be attributed to a multitude of cognitive and environmental factors. It's important to note that deficits in social competence resulting in a lowered quality of social contact has a bidirectional effect on social skills (Schmidt & Petermann, 2009). Examining the progression of social deficits in ADHD and associated social cognitive factors may facilitate greater understanding of the root cause of these deficits, thereby providing insight into possible coping and intervention strategies (Schmidt & Petermann, 2009). A systematic review analyzed various aspect of the social difficulties in children with ADHD, and it was described as including disruptive behaviour,

interference in conversations, high frustration in play scenarios and frequent rule breaking (Pineda-Alhucema, et al., 2018).

ADHD and social development. ADHD is commonly associated with having difficulties paying attention, difficulties with social interactions, difficulty reading social cues, and difficulties with emotional dysregulation (Bakola, Rizos, & Drigas, 2019). Barkley (1990) stated that between 50% to 60% of children with ADHD experience rejection by their peers. Comparatively, only 13-16% of typically developing children in elementary school experience rejection (Terry & Coie, 1991).

This substantial discrepancy has led many researchers to a more fulsome examination of the relationship of relationships between social development and ADHD. However, few have gone so far as to examine the etiology of these social behaviours (Carpenter Rich, Loo, Yang, Dang, & Smalley, 2009). Most studies have focused on aligning the ADHD symptomology with some of the socially inappropriate behaviours commonly found in children with ADHD, such as impulsive or disruptive behaviours (Carpenter Rich et al., 2009). Socially inappropriate behaviours include interrupting, becoming aggressive, or not listening during conversations. Not only do the symptoms of ADHD have a tendency to impact social interactions directly, but with half to two thirds of children with ADHD having a co-morbid disorder, these high comorbidity rates may also increase the likelihood of social difficulties (Antshel & Remer, 2003).

A more in-depth understanding of the functional impairments underlying the behaviours as well as the root cause of social deficits still needs to be explored further. Thus far, the social deficits in children with ADHD have been attributed to impulsivity, inattention, a lack of social knowledge, and deficits in social cognition (Staikova, et al., 2013).

ADHD and theory of mind. Children with ADHD often experience challenges in social

situations, struggling to apply higher order cognitive control to respond appropriately (DuPaul & Stoner, 2003). Challenges include difficulty applying ToM in social contexts which often leads to misinterpretation of social cues. One of the challenges for children with ADHD is that they demonstrate knowledge of social rules and behaviours when asked directly, but they have difficulty performing these skills in applied settings (Barkley, 2006; DuPaul & Stoner, 2003).

For example, a child when prompted in a laboratory setting may be able to correctly interpret cognitive perspective-taking. However, applying cognitive and affective perspective during a social interaction while inhibiting other impulses (e.g., the urge to interrupt) requires higher order thinking as well as ToM (Sibley, Evans, & Serpell, 2013). Hutchins et al. (2016) examined the difference between ToM measured in a laboratory setting and an ecological setting in children with ADHD. Although there were no significant differences between typically developing children and children with ADHD on their ability to demonstrate ToM in a laboratory setting, the same was not found in the ecological setting. Children with ADHD are able to apply explicit examples of ToM; however, when they are asked to apply these skills in an ecological setting, they have difficulty demonstrating these same skills. Specifically, children with ADHD have a harder time demonstrating higher order ToM in ecological settings (Hutchins et al., 2016).

If children with ADHD are struggling to demonstrate perspective-taking, examining what factors what may be impacting ToM performance in children with ADHD will help professionals determine how to mediate these social cognitive deficits. One theory is that the reduced sleep quality that is often experienced by children with ADHD may partially explain some of the social cognitive deficits reported by researchers.

Sleep and ADHD. As sleep difficulties have often been anecdotally reported in children and adults with ADHD, there are several studies that have focused on the neurological sleep

patterns in children with ADHD, as well as the consequences of lowered sleep quality in individuals with ADHD. It is important to consider the neurological process of sleep in individuals with ADHD, what contributes to any sleep disturbances, and what are the consequences of a poorer sleep quality for daytime activities.

Sleep problems have been reported in up to 50% of children with ADHD (Eyuboglu & Eyuboglu, 2018; Yoon, Jain, & Shapiro, 2011). Up to 30% of children with ADHD meet criteria for a clinical sleep disorder such as daytime sleepiness, insomnia, delayed sleep phase syndrome, fractured sleep, restless leg syndrome, and sleep disordered breathing (Yoon et al., 2011). Theories surrounding the neurological basis of ADHD have postulated that the complex cortical processes of inhibition and activation commonly associated with ADHD also play a central role in the regulation of sleep (Kirov et al., 2003). Therefore, the functional changes in a brain system's ability to inhibit stimuli associated with ADHD may also adversely affect the sleep cycle.

In the last two decades, there has been renewed interest in pursuing research comparing sleeping patterns in children with ADHD to those of typically developing children (Corkum, Davidson, & MacPherson, 2011; Cortese, et al., 2009). When compared to other childhood mental health disorders, children with ADHD are among those with the highest prevalence of sleep problems (Meltzer & Mindell, 2006).

The abnormal sleep patterns in children with ADHD do not appear to be explained by the use of stimulant medication. Sleep disturbances have been demonstrated to occur at an increased rate for all children with ADHD when compared to a control group, independent of pharmaceutical use (Konofal, Lecendreux, & Cortese, 2010). This finding is consistent between subjective reports (parent reporting) and objective physiological measures (Cortese et al., 2009).

Although sleep complaints are common in those with ADHD, the role and consequences of lowered sleep quality specific to those with ADHD is still in the early stages of research (Virring, Lambek, Thosen, Moller, & Jennum, 2016).

Sleep and social challenges in ADHD. One of the areas that sleep has been shown to have a significant role for children with ADHD involves social challenges (Lucas, Mulraney, & Sciberras, 2017). Researchers completed an analysis of daytime sleepiness to examine the relationship between sleep and daily functioning for children with ADHD, using teacher reports as a measure of daytime sleepiness. Daytime sleepiness was associated with higher levels of emotional and behavioural problems leading to social challenges as rated by teachers (Lucas et al., 2017). Although daytime sleepiness has been related to social challenges, further analysis of specific sleep disturbances that are causing the daytime sleepiness is still needed.

Objective measures of sleep have also found differences in the micro and macro-structure of children with ADHD's sleep cycles. Kirov et al. (2003) found three significant sleep differences in children with ADHD compared to their typically developing peers. The first difference is that children with ADHD spent more time in bed. The differences in sleep time is often attributed to taking a longer time to fall asleep, and a longer time getting up in the morning as a result of reduced sleep quality and quantity (Kirov, et al., 2003). Children who struggle to wake up and fall asleep are often not getting as restful a sleep as their peers and with potential consequences including academics, emotional control, and social responsiveness.

The second significant sleep difference is that children with ADHD have a longer REM sleep duration relative to controls (Kirov, et al., 2003). REM sleep is associated with many of the parasomnias which are responsible for sleep disturbances such as sleep walking sleep talking, night terrors and sleep wakings. The additional REM sleep may cause greater disturbances in the

ADHD children's sleep, resulting in more daytime sleepiness (Cortese et al., 2009).

Finally, the third significant sleep difference is that children with ADHD showed a higher number of movements during light sleep (Kirov et al., 2003). Light movements, may cause night wakenings and interruptions to the sleep cycles, resulting in decreased sleep quality. These three differences in sleep for children with ADHD may be the contributing factors to the increased daytime sleepiness reported by children and their parents (Cortese et al., 2009).

Despite the significant differences between sleep in those with and without ADHD, there is controversy between the directionality of sleep disturbances and attention symptoms. Sleep disturbances and deprivation may lead to ADHD-like symptoms and conversely, individuals with ADHD are more likely to suffer from sleep disturbances. Symptoms of ADHD such as procrastination, problems with mood, motivation, and energy have also be associated with sleep problems making it difficult to decipher the etiology of the symptoms (Yoon et al., 2012). ADHD is a neurological disorder, however when diagnosis relies on symptom count, if significant sleep disturbances are not accounted for by professionals, poor sleep quality may be mistaken for ADHD (Yoon et al., 2012).

Regarding the social, emotional and behavioural outcomes of sleep disturbances in children with ADHD, there are a variety of significant findings reported. Children with ADHD and sleep problems have been linked to worse child, caregiver and family outcomes (Sung et al., 2008). In addition, poor sleep has been associated with intense emotional outbursts and lack of emotional regulation, often impacting daily functioning. Emotional regulation has been further associated with poor daily functioning, poor quality of life, and worse school attendance (Posner et al., 2011; Sung et al., 2008). Further, a relationship between executive control skills and sleep problems has been identified in children with ADHD between the ages of four and seven years;

however, the directional nature of this relationship remains unclear (Schneider et al., 2015).

Sleep, Theory of Mind and ADHD. ToM has only recently been associated with sleep in typical populations (Tesfaye et al., 2017). Tesfaye amd Gruber (2017) proposed that examining the relationship between sleep and ToM in children with ADHD may help explain some of the interpersonal difficulties experienced by those with ADHD. The basis of the theoretical review was to build on of previous findings which have found ToM to be a positive predictor of successful social interactions (Imuta, Henry, Slaughter, Selcuk, & Ruffman, 2016). Despite the significance of ToM, researchers noted that relatively little is known regarding the mechanisms and underlying factors that contribute to the successful development of ToM (Tesfaye et al., 2017). Sleep has previously been associated with both EF and emotional processing difficulties in typical populations (Posner et al., 2011, Schneider et al., 2015). Despite the close relationship between EF, emotional information processing and affective ToM, the relationship between sleep and ToM has never been studied. Tesfaye et al., (2017) found significance between sleep and ToM in typically developing individuals and proposed that those with ADHD would be a specific population worth studying further. By examining the role of sleep on ToM in children with ADHD, it may be possible to identify some of the underlying factors which contribute to ToM development in these children.

Current Study

The purpose of the current study is to examine the impact of sleep on ToM in children with ADHD, as compared to typically developing children. Specifically, this study seeks to examine affective ToM which assesses emotional perspective-taking in children with and without ADHD. By assessing affective ToM, a skill that is considered more difficult than first order cognitive theory of mind, it may be possible to determine if there is difference between those

with and without ADHD as well as whether sleep disturbances acts as an underlying mechanism which impacts ToM.

Previous research has investigated the relationship between sleep and other forms of social cognition, (e.g., executive functions and emotional information processing) but the possible link between ToM and sleep have not been examined in those with ADHD (Posner et al., 2011). Neurological research suggests that the impact of sleep loss on children with ADHD may be different from typical children, as they have distinct sleep cycle structures. Further, the neurological systems most impacted by sleep disturbances may also be different in children with ADHD. ToM is an essential component to successful social interactions, given that being able to interpret and understand social cues appears to be a critical component to social skill development (Crick & Dodge, 1994). Therefore, an explicit investigation into the relationship between sleep quality (bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep disordered breathing, and daytime sleepiness) and ToM may provide insight into understanding and treating social difficulties in children with ADHD.

The current study aims to address the following research questions:

1. Is there a difference between the quality of sleep ((bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night wakings, parasomnias, sleep disordered breathing, and daytime sleepiness) in children with ADHD compared to children without ADHD?
2. What is the relationship between sleep quality and affective ToM in children with ADHD?
3. Is the relationship between sleep quality and affective ToM different between the ADHD group and the control group?

With respect to the first research question whether differences in sleep quality will be

different for children with and without ADHD, consistent with previous research, it is hypothesized that that children with ADHD will have a poorer sleep quality then their typically developing peers. Specifically, it is hypothesized that overall sleep disturbances score will be greater in the ADHD group as well as the specific daytime sleepiness subtest. (Corkum, et al., 2011; Cortese, et al., 2009).

For the second research question that examines sleep quality and affective ToM, it is hypothesized that reduced sleep quality will result in reduced affective ToM in the ADHD group based on the theoretical review by Tesfaye and Guber, 2017. Tesfaye et al., 2017 have identified a relationship between poor sleep and emotional and facial processing in typically developing children, and this research seeks to replicate these findings and extend them to children with ADHD.

For the third research question which examines specifically whether the relationship between sleep quality and ToM is different in the children with ADHD than the same relationship in children without ADHD, it is hypothesized that children with ADHD will have a stronger relationship between sleep and ToM when compared to the control group. The strength of the relationship will be analyzed for overall sleep disturbances as well as daytime sleepiness.

Chapter 3: Methodology

Participants

The current study included a total of 46 children ranging from 8 to 12 years of age from three major Canadian cities and surrounding area. Twenty children had a previous diagnosis of ADHD and 26 were a control group of typically developing children without ADHD. In the ADHD sample the mean age was 10.63 years (*SD*=1.28; 55.0% male). In the control group, the mean age was 10.08 years (*SD*=1.27; 61.5% male). A Chi-square test was conducted to compare gender for ADHD and control groups. There was not a significant different between gender in the ADHD group and the control group X^2 (2, N = 44) = .199, *p*= .655. No significant differences was found for age between the ADHD, and control groups, *t*(44)=1.418, *p*=.163. All participants listed their primary language as English.

A pre-screener questionnaire (see Appendix A) was administered to all potential participants to ensure eligibility for the study. All children in the ADHD group must have received a previous diagnosis of ADHD from a medical professional (e.g., physician or psychologist). If the children were taking stimulant medication at the time of the study, they were asked to continue taking their regular medication regime the morning of testing. The control group did not have a diagnosis of ADHD. The ADHD group had significantly greater symptoms of hyperactivity and impulsivity *t*(34.41)=7.416, *p*<.001 and significantly greater symptoms of inattention *t*(29.77)=9.64, *p*<.001 than the control group on the Conners 3-PRS. All participants, except for one had average full FSIQ (greater or equal to 90) WASI-II. One participant did not complete one of the subtests, however as her other three subtests were viable, and within the normal range her other measures were kept in the study. No significant differences were found between the ADHD and the control group on FSIQ *t*(43)=7.30, *p*=.469. Participants were asked

to list other medical health and/ or learning diagnoses (see Table 1 for demographic information). Exclusionary criteria for both groups included the intent to have a psychological assessment in the next year, lack of fluency in English, a history of epilepsy, gross motor difficulties, major hearing or vision problems, a diagnosis of Autism Spectrum Disorder, or other gross neurological disorder.

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	55.00	---	---	16	61.50	---	---
	Female	9	45.00	---	---	10	38.50	---	---
Ethnicity	Caucasian	18	90.00	---	---	15	57.70	---	---
	African	0	0	---	---	1	3.80	---	---
	Aboriginal	0	0	---	---	2	7.70	---	---
	East Indian	0	0	---	---	1	3.80	---	---
	Mixed/ Multiple	2	10.00	---	---	0	0	---	---
	Other	0	0	---	---	1	3.80	---	---
Medication Status	On Medication	16	80.00	---	---	0	0	---	---
	Vivanse	1	5.00	---	---	0	0	---	---
	Concerta	5	25.00	---	---	0	0	---	---
	Biphentin	6	30.00	---	---	0	0	---	---
	Methylphenidate/ Ritalin	1	5.00	---	---	0	0	---	---
	Combination of medication	3	15.00	---	---	0	0	---	---
Diagnosis	Learning Disability (Math)	1	5.00	---	---	0	0	---	---
	Learning Disability (Reading)	2	10.00	---	---	0	0	---	---
	Learning Disability (Not Specified)	2	10.00	---	---	0	0	---	---
	Anxiety	2	10.00	---	---	1	3.80	---	---
	Oppositional Defiant Disorder	1	5.00	---	---	0	0	---	---
	Oppositional Defiant Disorder and Anxiety	1	5.00	---	---	0	0	---	---
	Other	3	15.00	---	---	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

Participants completed individual measures of ToM abilities along with a brief cognitive assessment. The participants' parents completed questionnaires regarding their children's sleep

habits, and diagnostic behaviour. The current study was a part of a larger project; only measures pertinent to the current study are reported.

Parent measures.

Demographics questionnaire. The demographics questionnaire was completed by the parents of the participants (see Appendix B). Questions addressed the family history, including ethnicity, languages spoken as well as general family information (e.g., number of siblings). In addition, the demographic questionnaire included questions regarding about comorbid disorders (e.g., Depression, Anxiety, Autism Spectrum Disorder) were included.

Conners Rating Scale - 3rd Edition, Parent Report Short Form (Conners 3-PRS; Conners, 2008). The Conners 3-PRS (2008) is a standardized parent report questionnaire based on the criteria from the DSM-5 and is used for children aged six to 18 years. This measure asks parents to rate the presence of core ADHD symptoms and common behavioural problems associated with ADHD and common comorbid disorders (e.g., Oppositional Defiant Disorder and Conduct Disorder). The Conners 3-PRS is used in both research and clinical settings to assist in the diagnosis of ADHD (Conners, 2016) and assesses the areas of hyperactivity, impulsivity, inattention, executive functioning, learning problems, aggression and peer relations.

For this study, the total score (i.e., a t-score of symptoms count) was used to determine the presence of ADHD to confirm the ADHD sample. The scale confirmed the presence of ADHD for children who were in the ADHD group by having a minimum t-score of 70+ on one aspect of inattention, hyperactivity, or impulsivity and a minimum t-score of 65+ on the second aspect. However, as some ADHD participants were receiving medication at the time of the testing, the symptom count of the Conners 3-PRS may be lower as it assesses current functioning. Therefore, participants were asked about medication use during the demographic questionnaire

and their Conners 3-PRS symptom count will be evaluated appropriated. If a participant does not meet the required criteria on the Conners 3-PRS but has received a diagnosis of ADHD and is currently taking medication for their ADHD, their scores will still be included.

The Conners-3 PRS is a psychometrically reliable and valid measure that has been normed using populations from the United States and Canada (Conners, 2008). The measure has fair to strong reliability with test-retest reliability from two to four weeks, r = .72 to .98. The internal consistency coefficients are .85 to .94. (Conners, 2008) demonstrating consistency between the scales used within the measure. The Conners 3-PRS is able to discriminate between children and adolescents with ADHD and the general population with 77.61% accuracy, supporting acceptable discriminant validity (Conners, 2008).

Children's Sleep Habits Questionnaire (CSHQ). The Children's Sleep Habits Questionnaire (CSHQ; Owens et al., 2000) is a parent report measure used for sleep screening specifically designed for children between the ages of four and 12 years. The CSHQ is based on the clinical diagnoses of sleep disorders as described in the "International Classification of Sleep Disorders" (American Sleep Disorders Association, 1990). The ICSD has since been updated in 2014, however the CSHQ no longer follows the older version from 1990. The CSHQ is a 33-item parent questionnaire that asks questions related to eight sleep domains representing common clinical sleep complaints for school aged children. The CSHQ subscales includes: (a) bedtime behaviour, (b) sleep onset, (c) sleep duration, (d) anxiety around sleep, (e) night wakings, (f) parasomnias, (g) sleep-disordered breathing, and (h) daytime sleepiness. The scale is commonly used both as a clinical tool for screening for sleep disorders and for research purposes. The parents are asked to reflect upon the last week (or most recent typical week) in their child's life when answering questions. Parents then respond to statements about their child's sleep habits and

possible difficulties with sleep (e.g., Child struggles at bedtime (cries, refuses to stay in bed etc.)). There are three possible responses to each statement: "usually" for a behaviour being present five to seven times per week, "sometimes" for two to four times per week, or "rarely" for one time or less per week. Each habit is classified into one of the eight subscales and the total scores are totaled for each type of sleep disturbance. A higher score within each subscale is associated with decreased sleep quality.

Overall, the psychometric properties for the CHSQ indicate acceptable levels of reliability and validity. The internal consistency of the scale ranged from .68 for the community sample and .78 for the clinical sample, both of which are considered acceptable. Test-retest reliability fell between .62 and .79, within the acceptable range. The sensitivity of the measure was .80 and the specificity was .72, indicating that approximately 80% of the time the scale correctly identifies clinically significant sleep disturbances in children (Owens et al., 2000). Further, similar distribution between the types of sleep problems the community population and the identified clinical samples were found; however, the authors note that the primary purpose of the CSHQ is as a screening tool and not as a diagnostic measure (Owens et al., 2000).

Child measures.

Wechsler Abbreviated Scale of Intelligence – Second Edition (WASI-II; Wechsler, Zhou, & Psychological Corporation 2011). The WASI-II is an individually administered test of intelligence designed to determine whether the participants were functioning at the expected level for their age. The WASI-II provides composite scores that estimate the verbal comprehension and perceptual reasoning abilities of an individual aged six to 90 years of age. The WASI-II is used in psychoeducational, clinical and research settings to assess cognitive functioning in an abbreviated and accurate manner. The WASI-II has four subtests: Block Design, Vocabulary, Matrix

Reasoning, and Similarities. Subtest raw scores are calculated for each individual subtest and are converted into standard scores, including a Full-Scale Intellectual Quotient (FSIQ). The present study uses the FSIQ (which incorporates all subtests) to reflect overall cognitive functioning of the participations. A minimum standard score of 80 was required for both the ADHD and control group, indicating minimally average intelligence (American Psychological Association, 2013). The minimum standard ensures accurate and appropriate comprehension of questions by participants and that deficits in any area are not likely due to cognitive delays.

The WASI-II was standardized using a sample of 2300 children and adults. The sample was representative of the population in the United States based on age, sex, ethnicity, geographic region and education level. The internal consistency coefficients ranged from fair to excellent (r=.87 to .97). The test-retest reliability coefficients ranged from .79 to .90 which is considered acceptable to excellent. The concurrent validity of the WASI-II was assessed by comparing results with the Wechsler Intelligence Scale for Children (Fourth Edition) and the Wechsler Adult Intelligence Scale (Fourth Edition) which are both full length measures of intelligence. Correlations for concurrent validity ranged from acceptable to excellent (.71 to .92; Wechsler, 2011).

Reading the Mind in the Eyes test (Child). The Reading the Mind in the Eyes (RME) test (Child) (RME; Baron-Cohen, et al., 2001) helps to understand a child's ability to determine social causality. The test is designed for children ages eight to 14 years and consists of 28 images of eyes that depict emotional states and asks the child to choose between four mental state terms that best describes the eyes. The RME is used to assess the child's ability to recognize the emotional expressions in the pictures of the eyes. The child was presented the image of one set of eyes and the printed words of four mental states and ask to select the one that best represented

what the person in the photograph was feeling. If the child struggled with reading, the printed words were read aloud and repeated as necessary. Each response is scored as 0 for incorrect or 1 for correct responses. The total number of correct responses is used as the overall raw score for the RME.

The mental states presented ranged from simple (e.g., kind) to complex (e.g., thinking about something) and had previously been used in both typical adults and children as well as in clinical samples (e.g., Autism Spectrum Disorder). The task has poor internal consistency, theorized to be the result of the range in questions (Baron-Cohen et al., 2001), given that some of the questions present simple mental states and some questions represent more complex mental states. The RME displayed acceptable convergent validity with other measures of ToM such as the Strange Stories Test and the Faux Pas Test displaying consistency in measuring perspective-taking in children (Ferguson & Austin, 2010; Kirkland et al., 2012; Torralva et al., 2009). The RME has been further validated as a measure to examine social cognition (Baron-Cohen et al., 2001) while minimizing the strain on working memory or problem solving.

Procedure

Participant recruitment was conducted through posting information of the study in community groups and posts on social media (see Appendix C for recruitment email script). In addition, recruitment posters were placed in local coffee shops and medical clinics throughout three major Canadian cities. Social media sharing of the of the same poster was also done through the lab Facebook page. All participants who expressed interest completed a phone-based brief pre-screening questionnaire which took between 10 to 15 minutes to complete (see Appendix A). If inclusion criteria were met, participants would be scheduled for testing, sent the consent ahead of time, and provided with parking pass for their session.

The testing session began with informed consent (see Appendix D) with the child and the parent present. The consent forms were reviewed and signed by the parent and the parent was given their measures to complete and shown to a comfortable space to complete their work. Once the parent had left, the assent script (see Appendix E) was read to the children and they were asked to sign as well. Parents were given a demographics questionnaire, along with the Conners-3 PRS, and the CSHQ. The child worked one-on-one with the researcher to complete the WASI-II, the Reading the Mind in the Eyes test (Child), along with other measures that were outside the scope of the current project. The WASI-II was always completed first, to ensure that all participants met the criteria of being within the average range of intelligence or above, followed by a random order for the remaining tasks. Following participation, the parent returned to the room and were read the debrief form (see Appendix F), any questions were addressed, and the child was given $25 gift certificate as gratitude for his/her participation. All aspects of the study were approved by the Conjoint Faculties Research Ethics Board at the host institution (see Appendix G for ethics approval).

Chapter 4: Results

A total of 46 participants' (26 control and 20 ADHD) participated in the current study which included the sleep questionnaire (CSHQ) and the ToM measure (RME). First, the normality of the data was analyzed using frequency distributions examining, mean, median, missing values, skewness and kurtosis. Missing data points were analyzed through the missing values analyses using Little MCAR-test, which expressed that the data were missing at random as less than 5% of data was missing from each subscale. Two participants required a single subscale response to be pro-rated due to a missing item. The ToM measure (RME) had a missing data point. Missing data were then imputed using the 5th imputation with the expectation-maximization algorithm to estimate parameter based on the data that were available (Enders, 2003).

Skewness indicates to what extent the distribution differs from a normal distribution. Kurtosis indicates the sharpness of the peak of a frequency-distribution curve. Through analyses of skewness and kurtosis, the night wakings subscale and the RME both had values above what is considered a normal distribution. All other CSHQ subscales had skewness scores below two 2, and kurtosis scores below four which is considered within the normal range.

Next, the data were examined for outliers through standardized values. Two data points were found to be outside the threshold of +/- 3.25; one on a subscale of the CSHQ (night wakings) and one on the RME. Both data points were windsorized to no longer exceed the +/- 3.25 standardized value and impact the normal distribution of the data. Following the data winsorizing of the outliers, the data were re-examined for normality using skewness, kurtosis, and histograms and was determined to be satisfactory for further analyses.

A post-hoc power analysis was conducted using G*Power3 (Faul, Erdfelder, Lang,

& Buchner, 2007). With the present sample size, the power was determined to be 0.84, critical t(44) = 2.02 for overall sleep disturbances and 0.25, critical t(44) = 2.02 for the CET measure of ToM. The high power for the CSHQ overall score, validates the current findings, however the low power calculation value for the ToM measure indicates that the results for research question two and three should be interpreted with caution.

Research Question One

The first research question examined the difference between the quality of sleep in children with ADHD compared to children without ADHD. The means and standard deviations of the eight subscales from the CSHQ are presented in Table 2 for both the ADHD and the control group. An independent samples t-test examined whether there was a significant difference between groups on overall sleep quality. When examining the CSHQ total score the ADHD group reported significantly higher sleep problems than the control group $t(44) = 3.37, p = .002$. Significance in the same direction was also found for sleep duration $t(44) = 3.23, p = .003$, sleep anxiety $t(44) = 2.13, p = .04$ and daytime sleepiness, $t(44) = 2.48, p = .017$. All other t-tests on measures of sleep habits resulted in no significant differences between the ADHD group and the control group at a significance level of .05.

Table 2

Means and Standard Deviations of Child Sleep Habits Subscales for children in the ADHD and control groups

Subscale	ADHD Group *Mean (SD)*	Control Group *Mean (SD)*	t-value	Effect Size *Cohens' D*
Bedtime Resistance	7.65 (2.28)	6.75 (1.83)	1.48	.43
Sleep Onset Delay	1.95 (.83)	1.50 (.71)	1.99	.09
Sleep Duration	5.30 (2.20)	3.56 (1.08)	3.23*	1.00
Sleep Anxiety	6.00 (2.02)	4.89 (1.29)	2.13*	.65
Night Wakings	3.90 (1.37)	3.41 (.82)	1.45	.44
Parasomnias	8.70 (1.71)	8.02 (1.17)	1.48	.45
Disordered Breathing	3.20 (.41)	3.23 (.50)	-.25	.08
Daytime Sleepiness	11.55 (3.49)	9.04 (3.34)	2.47*	.37
Total Score	45.78 (8.05)	38.59 (6.41)	3.27*	.98

Note: * = $p<.05$

Research Question Two

The relationship between ToM and ADHD was examined. There was no significant difference between ToM scores on the RME in children with ADHD group ($M = 20.00$, $SD = 2.69$) when compared to the control group ($M = 18.81$, $SD = 6.41$), $t(44) = 1.316$, $p = .195$. Correlation analyses were used to examine the second research question regarding the relationship between sleep quality (CSHQ scores) and ToM (RME scores) in children with ADHD and in the control group. The data set was first split to separate children with and without ADHD. Correlation analyses were run to determine the relationship between each subscale of CSHQ as well as the total score with RME scores for children with ADHD. Contrary to what was predicted in the hypothesis, results indicated that there were no statistically significant correlations between the RME scores and any of the CSHQ subscales for the ADHD group (see Table 3).

Table 3

ToM and Sleep Habits Correlation Analyses for ADHD Group

Subscale of CSHQ	Correlation with RME scores	Significance (2-tailed)
Bedtime Resistance	-.394	.085
Sleep Onset Delay	.118	.619
Sleep Duration	-.044	.853
Sleep Anxiety	-.202	.392
Night Wakings	-.219	.353
Parasomnias	-.089	.708
Disordered Breathing	-.286	.222
Daytime Sleepiness	-.246	.295
Total Score	-.308	.186

Pearson correlation analyses were run to determine the relationship between each subscale of CSHQ as well as the total score with RME scores for the control group. Sleep Anxiety was the only subscale on the CSHQ that was significantly correlated with the RME (r=-.393, p=.047). Results indicated that there were no other statistically significant correlations between the RME scores and any of the CSHQ subscales for the control group (see Table 4).

Table 4

ToM and Sleep Habits Correlation Analyses for Control Group

Subscale of CSHQ	Correlation with RME scores	Level of significance (2-tailed)
Bedtime Resistance	-.257	.206
Sleep Onset Delay	-.316	.115
Sleep Duration	.068	.747
Sleep Anxiety	-.393*	.047
Night Wakings	.000	.999
Parasomnias	-.197	.335
Disordered Breathing	-.138	.500
Daytime Sleepiness	-.058	.778
Total Score	-.226	.267

Note: * = p<.05

Research Question Three

Finally, to explore whether there was a difference between Sleep Quality and ToM between the ADHD group and the control group, the correlation coefficients were compared. For

the ADHD group, and the control group, the correlation coefficients for the relationship between total sleep disturbances and the RME was changed into z-scores. To compare the correlation coefficients, the scores were converted into standardized values (z-scores) and then compared. Z-observed represents the difference between the correlation coefficients for the ADHD and control groups. As all z-observed scores were between +/- 1.96, there is no significant difference between the relationship between sleep quality and ToM in children with and without ADHD, contrary to the predictions (see Table 5).

Table 5

Difference between relationship of sleep quality and ToM for those with and without ADHD

Subscale of CSHQ	Pearson Correlation with RME scores (Control) r = N = 26	Pearson Correlation with RME scores (ADHD) r = N = 20	Z-Observed (one-tailed)
Bedtime Resistance	-.257	-.394	.315
Sleep Onset Delay	-.316	.118	.082
Sleep Duration	.068	-.044	.363
Sleep Anxiety	-.393*	-.202	.255
Night Wakings	.000	-.219	.242
Parasomnias	-.197	-.089	.363
Disordered Breathing	-.138	-.286	.312
Daytime Sleepiness	-.058	-.246	.274
Total Score	-.226	-.308	.390

Finally, to examine the relationship between sleep and ToM in when controlling for symptoms of ADHD, a partial correlation between the RME and the CSHQ when controlling for hyperactivity/impulsivity and inattention ratings on the Conners 3-PRS was run with the whole sample (see Table 6). As both hyperactivity/ impulsivity and inattention can impact ToM both symptom scales were inputted simultaneously. Again, no significant correlations were found between sleep quality and ToM when controlling for symptoms of ADHD.

Table 6

ToM and Sleep Habits Correlation Analyses when controlling for symptoms of ADHD

Subscale of CSHQ	Correlation with RME scores	Level of significance (2-tailed)
Bedtime Resistance	-.309	.044
Sleep Onset Delay	-.112	.477
Sleep Duration	.074	.637
Sleep Anxiety	-.233	.132
Night Wakings	-.098	.531
Parasomnias	-.107	.494
Disordered Breathing	-.191	.221
Daytime Sleepiness Score	-.099	.526
Total Score	-.203	.192

Chapter 5: Discussion

The objective of the current study was to investigate the impact of sleep on ToM in children with ADHD as compared to a control group of children. This paper was looking to expand on previous research examining the impact of sleep quality on social cognition in children with ADHD. Specifically, it sought to examine the relationship between various aspects of sleep quality and ToM. Three research questions were investigated.

Research Question One

The first research question addressed differences in sleep quality between the ADHD and the control group. The current study's findings supported the hypothesis that children with ADHD are rated as having more sleep problems than those in the control group. Specifically, the CSHQ examined eight types of sleep disturbances within the overall total sleep disturbance score. Among the eight subscales, results indicate that three had significant differences between the children with ADHD and the control group. Significantly greater problems were reported in the ADHD group with respect to overall daytime sleepiness, sleep duration, and sleep anxiety. These findings support the existing literature which suggests sleep problems are more common in children with ADHD (Cortese et al., 2009). No differences were found between the ADHD group and the control on bedtime resistance, sleep onset delay, night wakings, parasomnias, and disordered breathing.

Overall sleep disturbance. The overall sleep disturbance score, which encompasses all eight subscales, reflected significantly greater sleep disturbances in the ADHD group than the control group. The sleep disturbances score includes symptoms from various sleep disorders from the ICSD (1990). There can be many causes of sleep disturbances including difficulties involving sleep duration and sleep anxiety, as noted in the current study's ADHD group.

Other researchers have examined the sleep hygiene of children with ADHD and identified additional sleep habits that may be contributing to high rates of sleep disturbances. One study examined technology use after 9:00 pm in children with ADHD. There was a significant correlation when examining sleep duration and sleep problems in relation to nighttime media use for children with ADHD, even after controlling for age, sex, medication use, and ADHD symptom severity (Becker & Lienesch, 2018). Further, evidence suggests that children with ADHD are prone to excessive media use, possibly a result of the highly rewarding nature of technology and media (Tripp & Wickens, 2008). The higher overall sleep disturbance scores in the ADHD group of the current study may be related to the high technology use seen in children with ADHD, particularly nighttime technology use. Worth noting, Becker and Lienesch (2018) reported an association between overall sleep problems and increased problems with daytime sleepiness, sleep duration, and internalizing problems, findings that are strikingly similar to those of the present study.

Another explanation of the high rates of overall sleep disturbances in the current study's ADHD group involves the high rates of comorbidity with other psychiatric disorders such as anxiety and depression. Sleep disturbances are included diagnostically as symptoms of both anxiety and mood-related disorders (APA, 2013). The relatively high rates of sleep disturbances reported for the current study's ADHD could be a reflection of underlying comorbidities rather than specifically be linked to the ADHD diagnosis.

Daytime sleepiness. The ratings for daytime sleepiness were significantly higher for children with ADHD as compared to the control group. The daytime sleepiness subscale is often a reflection of the sleep quality throughout the night. Already identified in other subscales were sleep duration and sleep anxiety, which result in overall reduced sleep quality and increased

daytime sleepiness.

A possible explanation for the higher rates of daytime sleepiness in the group of children with ADHD is the high rates of Periodic Leg Movement (PLM) often reported by individuals with ADHD. The CSHQ is based on an earlier version of the ICSD; however, the most recent ICSD-III has updated its identification of sleep disorders. As such, the CSHQ does not include questions regarding PLM during sleep and RLS (Restless Leg Syndrome). RLS is a common sensorimotor disorder with a prevalence of 10% to 15 % in the general population which is characterized by uncomfortable leg sensations resulting in an urge to move the legs (Cortese et al., 2005). Individuals with RLS often report severe insomnia due to their leg discomfort and movement while trying to fall asleep (Cortese et al., 2005). One study found that up to 44% of individuals with ADHD have symptoms of RLS (Cortese et al., 2005). Despite the high comorbidity rates of RLS and PLM in children with ADHD, the current version of the CSHQ did not ask direct questions about leg movements or leg pains while sleeping, which may have impacted the daytime sleepiness findings. RLS has been associated with sleep disturbances, specifically in children with ADHD. The relatively high rates of RLS may account for some of the daytime sleepiness that is a biproduct of nighttime sleep disruption.

In addition to high comorbidity rates of sleep disorders, ADHD is also linked to higher rates of other psychiatric disorders such as Oppositional Defiance Disorder (ODD), Anxiety Disorders and Depressive Disorders (Mayes et al., 2009). Mayes and colleagues (2009) examined the impact of comorbid psychiatric disorders of ADHD and their impact on sleep. Children with ADHD and anxiety or depression had increased sleep problems than children with no anxiety or depression diagnosis. Conversely, children who had a diagnosis of ADHD and ODD did not differ in sleep problems than children with ADHD (Mayes et al., 2009). Increased daytime

sleepiness in the ADHD group may have been a result of increased comorbidities or symptoms of comorbid disorders within the ADHD group including anxiety, depression, RLS, or PLM.

Sleep Duration. Parents from the ADHD group reported significantly more problems with sleep duration in their children as compared to the control group. In the current study, 80% of participants in the ADHD group were on stimulant medication. Stimulant medications has been shown to result in sleep problems and may change circadian phase (Corkum et al. 2008). The circadian rhythm controls the body's sleep-wake cycle. The use of stimulant medication may alter the timing or regularity of circadian motor activity levels (Ironeside, Davidson, & Corkum, 2010). Interruption to the circadian rhythm from the stimulant medication may cause inappropriate tiredness throughout the day.

Morash-Conway, Gendron, and Corkum (2017) found that stimulant medication significantly reduced sleep duration, but not sleep efficiency. Despite the evidence supporting the relationship between sleep and medication for ADHD, stimulant medication is more often used for children with more severe ADHD symptoms, distorting whether the increase in sleep problems is related to the stimulant medication or the more severe presentation of ADHD (Morash-Conway et al., 2017). To examine the relationship between sleep and stimulation medication, while controlling for ADHD severity, Mayes and colleagues (2009) controlled for reported ADHD symptoms, and still found that the children with ADHD who were taking stimulant medication still had greater difficulty falling asleep than children with ADHD who were not on stimulant medication. Impacts from stimulation medication resulting in interruptions to the circadian rhythms may contribute to the increase in problems with sleep duration in children with ADHD.

Sleep Anxiety. Parents of children in the ADHD group reported significantly greater

problems with sleep anxiety than those in the control group. Sleep anxiety questions refer to fears of the dark, sleeping alone, and difficulty sleeping away from home. As previously mentioned, the comorbidity of anxiety and ADHD may have contributed to the greater sleep anxiety disturbances reported in the ADHD compared to the control group. One study which examined children with ADHD, children with an anxiety disorder, and those with both comorbidities found that children who have both an anxiety disorder and ADHD have greater sleep problems than those who have a diagnosis of ADHD alone or anxiety alone. The combination of ADHD and anxiety was determined to result in the highest reporting of sleep anxiety (Bériault, et al., 2018).

Additional investigation has examined the relationship between sleep quality and daytime sleepiness and determined that sequelae of compromised sleep include increased internalizing problems and emotional dysregulation (Gruber, 2014). Gruber noted that poor sleep impacts the underlying connections between the prefrontal cortex and the limbic system, including the amygdala and the reward pathway, which are also implicated in the control of negative emotions (Gruber, 2014). The disruption of the neural pathway caused by reduced sleep quality was posited to contribute to the increase of sleep anxiety in children with ADHD.

Many sleep studies which have examined the impact of poor sleep quality in children with ADHD have reported increased emotional reactivity, or increased internalizing behaviours (Cortese et al., 2009). Specifically, one study examined the impact of sleep deprivation on anxiety and found that sleep deprivation will intensify anxiety, possibly as a result of greater catastrophizing in adolescents (Talbot, McGlinchey, Kaplan, Dahl, & Harvey, 2010). In the current study, the children with ADHD may be experiencing greater sleep anxiety as a result of their relatively poor sleep quality. Specifically, the children with ADHD may be catastrophizing

when it comes to the sleep anxiety triggers (e.g., sleeping in the dark, sleeping alone in bed) which further increases anxiety. The increased sleep anxiety would only exacerbate sleep problems as it delays sleep onset and creates further sleep disturbances, in effect, creating a vicious cycle.

Research Question Two

The second research question examined whether sleep quality and ToM were related. First, the RME was compared between the ADHD group and the control group and no significant differences between groups was found. Further, data analyses showed no relationship between any of the sleep subscales or overall sleep disturbances with ToM. The lack of relationship between sleep and ToM was found in both the control and ADHD groups. The current data did not replicate the results found by Tesfaye and colleagues (2017) despite using the same ToM and Sleep measures. Tesfaye et al. (2017) previously found a significant relationship between sleep and ToM in typically developing children. No other research has examined the relationship with sleep and ToM.

The lack of significant results may be indicative of a relative strength for children who made up the ADHD sample. Although children with ADHD may still have social cognitive deficits in certain areas, the current study did not find any difference between children with ADHD and control children on the ability to identify emotions based on a person's eyes. Specifically, no differences were found on children with ADHD's ability to perform on first-order tasks of affective ToM.

A possible explanation for the lack of significance and findings that do not replicate the earlier study by Tesfaye and colleagues (2017) is that the RME measure did not assess cognitive ToM. Many studies which have examined ToM have also examined EF; specifically, inhibition

and cognitive flexibility (Mary et al., 2016). The RME task did not require children to inhibit any distractions as there was only one face presented at a time. Further, the ToM task involved in the current study did not require participants to shift between multiple perspectives in a single setting, which would require greater cognitive flexibility. The lack of differences between the ADHD group and the control group on the ToM task may be a reflection of the lack of additional EF control necessary to complete the task.

In addition, the RME may not be a pure task of ToM as some studies have not found differences between groups when controlling for ADHD symptoms. Thus, the group differences previously found on the RME may be a reflection of attention and not a true ToM deficit (Mary et al., 2016). It also is important to note that 80% of the ADHD sample in the current study are on stimulant medication, which may have remediated the attention component, enabling success on the perspective-taking component of the ToM task.

Research Question Three

The third research question examined whether the relationship between sleep and ToM was different in the children with ADHD compared to the control group. The current study found that the relationship between sleep and ToM was no different in children with ADHD than in the control group. In addition, the current study resulted in no relationship between sleep and ToM, even when controlling for symptoms of ADHD. The lack of difference between the ADHD group and the control group indicates that the impact sleep has on ToM is the same for both children with and without ADHD. Although sleep-wake cycles have previously been identified as unique in children with ADHD (Kirov et al., 2003), results from the current study suggest that children with ADHD's social cognitive skills are not impacted by poor sleep quality any different than children without ADHD.

An fMRI study examined the neurological processes in an ADHD group compared to a sleep-deprived group on neural regions previously implicated in EF regulation (Saletin, Rodriguez, Jackvony & Dickstsin, 2017). These researchers found that both the ADHD group and the sleep deprivation group displayed hypoactivation of the EF neuroanatomy. Thus, there may be a cumulative impact on EF in those with comorbid ADHD and sleep problems. Despite similar patterns, the fMRIs for the sleep deprivation group displayed a compensatory response in the subcortical arousal centers, whereas ADHD was associated with deactivations of the same network but with no compensatory response. Researchers concluded, that although both ADHD and sleep deprivation have an impact on EF, results indicate that there are distinct patterns of functional neuroanatomy for each group (Saletin, et al., 2017). The distinct neurological processes impacted by sleep deprivation versus ADHD suggest that contrary to researchers' expectations, the impact of sleep deprivation on EF would not be more severe in those with ADHD rather than a control group who only had sleep deprivation. This lack of difference may explain, in part, why the current study failed to demonstrate a difference in the impact of sleep on ToM between those with ADHD and those without.

Implications

The results from the current study support previous research that sleep quality is worse in children with ADHD compared the control group. Higher levels of sleep disturbances in children with ADHD, call for increased intervention to help improve sleep quality in children with ADHD, and develop targeted sleep interventions specific for children with ADHD.

School psychologists and other professionals may benefit from a better understanding of the importance of sleep quality particularly among children with ADHD. One of the most common recommendations for children with ADHD is behavioural interventions. Strategies such

as routine, consistency, and strict and direct limits around schoolwork and home-based activities are often recommended for children with ADHD (Hysing, 2014). Professionals working with these same children may want to apply the same behavioural principles to bedtime routines. Sleep routines, which establish consistency and predictability for children at nighttime can improve sleep hygiene. Previous studies have reported increased sleep quality with interventions designed to increasing sleep hygiene for children with ADHD, and developing positive habits around bedtime routines (Shokravi, Shooshtari, & Shahhatami, 2016). Further, limiting technology use before bedtime may help reduce overall sleep disturbances and increase sleep quality (Becker & Lienesch, 2018).

Professionals who work with children who have ADHD also need to understand the relationship between anxiety and sleep in children with ADHD. Specifically, the cyclical nature of this relationship in that poor sleep can exasperate anxiety and, conversely, that anxiety can worsen sleep quality. Managing anxiety, through strategies such as cognitive behavioural therapy have been found to minimize daytime anxiety and improve overall sleep quality (Bériault et al., 2018). In addition, educating parents on how to help the child manage nighttime anxieties, and prevent catastrophizing may help reduce sleep anxieties, and the impact on sleep quality (Talbot, et al., 2010).

Finally, the lack of significance found between the ADHD and the control group on the measure of affective ToM identifies potential theoretical implications for the conceptualization of ToM. Traditionally, ToM has been conceptualized in a divided manor which isolates cognitive and affective ToM into two distinct and unique social cognitive skills (Demers & Koven, 2015). Acknowledging the overlapping nature of the cognitive and affective components, as they would appear in an ecological setting is crucial not only for future development of measures, but also of

the generalizability of ToM research. When conceptualizing ToM as a social cognitive construct, examining the overlapping nature of cognitive and affective ToM as occurring at the same time rather than independently, may help provide insight into the deficits some children experience with perspective taking.

Limitations

Several limitations are present in the current study. The first is the relatively small sample size of participants with and without ADHD. A greater sample size of children with ADHD would allow for specific analyses on sleep quality between the different types of ADHD. Additionally, a larger sample size would have allowed an examination of participants' comorbid diagnoses and medication status on the impact on both sleep and ToM. Previous research has suggested that types of ADHD, comorbidities, and medication status may have additional impacts on sleep; being able to analyze each factor individually would allow for a more comprehensive examination of sleep quality in children with ADHD (Yoon et al., 2012). Past sleep research has excluded participants who had ADHD and comorbid depressive and anxiety disorders from their samples, believing they could have a strong impact on sleep that is unrelated to ADHD (Cortese et al., 2009). Anxiety disorders and depressive disorders are both psychiatric disorders that frequently impact sleep quality, and had the current study had a larger sample size, it could have either excluded those with comorbidities, or perhaps examined their impact on the sleep of children with ADHD versus the control group.

The current study's sample size also limited the inclusion criteria for the ADHD group. Participants in this study had ratings on the Conners 3-PRS that were below the symptom cut off for what would diagnostically be considered ADHD, but as they were taking medication for the treatment of their ADHD were still included. The lack of current ADHD symptoms was

attributed to the treatment of ADHD with medication; however, this could not be confirmed through other diagnostic measures. Additionally, the use of medication may have impacted the social cognitive deficits also attributed to ADHD. ADHD medication may have contributed to the lack of the significant differences between groups seen on the RME, a task which previously has resulted in lower scores in children with ADHD (Mary, et al., 2016).

A second limitation was the lack of diversity within the recruitment of participants. The current study was able to test participants from three provinces across Canada. However, the recruitment primarily came from connections within the university community. The majority of both mothers (63%) and fathers (45%) had an undergraduate degree or higher. Parental education has previously been used as a proxy for socioeconomic status (Tillman & Granvald, 2015). Parent education in the current sample appears to be greater than the 28% of Canadians in the general population who have a university degree (Statistics Canada, 2017). Further, when examining the impact of parental education on symptom reporting for children with ADHD, parents of children with ADHD who have higher education are more likely to report deficits in ADHD symptoms and executive functions (Tillman & Granvald, 2015). Parent education may also have an impact on the reporting of sleep disturbances. Importantly, this has not been directly studied and may also merit examination in future research.

Further, over 80% of participants identified as Caucasian and over 80% living with both parents. ADHD is a disorder that impacts all races, socioeconomic statuses, and living situations (Hauck, Lau, Wing, Kurdyak, & Tu, 2017). Sleep hygiene, which is highly sensitive to family structure and family routine, may be reported very differently in a diverse and representative population. The lack of diversity in the current sample may have impacted the differences between groups on sleep disturbances. Further, lack of diversity may also have an impact on

exposure to social situations, which in turn could have impacted ToM performance. Children who have greater exposure to social situations throughout development, tend to have greater ToM development (Tesfaye et al., 2017). Future studies should seek to gain information from a diverse population so that the application of the research can be applied to many family environments and living situations.

The final limitation of the current study was the unidimensional quality of the ToM measure. There are several dimensions to theory of mind, including cognitive and affective, first-order, second-order, and third-order understanding. The RME measure focused primarily on first-order affective ToM and did not encompass all the dimensions of the social cognitive skill. Ideally, a ToM measure would present children with situations that are ecologically valid and ask them to take perspective on the social situation that is occurring. An ecologically valid task would allow children to respond on both the cognitive and affective aspects of ToM. Further, if a measure which used social situations which replicated the social interactions that would normally be experienced by children, the identification and treatment of deficits would be more valid. Employing ToM tasks that replicate what children experience in their day-to-day lives and allow them to perform as they would in such everyday social situations, would provide a more robust examination of ToM differences in children with ADHD and the possible implications of poor sleep quality.

Directions for Future Research

The CSHQ is not a formal tool for diagnoses of sleep disorders, however perhaps had a formal diagnostic analyses of sleep disorders been completed, there would be a higher comorbidity of sleep disorders in the ADHD group. In particular, using a diagnostic tool which assesses RLS along with other sleep disorders included in the most recent version of the ICSD-

III, would build on the current understanding of sleep and ADHD.

One explanation for the high comorbidity rates between RLS and ADHD is that both are disorders that primarily affect central nervous system pathology. Both ADHD and RLS have been associated with dopamine deficiencies, specifically in the midbrain, frontal, and prefrontal regions of the brain. Although further evidence is still needed, it is possible that RLS exacerbates the symptoms of ADHD by having the RLS caused sleep deprivation result in symptoms of inattention and hyperactivity (Cortese et a., 2005). Examining the prevalence of RLS and PLM symptoms in children with ADHD may provide a greater understanding of the source of sleep difficulties in children with ADHD.

Further researching the specific qualities of the sleep disturbances experienced by children with ADHD may help with the development of direct and specific interventions to improve sleep quality. Using self-report measures of sleep may provide greater insight into the causes of the sleep disturbances. The current study noted overall greater daytime sleepiness and greater disturbances in sleep duration among children with ADHD; however, the exact etiology of poor sleep quality remains unknown, perhaps with the exception of sleep anxiety. Using self-report measures may provide improved insight into the source of sleep disturbances.

In addition to subjective sleep measures, confirmatory objective sleep studies which analyze the sleep-wake cycles may be essential to help fully understand the differences in sleep experienced by children with ADHD. Objective sleep measures would not only aid in the identification of sleep disturbances, but also help in the development of specific sleep intervention strategies. Objective methods of measuring sleep analyze brain activity during the night through electroencephalogram (EEG). Using objective sleep measures would allow for a more in-depth analyses of the neurochemical regulatory mechanisms of the sleep–wake cycle.

The neurochemical regulatory mechanisms involved in the sleep-wake cycle are closely associated with excitatory and inhibitory cortical processes which are also a neurological contributor to the cognitive and behaviour dysfunction seen in ADHD (Muzur et al. 2002). Just as children with ADHD struggle to inhibit their behaviour, they may also struggle to inhibit stimuli around them causing them to have difficulty falling and staying asleep (Yoon et al,. 2012).

The present study sought to expand on existing literature by examining the role of sleep quality in ToM in children with ADHD. Results of the study suggest that children with ADHD have lower sleep quality than a control group but no relationship between sleep and ToM was found. Further investigation is warranted to determine the nature of the relationship between sleep and social cognitive skills such as ToM 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:
Christina Gray, Faculty of Graduate Studies, Werklund School of Education, 403.210.6726 & cgray@ucalgary.ca
Kelsey Friesen, Faculty of Graduate Studies, Werklund School of Education, & kfriesen@ucalgary.ca
Tessa Ritchie, Faculty of Graduate Studies, Werklund School of Education, & tessa.ritchie1@ucalgary.ca
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 403.220.7
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 for

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.

APPENDIX G
Certification of Conjoint Research Ethics Approval

Conjoint Faculties Research Ethics Board
Research Services Office
2500 University Drive, NW
Calgary AB T2N 1N4
Telephone: (403) 220-4283/6289
cfreb@ucalgary.ca

CERTIFICATION OF INSTITUTIONAL ETHICS APPROVAL

Ethics approval for the following research has been renewed by the Conjoint Faculties Research Ethics Board (CFREB) at the University of Calgary. The CFREB is constituted and operates in compliance with the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* (TCPS 2).

Ethics ID:	REB17-0179_REN2
Principal Investigator:	Emma Climie
Co-Investigator(s):	There are no items to display
Student Co-Investigator(s):	There are no items to display
Study Title:	Theory of Mind in Children with ADHD
Sponsor:	Carlson Family Research Award in ADHD

Effective: Thursday, June 13, 2019 **Expires:** Saturday, June 13, 2020

Restrictions:

This Certification is subject to the following conditions:

1. Approval is granted only for the research and purposes described in the application.
2. Any modification to the approved research must be submitted to the CFREB for approval.
3. An annual application for renewal of ethics certification must be submitted and

approved by the above expiry date.

4. A closure request must be sent to the CFREB when the research is complete or terminated.

Approved By:	**Date:**
John H. Ellard, PhD, Chair , CFREB	Friday, May 24, 2019

Note: This correspondence includes an electronic signature (validation and approval via an online system).