8-1-2017

Social Cognition in Children with Attention-Deficit/Hyperactivity Disorder

Elyse Parke
University of Nevada, Las Vegas

SOCIAL COGNITION IN CHILDREN WITH ATTENTION-DEFICIT/ HYPERACTIVITY DISORDER

by

Elyse Martina Parke

Bachelor of Arts - Psychology
Westmont College
2009

Master of Arts - Psychology
University of Nevada, Las Vegas
2014

A dissertation submitted in partial fulfillment of
the requirements for the

Doctor of Philosophy - Psychology

Department of Psychology
College of Liberal Arts
The Graduate College

University of Nevada, Las Vegas
August 2017

UNLV | GRADUATE COLLEGE

Dissertation Approval

The Graduate College
The University of Nevada, Las Vegas

February 24, 2017

This dissertation prepared by

Elyse Parke

entitled

Social Cognition in Children with Attention-Deficit/Hyperactivity Disorder

is approved in partial fulfillment of the requirements for the degree of

Doctor of Philosophy - Psychology
Department of Psychology

Daniel Allen, Ph.D.
Examination Committee Chair

Kathryn Hausbeck Korgan, Ph.D.
Graduate College Interim Dean

Michelle Paul, Ph.D.
Examination Committee Member

Andrew Freeman, Ph.D.
Examination Committee Member

Merrill Landers, PT, DPT, Ph.D.
Graduate College Faculty Representative

Abstract

Social Cognition in Children with

Attention-Deficit/Hyperactivity Disorder

by

Elyse M. Parke, M.A.

Dr. Daniel N. Allen, Examination Committee Chair

Professor of Psychology

University of Nevada, Las Vegas

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder, which impacts behavioral outcomes, including social functioning. Children with ADHD demonstrate impairment across a number of social domains, including aggressive behavior, poor social skills, and higher rates of Oppositional Defiant Disorder compared to typically developing peers. However, the underlying neurocognitive underpinnings of these poor social outcomes are unclear. Furthermore, little is known regarding the impact of ADHD symptomatology on aspects of social cognition. Inattention, hyperactivity, and impulsivity may differentially impact components of social cognition. Determining whether performance on social cognition tasks is predictive of social skills and problem behaviors is also an area with limited research. Therefore, the current study investigated the relationship between behavioral outcomes, social cognition, and ADHD symptomatology. Children with ADHD performed significantly poorer than the control group on measures of affect recognition, pragmatic language, cognitive theory of mind (ToM), and cognitive empathy. Inattention was predictive of performance in these domains, but there was little improvement of the model with the addition of hyperactivity and impulsivity.

Pragmatic language, cognitive ToM, and cognitive empathy were predictive of parent ratings of problem and prosocial behaviors. Findings indicate that children with ADHD have difficulty with cognitive, but not affective components of social cognition.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by poor attention, excessive activity, and impulsivity (American Psychiatric Association [APA], 2013). In addition to an increased incidence of academic problems, many children with ADHD exhibit social skills deficits. Specifically, many children with ADHD exhibit poor eye contact, empathy, and difficulty developing age appropriate relationships with peers (Uekermann et al., 2010). These poor social skills may result in the high incidence of Oppositional Defiant Disorder (ODD), aggression, and other negative behavioral outcomes (Tseng, Kawabata, & Shur-Fen Fau, 2011). Therefore, it is clinically significant to investigate the underlying mechanisms resulting in poor social skills and defiant behavior in children with ADHD.

While poor social outcomes are demonstrated in the literature, the underlying cognitive and biological mechanisms responsible for these outcomes are unclear. Social cognition is a broader domain, which includes encoding and interpreting social cues, such as emotional content portrayed by affect recognition, theory of mind (ToM), and empathy (Uekermann et al., 2010). Affect recognition can apply to interpreting emotions in facial expressions and nonverbal communication (e.g., prosody, body language). Theory of mind describes the cognitive processing of another's thoughts and feelings, which is essential to navigating everyday social interactions and developing relationships (Beauchamp & Anderson, 2010). Other aspects of social cognition relevant to children with ADHD are empathy and pragmatic language. Empathy requires the emotional understanding of another's mental state. Pragmatic language refers to the use of language in a social context and is necessary for communicating and understanding social

and emotional intent (Grzadzinski et al., 2011). The current study provides a thorough investigation of social cognition, including theory of mind, affect recognition, pragmatic language, and empathy because these components of social cognition are implicated in poor behavioral outcomes (Leonard, Milich, & Lorch, 2011; Robinson et al., 2014; Sachs et al., 2012; Schonert-Reichl, Smith, Zaidman-Zait, & Hertzman, 2012).

Research in other clinical populations clearly demonstrates that appropriate social skills are dependent upon developed social cognition (Brune, 2005). There is conflicting evidence regarding whether social cognitive deficits are present in children with ADHD. Some studies indicate that children with ADHD demonstrate difficulty attending to, encoding, and recalling social cues (Moore, Hughes, & Robinson, 1992; Sibley, Evans, & Serpell, 2010). Previous research also indicates that children with ADHD perform significantly worse than healthy controls on affect recognition (Bae, Shin, & Lee, 2009; Ibáñez et al., 2011; Pelc et al., 2006; Williams et al., 2008) and more advanced theory of mind tasks (Buitelaar, van der Wess, Swaab-Barneveld, & van der Gaag., 1999; Sodian & Hülsken, Thoermer, 2003). Some studies demonstrate that participants with ADHD perform similarly to children with autism spectrum disorder on mentalizing and affect recognition measures (Buitelaar et al., 1999; Sinzig, Morsch, & Lehmkuhl, 2008). Other studies find that children with ADHD or at risk for ADHD do not significantly differ from control participants on social cognition tasks (Charman, Carroll, & Sturge, 2001; Dyck, Ferguson, & Shochet, 2001; Perner, Kain, & Barchfeld, 2002). Studies that find no differences suggest that social skills deficits are related to problems in social performance rather than problems with social cognition (de Boo & Prins, 2007; Huang-Pollock et al., 2009). Because there are conflicting findings in the literature, it is currently unclear the

extent to which social skills deficits relate more to performance or social cognitive deficits. This would be valuable information to guide appropriate targets for social skills interventions.

Contrasting findings in the literature may be explained by methodological considerations, such as the use of small sample sizes (Buitelaar et al., 1999) and examination of community samples of children at risk for ADHD (Perner et al., 2002). Studies also vary in the sample characteristics (e.g., ages, comorbidities) and types of measures, which may impact results. Furthermore, few studies have included females with ADHD, limiting the extent to which we can generalize social cognition findings to girls with ADHD. Another area lacking in the literature is the impact that core ADHD symptomatology has on measures of social cognition. Much of the studies that exist utilize behavior ratings of ADHD symptomatology and social functioning rather than direct measures (Bae et al., 2009; Solanto Pope-Boyd, Tryon, & Stepak, 2009). Little is known regarding the differential impact of inattention, hyperactivity, and impulsivity on social cognition performance. Children that exhibit more severe symptoms across one of the symptom domains may present with unique social cognitive profiles. Thus, there is need for a study examining the relationship between ADHD symptomatology and social cognition.

Finally, if functional differences and social cognitive deficits are responsible for poor social outcomes, then these variables should predict real world behavior ratings as demonstrated in other clinical populations (Brune, 2005; Thaler, Allen, Sutton, Vertinski, & Ringdahl, 2013). The proposed findings will further support the relationship between neurocognitive mechanisms, ADHD symptomatology, and behavioral outcomes. This data would also provide substantial clinical utility in determining social cognitive targets of early intervention and prevention of negative behavioral outcomes.

Chapter 2

Literature Review

Attention-Deficit/Hyperactivity Disorder

Attention-Deficit/Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by core symptoms of inattention, hyperactivity, and impulsivity (APA, 2013). These symptoms are developmentally inappropriate and may persist into adulthood (Miller, Hanford, Fassbender, Duke, & Schweitzer, 2011). ADHD is among the most commonly diagnosed psychological disorder in childhood (Barkley, 2014a), occurring in about 5% of the population (APA, 2013). This disorder is highly heritable (Stergiakouli et al., 2015) as well as influenced by environmental factors such as, socioeconomic status, prenatal exposure, familial conflict, and education level (van der Kolk et al., 2014). ADHD is more commonly diagnosed in males, with differences in symptom severity and subtype (Arnett, Pennington, Willcutt, DeFries, & Olson, 2014). Symptoms present in multiple settings and are associated with poor academic and behavioral outcomes (Daley & Birchwood, 2010). Diagnoses are based on determining symptom severity commonly assessed through clinical interviews, neuropsychological testing, and behavioral ratings.

The Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5; APA, 2013) currently classifies ADHD into the following presentations: predominantly hyperactive (ADHD-HI), predominately inattentive (ADHD-I), and combined (ADHD-C). This is a reclassification of subtypes present in the prior DSM 4th Edition (DSM-IV; APA, 2000). The newer term presentation was used in efforts to account for the temporal instability (Lahey, Pelham, Loney, Lee, & Willcutt, 2005; Lee, Lahey, Owens, & Hinshaw, 2008; Todd et al., 2008) and discrepancies across clinicians and diagnostic procedures (Rowland et al., 2008; Valo &

Tannock, 2010). However, studies clearly indicate that subtypes/presentations significantly differ with regard to neurocognitive, behavioral, and academic functioning (Barkley, 2013; Nigg, Tannock, & Rohde, 2010; Reirsen & Todorov, 2013). Research has generally focused on the inattentive and combined presentations as symptoms of inattention are most associated with neurocognitive and functional impairment (Halperin et al., 1990). Additionally, the hyperactive/impulsive presentation (ADHD-HI) is often considered a precursor to ADHD-C (Capdevila-Brophy et al., 2014). Children with the combined presentation tend to exhibit more externalizing behavior, including higher rates of aggression and substance abuse (Hofvander et al., 2011). This population is also more commonly diagnosed with Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD; Frick & Nigg, 2012). Children with predominately inattentive symptoms are more likely to struggle with anxiety, depression, learning problems, and exhibit a sluggish cognitive tempo (Barkley, 2014; Bauermeister, Barkley, Bauermeister, Martínez, & McBurnett, 2012; Becker & Langberg, 2013; Capdevila-Brophy et al., 2014; Saxby & Barkley, 2014).

Current conceptualizations of ADHD are that the primary deficit is in response inhibition (Barkley, 2014). This core neuropsychological impairment results in ADHD symptomatology and executive functioning deficits. For example, inattention is a disinhibition of attention to irrelevant stimuli. Hyperactivity is the disinhibition of motor activity and impulsivity is a disinhibition of verbal and decision-making processes (Nigg, 2001). Executive functioning deficits are thought to represent the core neuropsychological impairment in ADHD. Common findings include deficits in sustained attention, working memory, and response inhibition (Bunford et al., 2015). Recent attention has also focused on slowed processing speed and sluggish cognitive tempo (SCT) in children with ADHD (Bauermeister, Barkley, Bauermeister,

Martínez, & McBurnett, 2012; Becker & Langberg, 2013; Saxby & Barkley, 2014). Some researchers propose that children with SCT represent a unique subtype or subpopulation (Barkley, 2014b). However, further research is needed to validate this theory. While extensive research has been conducted with neuropsychological measures, little is known about social cognitive functioning in individuals with ADHD. This research can provide insight into the poor social, emotional, and behavioral outcomes often observed. Therefore, the proposed current study will address this matter by a comprehensive examination of social cognition and functioning in children with ADHD.

In the following sections, each of the areas relevant to the current study are reviewed. Specifically, social cognition, relevant neurobiological correlates, social functioning, and ADHD symptomatology are examined in light of the literature. Recent findings and theoretical considerations guide study hypotheses and conclusions.

Social Cognition: An overview

Definition and neural processes. Since the beginning of psychology as a formal discipline, psychologists have been interested in human's abilities to relate to one another and adapt in a social world (Thorndike, 1920; Wechsler, 1955). These abilities are distinct from other cognitive abilities, including IQ, verbal reasoning, attention, and executive function (Fiske & Taylor, 2013). These two domains of cognition are often termed "hot" and "cool/cold" cognitive abilities, with the latter term representing traditional neurocognitive testing (Prencipe et al., 2011). Social cognition is a broad construct that includes both social and emotional components. Other terms historically associated with this construct include emotional intelligence (Goleman, 1998), theory of mind (Frith, 1992), and emotion perception (Cannon, 1929). These terms reflect the broadness of social-emotional abilities associated with social

cognition. Emotional intelligence has been understood as including abilities to recognize and regulate one's emotions (Curci, Lanciano, Soleti, Zammuner, & Salovey, 2013), whereas social cognition refers to the capacity to relate social and emotional information to other people (Uekermann et al., 2010). Although these constructs are similar, they are distinct in their place in the field of psychology. Emotional intelligence has been historically studied in terms of personality theories, whereas social cognition generally is examined in the social and cognitive neurosciences. Thus, the current paper examines social cognition because of its relation to neuropsychology and neuroscience.

Models of social cognition include social information processing theory (Crick & Dodge, 1996) social-emotional processing stream framework (Oschner, 2008), and the Socio-Cognitive Integration of Abilities Model **(**SOCIAL; Beauchamp & Anderson, 2010). While there are subtle differences in these models, most theorists agree that social cognition includes affect recognition, social perception, theory of mind (ToM), and attributional style (Green, Olivier, Crawley, Penn, & Silverstein, 2005). Affect recognition is the ability to identify emotions in facial expressions and prosody. Social perception refers to the capacity to identify social cues and apply stores of social knowledge for appropriate social behavior. Theory of mind involves the ability to understand another's mental state and make appropriate inferences based on that information. Attributional style is the way in which people explain the causes of events in their lives. These four abilities are often impaired in a multitude of clinical populations, but have been primarily examined in individuals with autism (Sinzig, Morsch, & Lehmkuhl, 2008) and schizophrenia (Oschner, 2008).

The field of social cognitive neuroscience has recently expanded and attempted to identify the neurobiological mechanisms involved in social cognition. Neuroanatomical studies

have revealed that the amygdala is particularly involved in assessing threatening social stimuli, such as emotional facial expressions (Pelphrey, Adolphs, & Morris 2004). Structural abnormalities have been found in children with autism who often have profound deficits in social cognition (Pelphrey et al., 2004). Other brain regions associated with social cognition include the fusiform gyrus and superior temporal sulcus. The fusiform gyrus is thought to regulate analyzing static facial expressions (Kawasaki et al., 2012). The superior temporal sulcus is associated with biological motion and processing context of other people's actions (Deen & Saxe, 2012). Research indicates that the prefrontal cortex (PFC), orbitofrontal cortex (OFC), caudate nucleus, ventral striatum, and cerebellum (Adolphs, 2001; Cacioppo & Berntson, 1992; Lieberman, 2007; Ochsner & Lieberman, 2001) are also implicated in social cognition. The prefrontal lobe is associated with executive control of social and emotional processing and behavioral output (Uekermann et al., 2010). The PFC and OFC are most often associated with theory of mind and regulating emotional expression (Bechara, 2004; Bechara, Damasio & Damasio, 2000; Rolls, 2000). For example, lesion studies and case studies of patients with traumatic brain injury (TBI) have demonstrated the importance of the PFC and OFC in regulating emotions and higher order social thinking (Eslinger, Flaherty-Craig, & Benton, 2004). Furthermore, functional magnetic resonance imaging (fMRI) has demonstrated activity in these particular regions during activities requiring social abilities (Vaidya et al., 2005). Research also identifies the caudate nucleus as involved in processing positive emotions and nonverbal cues (Balleine, Delgado & Hikosaka, 2007; Lieberman, 2000) and the ventral striatum is involved in social reward processing (Delgado, 2007; Juckel et al., 2006). Finally, observance of patients with cerebellar cognitive affective syndrome provides evidence that the cerebellum is also involved in affect and regulation of social behavior (Schutter & van Honk, 2009).

Beyond individual brain regions, there may be specific circuits involved in the component of social behavior. For example, research indicates that the amygdala, insula, and ventral striatum work in conjunction to mediate emotion perception (Qin et al., 2014). Emotional regulation is distinct from emotion perception, as it involves the ability to generate, alter, and monitor emotional reactions. This process involves circuitry between PFC, anterior cingulate, and amygdala (Zotev, Phillips, Young, Drevets, & Bodurka, 2013). Theory of mind has also been extensively studied in the neurosciences. Across different methodologies and studies, research indicates that the medial PFC, temporal sulcus, temporoparietal junction, and temporal poles are involved in mentalizing/theory of mind (Blackmore, 2008). Thus, multiple brain regions are involved in social cognition as a whole and may differentially impact components within this broad construct.

Models of social cognition. A model of social cognition that has been applied to clinical populations is social information processing theory (SIP; Crick & Dodge, 1996; Dykas & Cassidy, 2011). This theory has often been applied to explain the underlying cognitive and neurological mechanisms resulting in aggressive behavior in children (Horsley, Orobio de Castro, & Van der Schoot, 2010). Key terms used to define social interactions within this model are *encoding, representing*, *goals*, *emotion regulation*, *response generation*, *evaluation*, and *enactment*. Social information must first be accurately *encoded* and *represented*. Then social *goals* are generated and response options are *generated* and *evaluated* to determine their appropriateness to the situation. Finally, *enactment* of emotional and behavioral reactions is *regulated* for adaptive social functioning. Clinical populations demonstrate deviations along each of the steps of information processing that leads to behavioral disturbances. For example, many factors could interfere with accurate encoding, including general inattention and/or

attentional biases to aggressive information. Research on individuals with increased aggressive behavior indicates that these individuals falsely encode and misattribute situations as overly hostile (Yaros, Lochman, Rosenbaum, & Jimenez-Camargo, 2014). Some speculate that these findings are due to biases of schema-consistent information across all populations (Horsley et al., 2010). Thus, at a very early stage of processing social information, some clinical populations may be biased toward aggressive information. While SIP theory is helpful in understanding cognitive components of social cognition, there is little research applying this model to neurobiological mechanisms (Beauchamp & Anderson, 2010).

More specific models of social cognition have attempted to connect social cognition and social functioning with their underlying neurobiological mechanisms. For example, the social-emotional processing stream theory proposed by Kevin Oschner (2008) has attempted to explain social and emotional deficits in schizophrenia. This model is composed of five hierarchical sub-constructs including, acquisition of social-affective values and responses (Construct 1), recognizing and responding to social-affective stimuli (Construct 2), low-level mental state inference (Construct 3), high-level mental state/trait inference (Construct 4), and context-sensitive regulation (Construct 5). Construct 1 involves learning and responding to social and non-social stimuli. The amygdala and ventral striatum are thought to be involved in this process of affective learning (Delgado, 2007; Pelphrey et al., 2004). Construct 2 is most associated with facial and emotional perception. The ability to recognize and respond to social-affective stimuli is regulated by an interaction between the amygdala and hippocampus. The amygdala assists in identifying environmental stimuli, while the hippocampus retrieves relevant social-emotional information for the context (Ochsner, 2008). Construct 3 is described as subliminal reactions to emotional states that are not distinctly defined. Mirror neurons which fire when someone

observes another person performing an action are thought to be involved in this process. However, activity of mirror neurons is more firmly established in motor and pain neurons (Lago-Rodríguez, Cheeran, Koch, Hortobagy, & Fernandez-del-Olmo, 2014) than in more complicated social processes, such as empathy (Oschner, 2008). Construct 4 (high-level mental state/trait inference) relates to encoding contextual information to assist in higher-level understandings of mental states. Higher-level social cognition involves the interpretation of more complex or subtle social cues and overlaps substantially with the theory of mind construct. The neural correlates for Construct 4 are the dorsal and rostral medial prefrontal cortex, the paracingulate cortex, the precuneus, the temporal-parietal junction, and the superior temporal sulces (Ocshner, 2008). Finally, Construct 5 is the behavioral output and decision making resulting from the processing involved at the lower four constructs. This construct is thought to involve social-emotional regulation mediated by the hippocampus, anterior cingulate cortex, and prefrontal cortex (Ocshner, 2008).

Another model involving a multi-disciplinary approach to social cognition is the developmental biopsychosocial model (SOCIAL). The SOCIAL model may be the best approach to understanding social cognition within the context of pediatric populations, such as children with ADHD. Therefore, it will be explored in depth and used along with empirical support to guide the proposed study. This model expounds upon three separate components (attention-executive, communication, and social-emotional) with unique biological correlates (Beauchamp & Anderson, 2010). Additionally, the SOCIAL model discusses the internal and external (environmental) factors that mediates each of these skills. This model indicates that an attention-executive component involves emotional regulation and processing speed relating to daily social interactions. The communication component is associated with language skills (e.g.,

pragmatic language), while the social-emotional component refers to affect recognition, attributional style, and theory of mind. Neuroanatomical correlates associated with these components include, the prefrontal cortex regulating the attention-executive component and the temporal and inferior frontal regions regulating the communication component. The social-emotional component has been more extensively studied in social neuroscience and has been broken down into several subcomponents. Facial and emotion perception is regulated by the amygdala, attributional style is controlled by the prefrontal cortex, and theory of mind is associated with the temporoparietal junction and prefrontal cortex. Beauchamp and Anderson (2010) argues that each of the subcomponents of socio-emotional abilities are impacted by developmental processes. Initial basic social processing, including facial recognition, generally occurs early on in development. Other more complex social processes, such as theory of mind and moral reasoning continue developing into adolescence. This behavioral developmental progression in social and emotional abilities may correspond to neurobiological development. For example, theory of mind may develop later because it is reliant upon prefrontal lobe development (O'Nions et al., 2014). Thus, a thorough review of this model is relevant to this study because of its developmental approach, link to neurobiological correlates, and suspected dysfunction in children with ADHD across all components in the SOCIAL model.

The attention-executive component within the SOCIAL system includes the larger constructs of attention and executive function. Conceptualizations of attention indicate that the construct is a multicomponent system including focusing, sustaining, shifting, and encoding (Mirsky, Antony, Duncan, Ahearn, & Kelham, 1991). Prior research indicates that children with ADHD demonstrate the most difficulty with the sustaining and encoding components (Thaler, Allen, Park, McMurray, & Mayfield, 2010), which are necessary for maintaining attention and

encoding pertinent social information.

The SOCIAL model separates executive functioning skills into three domains: attentional control, cognitive flexibility, and goal setting. Attentional control refers to the processes of selective attention, sustained attention, self-regulation, response inhibition, and self-monitoring. Selective attention involves focusing attentional control on a short-term task or goal (Gazzaley & Nobre, 2012), whereas sustained attention requires consistent goal directed attention over extended periods of time (Bonnelle et al., 2011). Self-regulation and response inhibition apply to monitoring and adjusting cognition, emotion, and behavior (Surman et al., 2013). Cognitive flexibility involves the abilities of working memory, attentional shifting, and conceptual transfer. Working memory is the ability to hold and manipulate short-term visual or verbal information (van Ewijk et al., 2014). Attentional shifting refers to a switching attention between two or more stimuli. Conceptual transfer involves switching, but primarily to complex or abstract concepts (Horowitz-Kraus, 2014). These abilities are often measured by tasks, such as the Wisconsin Card Sorting Test or the Delis Kaplan Executive Functioning system (DKEFS) Sorting subtest (Aker & Landrø, 2014). Finally, goal setting involves initiating, planning, problem solving, and strategic behavior. These steps in goal setting encompass the appropriate forethought and execution of cognitive, social, and emotional behaviors.

While each of these neuropsychological processes are distinct, they work in conjunction for cognitive control needed for everyday tasks. For example, one must first employ selective attention to information before they can mentally manipulate it in their working memory system (Gazzaley & Nobre, 2012). This network of cognitive abilities and associated neural networks is particularly relevant to the complex world of social interactions. When attention and executive functioning skills are disrupted, resulting social behavior is affected. For example, in clinical

populations poor attention can result in missing environmental social cues resulting in inappropriate social and emotional reactions to others. Poor impulse control and emotional regulation can also lead to aggressive behavior and poor implementation of behavioral strategies. For example, children may get rejected by their peers if they are frequently impulsive and unable to take turns in conversations or games. Conceptual inflexibility could create social problems, such as the inability to take feedback from others or understand another's opinion. Poor set shifting could also impact a child's ability to adjust to changes in routine, mood, context, or conversation. Aspects of goal setting, such as planning and arriving on time to social engagements could also be disrupted resulting in poor interpersonal relationships (Jacobs & Anderson, 2002). Attention and executive components are particularly impacted by developmental processes, such as the development in the prefrontal lobes (Beauchamp & Anderson, 2010). This neural development likely accounts for growth and fluctuations in executive control over social and emotional behavior in childhood and adolescence. Research reliably demonstrates that children and adolescents with ADHD are delayed in the aforementioned attention and executive abilities (Antshel, Hier, & Barkley, 2014). Thus, their social behavior and emotional control is also impacted by this delayed developmental process. Notably, interventions targeting attention and executive functioning often translate into improved social functioning as well (Greenberg, 2006; Riggs, Greenberg, Kusche, & Pentz, 2006). Processing speed is another neurocognitive ability often associated with social functioning, attention, and executive functioning (Anderson, 2008). Research indicates that these abilities develop in a linear fashion in childhood and progress more slowly in adolescence (Kail & Ferrer, 2007). Delays or disruptions in the development of processing speed can result in difficulty maintaining pace with conversations and complex social interactions. This phenomenon has

been demonstrated in clinical populations, such as schizophrenia (Jabben et al., 2008), TBI (Rassovsky et al., 2006), and ADHD (Bauermeister, Barkley, Bauermeister, Martínez, & McBurnett, 2012). These populations may benefit from learning adaptive strategies to cope with fast past interactions.

The SOCIAL model identifies both verbal and nonverbal communication as essential components of social interactions. Social communication includes multiple abilities, such as joint attention, expressive and receptive language, and integration of emotions and gestures (Landa, 2005). These abilities are strongly associated with successful social interactions and maintenance of interpersonal relationships (Byars et al., 2014). These communication processes are particularly impacted in individuals with autism (Gibson, Adams, Lockton, & Green, 2013). However, there are also subtle deficits in communication abilities in other clinical populations, such as ADHD (Leonard, Milich, & Lorch, 2011; Väisänen, Loukusa, Moilanen, & Yliherva, 2014). Joint attention refers to the initiation of an individual's and/or response to another's attempt at sharing attention to a stimulus (e.g., person, object; Redcay et al., 2013). Expressive communication is outward communication (e.g., vocabulary), whereas receptive language is internal understanding, such as comprehension of instructions (Leonard et al., 2011). Prior research indicates that children with ADHD are typical in their receptive language development (Barkley, DuPaul, & McMurray, 1990), but often have delays in their expressive language (Kim & Kaiser, 2000). Difficulties in expressive language could impact a child's ability to communicate their thoughts, emotions, and desires. Significant speech delays could also lead to peer ostracizing. Pragmatic language is also important in communication, as it is the use of language and nonverbal communication relating to social interactions (Leonard et al., 2011). Pragmatics includes the following: topic initiation, topic maintenance, turn taking, use of

context, interruptions, amount of talk, intensity (tone and volume), eye contact, facial expression, physical proximity, and gestures (Prutting & Kirchner, 1987). Detecting these subtle differences, such as changes in prosody, are useful in monitoring one's own tone and behavior. Furthermore, subtle aspects of language, such as irony, impact the ability to detect humor or sarcasm. Pragmatic communication has been shown to be impacted in children with ADHD (Grzadzinski et al., 2011), with a strong association between assessments of pragmatic abilities and social skills (Leonard et al., 2011).

The SOCIAL model proposes that communication and social abilities are linked on a neurobiological and developmental level. The biological basis for communication processes are the temporal, temporoparietal, and inferior frontal regions (Beauchamp & Anderson, 2010). These regions mature at different rates (Friederici, 2006), which may correspond with behavioral expressions of communication. Even as early as infancy, a social smile can be used to initiate communication. Later imitation and joint attention are used by young children to connect with others. These early signs of social abilities are the building blocks for language development. For example, studies indicate that joint attention in infants is predictive of a child's vocabulary (Pickard & Ingersoll, 2015). Expressive language development then in turn impacts later social development. For example, the higher a child's vocabulary, the greater their ability to express emotions and subsequently execute appropriate social interactions (Mostow, Izard, Fine, & Trentacosta, 2002).

The final socio-emotional component of the SOCIAL model directly addresses social cognitive abilities. As in other models of social cognition, the authors expand upon the subcomponents (affect recognition, attributional style, and theory of mind) to provide a comprehensive account for social cognition and its biological underpinnings. Facial and emotion

perception is the basic level process that requires attention to multiple details, including identity, gaze direction, and perceived intention (Calder & Young, 2005; Vuilleumier & Pourtois, 2007). Facial identity is somewhat biologically and behaviorally distinct from recognizing emotional expressions in faces (Bruce & Young, 1986). However, both abilities can be affected in clinical groups (Hefter, Manoach, & Barton, 2005; Vuilleumier & Pourtois, 2007). Certain aspects of the face are particularly relevant to understanding emotion. Research indicates that the central features (eyes and mouth) contains the most relevant social-emotional information (Calvo, Beltrán, & Fernández-Martín, 2014). Clinical populations often demonstrate deficits in recognizing emotional expressions in faces, which may be due to inattention to the most relevant information on the central visual cues (Vaidya, Jin, & Fellows, 2014).

The generally accepted definition of attribution is the way individuals attribute intent or causes to another's behavior (intent attribution) or personality characteristics (trait attribution; Harris, Todorov, & Fiske, 2005). These inferred intentions impact the way in which we relate to others. For example, if we infer that someone has hostile intentions, then subsequent interactions may be more aggressive. Attribution in the SOCIAL model is understood as the mediator between more basic levels of face/emotion processing and the more complex process of theory of mind (Beauchamp & Anderson, 2010). Social attribution is a distinct form of attribution that refers to the capability to infer social meaning (e.g., mental states) from external stimuli (Klin, 2000). Faulty attribution of intentions has been primarily studied in individuals with high rates of aggression. The SIP model has specifically been applied in this population to address biases towards perceiving hostile intentions in others (Crick & Dodge, 1996). This disruption in intent attribution could also apply to a wide range of clinical populations, such as psychiatric (Lahera et al., 2015) and neurodevelopmental conditions (Becker, 2014). Clearly misperceiving someone's

intention could lead to a range of dysfunctional social behavior (Orobio de Castro, Veerman, Koops, Bosch, & Monshouwer, 2002).

Theory of mind and empathy are the final subcomponents of the social-emotional domain in the SOCIAL model. According to this model and other theorists, theory of mind is one of the most complex forms of social cognition. Furthermore, theory of mind and empathy are interrelated processes. In order to be empathetic, one must first understand another's mental state. Not surprisingly, when someone is unable to mentalize, they show deficits in emotionally reacting to another's emotional state (Dvash & Shamay-Tsoory, 2014). These deficits can create social difficulties, such as appearing inconsiderate, calloused, or aloof to the emotions and thoughts of others. Developmentally, theory of mind evolves in a stepwise fashion (Beauchamp & Anderson, 2010) as the frontal lobes and supporting neural networks mature (Vetter, Altgassen, Phillips, Mahy, & Kliegel, 2013). Children often begin with egocentric cognitive biases and are then able to differentiate their perspective from others starting in early childhood (Brüne & Brüne-Cohrs, 2006). Through adolescence, this skill continues to mature in their ability to differentiate subtle signs of another's mental state. Across both typical and clinical populations, maturation of theory of mind is correlated with the quality of one's social relationships (Birch & Bloom, 2004; Hughes et al., 2005), as well as social problem solving, planning, and judgment (Baird & Astington, 2004; Sokol, Chandler, & Jones, 2004).

Finally, the SOCIAL model accounts for internal and external factors that impact social and emotional development. Internal factors include personality and temperament, which have environmental and biological components. For example, openness and extraversion are highly related to social skills (Guerin et al., 2011). External variables include family functioning, environment, socioeconomic status (SES), and culture. Each of these variables has the potential

to radically alter one's social and emotional development. For example, poverty is associated with a variety of poor outcomes in cognitive and neurological development, which could lead to poor social cognition and social skills. Furthermore, families may not be able to afford therapeutic interventions to mediate early neurodevelopmental concerns that impact social cognition. While internal and external factors affecting social cognition is important to address, the purpose of the current paper is to address neuropsychological components of social functioning. However, further studies should address the implications of these variables.

Measures of social cognition. Researchers and clinicians have grappled with formal measures of social cognition to account for observed social-emotional deficits. Many have found it difficult to develop measures that translate into real world social and emotional development. Currently, there is no exhaustive ability-based social cognition battery that has established psychometric properties. A review of the measures is helpful in understanding the state of the literature and determining future directions.

Measures examining emotion perception include recognition of emotion in facial expressions, vocal tone or prosody, and other nonverbal cues (e.g., body language). The most widely used and developed measures in this domain are affect recognition in faces. Generally, these measures attempt to represent universally recognized primary emotions, such as happiness, sadness, fear, surprise, disgust, and anger (Ekman & Friesen, 1971). Measures available in children include the Affect Recognition subtest on the Developmental Neuropsychological Assessment-Second Edition (NEPSY-II; Korkman, Kirk, & Kemp, 2007), Japanese and Caucasian Facial Expressions of Emotion (JACFEE; Matsumoto & Ekman, 1988), Frankfurt Test and Training of Social Affect (FEFA) using faces morphing photographs (Pelc et al., 2006), Ekman and Friesen (1975) facial expression photographs, and Cohn Kanade AU-coded Facial

Expressions Database Facial Emotion Matching (FEM; Tian, Kanade, & Cohn, 2001). Another commonly used measure of emotion recognition is the Diagnostic Analysis of Nonverbal Accuracy (DANVA; Norwick & Duke, 1994). The DANVA includes subtests that examine emotion recognition in faces, postures, gestures, and tones of voice (Norwick & Duke, 1994). Other experimental measures of nonverbal emotion recognition are Reading the Mind in the Voice (Golan, Baron-Cohen, Hill, & Rutherford, 2007) and Reading the Mind in Films (Golan, Baron-Cohen, Hill, & Golan, 2006). These are primarily research measures and are not commonly used in clinical evaluations, with the exception of the NEPSY-II.

Social communication has been largely overlooked in the social cognition literature. Measures of pragmatic language are often used by speech therapists and are not common practice in psychological research or clinical assessments. There have been a few measures developed to measure pragmatic language and social problem solving abilities. For example, the Test of Problem Solving (TOPS) assesses language-based social thinking abilities and strategies using logic and experience in children and adolescents. In elementary age children, it addresses critical thinking in social situations and requires the following areas: making inferences, negative questions, predicting, sequencing, problem solving, and determining causes (Bowers, Huisingh, & LoGiudice, 2005). The TOPS for adolescents includes the following subtests: making inferences, determining solutions, problem solving, interpreting perspectives, and transferring insights (Bowers, Huisingh, & LoGiudice, 2005). These language based abilities are essential to understand the nuances of conversations and context of social situations. For example, the ability to transfer insights from one social situation to the next is necessary for social learning. Furthermore, being able to comprehend and express sequences of events and generate possible solutions to problems are socially adaptive cognitive abilities. Other standardized measures of

pragmatic language include the Pragmatic Composite in the Children's Communication Checklist—Revised 2nd edition (CCC-2; Bishop, 2003) and the Test of Pragmatic Language (TOPL; Phelps-Terasaki & Phelps-Gunn, 1992), which requires children to generate responses to social situations in pictures. These measures have largely been used with children with autism, but some studies have examined other populations, such as children with ADHD (Kim & Kaiser, 2000) and TBI (Ryan et al., 2015).

Regarding measurement of attribution, the Social Attribution Task-Multiple Choice (SAT-MC) and Social Attribution Task (SAT) have been developed and used primarily in research settings. These assessments aim to capture participants' social relatedness and identification of intentions in others (Johannsesen, Lurie, Fiszdon, & Bell, 2013). This can be accomplished through visual shapes or pictures of people. The use of geometric shapes is intended to control for verbal and cognitive demands, which may confound results in clinical populations (Johannsesen et al., 2013). For example, Klin (2000) found that performance on the SAT was not related to verbal IQ or metalinguistic abilities in children with autism. This indicates that attributional style, while requiring verbal abilities, is a distinct neurocognitive skill. Another measure of social attribution is the Children's Attributional Style Questionnaire/Kastan–Revised (CASQ-R; Thompson, Kaslow, Weiss, & Nolen-Hoeksema, 1998). This is a self-report measure that asks children to explain presented situations based on two possible attributions. This questionnaire may be helpful in identifying maladaptive attributional styles in children (McQuade, Hoza, Waschbusch, Murray-Close, & Owens, 2011).

There have been many attempts to scientifically measure the real-world skills of theory of mind and empathy. However, many ToM measures are highly correlated with verbal memory, verbal IQ, processing speed, and executive function, which are impacted in many clinical groups

(Greig, Bryson, & Bell, 2004). Furthermore, both ToM and empathy may be difficult to capture in a laboratory setting. Despite these limitations, there are standardized and experimental measures of these social cognitive abilities that have been validated in typical and clinical populations.

Theorists have made the distinction between lower and higher order ToM abilities (Baron-Cohen, Leslie, & Frith, 1985; Sodian & Frith, 1992). Lower-order or first-order ToM generally refers to simpler false belief tasks that often relate to understanding about a location or contents of an object. False beliefs are the ability to recognize that others can believe or think differently about the world around them (Lagattuta et al., 2015). For example, the Smarties Test asks children what they believe is in a chocolate box. They are then shown that there is something else other than chocolates (e.g., pencils). The children are then asked what they think another person would think is in the chocolate box (Cassidy, Ropar, Mitchell, & Chapman, 2014). Children tend to pass this test by age 4 or 5 (Gopnik, & Astington, 1988). Another example is the Sally Anne task (Schneider, Nott, & Dux, 2014) where children are presented with two dolls or characters in a story named Sally and Anne. Both of these characters have a marble, basket, and box. Sally places her marble in a basket and Anne moves it into the box once Sally leaves the room. The child must then accurately answer that Sally would look for her marble where she left it, in the basket. Typically developing children will often fail this task under age 3 or 4 (Schneider et al., 2014). Higher-order or second-order ToM tasks are related to more complex mentalizing situations (Dvash & Shamay-Tsoory, 2014). For example, Happé's Strange Stories (1994) is a commonly used measure of these abilities. This measure asks participants to answer questions about stories or short social vignettes that have aspects that are not meant to be taken literally. The Hinting Task (Corcoran, Mercer, & Frith, 1995) is another

widely used measure of ToM. This measure requires participants to infer someone's intention based on veiled verbal communication of a character within a story. Interpretation of these types of stories requires the listener to utilize factors such as emotional expression, preceding context to statements, and relationships. The distinction between lower and higher-order ToM is important as some clinical groups or age ranges may master lower order ToM tasks, but persistently struggle with real world social situations because of higher order ToM deficits. Furthermore, performance on first and second-order ToM tasks can differentiate clinical groups. For example, the majority of children with autism fail first-order false belief tasks, whereas children with ADHD and or ODD often perform more similarly to typically developing peers (Buitelaar, Swaab, van der Wees, Wildschut, & van der Gaag, 1996).

Other attempts at capturing ToM are examining eye expressions to determine another person's mental state (Baron-Cohen et al., 2001) or analyzing abstract components and making attributions based on moving shapes (Kuzmanovic et al., 2014). However, these measures overlap substantially with attribution, with disagreement about whether these are distinct constructs. Some researchers have also divided ToM into emotional and cognitive subcomponents (Kalbe et al., 2010), which may reflect other researchers' understanding of the terms ToM and emotional empathy. For instance, some researchers use the term ToM and cognitive empathy interchangeably (Grove, Baillie, Allison, Baron-Cohen, & Hoekstra, 2014). Examples of emotional ToM or empathy are the Empathic Accuracy Paradigm (EAP; Hall & Schmid Mast, 2007), the Empathy Quotient (EQ; Baron-Cohen & Wheelwright, 2004), and Balanced Emotional Empathy Scale (BEES; Mehrabian & Epstein, 1972). The EQ is a self-report measure, whereas the BEES and EAP are experimental measures of empathy. The BEES shows participants video clips and asks them to rate how positive or negative the person in the

clip is feeling. The modality of the stimulus and test instructions may influence results. Thus, the EAP has video, audio, transcript, or silent video stimuli with instructions to either infer thoughts and feelings, infer thoughts, or infer feelings. In sum, ToM and empathy are complex constructs without a definitively agreed upon definitions and measurements.

Neuroscientific measures (e.g., fMRI, electroencephalograph [EEG]) are another method used to assess neurobiological underpinnings of social cognition. For example, one study presented subjects with paired words with unpleasant and neutral images while measuring event related potentials (ERPs; Deveney & Pizzagalli, 2008). Participants were told to enhance, maintain, or suppress their emotions related to the presented material. This was accomplished by instructing participants to imagine the situation was fake, while in the suppress condition. In the enhance condition participants imagined the situation was happening to them or a loved one. The maintain condition consisted of participants being instructed to attend, but not to alter their emotions or cognition in response to the stimuli. Findings indicated that there were unique variations in EEG waves when participants attend to and manipulate emotional stimuli.

These types of tasks are conducive when examining adolescent or adult participants. However, children may have difficulty imagining and monitoring their emotions. Thus, neuroscientific research with children is often accomplished by completing neuroimaging while children are engaged in social cognition tasks, such as Happé's strange stories (Mar, 2011). For example, studies have demonstrated a ToM network composed of the medial prefrontal cortex, precuneus, bilateral superior temporal sulcus, left temporal pole, left amygdala, and left superior frontal gyrus is activated when participants are comprehending false belief stories. While neuroscientific measures may better address neurobiological correlates of social cognition they also have limitations. For example, it is unclear whether brain regions activated in story-based

ToM tasks relate more to basic verbal comprehension or specifically ToM (Mar, 2011). Other limitations include non-task related neural activity (Frederick, Nickerson, & Tong, 2012), non-specificity of neurological findings (Weyandt, Swentosky, & Gudmundsdottir, 2013), and the need for more sophisticated scanning equipment. Furthermore, neuropsychological measures may correlate more with functional outcomes (Sanders et al., 2014). Thus, many studies use imaging measures in conjunction with standardized neuropsychological measures.

Many studies refer to the aforementioned measures as measuring different components of social cognition. For example, the TOPS measures social problem solving abilities and its scales may overlap with the constructs attribution and ToM. Some refer to attribution as an aspect of ToM, whereas some researchers consider this a separate construct. One could also make the case for tasks such as Reading the mind in the eyes or voice as simple emotion recognition or more complex mentalizing. This ambiguity in the literature about deficits related to clinical groups makes it difficult to accurately identify which components are affected in clinical groups. The state of the literature may also reflect the complexity of real world social cognition. For example, an integration of affect recognition, understanding another's mental state based on facial expression, and feeling empathy towards a person based on these perceptions all work in conjunction within a short time frame. Therefore, it may be difficult to disentangle each subcomponent of social cognition. Thus, when examining clinical populations, a comprehensive battery of social cognition measures is warranted to approximate real life social cognitive abilities. Therefore, consideration of the multiple dimensions of social cognition and the impact of developmental processes is essential to understanding social cognition in children with ADHD.

Social cognition in ADHD

Neural correlates. In ADHD populations, all three of the SOCIAL components and their associated brain regions have been linked to dysfunction. Studies have examined general cognitive abilities and their neural correlates that are necessary for appropriate social behavior. For example, functional changes in particular brain regions have been identified in children with ADHD while performing response inhibition and selective attention, and learning measures (Vaidya et al., 2005). Each of these cognitive abilities is also necessary to succeed in social tasks. For example, initial inappropriate responses need to be inhibited and attention to socially and emotionally relevant stimuli must be attended to for adequate social functioning. Hypoactivation in the ventral striatum was identified in adolescents with ADHD during anticipation of a rewarding stimulus (Scheres, Milham, Knutson, & Castellanos, 2007), but it is unclear if each of these areas are involved in social rewards and overall social and emotional processing within this population. Therefore, more research is needed to determine if the differences in these brain regions are responsible for the aforementioned deficits in social and emotional cognition in ADHD.

More specific studies have directly examined social cognitive abilities. In general, the literature indicates frontal-striatal dysfunction and other networks relevant to social cognition (Uekermann et al., 2010). Individuals with ADHD demonstrate functional differences across brain regions associated with social cognition (Uekermann et al., 2010). Notably, the orbitofrontal cortex is especially linked to social abilities in both healthy controls and participants with ADHD (Cubillo, Halari, Smith, Taylor, & Rubia, 2012). Studies indicate that these neural pathways create difficulties with both executive functioning and social cognition (Uekermann et al., 2010). For example, two studies have demonstrated normal activation in the

amygdala, but enhanced activation of the frontal and posterior cingulate cortex in response to angry facial expressions (Williams et al., 2008). Findings indicate that children with ADHD may have altered processing of emotional stimuli. Studies using ERPs also find a reduction of activity of P120 when processing the emotions anger and fear (Williams et al., 2008). Early and automatic perception of emotional information is associated with the P120. These neurological findings have been associated with deficits in emotion recognition, increased emotional lability, and symptoms of anxiety and depression. These studies clearly indicate that there are biological differences between control and ADHD groups in social and emotional processing. However, more research is needed to fully demonstrate the connection between these neural networks and social cognition as well as social skills deficits.

Neurocognitive evidence. It is clear that children with ADHD exhibit poor social outcomes. However, neuropsychological data is still in its infancy when it comes to addressing the underlying social cognitive deficits in this population. Preliminary evidence indicates that children with ADHD demonstrate difficulty attending to, encoding, and recalling social cues (Dodge & Newman, 1981; Moore et al., 1992). More specifically, they have difficulty understanding another's perspective and assessing the intent of others (Dodge, 1986). Their difficulty connecting events to short and long-term consequences leads them to be surprised by negative reactions from others and have poor understanding regarding their ineffective social responses (Barkley, 1998; Moore et al., 1992). Findings have generally been separated into measuring affect recognition, communication/language, theory of mind, empathy, and outcome measures (e.g., social skills ratings). Some of these subdomains of social cognition have clearer findings in the literature. A thorough investigation of the social cognitive components may offer

insight into spared and impaired abilities within this population. Once impacted abilities have been firmly established, treatment interventions can more specifically target social skills deficits.

Emotion perception. It has been generally demonstrated in the literature that children with ADHD often demonstrate deficits in emotion facial recognition (Cadesky, 2000; Marsh et al., 2008; Pelc et al., 2006; Sinzig et al., 2008). For example, one study examined children with ADHD alone, ADHD and autism, and autism alone. Findings indicated that children with both autism and ADHD had worse deficits in facial emotion recognition than children with only autism (Sinzig et al., 2008). These unexpected findings indicate that symptoms of ADHD impact social cognition in children with autism. Another study demonstrated that symptoms of ADHD affected facial emotion and affective prosody recognition abilities in children with autism (Oerlemans et al., 2014). Furthermore, studies comparing children with ADHD and autism find that their emotion facial recognition is comparable (Buitelaar et al., 1999). Conversely, others have found that children with autism perform worse than those with ADHD on facial emotional recognition tasks (Downs & Smith, 2004). Thus, further group comparisons are needed to clarify these findings. It may be that children with autism have more severe emotion recognition deficits, but that these deficits are still present in children with only ADHD. Despite limitations and conflicting results across these studies, prior research indicates that ADHD symptoms should be assessed when working with children with autism or other comorbid disorders. Furthermore, results of studies examining ADHD and autism indicate that social cognition and ADHD is a relevant matter of clinical and research interest.

Studies examining participants with only ADHD also find distinct deficits related to recognition of anger (Pelc et al., 2006; Williams et al., 2008), sadness (Cadesky, 2000; Pelc et al., 2006), fear (Miller et al., 2011; Williams et al., 2008), generally negative emotions (Bae et

al., 2009; Da Fonseca, Seguier, Santos, Poinso, & Deruelle, 2008), and more globalized emotional recognition delays (Yuill & Lyon, 2007). There is also evidence that children with ADHD also struggle with identifying positive emotions relative to healthy controls (Cadesky et al., 2000; Da Fonseca et al., 2009; Ludlow, Garrood, Lawrence, & Gutierrez, 2014). Studies have also examined community samples of children at risk for behavioral and attention problems, demonstrating similar emotion recognition deficits (Kats-Gold, Besser, & Priel, 2007). The literature also indicates that poor recognition of angry expressions is particularly associated with interpersonal difficulties (Pelc et al., 2006). Performance on emotion recognition tasks in children with ADHD may also be distinct from other behavioral disorders. For instance, children with ADHD made more random errors than those with only conduct problems (Cadesky et al., 2000). The implications of these findings are unclear. However, one would expect that misperception of negative emotions impacts social behavior.

The majority of emotion perception research examines various forms of recognition of emotion in faces. However, there have been other methods of emotionally relevant tasks. For example, the emotional Stroop measure is an attempt to capture unconscious emotional biases in participants (Posner et al., 2011). One study indicated that there was abnormal activity in the medial prefrontal cortex compared with controls when adolescents with ADHD performed an emotional Stroop task (Posner et al., 2011). This might indicate differences in emotional inhibition, which may be associated with emotional regulation deficits in individuals with ADHD. Other measures relevant to emotional perception are tasks examining retention of emotional memory. For example, one study found that all children regardless of ADHD status, remembered negative information best, followed by positive, and neutral information (Krauel et al., 2009). Children with ADHD also had more difficulty remembering neutral information

without emotional context compared to healthy controls. This could have implications for functioning, as problems with immediate attention appears to impact encoding of neutral information. Thus, those with ADHD may have difficulty remembering neutral information in conversations as well as emotional information, which could impact social functioning. Other methods that examine emotion perception are Dual Valence Emotional tests. For instance, Ibáñez and colleagues (2011) presented faces, words, or faces paired with words with positive or negative valence. This study indicated that there were differences measured by ERPs when adults with ADHD were presented with this emotional task. In sum, these studies indicate that there are a variety of measures and aspects of emotion perception that participants with ADHD perform poorly on across age groups.

Communication. Aspects of communication relevant to social cognition include affective prosody, reading nonverbal cues, and pragmatic language. Affective prosody is essential to social communication and overlaps with the construct of emotion perception. This term refers to the understanding of emotional tone/inflection in verbal communication (Imaizumi, Furuya, & Yamasaki, 2009). Prosody is essential to understanding humor, sarcasm, praise, and negative intent (Imaizumi et al., 2009). Studies indicate that participants with ADHD (Grabermann et al., 2013; Cadesky et al., 2000) and those at risk for ADHD (Kats-Gold et al., 2007) perform poorly on tasks requiring recognition of affective prosody. Specifically, one sample of adult men with ADHD had the most difficulty identifying prosody when the expressed emotional tone was incongruent with the semantic meaning (Grabermann et al., 2013). The authors noted that this difficulty with incongruent emotional information could be associated with the well-established executive functioning deficits in response inhibition. The weaker processing of prosody is also thought to relate to dysfunction in the serotonin systems impacted in ADHD (Grabermann et al.,

2013; Oades, 2008) and other clinical groups (Uekermann, Abdel-Hamid, Lehmkamper, Vollmoeller, & Daum, 2008). Additionally, there are developmental aspects that should be examined in measuring affective prosody. The literature indicates that typically developing children older than 8 years of age make less errors when identifying prosody, particularly related to sarcasm as well as incongruent emotional and semantic information (Imaizumi et al., 2009). Thus, it appears that adults with ADHD may have developmental delays in reading incongruent emotional cues.

With regard to social communication, pragmatic language abilities should be addressed. Research indicates that children with ADHD often struggle with pragmatics, meaning that a child has difficulty understanding language within a social context (Guerts & Embrechts, 2008; Staikova, Gomes, Tartter, McCabe, & Halperin, 2013; Väisänen, et al., 2014). Specifically, children with ADHD struggle with establishing conversational rapport (Bishop & Baird, 2001) and comprehending figurative language (Leonard et al., 2011). Studies have also demonstrated that children with ADHD and children with autism do not substantially differ in the pragmatic language abilities (Geurts et al., 2004; Bishop & Baird, 2001). However, further research is needed to validate and characterize pragmatic language skills in children with ADHD.

Attributional style. Attributional style has largely been examined when investigators are interested in comorbid mental health issues in children with ADHD. Studies also interpret hypotheses and results in terms of social information processing theory, described previously. Children and adults with ADHD commonly receive secondary diagnoses of depression, anxiety, ODD, and CD (Johannesen et al., 2013). The way in which someone describes the causes of experiences or events is often associated with developing the symptoms within these disorders. For example, studies suggest that negative external attribution biases relate to behavioral issues,

such as increased aggression (Becker, 2014). Conversely, negative internal attributional biases are correlated with internalizing symptoms, such as depression and anxiety (Becker, 2014). Overall, studies suggest that negative attributional styles are related to increased mental health symptoms and self-esteem (Treuting & Hinshaw, 2001). This is because negative attributions are linked to feeling helpless to enact change over events or one's life (Schepman, Fombonne, Collishaw, & Taylor, 2014). Having this external locus of control over events is associated with length and severity of depression. In children, a strong external locus of control in social events is associated with higher self-ratings of loneliness (Crick & Ladd, 1993). On the other hand, having stable and global attributions about positive events and unstable and specific attributions about negative events is related to healthy cognitive development. In other words, those with few depressive symptoms attribute their successes to their abilities and attribute failures to external factors (e.g., specific aspects of a task). Those with greater symptoms of depression and anxiety frequently attribute positive events to external factors and failures to internal factors (e.g., their lack of ability). Research indicates that individuals with ADHD demonstrate the same cognitive patterns depending on whether they are experiencing depression or anxiety (McQuade et al., 2011). Studies also indicate that children with ADHD are more likely to attribute hostile intentions from others than their peers (Andrade, Brodeur, Waschbusch, Stewart, & McGee, 2009). These principles have implications for social functioning. For example, if a child has a tendency to attribute negative or hostile intentions in others, their behavior will likely lead to peer rejection. Furthermore, attributional biases can lead to poor self-esteem and increase the likelihood of negative social interactions. Research indicates that lower self-esteem and strong external attributions about both positive and negative events is associated with more aggression in boys with ADHD and callous unemotional traits (Haas, Waschbusch, King, & Walsh, 2014).

Thus, assessing and intervening in negative attributional styles could improve social functioning. However, attributional styles are more directly related to comorbid mental health disorders, such as anxiety, depression, and conduct disorder. Since the focus of the proposed study is on ADHD and not these other disorders, this aspect of social cognition will not be examined. However, future studies may find it beneficial to assess attributional style when comorbid conditions are present.

Theory of mind. Few studies have addressed ToM in ADHD (Uekermann et al., 2010), which is an essential component of social cognition that should be assessed given the social delays in this population. As previously indicated, there is a distinction between cognitive and emotional ToM and empathy, with some overlapping of these terms in the literature. Neuroimaging studies also indicate that empathy and ToM share similar yet distinct neuronal networks (Vollm et al., 2006). Engagement in empathy tasks exhibits activation of the paracingulate cortex, anterior and posterior cingulate cortex, and the amygdala. Engagement in theory of mind tasks is often more associated with the lateral orbitofrontal cortex, middle frontal gyrus, cuneus, and superior temporal gyrus. Therefore, while interrelated empathy and theory of mind can be considered unique neurocognitive constructs. Furthermore, the distinction between lower and higher-order ToM tasks are important to specifically address social cognitive deficits within clinical populations. Overall, the literature is rather mixed when it comes to identifying deficits in cognitive theory of mind performance in participants with ADHD. Some of the conflicting results may be due to the lack of clarity in identifying and measuring ToM. A review of findings is useful in guiding the hypotheses of the current proposed study.

Regarding lower-order cognitive ToM or simple false belief tasks, research indicates that children with ADHD or those at risk for developing ADHD often perform similarly to healthy

controls (Perner et al., 2002; Hughes et al., 1998). These findings are not surprising, given that many children with autism also pass first-order cognitive ToM measures (Ozonoff, Pennington, & Rogers, 1991). Research is mixed as to whether children with ADHD perform poorly on high-order cognitive ToM tasks. Some studies find significant differences between participants with ADHD and healthy controls (Buitelaar et al., 1999; Sodian & Hülsken, 2005), whereas some studies do not find differences in children with ADHD (Charman et al., 2001; Dyck et al., 2001) or those at risk for developing the disorder (Perner et al., 2002) and control participants. Discrepancies could be due to differences in samples (e.g., comorbidity, gender, age, subtype) or methodology (e.g., type of measure). For example, the study by Buitelaar and colleagues (1999) only included 10 participants with ADHD. Sodian and colleagues (2003) indicated that children with ADHD had the most difficulty with ToM tasks when there were higher demands for response inhibition. These authors concluded that children with ADHD may not have deficits in theory of mind, but that poor inhibitory control impacts theory of mind abilities with higher demands for executive control (Sodian et al., 2003). Thus, the severity of impulsivity or response inhibition in children with ADHD may confound or exacerbate deficits in ToM.

Another open issue regarding social cognition in children with ADHD is the relationship between cognitive ToM and executive function (Uekermann et al., 2010). The relationship between these cognitive abilities has been established in typically developing children (Carlson, Moses, & Breton, 2002) and other clinical groups, such as autism (Ozonoff et al., 1991), TBI (Robinson et al., 2014), and schizophrenia (Couture, Granholm, & Fish, 2011). There are multiple theories as to how executive skills interact with complex social cognitive tasks (Kain & Perner, 2003). One theory indicates that ToM abilities result in self-insight and resulting ability to enact self-control. Another theory indicates that as executive functioning improves, ToM

abilities improve as well. However, findings by Perner and colleagues (2002) contradict the second theory. This study found that children with ADHD performed poorly on executive functioning measures, but had intact abilities demonstrated on second-order false belief tasks. Complicating the matter, is research suggesting that executive functioning is independent of social impairment (Huang-Pollock et al., 2009; Diamantopoulou et al., 2007; Bierderman et al., 2004). In sum, the literature is conflicted as to the extent cognitive ToM and executive functioning are associated, particularly in those with ADHD.

Another area of clinical and research interest is which executive functioning abilities are most associated with ToM. The broadness of measures deemed assessing executive functioning may account for some of the discrepancies in the relationship between executive and social functioning. For example, working memory and inhibitory control are particularly related to ToM performance (Fahie & Symons, 2003). Findings may differ depending on the ToM measure. For instance, Ahmed and Miller (2011) found that verbal fluency and deductive reasoning abilities on the Delis-Kaplan Executive Function System (D-KEFS) were most predictive of performance on the Strange Stories Test. This study also demonstrated that verbal fluency, problem solving, and gender were significant predictors of performance on the Faux Pas test. These findings indicate that assessment of specific components within the broad domain of executive functioning may be more relevant than others to ToM skills. While research has been conducted in this area, there are few studies examining specific executive functioning abilities in relation to ToM in ADHD. Of those that exist, the research indicates that inhibition and planning are particularly related to ToM abilities (Charman et al., 2001). However, other executive functioning abilities, such as verbal fluency and deductive reasoning have not been examined in children with ADHD. This should be addressed given the established executive deficits in this

group. There may be unique patterns of performance in children with ADHD when their ToM and a wide range of executive skills are compared.

Finally, another area needing attention is the relationship between language skills and cognitive ToM. It is generally accepted that verbal abilities are necessary for understanding false belief tasks (Slade & Ruffman, 2005). However, it is unclear the extent to which poor pragmatic language abilities may be impacting children's performance on ToM measures. Some have argued that language abilities have a causal role in ToM development. Furthermore, certain components such as syntax, pragmatics, or receptive language may differentially impact ToM development (Slade & Ruffman, 2005). However, it is unlikely that cognitive ToM and language could be disentangled within measures and real world social situations.

The literature has largely examined cognitive ToM and ignored the affective component regarding an understanding of another's feelings. From a theoretical perspective, it seems unlikely that children could demonstrate deficits in basic emotion perception and have intact complex social cognitive abilities related to emotion. Furthermore, the understanding of another's emotion is essential to expressing empathic concern. Thus, a further investigation of complex social cognitive abilities related to emotion is warranted. Thus far, few studies have investigated affective ToM. One study indicated that medication improved emotional ToM performance in children with ADHD (Maoz et al., 2014). Thus, it is likely that untreated children struggle with emotion based ToM tasks. Another study conducted by Demurie and colleagues (2011) indicated that participants with ADHD perform similar to controls and better than participants with autism on the Reading the Mind in the Eyes Test. However, this study only included 13 participants with ADHD. Thus, examination of this task would be beneficial

with a larger sample, given prior evidence of deficits in emotion perception in children with ADHD.

Empathy. Empathy has often been examined in clinical populations with social skills deficits. Cognitive empathy relates to a person's intellectual identification with the thoughts of others, while affective empathy relates to the emotional reactivity to another's feelings (Dadds et al., 2008). There has been particular research attention to understanding empathy or lack thereof in relation to aggression. As children with ADHD often exhibit high rates of aggression and antisocial behavior, it is no surprise that empathy would be an important social cognitive factor to explore. Thus, some studies have addressed this matter and found deficits in empathic accuracy in individuals with ADHD (Braaten & Rosen, 2000; Demurie et al., 2011; Downs & Smith, 2004; Dyck et al., 2001; Yuill & Lyon, 2007). For example, Braaten and Rosen (2000) examined children's empathy for characters in fictitious stories. Stories included positive/negative and simple/complex feelings. This study found that children with ADHD exhibited less of a match between their own emotions and the fictitious characters' feelings when compared to control participants. The clinical group also had less character-centered explanations which may indicate difficulties labeling and explaining another's emotion in context.

Another example of deficits in empathy is a study conducted by Demurie and colleagues (2011), demonstrated that adolescents with ADHD also have difficulty with perspective taking in an empathic accuracy task (Ickes, Stinson, Bissonnette, & Garcia, 1990). This task was developed in an attempt to capture naturalistic social situations involving empathic understanding. Many social cognition measures across domains are limited in that they have poor ecological validity. The empathic accuracy task is unique in that it has participants view

and rate their own video recorded interactions. Adolescents with ADHD performed somewhat better than those with ASD and worse than typically developing peers. Although results were not statistically significant, which was likely due to limited power, the authors argue that empathic understanding in individuals with ADHD is somewhat abnormal. These findings are consistent with comments made by Barkley (2014) that poor inhibitory control results in less empathy and poor perspective taking abilities in children with ADHD. Further studies are needed to confirm this hypothesis. The studies that have examined empathy have combined the cognitive and affective components. However, current research indicates that these are distinct abilities (Dadds et al., 2008). Furthermore, cognitive empathy may be less affected than emotional empathy in children with ADHD, based on performance on other social cognitive tasks. However, differential impairment of these abilities awaits investigation.

***Outcome measures*.** Demonstrating the relationship between social cognition and functional outcome measures is necessary to determine if research based social cognition measures translate into real world social behavior. Some studies have included outcome measures within their research battery and correlated ratings of social behavior with social cognition measures (Bae, Shin, & Lee, 2009; Charman et al., 2001; Pelc et al., 2006; Williams et al., 2008). For example, Charman and colleagues (2001) examined social competence through the socialization domain of the Vineland Adaptive Behavior Scales–Survey Edition (VABS: Sparrow, Balla, & Cichetti, 1984) and the Active Sociability Scale (Frith et al., 1994). Findings indicated that these measures of social ability were significantly correlated with ToM (Happé's Strange Stories) and executive functioning scores (Tower of Hanoi). Another study by Pelc and colleagues (2006) found that poor performance on facial emotion tasks was significantly correlated with ratings of interpersonal problems, as measured on the Inventory of Interpersonal

Problems (Horwitz Rosenberg, Baer, Ureño, & Villaseñor, 1988). The primary limitation across these studies is the use of parent ratings to measure social skills. However, few standardized measures directly examining real world social behavior exist. It may be beneficial to use clinician ratings (Williams et al., 2008) or teacher ratings (Bae et al., 2009) of social skills or social problems, which some studies have done. Studies may also benefit from using ratings from multiple informants (e.g., teachers, parents, clinicians) to measure social behavior in different contexts. For example, Bae and colleagues (2009) found that recognizing negative affect was significantly related to teacher's ratings of aggression in participants. Level of aggression may only be accurately assessed by parents and teachers who have the opportunity to observe aggressive behavior at home and in school on a regular basis. Clinician ratings are limited because of the cost and time associated with naturalistic behavior observations of participants. Furthermore, participants are less likely to act in an aggressive manner within the confines of a highly-structured laboratory assessment procedure. While clinicians may be more skilled at examining social reciprocity, or reading of social cues, they have limited ability to observe peer relationships and aggression. Therefore, the benefits and drawbacks to each informant of social skills should be considered. Regardless of limitations, the examination of the relationship between social cognitive performance and functional ratings is essential to any study investigating social development. It is clinically useful to determine this relationship, as behavior ratings are commonly used to assess social and emotional problems in children. This examination could assist in understanding the extent to which social cognitive measures relate to real world behavior as perceived by caregivers.

ADHD symptomatology and social cognition. While children with ADHD may have a high interest in peers, their inattention, impulsivity, and hyperactivity may interfere with their

ability to read social situations leading to negative feedback and rejection from peers. Few studies have directly investigated the differential impact that symptoms of hyperactivity, impulsivity, and inattention have on social cognition as well as social skills. Despite the paucity in the literature, there are some studies that address this matter (Kofler et al., 2011; Grzadzinski et al., 2011) that may provide insight into this matter and guide study hypotheses.

It may be that components of social cognition (e.g., cognitive ToM) are intact when children with ADHD are prompted in a controlled environment. Some studies suggest that children with ADHD do not lack social knowledge, but have difficulty utilizing their knowledge in real world settings (de Boo & Prins, 2007; Huang-Pollock et al., 2009). Therefore, social skills deficits may be more related to performance abilities than social cognition (Kofler et al., 2011). Some researchers have focused their attention on core symptomatology as a reason for social performance deficits rather than deficits in social cognition (Kofler et al., 2011). However, there remains disagreement as to the neurocognitive mechanisms and extent to which symptomatology is responsible for these social problems. For example, Grzadzinski and colleagues (2011) found that poor social cognition and autistic traits in children with ADHD could not be fully accounted for by ADHD symptomatology. Furthermore, while social difficulties improve with treatment of ADHD symptoms (Williams et al., 2008), they still remain present even after symptoms subside (McQuade & Hoza, 2008). Therefore, symptoms may exacerbate, but not cause mild social cognition deficits thought to be present in children with ADHD. Conversely, it could be that ADHD symptomatology prevents early social cognitive development resulting in continued delays after symptoms are treated. Thus, a thorough investigation on the impact of each symptom domain on social cognition may provide insight into this issue.

As indicated previously, current conceptualizations of attention indicate that the broad construct of attention can be divided into focusing/selective, sustaining, shifting, and encoding components (Mirsky et al., 1991). Children with ADHD often demonstrate deficits in sustained attention, encoding, and attention directed toward non-preferred tasks (Thaler et al., 2010). Sustained attention is generally defined as long term attentional maintenance to a task (Sullivan et al., 2007). This component of attention is often measured by tasks such as the Continuous Performance Test (CPT; Conners, 2000), which requires participants to complete simple and somewhat monotonous tasks with continued vigilance to visual stimuli. These measures have often been used in the diagnostic process of assessing for ADHD, as many adults and children with ADHD struggle with these tasks (Sullivan et al., 2007). Research indicates that performance on sustained attention predicts social problems in both healthy controls and children with ADHD (Andrade et al., 2009). Conversely, selective attention is not associated with teacher ratings of social skills. Deficits in sustained attention has the potential for wide ranging social consequences. For example, sustained attention may be particularly relevant to social situations, as extended periods of focus to conversations, facial expressions, and body language are necessary for reading and understanding social cues. There is some research support for a relationship between sustained attention and measures of emotional recognition in faces (Sinzig et al., 2008; Shin, Lee, Kim, Parke, & Lim, 2008) and voices (Sinzig et al., 2008). Thus, children with ADHD may miss and fail to encode these relevant cues resulting in poor social responses. They may also miss out on opportunities to demonstrate social reciprocity, impacting the development of peer friendships. Poor sustained attention may also impact a child's ability to understand and appropriately follow directions in a game, which could lead to peer rejection.

Therefore, sustained attention may serve as a useful target for treatment intervention for social skills deficits in ADHD.

There is debate in the literature about the uniqueness of hyperactivity and impulsivity as separate symptom domains (Toplak et al., 2009). Much of the research investigating ADHD symptomatology and social cognition examines impulsive and hyperactive symptoms as one category. However, research indicates that these two symptoms are unique in their neural correlates (Dalley, Mar, Economidou, & Robbins, 2008), neuropsychological performance (Brocki et al., 2010; Raiker et al., 2012), relation to behavioral outcomes (McKee, 2012; Palili et al., 2011), and symptom course (Larsson et al., 2006; McAuley et al., 2014). Therefore, the current study will examine hyperactivity and impulsivity as separate symptom categories.

Hyperactivity often refers to the excessive motor activity related to dysfunction in involuntary motor and arousal systems (Lijffijt, Kenemans, Verbaten, & van Engeland, 2005; Shim, Stratford, & Wirshafter, 2014; Teicher, Polcari, Fourligas, Vitaliano, & Navalta, 2012). Regarding social situations, hyperactivity may lead to a child getting out of their seat repeatedly throughout class. Children may be labeled as a classroom disruption and become unpopular among their peers. A significant correlation between ratings of hyperactivity and social problems has been demonstrated in other studies (Andrade et al., 2009; Leonard et al., 2011). A study by Leonard and colleagues (2011) indicated that the relationship between hyperactivity and social skills problems was fully mediated by pragmatic language abilities. Thus, hyperactivity alone may not account for social skills problems in children with ADHD. The authors of this study suggest that most of our social interactions rely on language and communicative abilities. Thus, the combination of excessive motor activity and poor social communication may interact

to disrupt social skills. Furthermore, the lack of control over motor, verbal, and behavioral decisions may lead to poor filtering of ineffective social strategies.

Impulsivity is also thought to significantly impact social interactions, perhaps more so than hyperactivity. For instance, symptoms of impulsivity often persist beyond adolescence and have continued social implications into adulthood, whereas hyperactivity often remits in adolescence (Larsson, Lichtenstein, & Larsson, 2006; McAuley, Crosbie, Charach, & Schachar, 2014; Moyá et al., 2012). Impulsivity is associated with poor response inhibition and rash decision making processes that can impact social and emotional behavior (Grzadzinski et al., 2011). For instance, symptoms of impulsivity are associated with aggression (Siznig et al., 2008), inappropriate intruding in conversations or during play (Abikoff et al., 2002), and increased rejection from peers (Greene et al., 1996; Hoza et al. 2005). Another consequence of impulsivity could be saying hurtful things due to poor response inhibition and emotional liability. Impulsivity is often assessed through verbal and motor response inhibition tasks, such as commissions on continuous performance tasks (Raiker, Rapport, Kofler, & Sarver, 2012). Thus far, there is some support for the relationship between ratings of impulsivity (Bae et al., 2009), response inhibition (Sinizig et al., 2008), and affect recognition abilities in children with ADHD. These studies provide support for the influence of impulsivity on social cognition in the population of interest to this study. Further research is needed to replicate these findings, as well as examine the impact of impulsivity on other aspects of social cognition (e.g., empathy and theory of mind).

Insight into the impact of symptomatology can also be gained by studies examining social cognition and behavior in ADHD presentations. Studies have suggested that children with combined symptoms are more likely to have behavioral and social problems than children with

predominantly inattentive symptoms (Gaub & Carlson, 1997; Semrud-Clikeman, 2010). Research has demonstrated that the inattentive presentation is associated with more deficits in social knowledge (Maedgen & Carlson, 2000; Wheeler & Carlson, 1994) and assertiveness (Solanto et al., 2009). The sluggish cognitive tempo (SCT) often found in children with the predominately inattentive type is also associated with higher social withdrawal, low leadership abilities (Marshall et al., 2014), and broader social functioning deficits (Becker & Langberg 2013; Becker et al. 2014; Carlson & Mann 2002). Research also indicates that children with higher rates of a SCT have more inattention to subtle social cues (Mikami, Huang-Pollock, Pfiffner, McBurnett, & Hangai, 2007). The increase on social withdrawal may lead to limited opportunities for social engagement (Mueller et al., 2014). Fewer instances of social learning could potentially impact the development of social cognition. Yet demonstration of a sluggish cognitive tempo may have a socially protective factor because these symptoms are associated with exhibiting less hostility (Mueller et al., 2014). Children with the combined presentation have more problems with self-control (Solanto et al., 2009), aggression (Becker et al., 2013), and they are less liked by peers (Wheeler Maedgen & Carlson, 2000). Both subtypes are at risk for social alienation and are less cooperative than their peers (Solanto et al., 2009). In sum, these studies suggest that ADHD presentations/subtypes are both at risk for social functioning difficulties, but for different underlying reasons. While it can be helpful to assess subtypes separately, a symptom dimensional approach may be more beneficial given the temporal and diagnostic instability of ADHD subtypes/presentations (Lahey et al., 2005; Lee et al., 2008; Todd et al., 2008). Therefore, the current study will examine ADHD symptomatology, but not separate ADHD presentation in hypotheses and analyses.

Another factor to consider regarding symptomatology, is the relationship between core symptoms and behavioral problems in ADHD. Conduct problems are thought to arise from ADHD symptomatology and there may be a causal role in social functioning deficits (Andrade & Tannock, 2014). As conduct problems arise, children may be punished by removing the child from social situations. Therefore, as teachers and/or parents provide consequences for inappropriate behavior, children become more limited in their opportunities for social learning and exposure to adaptive prosocial behavior (Andrade et al., 2009). Thus, children with ADHD and conduct problems may benefit from supplemental training on prosocial behavior due to the possibility of limited exposure to positive social learning. Specifically, they could benefit from instruction in appropriately waiting their turn in conversations or play and developing coping strategies for impulsive behavior. Not surprisingly, a study conducted by Andrade and colleagues (2014) indicated that higher teacher ratings of prosocial behavior are associated with less conduct problems. This study also indicated that symptoms of inattention, hyperactivity, and impulsivity predict greater peer problems. However, this study examined a community sample and awaits investigation in children diagnosed with ADHD.

Overall the research suggests that ADHD symptomatology has a relationship with social cognition and behavioral functioning. From a theoretical and empirical perspective, inattention and impulsivity appear to have the most influence on social cognition and social skill deficits in children with ADHD (Celestin-Westreich & Celestin, 2013). Additionally, there is support for similar neurobiology governing ADHD symptomatology and social cognition (Weyandt et al., 2013). However, this research is rather sparse and there is a need for further exploration.

Limitations and Future Directions

Limitations within the literature include small sample sizes (Buitelaar et al., 1999; Demurie et al., 2011), reliance on self-ratings of social knowledge (Maedgen & Carlson, 2000), and not examining the relationship between social cognition performance and measures of functional outcomes. Many studies also did not explore the impact that core ADHD symptomatology has on social cognition performance. Those that have examined symptomatology have largely investigated ratings of social behavior and not performance on social cognition measures (Solanto et al., 2009). Furthermore, many studies measuring social cognition, particularly ToM, have examined children at risk and not formally diagnosed with ADHD (Perner et al., 2002; Hughes et al., 1998). It is unclear whether these children will go on to develop the disorder. Thus, there is need for assessing social cognition deficits in a well-characterized ADHD population.

A major limitation in the research is that many studies only examined male participants (Braaten & Rosen, 2000; Charman et al., 2001; Grabermann et al., 2013; Grzadzinski et al., 2011; Shin et al., 2008). This is likely due to the higher prevalence rates of ADHD in males (APA, 2013), as well as a higher propensity for behavioral disturbances (Biederman et al., 2014). Attention problems in girls may often go unrecognized and undiagnosed because of the decreased likelihood of disruptive behavior (Hinshaw, 2002). However, some studies indicate that girls with ADHD also have social difficulties (Gaub & Carlson, 1997; Hinshaw, 2002). Thus, research investigating underlying social cognitive factors and symptomatology should include females in their sample.

Conclusion

A review of the current literature indicates that children with ADHD demonstrate impairment in emotion perception and social communication. However, it is unclear the extent to which cognitive and affective ToM and empathy are impacted in the disorder. This is likely ambiguous because of the sparse data, conflicting results, and differences in measurements and definition of constructs. For example, some studies combine cognitive and affective ToM and empathy into one measurement or social cognitive domain. However, separating these components into distinct categories could provide more insight into spared and impaired abilities. Therefore, for the purposes of the proposed study, ToM is defined as the understanding of another's thoughts and emotions. Empathy requires this understanding, but refers to a person's cognitive or emotional reactivity to another's thoughts and feelings. It is plausible that a person could understand another's cognition and affect, but be unmoved by this understanding on a consistent basis. Given previous evidence that emotion perception is particularly affected in ADHD, it is likely that more advanced social cognitive components of affective ToM and empathy are also impacted. Thus, it may be that children with ADHD do not lack an intellectual awareness of another's thoughts, but that the affective components of social cognition are developmentally delayed.

Data for the proposed study could provide insight into the cognitive underpinnings of social problems, as well as demonstrate their relationship with behavioral outcomes. Results may be used in guiding empirically based interventions targeting social cognition and social skills in children with ADHD. Social skills training programs could be developed to address specific social cognitive deficits in this population. For example, if the affective components of social cognition are impacted in ADHD, training programs targeting these skills could be

beneficial. Furthermore, it could be useful in identifying the relationship between social cognition and specific behavioral outcomes. Specifically, the current study proposes to examine ratings of the problematic behaviors of aggression, conduct problems, and social problems, which are often observed in children with ADHD. The current study will also examine the relationship between social cognitive performance and prosocial behaviors of cooperation, self-control, assertion, and responsibility. These behaviors are likely to be impacted if a child is delayed in their recognition and understanding of social-emotional situations. Conversely, interventions targeting deficits in social cognitive abilities could increase prosocial behavior.

Results of the proposed study may provide data about the relationship between ADHD symptoms and social cognitive deficits. Thus far, there is some evidence supporting the relationship between inattention and performance on social cognitive measures of affect recognition. However, few studies have included other social cognitive measures beyond affect recognition tasks. It would be expected that ADHD symptomatology would impact more advanced social cognitive tasks, if basic emotion recognition is affected. The relationship between the other symptom domains and acquisition of social cognitive skills is less clear, with sparse evidence. Overall, the literature demonstrates a relationship between impulsivity, hyperactivity, and poor social skills. However, this could be due to performance and/or social knowledge deficits. Impulsive and hyperactive behavior may lead to limited opportunities for exposure to social information and subsequent poor performance on social cognitive measures. Therefore, the present study will address this matter by examining the relationships and unique contributions of each symptom domain on multiple domains of social cognitive performance. From a theoretical perspective, ADHD symptoms could interfere with adequate encoding and storage of social and emotional information. Therefore, performance on social cognitive

measures could be delayed due to this interference. It is expected that the more severe the symptoms of ADHD, the greater the delay in acquisition of social cognitive information. While the current study cannot fully address this matter, data could provide a foundation for future research.

Finally, the proposed study will examine the relationship and relative contribution of social cognitive performance and functional outcomes. The relationship between social cognition and social behavior is established in other clinical groups. However, little research has examined this question in ADHD and the relative importance of each social cognitive variable in predicting functional outcomes. From a theoretical perspective, the affective areas of social cognition are likely most impacted in ADHD. Therefore, these components may have the most impact on social skills in this population. In sum, the proposed study will address the underlying mechanisms resulting in poor social skills and defiant behavior in children with ADHD.

Study Hypotheses

This study will examine the relationship between ADHD symptomatology, social cognition, and functional ratings. Specifically, it is predicted that

1) Children with ADHD will perform significantly poorer than healthy controls on measures of affect recognition, affective theory of mind, and affective empathy.
2) Symptoms of inattention, hyperactivity, and impulsivity will be significant predictors of performance on social cognitive measures.
3) Performance on social cognitive measures will be significant predictors of functional ratings.

Chapter 3

Methodology

Participants

Participants were children from ages 7-13 consisting of 25 healthy control participants with no clinical diagnosis (NC), 25 participants diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD). All participants had a parent present to provide informed consent. Children were included in this study if they received a diagnosis of ADHD Combined Presentation (ADHD-C) or ADHD Inattentive Presentation (ADHD-I) from a psychologist or physician. Participants were excluded from the study if English was not their primary language and/or they had comorbid autism spectrum disorder, traumatic brain injury, or other neurological conditions. Additionally, participants were excluded from the NC group if they had another DSM-5 diagnosis, a past history of ADHD, or first-degree relative with ADHD. All participants abstained from taking psychostimulant drugs 24 hours prior to the day of testing.

Measures

Diagnostic measures.

Kiddie-Sads-Present and Lifetime Version (K-SADS-PL). The K-SADS is a semi-structured interview to assess current and lifetime symptomatology. The K-SADS was used to confirm diagnoses of ADHD in the clinical group and to rule-out psychiatric conditions in control participants. Interviews were conducted with the parent that attended the evaluation with their child. The K-SADS assesses the following diagnostic categories:

Supplement #1: Affective Disorders (includes assessment of Major Depression, Dysthymic Disorder, Hypomania, and Mania)

Supplement #2: Psychotic Disorders

Supplement #3: Anxiety Disorders (includes assessment of Panic Disorder, Separation Anxiety Disorder, Social Phobia, Phobic Disorders, GAD, OCD, and PTSD)

Supplement #4: Behavioral Disorders (includes assessment of ADHD, ODD, and Conduct Disorder)

Supplement #5: Substance Abuse Disorders

Supplement #6: Eating Disorders

Supplement #7: Tic Disorders

Supplement #8: Autism Spectrum Disorders

Intelligence.

Wechsler Intelligence Scale for Children Fifth Edition (WISC-V). The WISC-V was administered to all children as a standard measure of intelligence. The WISC-V is a five-factor intelligence battery for children between 6 and 16 years of age.

WISC-V Verbal Comprehension Index (VCI). This index involves the expression of verbal concepts, application of previously acquired verbal knowledge, and academic aptitude. These skills are greatly impacted by a child's education and familiarity with U.S. culture. The VCI is composed of the following subtests:

Vocabulary. This subtest requires a child to define words with increasingly difficult vocabulary.

Similarities. This task assesses a child's ability to recognize conceptual similarities between words.

WISC-V Visual Spatial Index (PRI). The VSI assesses nonverbal reasoning abilities requiring attention to visual elements and spatial skills. This index is composed of the following subtests:

Block Design. This task involves arranging blocks to match a designated pattern within a specified time limit.

Visual Puzzles. Participants must mentally manipulate geometric shapes to form a puzzle.

WISC-V Fluid Reasoning Index (FRI).

Figure Weights. Participants use reasoning abilities to identify similarly weighted objects on scales.

Matrix Reasoning. Participants choose pictures to complete a visual and conceptual pattern.

WISC-V Working Memory Index.

Picture Span. Participants were asked to identify pictures in the order in which they were briefly seen previously.

Digit Span. Participants were asked to repeat an increasing series of numbers forwards, backwards, and in order from smallest to largest.

WISC-V Processing Speed Index.

Coding. Participants quickly copied geometric symbols or numbers that are paired with numbers according to a key.

Symbol Search. Children identified the presence or absence of a target symbol in a row of geometric symbols.

Academic measures.

Woodcock Johnson Tests of Achievement Fourth Edition (WJ ACH-IV). The Applied Problems, Letter Word Identification, and Spelling subtests of the WJ ACH-IV were used to screen for an indication of learning problems in participants to characterize the sample.

Demographic ratings.

Petersen Puberty Scale. The Pubertal Development Scale consists of items used to ascertain pubertal status for subjects. This scale is beneficial in determining developmental status, which can impact neurocognitive development.

Child and Adolescent Disruptive Behavior Inventory (CADBI). The CADBI Screener is a brief questionnaire consisting of 25 items related to oppositional behavior. Part 1 and Part 2 (items 1-16) were administered.

ADHD symptomatology.

DSM ADHD Symptom Rating Scale (DSM-ADHD-SRS). ADHD Symptoms were assessed with the DSM-ADHD-SRS, which is an 18-item scale adapted from the ADHD Rating Scale-IV (DuPaul, Power, Anastopoules, & Reid, 1998). The DSM-ADHD-SRS was completed by each child's parent, and operationalizes the 18 Criteria A symptoms from the DSM-IV and DSM-5 for ADHD. Parents were instructed to rate symptom severity. Consistent with the DSM-5, nine items were designed to explicitly capture symptoms of inattention, seven for hyperactivity, and three for impulsivity. The frequencies of behavioral symptoms were quantified by using a four-point Likert-type rating scale including: 0 = never or rarely, 1 = sometimes, 2 = often, and 3 = very often. Previous work has demonstrated that the scale has high internal consistency (Cronbach's $\alpha = .88$) and measures three distinct symptom domains (Parke et al., 2015; Thaler et al., 2013).

Emotion perception.

NEPSY–II Affect Recognition subtest. The NEPSY-II Affect Recognition subtest involves asking whether or not two faces show the same affect followed by a second task asking for the selection of two photos from 3-4 with the same affect. A third task requires participants

to select one of four faces that show the same affect as the photo at the top of the page. Finally, participants were briefly shown a face and then asked to select two photos that depicts the same affect as the photo previously seen.

Social communication.

Children s Communication Checklist-2 (CCC-2). The CCC-2 is a 70-item parent or caregiver rating scale to assess a child's language skills. The social initiation, detection of context, nonverbal communication, social relationships, and interests scales were used in the analyses.

Affective theory of mind.

The Reading the Mind in the Eyes Test (Eyes Test). The Eyes Test (Baron-Cohen et al., 2001) is a test of affective theory of mind in which a participant is presented with items comprised of photographs of the eye-region of different actors and actresses on a computer screen. Four words describing emotions were presented at the four corners of the paper. The participant was prompted to state which emotion word was best captured by the eyes. While this measure is similar to affect recognition tasks, research indicates that it requires more complex cognitive abilities than simple emotion recognition measures (Baron-Cohen et al., 2001). Because this measure only includes Caucasian faces and was developed using a predominately Caucasian sample, the NEPSY-II Contextual task will also be included in this domain.

NEPSY-II Contextual Theory of Mind. In the Contextual task, participants were shown a picture depicting a social context and asked to select a photograph from four options that depicts the appropriate affect of one of the people in the picture.

Cognitive theory of mind.

Happé's Strange Stories. These stories were developed to measure higher-order theory of mind abilities (Happé, 1994). The types of stories are pretend, joke, lie, white lie, figure of speech, misunderstanding, double bluff, sarcasm, persuasion, contrary emotions, appearance/reality, and forgetting. There were two stories for each category. Children were presented with the picture and short story. The examiner read the story out loud and continued to present the physical stimulus to minimize memory components. After each story was read the participant was asked the following two test questions: the comprehension question (Was it true what X said?) and the justification question (Why did X say that?). Answers to justification questions were scored as correct or incorrect based on mental and physical state criteria described by Happé (1994).

Cognitive and affective empathy.

Interpersonal Reactivity Scale (IRI). The IRI is a 28 item self-report scale designed to measure both cognitive and emotional components of empathy. Subscale scores range from 0 to 28. The subscales of the IRI are perspective taking, fantasy scale, empathic concern, and personal distress. The scale was adapted for completion by parents on their child's empathy. Parent ratings of their child on the empathic concern and personal distress scales on the IRI will be also used as measures of affective empathy. Parent ratings of their child's perspective taking and fantasy scales were used as measures of cognitive empathy. Descriptions of the scales are as follows:

Fantasy Scale. This scale examines the tendency to both identify with fictional characters and imagining oneself in the character's emotions and actions.

Perspective Taking. This measures the child's tendency to take on the psychological point of view of others.

Empathic Concern. This scale examines a child's concern for others and sympathy for others in physical or emotional distress.

Personal Distress. This scale is designed to capture the emotional distress a child feels in stressful situation that others face.

Functional measures.

Behavior Assessment System for Children – Second Edition (BASC-2). Social, emotional, and behavioral functioning were assessed using the BASC-2 (Reynolds & Kamphus, 2004), a checklist for problematic behaviors of children ages 2 to 18 years of age. It includes three measures: The Parent Rating Scales (PRS), the Teacher Rating Scales (TRS), and the Self-Report of Personality (SRP). For the purposes of this study, the PRS Aggression, Conduct Problems, and Social Skills subscales were used as functional ratings.

Social Skill Rating Scale (SSRS). The SSRS is a rating scale that assesses social behavior in children aged 3 to 18. It has separate norms for males and females. The Social Skills Scale measures cooperation, assertion, self-control, and responsibility.

Procedures

Participants were recruited by marketing to parents at University of Nevada, Las Vegas, community mental health centers, and the community at large. Participants were recruited through posted advertisements as well as presentations given to treating psychologists in community mental health centers. Participants received monetary compensation ($40). Children in the ADHD group received a brief report including their scores of the standardized measures from the study and a list of resources for parents of children with ADHD. Study procedures

were approved by the UNLV IRB for protection of human subjects. Testing took place at the University of Nevada, Las Vegas (UNLV) Partnership for Research, Assessment, Counseling, Therapy and Innovative Clinical Education (PRACTICE).

Individuals interested in participating in the study initially called a private study line located in the Neuropsychology research laboratory on the UNLV campus. Before answering any questions, participants were given a brief description of study procedures, including initial screening questions, and asked to provide verbal consent to be asked the initial screening questions. Once verbal consent was obtained, participants' parents answered questions to determine eligibility for their child in participating. Individuals that met initial selection criteria on screening were scheduled to complete additional testing procedures at the UNLV PRACTICE. Before participants began study procedures, written informed consent was obtained from parents and written assent from participants. Questions were encouraged.

Once informed consent was reviewed and obtained, participants and their parents completed diagnostic and testing procedures. The parent KSADS-PL was used to determine the presence or absence of Axis I disorders, including ADHD. After it was determined that the participant was eligible, the battery of neurocognitive tests was administered in a fixed order. All testing was conducted by trained doctoral level graduate students in a quiet private room at the PRACTICE. Trained research assistants administered some phone screening and parent interviewing under the supervision of the graduate student. Participants were provided breaks whenever requested or as deemed appropriate by the examiner in order to control for fatigue effects, alleviate anxiety, and maintain motivation.

Data Analyses

Data entry and screening. Data was double entered into a database and analyzed by SPSS version 22.0. During the preliminary data screening process, frequency distributions for all variables were inspected for out of range variables, which would indicate the presence of a data entry error. Data were examined to ensure that it meets assumptions for ANOVA and regression analyses, including multivariate normality, homogeneity of variance, and independence of observations (Howell, 2012). Data were also examined for multicollinearity and to determine if there is a linear relationship between predictor and dependent variables for multiple regression analyses (Howell, 2012).

Preliminary analyses

Prior to analyses on the primary hypotheses, descriptive statistics were calculated for each group on demographic variables, including age, gender, and ethnicity. ANOVA and chi-square analyses were used to determine whether the two groups significantly differ on these variables. If significant differences emerged, significant variables would serve as covariates in subsequent analyses.

Prior to conducting the main analyses, scores were developed for each of the social cognitive domains, including 1) affect recognition, 2) pragmatic language, 3) affective ToM, 4), cognitive ToM, 5) affective empathy, and 6) cognitive empathy. Raw test scores were converted into z-scores based on the performance of the control group. Z-score means of measures were calculated for each of the social cognitive components, resulting in six domain scores that were standardized based on normal control performance. This allows for direct comparisons among the social cognitive domains across the groups.

Raw scores on the NEPSY-II emotion recognition subtest total score composed the Affect Recognition domain. Scores on the CCC-2 Pragmatic subscales for Initiation, Context,

Nonverbal Communication, Social Relations, and Interests composed the Pragmatic Language domain. The raw score contributing to the affective ToM domain were the Reading the Mind in the Eyes Task total score and NEPSY-II Contextual Task. The raw score contributing to the cognitive ToM domain was the Happé's Strange Stories total score. The raw scores on the parent ratings on the perspective taking and fantasy scales contributed to the cognitive empathy domain. The raw scores on the parent ratings on the empathic concern and personal distress scales on the IRI composed the affective empathy domain.

Primary Analyses

The analytical approach to the proposed hypotheses are as follows:

1. Children with ADHD will perform significantly poorer than healthy controls on measures of affect recognition, affective theory of mind, and affective empathy.

To evaluate hypothesis 1, a mixed model ANOVA was used in which group membership (NC or ADHD) was a between subjects factor and the six social cognitions tests served as a repeated measure. A main effect for group was anticipated indicating that overall the ADHD group received lower scores on the social cognition measures than the control group. A main effect for measure was also anticipated indicating that overall some measures are more difficult than others. Consistent with the hypothesis, an interaction effect would indicate that the ADHD group had particular difficulty on tasks with affective components (emotion perception, affective Tom, and affective empathy) compared to cognitive tasks (ToM and cognitive empathy). This was expected because of the emotion perception requirement in affective ToM and empathy tasks. Separate ANOVAs were conducted for each of the six social cognitive domains to examine the pattern of performance on social cognitive measures.

2. Symptoms of inattention, hyperactivity, and impulsivity will be significant predictors of performance on social cognitive measures.

Raw scores on the DSM ADHD SRS were correlated with measures of ADHD social cognitive domains. Significant correlates were indicators of possible predictors. To determine the relative contribution of ADHD symptomatology on social cognitive performance, significant predictors were entered into a hierarchical multiple regression analyses for social cognitive performance. Changes in R^2 were observed as predictor variables were introduced to determine the relative proportion of variance increased with each new predictor variable. It was expected that each of the symptom domains, particularly inattention and impulsivity would be negatively correlated with performance on social cognitive tasks. Provided each symptom domain was significantly correlated with social cognitive performance, symptoms were entered into the model based on their theorized contribution. Inattention was entered as step 1, followed by impulsivity as step 2, and finally hyperactivity as step 3. Statistical significance and strong negative standardized regression coefficients (β) were anticipated, indicating that ratings of ADHD symptoms were effective predictors of performance on social cognitive measures. A statistically significant *R* for the regression was anticipated. It was predicted that the identified model would explain a significant proportion of the variation in social cognitive performance. All regressions were performed with the combined control and ADHD groups for increased statistical power and because the general population also demonstrates inattentiveness, impulsivity, and hyperactivity. The presence of mild symptoms occurring as part of normal behavioral variation in non-clinical populations was also anticipated to influence development of social cognitive abilities.

3. Performance on social cognitive measures will be significant predictors of functional ratings.

The analytic approach used for hypothesis 3 was the same as used for hypothesis 2. Scores on the social cognitive measures were correlated with problem (BASC-2 aggression and conduct problems) and prosocial behaviors (BASC-2 Social Skills, SSRS cooperation, assertion, self-control, and responsibility). Significant correlates were indicators of possible predictors. To determine the relative contribution of social cognitive performance on functional ratings, significant predictors were entered into hierarchical multiple regressions. If all variables were significantly correlated with outcome measures, then they would be entered in according to their theorized level of difficulty, moving from simple to more complex. Affect recognition performance would be entered in step 1, followed by affective ToM in step 2, affective empathy in step 3, cognitive ToM in step 4, and cognitive empathy in step 5, and pragmatic language in step 6. Statistical significance and strong standardized regression coefficients (β) were anticipated, indicating that social cognitive scores were effective predictors of functional ratings. A statistically significant *R* for the regression was anticipated. It was predicted that the identified model would explain a significant proportion of the variation in problem and prosocial behaviors. All regressions were performed with both the control and ADHD groups because it is likely that social cognition and functional social outcomes are related in both clinical and the general population.

Chapter 4

Results

Data Screening

Initial screening and evaluation of the data took place in order to ensure accuracy of the data and assumptions of ANOVA and regression were met.

Accuracy of data file. Frequency statistics were evaluated in order to ensure all data fell within range. Data was also examined for missing cases, of which none were present.

Preliminary Analyses

Conversion to z-scores. Prior to conducting the main analyses, scores were developed for each of the social cognitive domains, including 1) affect recognition, 2) pragmatic language, 3) affective ToM, 4), cognitive ToM, 5) affective empathy, and 6) cognitive empathy. Raw test scores were converted into z-scores based on the performance of the control group. Z-score means of measures were calculated for each of the social cognitive components, resulting in six domain scores that were standardized based on normal control performance. This allows for direct comparisons among the social cognitive domains across the groups.

Assumptions of ANOVA

Independence of cases. This assumption was met.

Normality. Normality was examined by plotting the residuals as a histogram and examining Q-Q plots.

Homogeneity of variance. Levene's test was used to assess the equality of variances for variables. Levene's test was significant for pragmatic language and cognitive ToM. Therefore, Welch's ANOVA was used in the analyses.

Assumptions of Regression

Linearity. Through examination of scatter plots of all dependent variables and plots of the residuals from regression analyses, the variables exhibited a linear relationship.

Multicollinearity. Multicollinearity was examined using a correlation matrix. Variables are considered multicollinear if the correlation between them are > .90. There were no correlations exceeding .90, suggesting the absence of multicollinearity.

Homoscedasticity. Homoscedasticity was checked by examining residual scatter plots.

Detecting Outliers

Multivariate outliers were evaluated by a Mahalanobis distance of $p < .001$ for the χ^2 value. Mahalanobis distance calculated using linear regression indicated one multivariate outlier. The analyses were run with and without the outlier. The results did not differ when the outlier was excluded from the analyses. Thus, this was likely not an overly influential outlier and it remained in the analyses.

Demographic data is provided in Table 1. As indicated in Table 1, groups did not significantly differ on age, gender, ethnicity, or gross household income, height, or weight. The ADHD group performed significantly worse than controls on measures of academic achievement and all indexes of the WISC-V, with the exception of the Fluid Reasoning Index.

Table 1

Demographic, IQ, Academic Achievement, and Pragmatic Language Subscales Information by Group

Variable	Group				
	Control (*n*=25)	ADHD (*n*=25)			
	Mean (SD)	Mean (SD)	*F*	*P*	Cohen's *d*
Age	10.07 (1.90)	10.57 (2.09)	.78	.38	-.25
Gross Family Income	122560.00 (77051.97)	99033.33 (72650.51)	1.21	.28	.31
Puberty-Height (inches)	54.00 (4.74)	56.05 (6.17)	1.47	.23	-.37
Puberty-Weight (pounds)	76.48 (34.83)	94.31 (45.72)	2.25	.14	-.44
WISC-V FSIQ	107.44 (10.65)	98.08 (15.15)	6.39	.015	.71
WISC-V VCI	110.40 (12.06)	101.20 (13.85)	6.27	.016	.71
WISC-V VSI	107.52 (13.15)	100.12 (11.55)	4.47	.04	.60
WISC-V FRI	104.88 (10.80)	103.76 (16.48)	.08	.78	.08
WISV-V WMI	102.12 (12.77)	93.52 (15.43)	4.61	.04	.61
WISV-V PSI	101.16 (13.29)	88.76 (12.14)	11.86	.001	.97
WJ-IV Brief Ach	107.32 (11.65)	93.80 (17.90)	10.02	.003	.90
WJ-IV Letter Word	105.32 (9.72)	93.84 (16.30)	9.15	.004	.86
WJ-IV App Prob	109.16 (15.32)	96.60 (16.83)	7.62	.008	.78
WJ-IV Spelling	105.20 (11.91)	92.56 (18.46)	8.27	.006	.81
Pragmatic Language					
Initiation	11.28 (2.05)	7.32 (2.16)			
Context	11.68 (1.93)	8.32 (2.10)			
Nonverbal Communication	11.20 (1.89)	8.32 (2.29)			
Social Relations	11.36 (1.89)	7.96 (2.17)			
Interests	11.52 (2.22)	8.16 (1.49)			
			χ^2	*P*	
Gender (% male)	60.0	76.0	1.47	.23	.35
Ethnicity (%)			6.68	.25	.79
Caucasian	72.0	44.0			
African American	8.0	12.0			
Hispanic/Latino	4.0	16.0			
Asian American	4.0	4.0			
Multi-racial	12.0	24.0			

Note. SD = Standard Deviation; WISC-V FSIQ = Wechsler Intelligence Scale for Children Fifth Edition Full Scale IQ; WISC-V VCI = Verbal Comprehension Index; VSI = Visual Spatial Index; FRI = Fluid Reasoning Index; WMI = Working Memory Index; PSI = Working Memory Index; WJ-IV Brief Ach= Woodcock Johnson Tests of Achievement Fourth Edition Brief Achievement; WJ-IV Letter Word = Letter Word Identification; WJ-IV App Prob = Applied Problems.

The differences in IQ and academic achievement were expected based on prior research indicating that children with ADHD often exhibit deficits in working memory and processing speed (Parke, Thaler, Etcoff, & Allen, 2015). Slowed processing speed and weaknesses in fine motor dexterity can impact the Visual Spatial Index because of the time components embedded in these measures. These cognitive weaknesses, poor attention, and genetic vulnerability to learning disorders also affect academic skills in children with ADHD (Barkley, 2014a). Full Scale IQ was entered as a covariate in analyses to determine if social cognition was impacted beyond general cognitive skills in this population.

Within the ADHD group, 68% percent were currently prescribed a psychostimulant medication. These medications were not taken 24 hours prior to the study. Presentation of ADHD and comorbid diagnosis information, based on the KSADS Parent Interview, can be found in Table 2. Disruptive symptoms measured by parent ratings on the CADBI are reported in Table 3.

Table 2

ADHD Presentation and Comorbid Diagnosis

Diagnosis	Frequency (%)
ADHD-Combined	64 (*n*=16)
ADHD- Inattentive	36 (*n*=9)
Oppositional Defiant Disorder	44 (*n*=11)
Generalized Anxiety Disorder	8 (*n*=2)
Major Depressive Disorder	8 (*n*=2)

Table 3

Disruptive Behavior Symptoms for the ADHD Group

	Behavior Towards Adults Frequency (%)				Behavior Towards Peers (*n*) Frequency (%)			
Behavior	Never	Monthly	Weekly	Daily	Never	Monthly	Weekly	Daily
Argues	16	24	4	40	16	32	12	40
Loses temper	12	40	12	36	12	44	12	32
Refuses to obey/cooperate	40	28	16	16	28	36	4	32
Annoys on purpose	44	24	12	16	28	32	4	36
Blames	24	36	12	28	28	24	12	36
Becomes Annoyed	16	48	8	28	16	36	4	44
Angry/Resentful	36	44	4	16	36	32	4	28
Vindictive	80	16	0	4	56	20	0	24

Note. All ratings describe the child's behavior in the last month; Frequency = the percent of parents that reported this symptom and frequency in their child; Weekly = 2-6 times per week; Monthly = 1-2 times, 3-4 times, and 2-6 times in a month; Daily = 1 times per day, 2-5 times per day, 6-9 times per day, and 10 or more times per day.

Primary Analyses

Hypothesis 1. A mixed model ANOVA was used in which group membership (Control or ADHD) was a between subjects factor and the social cognitions tests served as a repeated measure. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(14) = 49.17$, $p < .001$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .74$). Results of the ANOVA indicated significant effects for Social Cognition scores, $F(3.70, 177.50) = 12.66$, $p < .001$, $\eta p^2 = .21$ and for Group, $F(1, 48) = 26.57$, $p < .001$, $\eta p^2 = .36$. Analyses were followed up with separate ANOVAs and analysis of covariance (ANCOVAs) with Full Scale IQ (FSIQ) as a covariate for each of the six social cognitive domains to examine the pattern of performance on social cognitive measures. There were no within subjects effects for the ADHD group, but poorer performance on cognitive ToM compared to affect recognition approached significance, $p = .057$. Between subjects effects were

still significant when FSIQ was entered as a covariate, with the exception of parent ratings of cognitive empathy. Table 4 summarizes these results. As can be seen from the table, the ADHD and control groups performed significantly poorer on measures of affect recognition, pragmatic language, cognitive ToM, and parent ratings of cognitive empathy. There were no within subjects effects, but worse performance on cognitive ToM compared to affect recognition in children with ADHD approached significance, $p = .057$. Results are also graphically represented in Figure 1.

Table 4

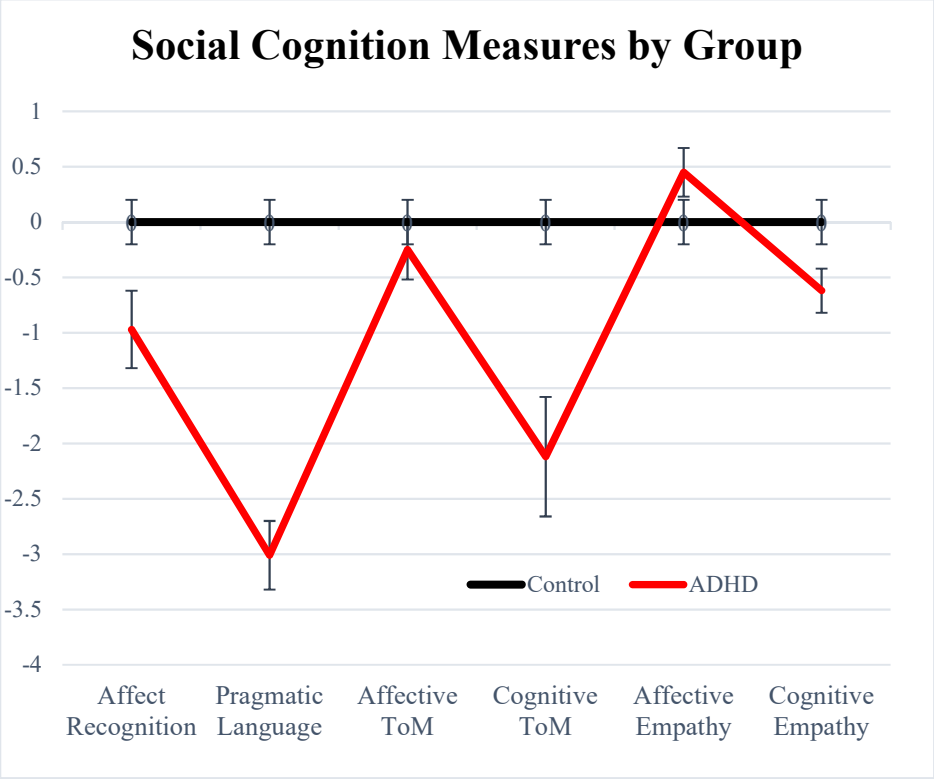
Main Variable Information and Effects for ADHD Group

Variable	Group					
	Control (*n*=25)	ADHD (*n*=25)				
	Raw/SS	Raw/SS	z score		IQ as Covariate	
	M (SD)	*M (SD)*	*M (SD)*	*F*	*F*	Cohen's *d*
AR	11.64 (1.98)	9.72 (1.65)	-.97 (1.74)	5.88*	3.23*	-.68
PL	9.80 (6.68)	29.92 (10.19)	-3.01 (1.53)	68.19**	33.97**	-2.33
A ToM	23.84 (3.20)	23.04 (4.25)	-.25 (1.33)	.57	.44	-.21
C ToM	43.48 (3.02)	38.00 (6.30)	-2.12 (2.71)	13.53**	20.38**	-1.04
A Emp	32.88 (6.19)	35.68 (6.71)	.45 (1.08)	2.35	1.16	.43
C Emp	29.60 (9.59)	23.64 (9.72)	-.62 (1.01)	4.76*	2.69	-.62

Note. * = $p < .05$; ** = $p < .01$; SS = Standard Score; All scores are reported as raw scores except the Affect Recognition test. Within Subjects Effects reported for ADHD group; AR = NEPSY-II Affect Recognition Subtest; PL = Children's Communication Checklist-2 Pragmatic Language Score; A ToM = Reading the Mind in the Eyes Total Score and NEPSY-II Contextual Items from Theory of Mind Subtest; C ToM = Happé's Strange Stories Total Score; A Emp = Interpersonal Reactivity Scale Affective Empathy Parent Rating; C Emp = Interpersonal Reactivity Scale Cognitive Empathy Parent Rating.

Figure 1

Social Cognition Performance by Group



Note. AR = NEPSY-II Affect Recognition Subtest; PL = Children's Communication Checklist-2 Pragmatic Language Score; A ToM = Reading the Mind in the Eyes Total Score and NEPSY-II Contextual Items from Theory of Mind Subtest; C ToM = Happé's Strange Stories Total Score; A Emp = Interpersonal Reactivity Scale Affective Empathy Parent Rating; C Emp = Interpersonal Reactivity Scale Cognitive Empathy Parent Rating; Standard error was used for error bars.

Hypothesis 2. Hierarchical multiple regression analyses were conducted to examine the relation of social cognitive performance to ADHD symptoms. Simple correlation values of all pairs of variables in the analysis are shown in Table 5.

Table 5

Correlations among Social Cognition Variables and ADHD Symptoms

Variable	Inattention	Hyperactivity	Impulsivity
Affect Recognition	**-.33***	**-.40***	-.23
Pragmatic Language	**-.77****	**.65****	**-.68****
Affective ToM	-.14	-.15	-.09
Cognitive ToM	**-.42****	**-.51****	**-.36****
Affective Empathy	.21	.24	.22
Cognitive Empathy	**-.30***	-.25	**-.29***

Note. * = $p < .05$; ** = $p < .01$; ToM = Theory of Mind.

Symptom domains that were significantly correlated with social cognitive performance were entered into the model based on their theorized contribution. Inattention was entered as step 1, followed by impulsivity as step 2, and finally hyperactivity as step 3. When not all symptoms domains were significantly correlated, they were entered in this order, with the exclusion of the nonsignificant symptom domain (e.g., impulsivity predicting affect recognition). Results are summarized in Table 6. Inattention was a significant predictor for affect recognition, cognitive ToM, pragmatic language, and parental ratings of cognitive empathy. The inclusion of hyperactivity or impulsivity significantly increased the proportion of explained variance for cognitive ToM, but not for models for other social cognitive variables. Nonlinear effects were checked by examining the squared term for predictor variables. These were not statistically significant or an improvement upon the linear model, indicating the absence of nonlinear effects.

Table 6

Regression Analyses for ADHD Symptoms' Incremental Prediction of Social Cognitive Performance

Variable	Model/predictors	R^2 Change	β	F Change	Cohen's f^2
Affect Recognition	**Model 1: Inattention**	**.11**	**-.33**	**5.72***	**.12**
	Model 2: Inattention + Hyperactivity	.06	-.07 -.35	3.09	.16
Pragmatic Language	**Model 1: Inattention**	**.60**	**-.77**	**70.57****	**1.47**
	Model 2: Inattention + Impulsivity	.03	-.59 -.24	3.36	1.65
	Model 3: Inattention + Impulsivity + Hyperactivity	.00	-.60 -.25 .01	.00	1.65
Cognitive ToM	**Model 1: Inattention**	**.17**	**-.42**	**10.00****	**.20**
	Model 2: Inattention + Impulsivity	.01	-.32 -.13	.43	.22
	Model 3: Inattention + Impulsivity + Hyperactivity	**.10**	**-.16** **.31** **-.65**	**6.55***	**.39**
Cognitive Empathy	**Model 1: Inattention**	**.08**	**-.29**	**4.34***	**.09**
	Model 2: Inattention + Impulsivity	.02	-.16 -.18	.77	.09

Note. * = $p < .05$; ** = $p < .01$; ToM = Theory of Mind.

Hypothesis 3. Hierarchical multiple regression analyses were conducted to examine the predictive relationship of social cognitive performance to functional ratings of problem (BASC-2 aggression and conduct problems) and prosocial behaviors (BASC-2 Social Skills, SSRS cooperation, assertion, self-control, and responsibility). Simple correlation values of all pairs of variables in the analysis are shown in Table 7.

Table 7

Correlations among Social Cognition Variables and Behavior Ratings

Variable	Problem Behaviors	Prosocial Behaviors
Affect Recognition	-.17	.20
Pragmatic Language	**-.47****	**.55****
Affective ToM	-.13	.16
Cognitive ToM	**-.40****	**.60****
Affective Empathy	-.12	.06
Cognitive Empathy	**-.55****	**.48****

Note. * = $p < .05$; ** = $p < .01$; ToM = Theory of Mind.

Social cognitive domains that were significantly correlated with problem and prosocial behaviors were entered into the model based on their theorized contribution. Cognitive ToM was entered as step 1, followed by cognitive empathy as step 2, and finally pragmatic language as step 3. Performance in each social cognitive domain provided a unique proportion of the variance in parent ratings of problem and prosocial behaviors. Nonlinear effects were checked by examining the squared term for predictor variables. These were not statistically significant, indicating the absence of nonlinear effects. Findings are summarized in Table 8.

Table 8

Regression Analyses for Social Cognitive Performance's Incremental Prediction of Problem and Prosocial Behaviors

Variable	Model/predictors	R^2 Change	β	F Change	Cohen's f^2
Problem Behaviors	Model 1: Cog ToM	.13	-.36	7.21**	.15
	Model 2: Cog ToM +	.23	-.23	16.86**	.56
	Cog Empathy +		-.50		
	Model 3: Cog ToM +	.06	-.12	4.70*	.72
	Cog Empathy +		-.45		
	Pragmatic Language		-.27		
Prosocial Behaviors	Model 1: Cog ToM	.31	.56	21.91**	.46
	Model 2: Cog ToM +	.10	.47	7.84**	.70
	Cog Empathy +		.33		
	Model 3: Cog ToM +	.11	.33	10.78**	1.10
	Cog Empathy +		.26		
	Pragmatic Language		.38		

Note. * = $p < .05$; ** = $p < .01$; Cog ToM = Cognitive Theory of Mind; Cog Empathy = Cognitive Empathy.

Chapter 5

Discussion

There is clear evidence that children with ADHD exhibit social problems including, aggression, poor eye contact, and difficulty developing age appropriate relationships with peers (Uekermann et al., 2010). However, further exploration of the underlying cognitive deficits that could be contributing to social impairment is lacking in the literature. Research has indicated that children with ADHD demonstrate impairment in aspects of social cognition, such as emotion perception, particularly related to facial expressions (Bae, Shin, & Lee, 2009; Ibáñez et al., 2011; Pelc et al., 2006; Williams et al., 2008). Given that this basic social cognitive skill is impacted, it was predicted that more complex social cognitive components of affective ToM and empathy would also be affected. Identifying a comprehensive profile of social cognitive performance in children with ADHD could provide insight into behavioral outcomes and identify targets for treatment.

Affect Recognition

Results of the current study replicated prior studies demonstrating that children with ADHD perform worse than typically developing peers on measures of facial affect recognition (Bae et al., 2009; Ibáñez et al., 2011; Pelc et al., 2006; Williams et al., 2008). Prior studies had used experimental measures and the current study demonstrated this difference in the clinical measure included on the NEPSY-II. The NEPSY-II validity study for ADHD included 55 children that met criteria for ADHD, Combined Type and found that they performed significantly lower than matched controls on the Affect Recognition subtest, concluding that visual inattention impacts facial emotion perception (Kemp & Korkman, 2010). The current study included children with both the inattentive and combined presentation, given that

inattention may be the primary symptom interfering with emotion perception. In the current study, it should be noted that the mean performance on the NEPSY-II Affect Recognition subtest was 9.72 for the ADHD group, which is within the average range. However, when directly comparing their performance to the control group, the results were statistically different. While it is possible that the control group in the current study was high functioning, their Full Scale IQ was in the average range, indicating that their performance may be reflective of the general population. The current study suggests that differences in facial affect recognition may be subtle and not readily apparent in a clinical evaluation using the NEPSY-II. Therefore, thorough behavioral observations and a clinical interview with parents regarding the child's ability to perceive emotions may be beneficial. Further development of clinical measures that are sensitive to emotion recognition deficits is also warranted.

Affective Theory of Mind

Contrary to expectation, children with ADHD had more difficulty with cognitive components of social cognition (pragmatic language, cognitive ToM, and cognitive empathy), rather than the affective domains (affective ToM and empathy). Interestingly, poorer performance compared to controls on facial affect recognition did not translate into deficits in affective empathy or ToM. Performance on facial affect recognition tests may be more related to cognitive components of social learning than initially expected. The current findings are consistent with a prior study demonstrating that participants with ADHD perform similar to controls on the Reading the Mind in the Eyes Test (Demurie et al., 2011), but validated the result with a larger sample size. However, a recent study found that children with ADHD performed worse than a control group on this measure (Mary et al., 2016). Given the relatedness of facial affect recognition and affective ToM, it is possible that affective ToM is impacted in children

with ADHD, but that the measures used in the current study were not reliably sensitive to these deficits. The Reading the Mind in the Eyes measure was initially created for use in adults and includes pictures of Caucasian adult faces (Baron-Cohen et al., 2001). The NEPSY-II Contextual task was also included, as it uses a child's face and was validated in an ethnically diverse standardization sample. However, there are limited items in this measure. When examining performance for both of these measures, it appears that children in both groups struggled with the Reading the Mind in the Eyes measure and easily completed the NEPSY-II Contextual task. Thus, there may be a floor effect for the Reading the Mind in the Eyes test and a ceiling effect for the NEPSY-II Contextual task. Additionally, others have questioned the ecological validity of static measures of affective ToM (Demurie et al., 2011). Unfortunately, there are limited dynamic measures available, particularly ones used for a clinical evaluation and with standardized norms. Thus, further development of measures for affective ToM in children is also recommended.

Affective Empathy

The current study suggests that symptoms of ADHD interfere with social learning, but not the emotional reactivity involved in social experiences. Previous studies found deficits in empathic accuracy, meaning the ability to identify and personally match emotional reactions (Braaten & Rosen, 2000; Demurie et al., 2011; Downs & Smith, 2004; Dyck et al., 2001; Yuill & Lyon, 2007). These measures may be complicated by the cognitive components of the task because they often involve comprehension and interpretation of stories or pictures. Conversely, parent ratings of children's empathy may capture real world emotional reactions. In the current study, parents rated their children with ADHD as somewhat more empathetic than the parent ratings of the control group. Although these results were not statistically significant, it is

interesting that parents rated their children with ADHD at least as empathetic as their typically developing peers. It may be that children with ADHD have difficulty accurately identifying and matching the emotions of others on performance based measures, but they are emotionally reactive in real life situations. Furthermore, their tendency towards emotion dysregulation because of deficits in executive functioning (Barkley, 2014a), may lead them to be perceived as equally or more empathetic than typically developing peers. Emotional reactions from others are salient stimuli and may have more of an impact on children with ADHD than their peers. For example, if another child is crying a child with ADHD may attend to this noise at the expense of attending to other relevant information (e.g., classroom instruction or other social cues). They may also have difficulty regulating their reaction to another's distress and take longer than peers to calm down from distress or excitement. Therefore, children with ADHD may experience affective empathy but inappropriately regulate their reactions. Their potentially affected cognitive ToM could also impact their ability to accurately understand the complexity of reasons behind another's emotions.

Cognitive Theory of Mind

The current study provides insight into the cognitive domains of social learning in children with ADHD. Similar to the impact of ADHD symptoms on academic learning, social cognition could also be affected by these symptoms. Others have identified ToM performance in ADHD as an area that needs further study (Uekermann et al., 2010). Cognitive ToM is associated with language abilities and executive functioning skills (Ahmed & Miller, 2011; Slade & Ruffman, 2005). Therefore, it is plausible that children with ADHD would also exhibit deficits in cognitive ToM if pragmatic language skills and executive functioning are areas of weakness. Furthermore, imaging studies examining participants with ADHD have demonstrated

dysfunction in brain regions involved with ToM (Uekermann et al., 2010). Of the few studies conducted, there were conflicting results regarding cognitive ToM performance in this population (Uekermann et al., 2010). The current study is consistent with prior research indicating advanced cognitive ToM abilities are affected in children with ADHD (Buitelaar et al., 1999; Sodian & Hülsken, 2005; Hutchins et al., 2016). Conflicting results in the literature may be related to differences in ADHD presentations, variability within the population, the influence of comorbid diagnoses, and differences in measures. Overall, the current study and literature indicate that ToM should be included in evaluations of children with ADHD (Slama et al., 2011). Furthermore, deficits in ToM should not solely be used in differentiating between diagnoses of ADHD and autism spectrum disorder (Demurie et al., 2011). Although these children might not consistently exhibit ToM deficits, they are at risk for weaknesses in this area, particularly if social skills are a presenting concern for parents. While attention, executive functioning, and language abilities are related to ToM performance (Ahmed & Miller, 2011), each of these skills represent distinct constructs. Daily social interactions require a complex interaction between these skills and their unique contributions are difficult to disentangle.

Cognitive Empathy

There was limited prior research on cognitive empathy in children with ADHD. The current study found that parent ratings of cognitive empathy were lower than parent ratings of control participants. Results approached significance after controlling for IQ. The current study used the Fantasy and Perspective Taking scales on the IRI in an attempt to capture children's tendency to imagine themselves in another's situation. It is reasonable that if children have difficulty understanding another's point of view (cognitive ToM), then they would be less likely to envision themselves from another's perspective. This is consistent with previous studies

indicating performance based deficits and lower parent ratings of perspective taking in children with ADHD (Demurie et al., 2011; Schwenck et al., 2011). Overall, current study findings indicate that children with ADHD may be emotionally reactive to others but that they are less likely to take another's perspective. Thus, cognitive empathy may be a useful target for intervention to improve social skills. For example, the use of social stories and instruction on understanding emotional scripts may be beneficial (Ornaghi, Brockmeier, & Grazzani, 2014). Rather than addressing whether a child responds emotionally to others, it may be more important to assess and treat the adaptiveness of their emotional responses in stressful situations.

Pragmatic Language

Study results are consistent with prior studies indicating pragmatic language is affected in children with ADHD or those at risk for developing the disorder (Guerts & Embrechts, 2008; Leonard et al., 2011; Staikova et al., 2013; Väisänen, et al., 2014). Interestingly, the mean performance on the WISC-V Verbal Comprehension Index was in the average range for this sample, indicating that pragmatic language is distinct from Verbal IQ. The current study is different from some prior studies in that it thoroughly assessed and only included children diagnosed with ADHD (Leonard et al., 2011), included a control group (Guerts & Embrechts, 2008), and assessed Verbal IQ (Staikova et al., 2013; Väisänen, et al., 2014). Pragmatic language abilities are often not assessed in neuropsychological evaluations, but now there is further evidence that abilities can be compromised in children with ADHD. Thus, comprehensive evaluations should include or refer to speech and language pathology to assess pragmatic language, given the relationship between pragmatic skills and problem and prosocial behaviors.

Contribution of ADHD Symptoms on Social Cognition

Prior research indicated that ADHD symptoms are associated with social problems (Williams et al., 2008), but there are few studies investigating the role that ADHD symptomatology plays in social cognition. According to theory and extensive evidence of the impact that ADHD symptoms have on other non-social learning tasks (Barkley, 2014a), it was expected that these symptoms would also interfere with social learning. Theoretically, ADHD symptomatology could prevent early social cognitive development resulting in continued delays even after symptoms are treated. For example, inattention may interfere with the ability to focus and sustain attention during conversations or play. Hyperactivity and impulsivity could lead to rejection and isolation from peers (e.g., time out) providing them with limited opportunities for social development.

The present study examined the relationships and unique contributions of each symptom domain on multiple aspects of social cognitive performance. It was expected that the more severe the symptoms of ADHD, the greater the delay in acquisition of social cognitive information. Prior studies indicated that children with predominately inattentive symptoms had more deficits in social knowledge than children with hyperactive and impulsive symptoms (Maedgen & Carlson, 2000; Mikami et al., 2007; Wheeler & Carlson, 1994). Researchers have suggested that hyperactivity and impulsivity interfere with appropriately enacting social knowledge, rather than the initial acquisition of skills (Kofler et al., 2011). Thus, inattention was entered first into the regression models. Impulsivity was entered next because of its strong association with executive functioning skills involved in social cognition and learning (Carlson & Moses, 2001; Celestin-Westreich & Celestin, 2013), as well as previous findings of its relationship with affect recognition skills (Bae et al., 2009). The current study demonstrated that

inattention was predictive of performance on affect recognition, pragmatic language, cognitive ToM, and cognitive empathy. Findings are consistent with prior studies demonstrating a relationship between sustained attention and measures of emotion recognition in faces (Sinzig et al., 2008; Shin et al., 2008). Results provide evidence that inattention interferes with social learning, particularly on cognitively related tasks.

Hyperactivity and impulsivity did not significantly contribute to explaining variance in the model for most domains of social cognition, with the exception of cognitive ToM. Surprisingly, there was a greater correlation between hyperactivity and performance on affect recognition and cognitive ToM. An explanation of this finding could be that behavioral disinhibition, including motor activity (hyperactivity) impacts social learning. Previous studies have demonstrated a relationship between hyperactivity and affect recognition (Aspan et al., 2014) and ToM (Maoz et al., 2014). These symptom domains may have more of a role in performing social skills and modulating emotional reactions, but appear to have a relationship with some aspects of social cognition.

Outcome Measures

A primary purpose of neuropsychological assessments is to measure deficits that translate into real world impairment. While this relationship may be clearly established in other neuropsychological domains and with other populations (Bowie, Reichenberg, Patterson, Heaton, & Harvey, 2006), the relationship between social cognitive performance and ratings of social behavior has not been thoroughly explored in children with ADHD. Study findings indicated that social cognitive performance in pragmatic language, cognitive ToM, and cognitive empathy were predictive of both problem and prosocial behaviors. Results suggest that cognitively and language based domains of social cognition are most important in demonstrating

social skills and inhibiting aggressive or oppositional behavior. It is likely that if children are limited in their social communication skills and understanding of another's thoughts they are more likely to act out. This is consistent with research demonstrating the importance of language abilities and social skills (Leonard et al., 2011).

Contrary to predictions and previous studies (Bae et al., 2009; Pelc et al., 2006), affect recognition was not correlated with parent ratings of problem and prosocial behaviors. This is surprising given that affect recognition deficits in children with ADHD are the most validated finding in the literature (Bora & Pantelis, 2016). Furthermore, affective components of social cognition were not correlated with problem and prosocial skills. It is possible that children with ADHD are emotionally connected with others, but they lack the problem-solving skills to control aggression and demonstrate social skills, such as cooperation.

Limitations and Future Directions

The current study did not exclude children with learning disabilities, which may have contributed to findings. Language and general cognitive abilities are important in social interactions and learning differences likely also affect social learning and communication. Similarly, a meta-analysis of social cognition in children with ADHD also concluded that general cognitive impairment contributes to social cognitive deficits (Bora & Pantelis, 2016). This does not negate that social cognitive skills are a distinct construct that may be more predictive of social skills than general intelligence alone. Although the current sample exhibited a lower IQ than the control group, differences between affect recognition, pragmatic language, and cognitive ToM performance were statistically significant between groups after controlling for Full Scale IQ.

The current study included children with comorbid diagnoses of anxiety, depression, and oppositional behavior, which can also impact social cognition skills (Wyer & Srull, 2014). However, children with ADHD are prone to developing these disorders and children with comorbid conditions will commonly be seen in clinical practice. Future studies should examine the contribution of these comorbid diagnoses to social cognition performance. Finally, it should be noted that the current study included groups from a high socio-economic status. Challenges in recruiting participants with lower family incomes is a common challenge when conducting research. Therefore, results should be interpreted with this information in mind and future studies should address barriers to research participation to recruit more economically diverse groups.

Conclusion

Findings were surprising in that children with ADHD had more difficulty with cognitive, but not affective components of social cognition. Inattention was predictive of performance in these domains, but there was little improvement of the model with the addition of hyperactivity and impulsivity. While the current study provides insight into social cognitive deficits in children with ADHD, further development of social cognitive tests is needed, as well as exploration of differences in presentations and comorbid diagnoses. Implications for clinical practice include, addressing social cognitive deficits in evaluations and in feedback with parents. Recommendations for social skills training may be beneficial.

Appendix

Social Cognitive Construct	Abbreviation
Affect Recognition	AR
Pragmatic Language	PL
Theory of Mind	ToM
Affective Theory of Mind	A ToM
Cognitive Theory of Mind	C ToM
Affective Empathy	A Emp
Cognitive Empathy	C Emp

References

Abikoff, H. B., Jensen, P. S., Arnold, L. L., Hoza, B., Hechtman, L., Pollack, S., …, Wigal, T. (2002). Observed classroom behavior of children with ADHD: Relationship to gender and comorbidity. *Journal of Abnormal Child Psychology, 30*, 349–359. doi: 10.1023/A:1015713807297

Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology, 11*, 231–239. doi:10.1016/S0959-4388(00)00202-6

Ahmed, F. S., & Stephen Miller, L. (2011). Executive function mechanisms of theory of mind. *Journal of Autism and Developmental Disorders, 41*, 667-678. doi: 10.1007/s10803-010-1087-7

Aker, M., & Landrø, N. I. (2014). Executive control of emotional processing: A set-shifting task. *The Clinical Neuropsychologist*, 28, 1311-1320. doi:10.1080/13854046.2014.984762

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: American Psychiatric Publishing.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Anderson, P. (2008). Towards a developmental model of executive function. In V. A. Anderson, R. Jacobs, & P. J. Anderson (Eds.), *Executive functions and the frontal lobes: A lifespan perspective* (pp. 3–22). Hove, England: Psychology Press.

Andrade BF, Brodeur DA, Waschbusch DA, Stewart SH, McGee, R (2009) Selective and sustained attention as predictors of social problems in children with typical and

disordered attention ability. *Journal of Attention Disorders, 12*, 341–352. doi:10.1177/1087054708320440

Andrade, B. F., & Tannock, R. (2014). Sustained impact of inattention and hyperactivity-impulsivity on peer problems: Mediating roles of prosocial skills and conduct problems in a community sample of children. *Child Psychiatry & Human Development*, *45*, 318-328. doi: 10.1007/s10578-013-0402-x

Antshel, K. M., Hier, B. O., & Barkley, R. A. (2014). Executive functioning theory and ADHD. In *Handbook of executive functioning* (pp. 107-120). New York, NY: Springer.

Arnett, A. B., Pennington, B. F., Willcutt, E. G., DeFries, J. C., & Olson, R. K. (2014). Sex differences in ADHD symptom severity. *Journal of Child Psychology and Psychiatry*. Advance online publication. doi:10.1111/jcpp.12337

Aspan, N., Bozsik, C., Gadoros, J., Nagy, P., Inantsy-Pap, J., Vida, P., & Halasz, J. (2014). Emotion recognition pattern in adolescent boys with attention-deficit/hyperactivity disorder. *BioMed Research International*, 1-8. doi:10.1155/2014/761340

Auyeung, B., Wheelwright, S., Allison, C., Atkinson, M., Samarawickrema, N., & Baron-Cohen, S. (2009). The children's empathy quotient and systemizing quotient: Sex differences in typical development and in autism spectrum conditions. *Journal of Autism and Developmental Disorders*, *39*, 1509-1521. doi:10.1007/s10803-009-0772-x

Bae, S. M., Shin, D. W., & Lee, S. J. (2009). The effect of impulsivity and the ability to recognize facial emotion on the aggressiveness of children with attention-deficit hyperactivity disorder. *Journal of the Korean Academy of Child and Adolescent*

Psychiatry, *20*, 17-22. Retrieved from http://www.koreamed.org/SearchBasic.php?RID=0135JKACAP/2009.20.1.17&DT=1

Baird, J. A., & Astington, J. W. (2004). The role of mental state understanding in the development of moral cognition and moral action. *New Directions for Child and Adolescent Development, 103,* 37–49. doi:10.1002/cd.96

Balleine, B.W., M.R. Delgado & O. Hikosaka. (2007). The role of the dorsal striatum in reward and decision-making. *Journal of Neuroscience, 27*, 8161–8165. doi:10.1523/JNEUROSCI.1554-07.2007

Barkley, R. A. (2013). Distinguishing sluggish cognitive tempo from ADHD in children and adolescents: Executive functioning, impairment, and comorbidity. *Journal of Clinical Child & Adolescent Psychology*, *42*, 161-173. doi:10.1080/15374416.2012.734259

Barkley, R. A. (Ed.). (2014a). *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment*. Guilford Publications.

Barkley, R. A. (2014b). Sluggish cognitive tempo (concentration deficit disorder?): Current status, future directions, and a plea to change the name. *Journal of Abnormal Child Psychology*, *42*, 117-125. doi:10.1007/s10802-013-9824-y

Barkley, R. A., DuPaul, G. J., & McMurray, M. B. (1990). A comprehensive evaluation of attention deficit disorder with and without hyperactivity. *Journal of Consulting and Clinical Psychology, 58*, 775–789. doi:10.1037/0022-006X.58.6.775.

Baron-Cohen, S. (2002). The extreme male brain theory of autism. *Trends in cognitive sciences*, *6*, 248-254. doi:10.1016/S1364-6613(02)01904-6

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a 'theory of mind'? *Cognition, 21,* 37-46. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2934210

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*, 163–175. doi:10.1023/B:JADD.0000022607.19833.00

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" test revised version: A study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, *42*, 241-251. doi:10.1111/1469-7610.00715

Bauermeister, J. J., Barkley, R. A., Bauermeister, J. A., Martínez, J. V., & McBurnett, K. (2012). Validity of the sluggish cognitive tempo, inattention, and hyperactivity symptom dimensions: Neuropsychological and psychosocial correlates. *Journal of Abnormal Child Psychology*, *40*, 683-697. doi:10.1007/s10802-011-9602-7

Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: An integrative framework for the development of social skills. *Psychological Bulletin, 136*, 39-64. doi:10.1037/a0017768

Bechara, A. (2004). The role of emotion in decision making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition. 55,* 30–40. doi:10.1016/j.bandc.2003.04.001

Bechara, A., H. Damasio & A.R. Damasio. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10*, 295–307. doi:10.1093/cercor/10.3.295

Becker, S. P. (2014). *Social Information Processing, Comorbid Mental Health Symptoms, and Peer Isolation among Children with Attention-Deficit/Hyperactivity Disorder* (Doctoral dissertation, Miami University).

Becker, S. P., & Langberg, J. M. (2013). Sluggish cognitive tempo among young adolescents with ADHD: relations to mental health, academic, and social functioning. *Journal of Attention Disorders*. 17, 681-689. doi:10.1177/1087054711435411.

Becker, S. P., Luebbe, A. M., Fite, P. J., Stoppelbein, L., Greening, L. (2014). Sluggish cognitive tempo in psychiatrically hospitalized children: Factor structure and relations to internalizing symptoms, social problems, and observed behavioral dysregulation. *Journal of Abnormal Child Psychology*, 42. 49-62. doi:10.1007/s10802-013-9719-y.

Biederman, J., Kwon, A., Aleardi, M., Chouinard, V. A., Marino, T., Cole, H., ... & Faraone, S. V. (2014). Absence of gender effects on attention deficit hyperactivity disorder: Findings in nonreferred subjects. *The American Journal of Psychiatry, 162*, 1083-1089. doi:10.1176/appi.ajp.162.6.1083

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., ... & Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting and Clinical Psychology*, *72*, 757. doi: 10.1037/0022-006X.72.5.757

Birch, S. A., & Bloom, P. (2004). Understanding children's and adults' limitations in mental state reasoning. *Trends in Cognitive Science, 8,* 255–260. doi:10.1016/j.tics.2004.04.011

Bishop, D.V.M. (2003). Children's Communication Checklist—Revised (2nd ed.). San Antonio, TX: The Psychological Corporation.

Bishop, D. V., & Baird, G. (2001). Parent and teacher report of pragmatic aspects of communication: use of the children's communication checklist in a clinical setting. *Developmental Medicine & Child Neurology, 43*, 809-818. doi:10.1111/j.1469-8749.2001.tb00168.x

Blakemore, S. J. (2008). The social brain in adolescence. *Nature Reviews Neuroscience, 9,* 267–277. doi:10.1038/nrn2353

Bonnelle, V., Leech, R., Kinnunen, K. M., Ham, T. E., Beckmann, C. F., De Boissezon, X., ... & Sharp, D. J. (2011). Default mode network connectivity predicts sustained attention deficits after traumatic brain injury. *The Journal of Neuroscience*, *31*, 13442-13451.doi:10.1523/JNEUROSCI.1163-11.2011

Bora, E., & Pantelis, C. (2016). Meta-analysis of social cognition in attention-deficit/hyperactivity disorder (ADHD): comparison with healthy controls and autistic spectrum disorder. *Psychological Medicine*, *46*, 699-716. doi:10.1017/S0033291715002573

Bowers, L., Huisingh, R., & LoGiudice, C., (2005). *Test of Problem Solving 2 Adolescent Test of Problem Solving - TOPS 2 Adolentary*. Austin, TX: Linguisystems.

Bowers, L., Huisingh, R., & LoGiudice, C., (2005). *Test of Problem Solving 3 Elementary Test of Problem Solving - TOPS 3 Elementary*. Austin, TX: Linguisystems.

Bowie, C. R., Reichenberg, A., Patterson, T. L., Heaton, R. K., & Harvey, P. D. (2006). Determinants of real-world functional performance in schizophrenia subjects: Correlations with cognition, functional capacity, and symptoms. *American Journal of Psychiatry*, *163*, 418-425. doi:10.1176/appi.ajp.163.3.418

Braaten, E. B., & Rosen, L. A. (2000). Self-regulation of affect in attention deficit-hyperactivity disorder (ADHD) and non-ADHD boys: Differences in empathic responding. *Journal of Consulting and Clinical Psychology, 68*, 313-321. doi: 10.1037/0022-006X.68.2.313

Brocki, K. C., Eninger, L., Thorell, L. B., & Bohlin, G. (2010). Interrelations between executive function and symptoms of hyperactivity/impulsivity and inattention in preschoolers: A two year longitudinal study. *Journal of Abnormal Child Psychology, 38*, 163-171. doi:10.1007/s10802-009-9354-9

Bruce, V., & Young, A. (1986). Understanding face recognition. *British Journal of Psychology, 77,* 305–327. doi:10.1111/j.2044-8295.1986.tb02199.x

Brüne, M. (2005). Emotion recognition, 'theory of mind,' and social behavior in schizophrenia. *Psychiatry Research, 133*, 135-147. doi:10.1016/j.psychres.2004.10.007

Brüne, M., & Brüne-Cohrs, U. (2006). Theory of mind: Evolution, ontogeny, brain mechanisms and psychopathology. *Neuroscience & Biobehavioral Reviews, 30,* 437–455. doi:10.1016/j.neubiorev.2005.08.001

Buitelaar, J. K., Swaab, H., van der Wees, M., Wildschut, M., & van der Gaag, R. J. (1996). Neuropsychological impairments and deficits in theory of mind and emotion recognition in a non-autistic boy. *European Child & Adolescent Psychiatry, 5*, 44-51.

Buitelaar, J. K., van der Wess, M., Swaab-Barneveld, H., & van der Gaag, R. J. (1999). Theory of mind and emotion recognition functioning in autistic spectrum disorders and in psychiatric control and normal children. *Developmental Psychopathology, 11*, 39-58. Retrieved from http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=43625&fileId=S0954579499001947

Bunford, N., Brandt, N. E., Golden, C., Dykstra, J. B., Suhr, J. A., & Owens, J. S. (2015). Attention-deficit/hyperactivity disorder symptoms mediate the association between deficits in executive functioning and social impairment in children. *Journal of Abnormal Child Psychology*, *43*, 133-147. doi:10.1007/s10802-014-9902-9

Byars, A. W., Johnson, C. S., Perkins, S. M., Fastenau, P. S., Dunn, D. W., & Austin, J. K. (2014). Language and social functioning in children and adolescents with epilepsy. *Epilepsy & Behavior*, *31*, 167-171. doi:10.1016/j.yebeh.2013.11.007

Cacioppo, J.T. & G.G. Berntson. (1992). Social psychological contributions to the decade of the brain: Doctrine of multilevel analysis. *American Psychologist, 47,* 1019–1028. doi:10.1037/0003-066X.47.8.1019

Cadesky, E. B., Mota, V. L., & Schachar, R. J. (2000). Beyond words: How do children with ADHD and/or conduct problems process nonverbal information about affect? *Journal of the American Academy of Child & Adolescent Psychiatry*, *39*, 1160–1167. doi:10.1097/00004583-200009000-00016

Calder, A. J., & Young, A. W. (2005). Understanding the recognition of facial identity and facial expression. *Nature Reviews Neuroscience, 6,* 641–651. doi:10.1038/nrn1724

Calvo, M. G., Beltrán, D., & Fernández-Martín, A. (2014). Processing of facial expressions in peripheral vision: Neurophysiological evidence. *Biological Psychology*, *100*, 60-70. doi:10.1007/s00426-013-0492-x

Cannon, W. B. (1929). *Bodily changes in pain, hunger, fear, and rage, vol 2.* New York, NY: Appleton.

Carlson, C. L., & Mann, M. (2002). Sluggish cognitive tempo predicts a different pattern of impairment in the attention deficit hyperactivity disorder, predominantly inattentive type.

Journal of Clinical Child and Adolescent Psychology, 31, 123–129. doi:10.1207/153744202753441738.

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development*, *11*, 73-92.doi:10.1002/icd.298

Cassidy, S., Ropar, D., Mitchell, P., & Chapman, P. (2014). Can adults with autism spectrum disorders infer what happened to someone from their emotional response? *Autism Research, 7*, 112-123. doi: 10.1002/aur.1351

Celestin-Westreich, S., & Celesti, L.-P. (2013). ADHD Children's Emotion Regulation in FACE© – Perspective (Facilitating Adjustment of Cognition and Emotion): Theory, Research and Practice. doi: 10.5772/54422

Charman, T., Carroll, F., & Sturge, C. (2001). Theory of mind, executive function and social competence in boys with ADHD. *Emotional and Behavioural Difficulties*, *6*, 31-49. doi:10.1080/13632750100507654

Conners, C. K., (2000). Conners' Continuous Performance Test II (CPT II V. 5). *North Tonawanda, NY: Multi-Health Systems Inc*.

Corcoran, R., Mercer, G. and Frith, C. D. (1995) Schizophrenia, symptomatology and social inference: investigating theory of mind in people with schizophrenia. *Schizophrenia Research, 17*, 5-13. doi:10.1016/0920-9964(95)00024-G

Couture, S. M., Granholm, E. L., & Fish, S. C. (2011). A path model investigation of neurocognition, theory of mind, social competence, negative symptoms and real-world functioning in schizophrenia. *Schizophrenia Research*, *125*, 152-160. doi:10.1016/j.schres.2010.09.020

Crick, N. R., & Dodge, K. A. (1996). Social information-processing mechanisms in reactive and proactive aggression. *Child Development*, *67*, 993-1002. doi:10.1111/j.1467-8624.1996.tb01778.x

Crick, N. R., & Ladd, G. W. (1993). Children's perceptions of their peer experiences: Attributions, loneliness, social anxiety, and social avoidance. *Developmental Psychology*, *29*, 244. doi:10.1037/0012-1649.29.2.244

Cubillo, A., Halari, R., Smith, A., Taylor, E., & Rubia, K. (2012). A review of fronto-striatal and fronto-cortical brain abnormalities in children and adults with Attention Deficit Hyperactivity Disorder (ADHD) and new evidence for dysfunction in adults with ADHD during motivation and attention. *Cortex*, *48*, 194-215. doi:10.1016/j.cortex.2011.04.007

Curci, A., Lanciano, T., Soleti, E., Zammuner, V. L., & Salovey, P. (2013). Construct validity of the Italian version of the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT) v2. 0. *Journal of personality assessment*, *95*, 486-494. doi:10.1080/00223891.2013.778272

Da Fonseca, D., Seguier, V., Santos, A., Poinso, F., & Deruelle, C. (2009). Emotion understanding in children with ADHD. *Child Psychiatry and Human Development*, *40*, 111–121. doi:10.1007/s10578-008-0114-9

Dadds, M. R., Hunter, K., Hawes, D. J., Frost, A. D., Vassallo, S., Bunn, P., ... & El Masry, Y. (2008). A measure of cognitive and affective empathy in children using parent ratings. *Child Psychiatry and Human Development*, *39*, 111-122. doi:10.1007/s10578-007-0075-4

Daley, D., & Birchwood, J. (2010). ADHD and academic performance: why does ADHD impact on academic performance and what can be done to support ADHD children in the

classroom?. *Child: Care, Health and Development*, *36*, 455-464. doi:10.1111/j.1365-2214.2009.01046.x

Dalley, J. W., Mar, A. C., Economidou, D., & Robbins, T. W. (2008). Neurobehavioral mechanisms of impulsivity: Fronto-striatal systems and functional neurochemistry. *Pharmacology, Biochemistry and Behavior*, *90*, 250-260. doi:10.1016/j.pbb.2007.12.021

de Boo, G. M., & Prins, P. J. (2007). Social incompetence in children with ADHD: Possible moderators and mediators in social-skills training. *Clinical Psychology Review*, *27*, 78-97. doi:10.1016/j.cpr.2006.03.006

Deen, B., & Saxe, R. R. (2012). Neural correlates of social perception: The posterior superior temporal sulcus is modulated by action rationality, but not animacy. In *Proceedings of the 33rd Annual Cognitive Science Society Conference* (pp. 276-81).

Delgado, M.R. (2007). Reward-related responses in the human striatum. *Annals of New York Academy of Science, 1104*, 70–80. doi:10.1196/annals.1390.002

Demurie, E., De Corel, M., & Roeyers, H. (2011). Empathic accuracy in adolescents with autism spectrum disorders and adolescents with attention-deficit/hyperactivity disorder. *Research in Autism Spectrum Disorders, 5*, 126-134. doi: 10.1016/j.rasd.2010.03.002

Deveney, C. M., & Pizzagalli, D. A. (2008). The cognitive consequences of emotion regulation: an ERP investigation. *Psychophysiology*, *45*, 435-444. doi:10.1111/j.1469-8986.2007.00641.x

Diamantopoulou, S., Rydell, A. M., Thorell, L. B., & Bohlin, G. (2007). Impact of executive functioning and symptoms of attention deficit hyperactivity disorder on children's peer relations and school performance. *Developmental Neuropsychology, 32*, 521-542. doi: 10.1080/87565640701360981

Downs, A., & Smith, T. (2004). Emotional understanding, cooperation, and social behavior in high-functioning children with autism. *Journal of Autism and Developmental Disorders, 34*, 625-635. doi:10.1007/s10803-004-5284-0

Dvash, J., & Shamay-Tsoory, S. G. (2014). Theory of mind and empathy as multidimensional constructs: Neurological foundations. *Topics in Language Disorders*, *34*, 282-295.10.1097/TLD.0000000000000040

Dyck, M.J., Ferguson, K., & Shochet, I.M., (2001). Do autism spectrum disorders differ from each other and from non-spectrum disorders on emotion recognition tests? *European Child & Adolescent Psychiatry, 10*, 105–116. doi:10.1007/s007870170033

Dykas, M. J., & Cassidy, J. (2011). Attachment and the processing of social information across the life span: Theory and evidence. *Psychological Bulletin*, *137*, 19-46. doi:10.1037/a0021367.

Ekman, P., & Friesen, W. V. (1971). Constants across culture in the face and emotion. *Journal of Personality and Social Psychology, 17,* 124-129.

Ernst, M., Liebenauer, L.L., King, C., Fitzgerald, G.A., Cohen, R.M., & Zametkin, A.J. (1994). Reduced brain metabolism in hyperactive girls. *Journal of the Academy of Child and Adolescent Psychiatry, 33,* 858–868. doi:10.1097/00004583-199407000-00012

Fahie, C. M., & Symons, D. K. (2003). Executive functioning and theory of mind in children clinically referred for attention and behavior problems. *Journal of Applied Developmental Psychology, 24*, 51-73. doi: 10.1016/s0193-3973(03)00024-8

Fiske, S. T., & Taylor, S. E. (2013). *Social cognition: From brains to culture*. Thousand Oaks, CA: Sage.

Frederick, B. D., Nickerson, L. D., & Tong, Y. (2012). Physiological denoising of BOLD fMRI data using Regressor Interpolation at Progressive Time Delays (RIPTiDe) processing of concurrent fMRI and near-infrared spectroscopy (NIRS). *Neuroimage*, *60*, 1913-1923. doi:10.1016/j.neuroimage.2012.01.140

Friederici, A. D. (2006). The neural basis of language development and its impairment. *Neuron, 52,* 941–952. doi:10.1016/j.neuron.2006.12.002

Frith, C. D. (1992). *The cognitive neuropsychology of schizophrenia.* New York, NY: Psychology Press.

Frith, U. (1994). Autism and theory of mind in everyday life. *Social development*, *3*, 108-124. doi: 10.1111/j.1467-9507.1994.tb00031.x

Gaub, M., & Carlson, C. L. (1997). Behavioral characteristics of *DSM-IV* ADHD subtypes in a school-based population. *Journal of Abnormal Child Psychology, 25*, 103-111. doi:10.1097/00004583-199708000-00011

Gazzaley, A., & Nobre, A. C. (2012). Top-down modulation: Bridging selective attention and working memory. *Trends in Cognitive Sciences*, *16*, 129-135. doi:10.1016/j.tics.2011.11.014

Gershon, J. (2002). A meta-analytic review of gender differences in ADHD. *Journal of Attention Disorders*, *5*, 143-154. doi:10.1177/108705470200500302

Gibson, J., Adams, C., Lockton, E., & Green, J. (2013). Social communication disorder outside autism? A diagnostic classification approach to delineating pragmatic language impairment, high functioning autism and specific language impairment. *Journal of Child Psychology and Psychiatry*, *54*, 1186-1197. doi:10.1111/jcpp.12079

Golan, O., Baron-Cohen, S., Hill, J. J., & Golan, Y. (2006). The "Reading the mind in films" task: Complex emotion recognition in adults with and without autism spectrum conditions. *Social Neuroscience, 1*, 111-123. doi:10.1080/17470910600980986

Golan, O., Baron-Cohen, S., Hill, J. J., & Rutherford, M. D. (2007). The 'Reading the mind in the voice' test-revised: A study of complex emotion recognition in adults with and without autism spectrum conditions. *Journal of Autism and Developmental Disorders*, *37*, 1096-1106. doi:10.1007/s10803-006-0252-5

Goleman, D. (1998). *Working with emotional intelligence*. New York, NY: Bantam Books.

Gopnik, A., & Astington, J. W. (1988). Children's understanding of representational change and its relation to the understanding of false belief and the appearance-reality distinction. *Child Development, 59*, 26-37. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/3342716

Grabemann, M., Mette, C., Zimmermann, M., Heinrich, V., Uekermann, J., Wiltfang, J., . . . Kis, B. (2013). No clear effects of acute tryptophan depletion on processing affective prosody in male adults with ADHD. *Acta Psychiatrica Scandinavica, 128*, 142-148. doi: 10.1111/acps.12130

Grove, R., Baillie, A., Allison, C., Baron-Cohen, S., & Hoekstra, R. A. (2014). The latent structure of cognitive and emotional empathy in individuals with autism, first-degree relatives and typical individuals. *Molecular Autism*, *5*, 42-52. Retrieved from http://www.molecularautism.com/content/5/1/42

Grzadzinski, R., Di Martino, A., Brady, E., Mairena, M. A., O'Neale, M., Petkova, E., ... & Castellanos, F. X. (2011). Examining autistic traits in children with ADHD: does the

autism spectrum extend to ADHD?. *Journal of Autism and Developmental Disorders*, *41*, 1178-1191. doi:10.1007/s10803-010-1135-3

Green, M. F., Olivier, B., Crawley, J. N., Penn, D. L., & Silverstein, S. (2005). Social cognition in schizophrenia: Recommendations from the MATRICS new approaches conference. *Schizophrenia Bulletin, 31,* 882-887. doi:10.1093/schbul/sbi049

Greenberg, M. T. (2006). Promoting resilience in children and youth: Preventive interventions and their interface with neuroscience. Annals of the New York Academy of Sciences: Vol. 1094. Resilience in children (pp. 139–150). New York, NY: New York Academy of Sciences.

Greene, R. W., Biederman, J., Faraone, S. V., Ouellette, C. A., Penn, C., & Griffin, S. M. (1996). Toward a new psychometric definition of social disability in children with attention-deficit hyperactivity disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 35*, 571–578. doi:10.1097/00004583-199605000-00011

Greig, T.C., Bryson, G.J., & Bell, M.D. (2004). Theory of mind performance in schizophrenia: diagnostic, symptom, and neuropsychological correlates. *Journal of Nervous and Mental Disease*, 192, 12–18, doi:10.1097/01.nmd.0000105995.67947.fc

Grzadzinski, R., Di Martino, A., Brady, E., Mairena, M. A., O'Neale, M., Petkova, E., ... & Castellanos, F. X. (2011). Examining autistic traits in children with ADHD: Does the autism spectrum extend to ADHD?. *Journal of Autism and Developmental Disorders*, *41*, 1178-1191. doi:10.1007/s10803-010-1135-3

Geurts, H. M., & Embrechts, M. (2008). Language profiles in ASD, SLI, and ADHD. *Journal of Autism and Developmental Disorders, 38*, 1931-1943. doi: 10.1007/s10803-008-0587-1

Haas, S. M., Waschbusch, D. A., King, S., & Walsh, T. M. (2014). Examining the Role of Callous-Unemotional Traits in the Attributional Styles and Self Competence Evaluations of Children with Conduct Problems and ADHD. *Journal of Psychopathology and Behavioral Assessment*, 1-11. doi:10.1007/s10862-014-9459-5

Hall, J. A., & Schmid Mast, M. (2007). Sources of accuracy in the empathic accuracy paradigm. *Emotion*, *7*, 438-446. doi:10.1037/1528-3542.7.2.438

Halperin, J.M., Neweorn, J.H., Sharma, V., Healey, J.M., Wolf, L.E., Pascualvaca, D.M., & Schwartz, S. (1990). Inattentive and noninattentive ADHD children: Do they constitute a unitary group? *Journal of Abnormal Child Psychology, 18,* 437-449. doi: 10.1007/BF00917645

Halpern, D. F. (2013). *Sex differences in cognitive abilities*. New York, NY: Psychology Press.

Happé, F. G. (1994). An advanced test of theory of mind: understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Developmental Disorders, 24*, 129-154. doi: 10.1007/BF02172093

Harris, L. T., Todorov, A., & Fiske, S. T. (2005). Attributions on the brain: Neuro-imaging dispositional inferences, beyond theory of mind. *Neuro-Image, 28,* 763–769. doi:10.1016/j.neuroimage.2005.05.021

Hefter, R. L., Manoach, D. S., & Barton, J. J. (2005). Perception of facial expression and facial identity in subjects with social developmental disorders. *Neurology, 65,* 1620–1625. doi:10.1212/01.wnl.0000184498.16959.c0

Hinshaw, S. P. (2002). Preadolescent girls with attention-deficit/hyperactivity disorder: I. Background characteristics, comorbidity, cognitive and social functioning, and parenting

practices. *Journal of Consulting and Clinical Psychology, 70*, 1086-1098. doi: 10.1037//0022-006x.70.5.1086

Horsley, T. A., de Castro, B. O., & Van der Schoot, M. (2010). In the eye of the beholder: eye-tracking assessment of social information processing in aggressive behavior. *Journal of Abnormal Child Psychology, 38*, 587-599. doi: 10.1007/s10802-009-9361-x

Horowitz, L. M., Rosenberg, S. E., Baer, B. A., Ureño, G., & Villaseñor, V. S. (1988). Inventory of interpersonal problems: psychometric properties and clinical applications. *Journal of Consulting and Clinical Psychology*, *56*, 885-892. doi:10.1037/0022-006X.56.6.885

Horowitz-Kraus, T. (2014). Pinpointing the deficit in executive functions in adolescents with dyslexia performing the Wisconsin card sorting test An ERP Study. *Journal of Learning Disabilities*, *47*, 208-223. doi:10.1177/0022219412453084

Howell, D. (2012). *Statistical methods for psychology*. Belmont, CA: Cengage Learning.

Hoza, B., Mrug, S., Gerdes, A. C., Hinshaw, S. P., Bukowski, W. M., Gold, J. A., et al. (2005). What aspects of peer relationships are impaired in children with attention-deficit/hyperactivity disorder? *Journal of Consulting and Clinical Psychology, 73*, 411–423. doi: 10.1037/0022-006X.73.3.411

Huang-Pollock, C. L., Mikami, A. Y., Pfiffner, L., & McBurnett, K. (2009). Can executive functions explain the relationship between attention deficit hyperactivity disorder and social adjustment? *Journal of Abnormal Child Psychology, 37*, 679–691. doi:10.1007/s10802-009-9302-8

Hughes, C., Dunn, J., & White, A. (1998). Trick or treat?: uneven understanding of mind and emotion and executive dysfunction in "hard-to-manage" preschoolers. *Journal of Child Psychology and Psychiatry, 39*, 981-994. doi:10.1111/1469-7610.00401

Hughes, C., Jaffee, S. R., Happé´, F., Taylor, A., Caspi, A., & Moffitt, T. E. (2005). Origins of individual differences in theory of mind: From nature to nurture? *Child Development, 76,* 356–370. doi:10.1111/j.1467-8624.2005.00850_a.x

Hutchins, T. L., Prelock, P. A., Morris, H., Benner, J., LaVigne, T., & Hoza, B. (2016). Explicit vs. applied theory of mind competence: A comparison of typically developing males, males with ASD, and males with ADHD. *Research in Autism Spectrum Disorders*, *21*, 94-108. doi:10.1016/j.rasd.2015.10.004

Ibáñez, A., Petroni, A., Urquina, H., Torrente, F., Torralva, T., Hurtado, E., ... & Manes, F. (2011). Cortical deficits of emotional face processing in adults with ADHD: its relation to social cognition and executive function. *Social Neuroscience*, *6*, 464-481. doi:10.1080/17470919.2011.620769

Ickes, W., Stinson, L., Bissonnette, V., & Garcia, S. (1990). Naturalistic social cognition: Empathic accuracy in mixed-sex dyads. *Journal of Personality and Social Psychology, 59*, 730–742. doi:10.1037/0022-3514.59.4.730

Imaizumi, S., Furuya, I., & Yamasaki, K. (2009). Voice as a tool communicating intentions. *Logoped Phoniatr Vocol, 34*, 196-199. doi: 10.3109/14015430903311192

Jabben, N., van Os, J., Burns, T., Creed, F., Tattan, T., Green, J., ... Krabbendam, L. (2008). Is processing speed predictive of functional outcome in psychosis? *Social Psychiatry and Psychiatric Epidemiology, 43,* 437–444. doi:10.1007/s00127-008-0328-y

Jacobs, R., & Anderson, V. (2002). Planning and problem-solving skills following focal frontal brain lesions in childhood: Analysis using the Tower of London. Child Neuropsychology, 8, 93–106. doi:10.1076/chin.8.2.93.8726

Johannesen, J. K., Lurie, J. B., Fiszdon, J. M., & Bell, M. D. (2013). The Social Attribution Task-Multiple Choice (SAT-MC): A Psychometric and Equivalence Study of an Alternate Form. *ISRN Psychiatry, 2013*, 830825. doi: 10.1155/2013/830825

Juckel, G., Schlagenhauf, F., Koslowski, M., Wustenberg, T., Villringer, A., Knutson, B., … , & Heinz, A. (2006). Dysfunction of ventral striatal reward prediction in schizophrenia. *Neuroimage, 29*, 409–416. doi:10.1016/j.neuroimage.2005.07.051

Kail, R. V., & Ferrer, E. (2007). Processing speed in childhood and adolescence: Longitudinal models for examining developmental change. *Child Development, 78,* 1760–1770. doi:10.1111/j.1467-8624.2007.01088.x

Kain, W. & Perner, J., (2003). Do children with ADHD not need their frontal lobes for theory of mind? A review of brain imaging and neuropsychological studies. In: Brune, M., Ribbert, H., Schiefenhovel, W. (Eds.), The Social Brain: Evolution and Pathology, pp. 197–230.

Kalbe, E., Schlegel, M., Sack, A. T., Nowak, D. A., Dafotakis, M., Bangard, C., ... & Kessler, J. (2010). Dissociating cognitive from affective theory of mind: A TMS study. *Cortex*, *46*, 769-780. doi:10.1016/j.cortex.2009.07.010

Kats-Gold, I., Besser, A., & Priel, B. (2007). The role of simple emotion recognition skills among school aged boys at risk of ADHD. *Journal of Abnormal Child Psychology, 35*, 363-378. doi: 10.1007/s10802-006-9096-x

Kawasaki, H., Tsuchiya, N., Kovach, C. K., Nourski, K. V., Oya, H., Howard, M. A., & Adolphs, R. (2012). Processing of facial emotion in the human fusiform gyrus. *Journal of Cognitive Neuroscience*, *24*, 1358-1370. doi:10.1162/jocn_a_00175

Kemp, S. L., & Korkman, M. (2010). *Essentials of NEPSY-II assessment*. Hoboken, N.J: John Wiley & Sons.

Kim, O. H., & Kaiser, A. P. (2000). Language characteristics of children with ADHD. *Communication Disorders Quarterly, 21*, 154–166. doi:10.1177/152574010002100304.

Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher functioning autism and Asperger syndrome: The Social Attribution Task. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 41,* 831–846. doi:10.1111/1469-7610.00671

Kofler, M. J., Rapport, M. D., Bolden, J., Sarver, D. E., Raiker, J. S., & Alderson, R. M. (2011). Working memory deficits and social problems in children with ADHD. *Journal of Abnormal Child Psychology*, *39*, 805-817. doi: 10.1007/s10802-011-9492-8

Korkman, M., Kirk, U., & Kemp, S. (2007). *NEPSY-II. A Developmental Neuropsychological Assessment*. San Antonio, TX: The Psychological Corporation.

Krauel, K., Duzel, E., Hinrichs, H., Rellum, T., Santel, S., & Baving, L. (2009). Emotional memory in ADHD patients with and without comorbid ODD/CD. *Journal of Neural Transmission, 116*, 117-120. doi: 10.1007/s00702-008-0154-0

Kuzmanovic, B., Schilbach, L., Georgescu, A. L., Kockler, H., Santos, N. S., Shah, N. J., ... & Vogeley, K. (2014). Dissociating animacy processing in high-functioning autism: neural correlates of stimulus properties and subjective ratings. *Social neuroscience*, *9*, 309-325. doi: 10.1080/17470919.2014.886618

Lago-Rodríguez, A., Cheeran, B., Koch, G., Hortobagy, T., & Fernandez-del-Olmo, M. (2014). The role of mirror neurons in observational motor learning: An integrative review. *European Journal of Human Movement*, *32*, 82-103. Retrieved from http://eurjhm.com/index.php/eurjhm/article/view/320

Lagattuta, K. H., Kramer, H. J., Kennedy, K., Hjortsvang, K., Goldfarb, D., & Tashjian, S. (2015). Beyond Sally's Missing Marble: Further Development in Children's Understanding of Mind and Emotion in Middle Childhood. *Advances in Child Development and Behavior, 48*, 185-217. doi: 10.1016/bs.acdb.2014.11.005

Lahey, B. B., Pelham, W. E., Loney, J., Lee, S. S., & Willcutt, E. (2005). Instability of the DSM-IV subtypes of ADHD from preschool through elementary school. *Archives of General Psychiatry, 62*, 896–902. doi:10.1001/archpsyc.62.8.896

Lai, M. C., Lombardo, M. V., Pasco, G., Ruigrok, A. N., Wheelwright, S. J., Sadek, S. A., ... & Baron-Cohen, S. (2011). A behavioral comparison of male and female adults with high functioning autism spectrum conditions. *PloS one*, *6*, e20835. doi:10.1371/journal.pone.0020835

Landa, R. J. (2005). Assessment of social communication skills in preschoolers. *Mental Retardation and Developmental Disabilities Research Reviews, 11,* 247–252. doi:10.1002/mrdd.20079

Larsson, H., Lichtenstein, P., & Larsson, J. (2006). Genetic contributions to the development of ADHD subtypes from childhood to adolescence. *Journal of the American Academy of Child & Adolescent Psychiatry*, *45*, 973-981 doi:10.1097/01.chi.0000222787.57100.d8

Lee, S. S., Lahey, B. B., Owens, E. B., & Hinshaw, S. P. (2008). Few preschool boys and girls with ADHD are well-adjusted during adolescence. *Journal of Abnormal Child Psychology*, *36*, 373-383. doi:10.1007/s10802-007-9184-6

Leonard, M. A., Milich, R., & Lorch, E. P. (2011). The role of pragmatic language use in mediating the relation between hyperactivity and inattention and social skills

problems. *Journal of Speech, Language, and Hearing Research*, *54*, 567-579. doi:10.1044/1092-4388(2010/10-0058)

Lieberman, M. D. (2000). Intuition: A social cognitive neuroscience approach. *Psychological Bulletin, 126*, 109–137. doi:10.1037/0033-2909.126.1.109

Lieberman, M.D. (2007). Social cognitive neuroscience: A review of core processes. *Annual Review of Psychology, 58,* 259–289. doi:10.1146/annurev.psych.58.110405.085654

Lijffijt, M., Kenemans, J. L., Verbaten, M. N., & van Engeland, H. (2005). A meta-analytic review of stopping performance in attention-deficit/hyperactivity disorder: deficient inhibitory motor control?. *Journal of Abnormal Psychology*, *114*, 216-222. doi:10.1037/0021-843X.114.2.216

Ludlow, A. K., Garrood, A., Lawrence, K., & Gutierrez, R. (2014). Emotion recognition from dynamic emotional displays in children with ADHD. *Journal of Social and Clinical Psychology*, *33*, 413-427. doi: 10.1521/jscp.2014.33.5.413

Maedgen, J. W., & Carlson, C. L. (2000). Social functioning and emotional regulation in the attention deficit hyperactivity disorder subtypes. *Journal of Clinical Child Psychology, 29*, 30-42. doi:10.1207/S15374424jccp2901_4

Mah, L. W., Arnold, M. C., & Grafman, J. (2014). Deficits in social knowledge following damage to ventromedial prefrontal cortex. The Journal of Neuropsychiatry, 17, 66-74. doi: 10.1176/jnp.17.1.66

Maoz, H., Tsviban, L., Gvirts, H. Z., Shamay-Tsoory, S. G., Levkovitz, Y., Watemberg, N., & Bloch, Y. (2014). Stimulants improve theory of mind in children with attention deficit/hyperactivity disorder. *Journal of Psychopharmacologyl, 28*, 212-219. doi: 10.1177/0269881113492030

Mar, R. A. (2011). The neural bases of social cognition and story comprehension. *Annual Review of Psychology, 62*, 103-134. doi: 10.1146/annurev-psych-120709-145406

Marshall, S. A., Evans, S. W., Eiraldi, R. B., Becker, S. P., & Power, T. J. (2014). Social and academic impairment in youth with ADHD, predominately inattentive type and sluggish cognitive tempo. *Journal of Abnormal Child Psychology, 42*, 77-90. doi: 10.1007/s10802-013-9758-4

Marton, I., Wiener, J., Rogers, M., Moore, C., & Tannock, R. (2009). Empathy and social perspective taking in children with Attention-Deficit/Hyperactivity Disorder. *Journal of Abnormal Child Psychology, 37*, 107-118. doi: 10.1007/s10802-008-9262-4

Mary, A., Slama, H., Mousty, P., Massat, I., Capiau, T., Drabs, V., & Peigneux, P. (2016). Executive and attentional contributions to theory of mind deficit in attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *22*, 345-365. doi:10.1080/09297049.2015.1012491

Matsumoto D. & Ekman, P. (1988). Japanese and Caucasian facial expressions of emotion (JACFEE) [Slides]. San Francisco, CA: Intercultural and Emotion Research Laboratory, Department of Psychology, San Francisco State University.

McAuley, T., Crosbie, J., Charach, A., & Schachar, R. (2014). The persistence of cognitive deficits in remitted and unremitted ADHD: A case for the state-independence of response inhibition. *Journal of Child Psychology and Psychiatry*, *55*, 292-300.doi:10.1111/jcpp.12160

McKee, T. E. (2012). Examining the dimensionality of ADHD symptomatology in young adults using factor analysis and outcome prediction. *Journal of Attention Disorders, 16*, 427-437. doi:10.1177/1087054710396039

McQuade, J. D., & Hoza, B. (2008). Peer problems in attention deficit hyperactivity disorder: Current status and future directions. *Developmental Disabilities and Research Reviews, 14*, 320–324. doi: 10.1002/ddrr.35

McQuade, J. D., Hoza, B., Waschbusch, D. A., Murray-Close, D., & Owens, J. S. (2011). Changes in self-perceptions in children with ADHD: A longitudinal study of depressive symptoms and attributional style. *Behavior Therapy, 42*, 170-182. doi: 10.1016/j.beth.2010.05.003

Mehrabian, A., & Epstein, N. (1972). A measure of emotional empathy. *Journal of Personality, 40*, 525–543. doi: 10.1111/j.1467-6494.1972.tb00078.x

Mendelsohn, D., Levin, H. S., Bruce, D., Lilly, M., Harward, H., Culhane, K. A., & Eisenberg, H. (1992). Late MRI after head injury in children: Relationship to clinical features and outcome. *Child's Nervous System, 8,* 445–452. doi:10.1007/BF00274405

Mikami AY, Huang-Pollock C, Pfiffner LJ, McBurnett K, & Hangai D. (2007). Social skills differences among attention-deficit/hyperactivity disorder types in a chat room assessment task. *Journal of Abnormal Child Psychology, 35*, 509–521. doi:10.1007/s10802-007-9108-5.

Miller, M., Hanford, R. B., Fassbender, C., Duke, M., & Schweitzer, J. B. (2011). Affect recognition in adults with ADHD. *Journal of Attention Disorders, 15*, 452-460. doi: 10.1177/1087054710368636

Mirsky, A. F., Antony, B. J., Duncan, C. C., Ahearn, M. B., & Kelham, S. G. (1991). Analysis of the elements of attention: A neuropsychological approach. *Neuropsychology Review, 2,* 109-145. doi:1040-7308/91/0600-0109S06.50/0

Moore, L.A., Hughes, J.N., & Robinson, M. (1992). A comparison of the social information-processing abilities of rejected and accepted hyperactive children, *Journal of Clinical Child Psychology 21*,123–31. doi:10.1207/s15374424jccp2102_4

Mostow, A. J., Izard, C. E., Fine, S., & Trentacosta, C. J. (2002). Modeling emotional, cognitive, and behavioral predictors of peer acceptance. *Child Development, 73,* 1775–1787. doi:10.1111/1467-8624.00505

Moyá, J., Stringaris, A. K., Asherson, P., Sandberg, S., & Taylor, E. (2012). The impact of persisting hyperactivity on social relationships: A community-based, controlled 20-year follow-up study. *Journal of Attention Disorders*, *18*, 52-60. doi:10.1177/1087054712436876

Mueller, A. K., Tucha, L., Koerts, J., Groen, Y., Lange, K. W., & Tucha, O. (2014). Sluggish cognitive tempo and its neurocognitive, social and emotive correlates: a systematic review of the current literature. *Journal of Molecular Psychiatry*, *2*, 5-13. doi:10.1186/2049-9256-2-5

Nigg, J. T. (2001). Is ADHD a disinhibitory disorder?. *Psychological bulletin*, *127*, 571-598. doi:10.1037/0033-2909.127.5.571

Nigg, J. T., Tannock, R., & Rohde, L. A. (2010). What is to be the fate of ADHD subtypes? An introduction to the special section on research on the ADHD subtypes and implications for the DSM–V. *Journal of Clinical Child & Adolescent Psychology*, *39*, 723-725. doi:10.1080/15374416.2010.517171

Nowicki Jr, S., & Duke, M. P. (1994). Individual differences in the nonverbal communication of affect: The Diagnostic Analysis of Nonverbal Accuracy Scale. *Journal of Nonverbal Behavior*, *18*, 9-35. doi:10.1007/BF02169077

O'Nions, E., Sebastian, C. L., McCrory, E., Chantiluke, K., Happé, F., & Viding, E. (2014). Neural bases of Theory of Mind in children with autism spectrum disorders and children with conduct problems and callous-unemotional traits. *Developmental Science*, *17*, 786-796. doi:10.1111/desc.12167

Oades RD. (2008). Dopamine-serotonin interactions in attention deficit hyperactivity disorder (ADHD). *Progress in Brain Research, 172*, 543–565. doi:10.1016/S0079-6123(08)00926-6

Ochsner, K. V. (2008). The social-emotional processing stream: Five core constructs and their translational potential for schizophrenia and beyond. *Biological Psychiatry, 64,* 48-61. doi:10.1016/j.biopsych.2008.04.024

Ochsner, K. & Lieberman, M. (2001). The emergence of social cognitive neuroscience. *American Psychologist, 56,* 717-734. doi:10.1037/0003-066X.56.9.717

Oerlemans, A. M., van der Meer, J. M., van Steijn, D. J., de Ruiter, S. W., de Bruijn, Y. G., de Sonneville, L. M., . . . Rommelse, N. N. (2014). Recognition of facial emotion and affective prosody in children with ASD (+ADHD) and their unaffected siblings. *European Child and Adolescent Psychiatry, 23*, 257-271. doi: 10.1007/s00787-013-0446-2

Ornaghi, V., Brockmeier, J., & Grazzani, I. (2014). Enhancing social cognition by training children in emotion understanding: A primary school study. *Journal of Experimental Child Psychology*, *119*, 26-39. doi:10.1016/j.jecp.2013.10.005

Orobio de Castro, B., Veerman, J. W., Koops, W., Bosch, J. D., & Monshouwer, H. J. (2002). Hostile attribution of intent and aggressive behavior: A meta-analysis. *Child Development, 73,* 916–934. doi:10.1111/1467-8624.00447

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry*, *32*, 1081-1105. doi:10.1111/j.1469-7610.1991.tb00351.x

Parke, E. M., Thaler, N. S., Etcoff, L. M., & Allen, D. N. (2015). Intellectual Profiles in Children with ADHD and Comorbid Learning and Motor Disorders. *Journal of Attention Disorders*, Advanced Online Copy, 1-10. doi: 10.1177/1087054715576343.

Palili, A., Kolaitis, G., Vassi, I., Veltsista, A., Bakoula, C., & Gika, A. (2011). Inattention, hyperactivity, impulsivity--epidemiology and correlations: A nationwide Greek study from birth to 18 years. *Journal of Child Neurology, 26*, 199-204. doi:10.1177/0883073810379640

Pelc, K., Kornreich, C., Foisy, M. L., & Dan, B. (2006). Recognition of emotional facial expressions in attention-deficit hyperactivity disorder. *Pediatric Neurology*, *35*, 93-97. doi:10.1016/j.pediatrneurol.2006.01.014

Pelphrey, K., Adolphs, R., & Morris, J. P. (2004). Neuroanatomical substrates of social cognition dysfunction in autism. *Mental Retardation and Developmental Disabilities Research Reviews, 10,* 259-271. doi:10.1002/mrdd.20040

Perner, J., Kain, W., & Barchfeld, P. (2002). Executive control and higher-order theory of mind in children at risk of ADHD. *Infant and Child Development*, *11*, 141-158. doi:10.1002/icd.302

Phelps-Terasaki, D., & Phelps-Gunn, T. (1992). Test of pragmatic language. East Moline, IL: Linguisystems.

Pickard, K. E., & Ingersoll, B. R. (2015). Brief Report: High and Low Level Initiations of Joint Attention, and Response to Joint Attention: Differential Relationships with Language and

Imitation. *Journal of Autism and Developmental Disorders*, *45*, 262-268.doi:10.1016/j.neuron.2006.12.002

Posner, J., Maia, T. V., Fair, D., Peterson, B. S., Sonuga-Barke, E. J., & Nagel, B. J. (2011). The attenuation of dysfunctional emotional processing with stimulant medication: an fMRI study of adolescents with ADHD. *Psychiatry Research, 193*, 151-160. doi: 10.1016/j.pscychresns.2011.02.005

Prencipe, A., Kesek, A., Cohen, J., Lamm, C., Lewis, M. D., & Zelazo, P. D. (2011). Development of hot and cool executive function during the transition to adolescence. *Journal of experimental child psychology*, *108*, 621-637. doi:10.1016/j.jecp.2010.09.008

Prutting, C. A., & Kittchner, D. M. (1987). A clinical appraisal of the pragmatic aspects of language. *Journal of Speech and hearing Disorders*, *52*, 105-119. doi:10.1044/jshd.5202.105

Qin, S., Young, C. B., Duan, X., Chen, T., Supekar, K., & Menon, V. (2014). Amygdala subregional structure and intrinsic functional connectivity predicts individual differences in anxiety during early childhood. *Biological Psychiatry*, *75*, 892-900. doi:10.1016/j.biopsych.2013.10.006

Raiker, J. S., Rapport, M. D., Kofler, M. J., & Sarver, D. E. (2012). Objectively-measured impulsivity and attention-deficit/hyperactivity disorder (ADHD): testing competing predictions from the working memory and behavioral inhibition models of ADHD. *Journal of Abnormal Child Psychology, 40*, 699-713. doi: 10.1007/s10802-011-9607-2

Rassovsky, Y., Satz, P., Alfano, M. S., Light, R. K., Zaucha, K., McArthur, D. L., & Hovda, D. (2006). Functional outcome in TBI II: Verbal memory and information processing speed

mediators. *Journal of Clinical and Experimental Neuropsychology, 28,* 581–591. doi:10.1080/13803390500434474

Redcay, E., Dodell-Feder, D., Mavros, P. L., Kleiner, M., Pearrow, M. J., Triantafyllou, C., ... & Saxe, R. (2013). Atypical brain activation patterns during a face-to-face joint attention game in adults with autism spectrum disorder. *Human Brain Mapping*, *34*, 2511-2523. doi:10.1002/hbm.22086

Riggs, N. R., Greenberg, M. T., Kusche, C. A., & Pentz, M. A. (2006). The mediational role of neurocognition in the behavioral outcomes of a social–emotional prevention program in elementary school students: Effects of the PATHS Curriculum. *Prevention Science, 7*, 91–102. doi:10.1007/s11121-005-0022-1

Robinson, K. E., Fountain-Zaragoza, S., Dennis, M., Taylor, H. G., Bigler, E. D., Rubin, K., ... & Yeates, K. O. (2014). Executive functions and Theory of Mind as predictors of social adjustment in childhood traumatic brain injury. *Journal of Neurotrauma*, *31*, 1835-1842. doi:10.1089/neu.2014.3422.

Rolls, E.T. (2000). The orbitofrontal cortex and reward. *Cerebral Cortex, 10*, 284–294. doi:10.1093/cercor/10.3.284

Rowland, A. S., Skipper, B., Rabiner, D. L., Umbach, D. M., Stallone, L., Campbell, R. A., …Sandler, D.P. (2008). The shifting subtypes of ADHD: Classification depends on how symptom reports are combined. *Journal of Abnormal Child Psychology, 36*, 731–743. doi:10.1007/s10802-007-9203-7

Ryan, N. P., Catroppa, C., Beare, R., Coleman, L., Ditchfield, M., Crossley, L., . . . Anderson, V. A. (2015). Predictors of longitudinal outcome and recovery of pragmatic language and its

relation to externalizing behaviour after pediatric traumatic brain injury. *Brain Lang, 142*, 86-95. doi: 10.1016/j.bandl.2015.01.007

Sachs, G., Winklbaur, B., Jagsch, R., Lasser, I., Kryspin-Exner, I., Frommann, N., & Wolwer, W. (2012). Training of affect recognition (TAR) in schizophrenia-Impact on functional outcome. *Schizophrenia Research, 138*, 262-267. doi:10.1016/j.schres.2012.03.005

Sanders, R. D., Schuepbach, D., Goldstein, G., Haas, G. L., Sweeney, J. A., & Keshavan, M. S. (2014). Relationships between cognitive and neurological performance in neuroleptic-naive psychosis. *The Journal of Neuropsychiatry & Clinical Neurosciences, 16*, 480-487. doi:10.1176/jnp.16.4.480

Saxbe, C., Barkley, R. A. (2014). The second attention disorder? Sluggish cognitive tempo vs. attention-deficit/hyperactivity disorder: Update for clinicians. *Journal of Psychiatric Practice*, *20*, 38-49. doi:10.1097/01.pra.0000442718.82527.cd.

Schepman, K., Fombonne, E., Collishaw, S., & Taylor, E. (2014). Cognitive styles in depressed children with and without comorbid conduct disorder. *Journal of Adolescence, 37*, 622-631. doi: 10.1016/j.adolescence.2014.04.004

Scheres, A., Milham, M.P., Knutson, B. & Castellanos, F.X. (2007). Ventral striatal hyporesponsiveness during reward anticipation in attention -deficit/hyperactivity disorder. *Biological Psychiatry 61,* 720–724. doi:10.1016/j.biopsych.2006.04.042

Schneider, D., Nott, Z. E., & Dux, P. E. (2014). Task instructions and implicit theory of mind. *Cognition, 133*, 43-47. doi: 10.1016/j.cognition.2014.05.016

Schonert-Reichl, K. A., Smith, V., Zaidman-Zait, A., & Hertzman, C. (2012). Promoting children's prosocial behaviors in school: Impact of the "Roots of Empathy" program on

the social and emotional competence of school-aged children. *School Mental Health*, *4*, 1-21.doi:10.1007/s12310-011-9064-7

Schutter, D.J. & van Honk, J. (2009). The cerebellum in emotion regulation: A repetitive transcranial magnetic stimulation study. *Cerebellum, 8*, 28–34. doi:10.1007/s12311-008-0056-6

Schutter, D.J. & van Honk, J. (2006). An electrophysiological link between the cerebellum, cognition and emotion: Frontal theta EEG activity to single-pulse cerebellar TMS. *Neuroimage, 33*, 1227–1231. doi:10.1016/j.neuroimage.2006.06.055

Schwenck, C., Schmitt, D., Sievers, S., Romanos, M., Warnke, A., & Schneider, W. (2011). Cognitive and emotional empathy in children with ADHD and conduct disorder. *Zeitschrift fur Kinder-und Jugendpsychiatrie und Psychotherapie*, *39*, 265-276. doi:10.1024/1422-4917/a000118

Semrud-Clikeman, M. (2010). The role of inattention and social perception and performance in two subtypes of ADHD. *Archives of Clinical Neuropsychology*, *25*, 771–780. doi:10.1093/arclin/acq074

Shim, I., Stratford, T. R., & Wirtshafter, D. (2014). Dopamine is differentially involved in the locomotor hyperactivity produced by manipulations of opioid, GABA and glutamate receptors in the median raphe nucleus. *Behavioural Brain Research*, *261*, 65-70. doi:10.1016/j.bbr.2013.12.004

Shin, D. W., Lee, S. J., Kim, B. J., Park, Y., & Lim, S. W. (2008). Visual attention deficits contribute to impaired facial emotion recognition in boys with attention-deficit/hyperactivity disorder. *Neuropediatrics*, *39*, 323-327. doi: 10.1055/s-0029-1202286

Sibley, M.H., Evans, S.W., & Serpell, Z.N. (2010). Social cognition and interpersonal impairment in young adolescents with ADHD. *Journal of Psychopathology and Behavioral Assessment 32,* 193-202. doi:10.1007/s10862-009-9152-2

Sinzig, J., Morsch, D., & Lehmkuhl, G. (2008). Do hyperactivity, impulsivity and inattention have an impact on the ability of facial affect recognition in children with autism and ADHD? *European Child & Adolescent Psychiatry, 17*, 63–72. doi:10.1007/s00787-007-0637-9

Slade, L., & Ruffman, T. (2005). How language does (and does not) relate to theory of mind: A longitudinal study of syntax, semantics, working memory and false belief. *British Journal of Developmental Psychology*, *23*, 117-141. doi: 10.1348/026151004X21332

Slama, H., Mary, A., Mousty, P., Massat, I., & Peigneux, P. (2011). Theory of mind and ADHD. *ADHD in Practice*, *3*, 4-7.

Sodian, B., & Frith, U. (1992). Deception and sabotage in autistic, retarded and normal children. *Journal of Child Psychology and Psychiatry, 33,* 591-605. doi:10.1111/j.1469-7610.1992.tb00893.x

Sodian, B., & Hülsken, C. (2005). The developmental relation of theory of mind and executive functions: A study of advanced theory of mind abilities in children with attention deficit hyperactivity disorder. In W. Schneider, R. Schumann-Hengsteler, & B. Sodian (Eds.), *Young children's cognitive development: Interrelationships among executive functioning, working memory, verbal ability, and theory of mind* (pp. 175–187). Mahwah, NJ: Lawrence Erlbaum Associates.

Sodian, B., Hülsken, C., & Thoermer, C. (2003). The self and action in theory of mind research. *Consciousness and Cognition, 12*, 777–782. doi:10.1016/S1053-8100(03)00082-5

Sokol, B. W., Chandler, M. J., & Jones, C. (2004). From mechanical to autonomous agency: The relationship between children's moral judgments and their developing theories of mind. *New Directions for Child and Adolescent Development, 103,* 19–36. doi:10.1002/cd.95

Solanto, M. V., Pope-Boyd, S. A., Tryon, W. W., & Stepak, B. (2009). Social functioning in predominantly inattentive and combined subtypes of children with ADHD. *Journal of Attention Disorders*, *13*, 27-35. doi:10.1177/1087054708320403

Sparrow, S., Balla, D. & Cichetti, D. (1984). *Vineland Adaptive Behavior Scales*. Circle Pines, MN: American Guidance Services.

Staikova, E., Gomes, H., Tartter, V., McCabe, A., & Halperin, J. M. (2013). Pragmatic deficits and social impairment in children with ADHD. *Journal of Child and Psychology and Psychiatry, 54*, 1275-1283. doi: 10.1111/jcpp.12082

Stergiakouli, E., Martin, J., Hamshere, M. L., Langley, K., Evans, D. M., St Pourcain, B., . . . Davey Smith, G. (2015). Shared genetic influences between attention-deficit/hyperactivity disorder (ADHD) traits in children and clinical ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry, 54*, 322-327. doi: 10.1016/j.jaac.2015.01.010

Sullivan, K., Hatton, D. D., Hammer, J., Sideris, J., Hooper, S., Ornstein, P. A., & Bailey, D. B., Jr. (2007). Sustained attention and response inhibition in boys with fragile X syndrome: measures of continuous performance. *American Journal of Medical Genetics. Part B: Neuropsychiatric Genetics, 144B*, 517-532. doi: 10.1002/ajmg.b.30504

Surman, C. B., Biederman, J., Spencer, T., Miller, C. A., Petty, C. R., & Faraone, S. V. (2013). Neuropsychological deficits are not predictive of deficient emotional self-regulation in

adults with ADHD. *Journal of Attention Disorders*, XX(X) 1-8. doi:10.1177/1087054713476548

Tabachnick, B. G. & Fidell, L. S. (2013). *Using Multivariate Statistics*, 6th ed. Boston, MA: Pearson.

Teicher, M. H., Polcari, A., Fourligas, N., Vitaliano, G., & Navalta, C. P. (2012). Hyperactivity persists in male and female adults with ADHD and remains a highly discriminative feature of the disorder: a case-control study. *BMC psychiatry*, *12*, 190-204. doi:10.1186/1471-244X-12-190

Thaler, N. S., Allen, D. N., Park, B. S., McMurray, J. C., & Mayfield, J. (2010). Attention processing abnormalities in children with traumatic brain injury and attention-deficit/hyperactivity disorder: Differential impairment of component processes. *Journal of Clinical and Experimental Neuropsychology, 32,* 929-936, doi:20.2080/1380391003596488

Thaler, NS., Allen, D.N., Sutton, G.P., Vertinski, M., & Ringdahl, E.N. (2013). Differential impairment of social cognition factors in bipolar disorder with and without psychotic features and schizophrenia. *Journal of Psychiatric Research, 47*, 2005-10. doi:10.1016/j.jpsychires.2013.09.010

Thompson M, Kaslow NJ, Weiss B, Nolen Hoeksema S. (1994). Children's Attributional Style Questionnaire-Revised: Psychometric examination. *Psychological Assessment, 10*, 166–170.

Thorndike, E. L. (1920). Intelligence and its use. *Harper's Magazine, 140,* 227-235.

Tian, Y. L., Kanade, T., & Cohn, J. F. (2001). Recognizing action units for facial expression analysis. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, *23*, 97-115. doi:10.1109/34.908962

Todd, R. D., Huang, H., Todorov, A. A., Neuman, R. J., Reiersen, A. M., Henderson, C. A., & Reich, W. C. (2008). Predictors of stability of attention-deficit/hyperactivity disorder subtypes from childhood to young adulthood. *Journal of the American Academy of Child and Adolescent Psychiatry, 47*, 76–85. doi:10.1097/chi.0b013e31815a6aca

Toplak, M. E., Pitch, A., Flora, D. B., Iwenofu, L., Ghelani, K., Jain, U., & Thannock, R. (2009). The unity and diversity of inattention and hyperactivity/impulsivity in ADHD: Evidence for a general factor with separable dimensions. *Journal of Abnormal Child Psychology, 37*, 1137–1150. doi:10.1007/s10802-009-9336-y

Treuting, J. J., & Hinshaw, S. P. (2001). Depression and self-esteem in boys with attention-deficit/hyperactivity disorder: Associations with comorbid aggression and explanatory attributional mechanisms. *Journal of Abnormal Child Psychology*, *29*, 23-39. doi:10.1023/A:1005247412221

Tseng, W., Kawabata, Y., & Shur-Fen Fau, S. (2011). Social adjustment among Taiwanese children with symptoms of ADHD, ODD, and comorbid with ODD. *Child Psychiatry & Human Development*, *42*, 134-151. doi:10.1007/s10578-010-0204-3

Uekermann J, Abdel-Hamid M, Lehmkamper C, Vollmoeller W, Daum I. (2008). Perception of affective prosody in major depression: a link to executive functions? *Journal of the International Neuropsychological Society, 14*, 552–561. doi:10.1017/S1355617708080740

Uekermann, J., Abdel-Hamid, M., Schimmelmann, B.G., Hebebrand, J., Daum, I., Wiltfang, J., & Kis, B. (2010). Social cognition in attention-deficit hyperactivity disorder (ADHD). *Neuroscience and Biobehavioral Reviews, 34*, 734-743. doi:10.1016/j.neubiorev.2009.10.009

Vaidya, C. J., Bunge, S. A., Dudukovic, N. M., Zalecki, C. A., Elliott, G. R., & Gabrieli, J. D. (2005). Altered neural substrates of cognitive control in childhood ADHD: Evidence from functional magnetic resonance imaging. *The American Journal of Psychiatry, 162*, 1605-1613. doi:10.1176/appi.ajp.162.9.1605

Vaidya, A. R., Jin, C., & Fellows, L. K. (2014). Eye spy: The predictive value of fixation patterns in detecting subtle and extreme emotions from faces. *Cognition*, *133*, 443-456. doi:10.1016/j.cognition.2014.07.004

Vaidya, C. J., Bunge, S. A., Dudukovic, N. M., Zalecki, C. A., Elliott, G. R., & Gabrieli, J. D. (2005). Altered neural substrates of cognitive control in childhood ADHD: evidence from functional magnetic resonance imaging. *The American Journal of Psychiatry*, *162*, 1605-1613. doi:10.1176/appi.ajp.162.9.1605

Väisänen, R., Loukusa, S., Moilanen, I., & Yliherva, A. (2014). Language and pragmatic profile in children with ADHD measured by Children's Communication Checklist 2nd edition. *Logopedics Phoniatrics Vocology*, *39*, 179-187. doi:10.3109/14015439.2013.784802

Valo, S., & Tannock, R. (2010). Diagnostic instability of DSM–IV ADHD subtypes: Effects of informant source, instrumentation, and methods for combining symptom reports. *Journal of Clinical Child & Adolescent Psychology*, *39*, 749-760. doi:10.1080/15374416.2010.517172

van Ewijk, H., Heslenfeld, D. J., Luman, M., Rommelse, N. N., Hartman, C. A., Hoekstra, P., ... & Oosterlaan, J. (2014). Visuospatial working memory in ADHD patients, unaffected siblings, and healthy controls. *Journal of Attention Disorders*, *18*, 369-378. doi:10.1177/1087054713482582

van der Kolk, A., Bouwmans, C. A., Schawo, S. J., Buitelaar, J. K., van Agthoven, M., & Hakkaart-van Roijen, L. (2014). Association between quality of life and treatment response in children with attention Deficit Hyperactivity Disorder and their parents. *Journal of Mental Health Policy and Economics, 17*, 119-129. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/25543115

Vetter, N. C., Altgassen, M., Phillips, L., Mahy, C. E., & Kliegel, M. (2013). Development of affective theory of mind across adolescence: disentangling the role of executive functions. *Developmental Neuropsychology*, *38*, 114-125. doi:10.1080/87565641.2012.733786

Vollm, B. A., Taylor, A. N., Richardson, P., Corcoran, R., Stirling, J., McKie, S., . . . Elliott, R. (2006). Neuronal correlates of theory of mind and empathy: A functional magnetic resonance imaging study in a nonverbal task. *Neuroimage, 29*, 90-98. doi: 10.1016/j.neuroimage.2005.07.022

Vuilleumier, P., & Pourtois, G. (2007). Distributed and interactive brain mechanisms during emotion face perception: Evidence from functional neuroimaging. *Neuropsychologia, 45,* 174–194. doi:10.1016/j.neuropsychologia.2006.06.003

Wechsler, D. (1955). *Wechsler Adult Intelligence Scale* (Manual). New York NY: Psychological Corporation.

Weyandt, L., Swentosky, A., & Gudmundsdottir, B. G. (2013). Neuroimaging and ADHD: fMRI, PET, DTI findings, and methodological limitations. *Developmental neuropsychology*, *38*, 211-225. doi:10.1080/87565641.2013.783833

Wheeler Maedgen, J., & Carlson, C. L. (1994). The social functioning of children with ADD with hyperactivity and ADD without hyperactivity: A comparison of their peer relations and social deficits. *Journal of Emotional and Behavioral Disorders, 2*, 2-12. doi:10.1177/106342669400200101

Williams, L. M., Hermens, D. F., Palmer, D., Kohn, M., Clarke, S., Keage, H., ... & Gordon, E. (2008). Misinterpreting emotional expressions in attention-deficit/hyperactivity disorder: Evidence for a neural marker and stimulant effects. *Biological Psychiatry*, *63*, 917-926. doi:10.1016/j.biopsych.2007.11.022

Wyer Jr, R. S., & Srull, T. K. (2014). *Handbook of Social Cognition: Volume 2: Applications*. Psychology Press.

Yaros, A., Lochman, J. E., Rosenbaum, J., & Jimenez-Camargo, L. A. (2014). Real-time hostile attribution measurement and aggression in children. *Aggressive Behavior*, *40*, 409-420. doi:10.1002/ab.21532

Yuill, N., & Lyon, J. (2007). Selective difficulty in recognizing facial expressions of emotion in boys with ADHD. General performance impairments or specific problems in social cognition? *European Child & Adolescent Psychiatry, 16*, 398-404. doi: 10.1007/s00787-007-0612-5

Zotev, V., Phillips, R., Young, K. D., Drevets, W. C., & Bodurka, J. (2013). Prefrontal control of the amygdala during real-time fMRI neurofeedback training of emotion regulation. *PloS one*, *8*, e79184. doi:10.1371/journal.pone.0079184

Curriculum Vitae

Elyse M. Parke

Office Contact:
The Children's Hospital of Philadelphia
CSH Suite 021 267-216-8497 (o)
Philadelphia, PA 19104 eparke25@gmail.com

EDUCATION

The Children's Hospital of Philadelphia July 2016-Present
Pre-doctoral Clinical Internship Neuropsychology Track
Fellow, Leadership Education in Neurodevelopmental Disabilities (LEND)

University of Nevada, Las Vegas Fall 2014–Present
Las Vegas, NV
Advisor: Daniel N. Allen, Ph.D.
Doctoral Student in APA-Accredited Clinical Psychology Program-
Neuropsychology Track
Dissertation: Social Cognition in Children with Attention-Deficit/Hyperactivity
Disorder

University of Nevada, Las Vegas Fall 2011–Spring 2014
Las Vegas, NV
Advisor: Daniel N. Allen, Ph.D.
Masters Student in APA-Accredited Clinical Psychology Program
Thesis: WISC-IV Profiles in Children with Attention-Deficit/Hyperactivity
Disorder and Comorbid Learning Disabilities

Westmont College Fall 2011–Spring 2014
Santa Barbara, CA
Graduated Cum Laude
Bachelors of Arts in Psychology

HONORS AND AWARDS

UNLV Dean's Graduate Student Award……. .2015
Nevada Regents' Scholar Award Nominee……...2015
Graduate & Professional Student Association travel funding ……..2013
UNLV Summer Scholarship……..2013
Cum Laude…….2009
Westmont College Dean's List…… 2009
Westmont College Provost Scholarship……...2005-2009

INTERNSHIP EXPERIENCE

Inpatient Rotation in Neuro-Rehabilitation 1/2017-6/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisors: Thomas Flynn, Ph.D., ABPP-Cn, Lauren Krivitzky, Ph.D., ABPP-Cn, Hannah-lise Schofield, Ph.D. ABPP-Cn

- Conduct inpatient neuropsychological assessments to assist with school re-entry planning.
- Provide results and recommendations at school re-entry meetings to rehabilitation team, parents, and school team.
- Diagnoses include stroke, autoimmune encephalitis, brain tumors, and traumatic brain injury.
- Consultation with interdisciplinary team.
- Attend group supervision and neuropsychology didactics.
- Rotation is designed to meet Houston Conference/Div. 40 requirements for neuropsychology-focused internship experience.

Inpatient Rehabilitation Services 1/2017-6/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisor: Gayle Chesley, Ph.D.

- Consultation with Rehabilitation team, co-treatment with other members of team, and individual psychotherapy with individuals on inpatient rehabilitation unit participating in speech and language, occupational, and physical therapy.
- Common referral issues include adjustment to illness and changes in functioning, behavior management, and education about brain injury.
- Attend and present at bi-weekly interdisciplinary Team Planning Meetings.
- Facilitate Brain Injury Support Group with current and past inpatients.

Pediatric Regional Epilepsy Program 1/2017-6/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisor: Amanda Riisen, Psy.D.

- Individual and/or family CBT based therapy with patients and families coping with epilepsy and co-morbid behavioral health diagnoses.
- Consultation with medical team around patient / family coping with anti-epileptic drug side effects, epilepsy surgery, ketogenic diet, and any additional medical treatments.
- Common referral issues include adjustment to illness, treatment adherence, managing medication side effects, child/parent coping with anxiety directly related to seizures, and assessment / treatment for co-morbid psychiatric issues such as anxiety, depression, ADHD, and behavioral issues.

Cleft Lip/Palate and Craniofacial Clinic 1/2017-6/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisor: Leanne Magee, Ph.D.

- Minor experience in conducting psychosocial assessments and consultation with patients with craniofacial/cleft conditions at their annual team evaluation.
- Common referrals include psychosocial support related to preparing children/families for surgical procedures, coping with appearance-related teasing/bullying, navigating assessment and treatment of school/learning problems.

Outpatient Neuropsychology Assessment 7/2016-1/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisor: Thomas Flynn, Ph.D., ABPP-Cn

- Conduct comprehensive outpatient neuropsychological assessments of medically complex patients, including pre-and post-epilepsy surgery evaluations and occasional inpatient evaluations.
- Diagnoses include epilepsy, metabolic disorders, genetic disorders, stroke, and anti-NMDA receptor encephalitis.
- Attend weekly epilepsy surgery conference.
- Attend group supervision and neuropsychology didactics.
- Rotation is designed to meet Houston Conference/Div. 40 requirements for neuropsychology-focused internship experience.

Pediatric Stroke Program 7/2016-1/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisor: Lauren Krivitzky, Ph.D., ABPP-Cn

- Participate in weekly multidisciplinary clinic that provides comprehensive treatment and assessment of children who have suffered from strokes or other vascular conditions
- Team includes individuals from neurology, nursing, neuropsychology, physical therapy, occupational therapy, speech-language therapy, social work, and school intervention.
- Collaborate with neurologist and other team members in adapting appropriate recommendations/interventions.
- Identify patients in need of comprehensive neuropsychological assessment through interview.
- Consultation and education for parents/patients on issues related to behavioral, learning/cognitive, and psychological concerns secondary to history of stroke.

Group Treatment for Families and Children with ADHD 7/2016-1/2017
The Children's Hospital of Philadelphia, Philadelphia, PA
Supervisor: Thomas Power, Ph.D.

- Conduct multi-family group sessions using manualized interventions (4 week ADHD Boot Camp and 9 week Family School Success).
- Respond to family and teacher needs via between-session phone contacts.
- Complete progress notes, treatment plan, and discharge summaries.

Leadership Education in Neurodevelopmental Disabilities (LEND) Fellowship
The Children's Hospital of Philadelphia, Philadelphia, PA
Research Mentor: Judith Miller, Ph.D.
Community Project Mentor: Judith Miller, Ph.D.
Family Project Mentor: Amy Kratchman

- Research: Participate in ongoing research on quality of life in children with Autism Spectrum Disorder within the Center for Autism Research at CHOP
- Community: Co-lead parent group in Chinatown Medical Center through interpretation services.
- Family: Participate in family-led experience throughout fellowship year
- Overall fellowship work focuses on research, community advocacy, and multidisciplinary partnerships across disciplines supporting work within pediatric illness populations and youth with neurodevelopmental disorders

PREDOCTORAL CLINICAL EXPERIENCE

Children's Specialty Center of Nevada/Cure 4 the Kids Foundation 6/2015–6/2016
Supervisor: Danielle Bello, Ph.D.
Doctoral Practicum Student

- Neuropsychological assessments set in a multi-disciplinary medical clinic focusing on diseases of childhood including brain tumors, leukemia, other cancers, sickle cell anemia, inherited bleeding disorders, and genetic conditions.
- Participated in a multi-disciplinary childhood cancer survivor clinic.
- Participated in all aspects of neuropsychological evaluation including interview, testing, scoring, report writing, and feedback.

UNLV Center for Autism Spectrum Disorders 7/2015–3/2016
Supervisor: Rachel Davis, Ph.D. and Julie Foutz Beasley, Ph.D.
Doctoral Practicum Student and Clinical Graduate Assistant

- Clinic coordinator and member of multi-disciplinary diagnostic team specializing in the diagnosis and treatment of neurodevelopmental disorders.
- Conducted parent interviews, administered the ADOS-2 with live viewing and scoring by the multi-disciplinary team, administered psychodiagnostic and neuropsychological assessments, wrote integrated reports, and provided feedback to families.

Pediatric Specialty Clinic 5/2015–9/2015
The PRACTICE: A UNLV Community Mental Health Clinic
Supervisor: Adrianna Wechsler Zimring, Ed.D. Ph.D.
Doctoral Practicum Student

- Provided individual therapy in an outpatient department-sponsored training clinic designed to prevent hospitalization of high-risk children and adolescents.
- Responsible for case conceptualization, treatment and termination planning, and crisis intervention.
- Applied an integrative approach informed by CBT, DBT, ACT, IPT, and biopsychosocial theoretical perspectives.

Center for Applied Neuroscience 5/2014–6/2015
Supervisor: Sharon Jones-Forrester, Ph.D. and Thomas Kinsora, Ph.D.
Doctoral Practicum Student

- Conducted neuropsychological assessment with children, adolescents, adults, and older adults in an outpatient setting and at the Public Defender's office. Participated in all aspects of neuropsychological evaluation including interview, testing, scoring, and report writing.
- Cases included forensic and competency evaluations and referrals from the Department of Family Services and Local Military Bases.
- Commonly presented patient diagnoses included cognitive disorders of varying etiologies, TBI, chronic medical conditions, learning disabilities, ADHD, and developmental disabilities.
- Attended weekly practicum seminars on campus, which include didactic, group supervision, and case conference components.

University of Nevada School of Medicine 8/2013–5/2015
Supervisors: Julie Beasley, Ph.D., Colleen Morris, M.D.,
& Mario Gaspar de Alba, M.D.
Doctoral Practicum Student

- Member of multidisciplinary diagnostic team specializing in diagnosis and treatment of fetal alcohol syndrome, genetic disorders (e.g. Neurofibromatosis, Crouzon), and neurodevelopmental disabilities.
- Administered neuropsychological assessments, wrote integrated neuropsychological reports, assisted with treatment recommendations and referrals, and consulted with medical providers.

The Office of Dr. Julie Foutz Beasley, Pediatric Neuropsychologist 8/2013–5/2015
Primary Supervisor: Julie Foutz Beasley, Ph.D.
Doctoral Practicum Student

- Administered neuropsychological assessments and wrote integrated neuropsychological reports for children and adolescents with projected neurocognitive deficits, developmental disabilities, and learning disorders. Diagnoses seen included genetic syndromes, epilepsy, cancer, cerebral palsy, ADHD, autism spectrum disorder, and fetal alcohol syndrome.
- Provided individual therapy for children with anxiety disorders and their families using cognitive behavioral and play therapy.
- Participated in behavior therapy for young children with developmental delays and their family members using the Early Start Denver Model, play and attachment focused therapy, and behavioral interventions.
- Assisted in training practicum students on neuropsychological assessment administration.

Partnership for Research, Assessment, Counseling, Therapy, and Innovative Clinical Education (PRACTICE): A UNLV Community Mental Health Clinic 8/2011–8/2012
Supervisor: Christopher A. Kearney, Ph.D.
Doctoral Practicum Student

- Provided supervised long-term individual therapy with primarily children and co-lead a DBT skills group with adults.
- Commonly presented patient diagnoses included anxiety and affective disorders, ADHD, Oppositional Defiant Disorder, learning disorders, and developmental disabilities.
- Primary theoretical approach used was CBT.
- Responsible for case conceptualization, treatment and termination planning, and crisis intervention.
- Supervision consisted of weekly individual and group meetings with video tape review as well as weekly practicum seminars, which included didactic, group supervision, and case conference components.

The PRACTICE: A UNLV Community Mental Health Clinic 8/2011–12/2012
UNLV Psychological Assessment and Testing Clinic
Supervisor: Michelle G. Paul, Ph.D.
Doctoral Practicum Student

- Conducted comprehensive neuropsychological and psychological assessments, completed integrated reports, and provision of interviewing and feedback for individual children and adolescents with a range of psychological disorders in a community clinic setting.
- Primary diagnoses included cognitive and learning disabilities, mood disorders, and anxiety disorders.
- Weekly supervision included reviewing cases, joint determination of assessment battery and interpretation of results, report revisions, and discussion of feedback.

RESEARCH EXPERIENCE

Neuropsychology Research Program 1/2011-8/2017
University of Nevada, Las Vegas
Advisor: Daniel N. Allen, Ph.D.

Dissertation Study: Social Cognition in Attention-Deficit/ Hyperactivity Disorder
Scheduled Defense Date: 2/24/2016

- Engaged in protocol development, training of graduate and undergraduate students on study procedures, recruitment, IRB submission, screening participants, and assessing children with and without ADHD.
- Assessments include KSADS-PL, WISC-V, NEPSY-II, WJ-ACH-IV, Reading the Mind in the Eyes Test, and Happe's Strange Stories.

Study: Standardization of Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V) and WISC-V Integrated 5/2013-5/2014

- Served as Site Coordinator for Pearson Corporation.
- Engaged in recruitment, IRB submission, screening participants, and assessing children with TBI, ADHD, and Intellectual Disability.

Master's Thesis Study: WISC-IV Profiles of Children with Attention-Deficit/Hyperactivity Disorder and Comorbid Learning Disabilities 1/2012-5/2014

- Developed research design, statistical analyses, and manuscript preparation and submission.

Study: Standardization of Halstead Category Test Computer Version 8/2011-5/2012

- Administered assessment battery and trained research assistants in scoring and administration procedures.
- Assessments included Halstead Category Test (computer and original version), Stroop Task, Finger Tapping, Grip Strength, Grooved Pegboard, Trail making Test A & B, WAIS-III subtests, Wisconsin Card Sorting Test, and TOVA.

Study: Social Cognition in Individuals with Schizophrenia and Bipolar Disorder 8/2011-5/2013

- Engaged in phone screening of potential participants, scheduling of participants, and training on test scoring and assessment procedures.
- Assessments included the SCID, quality of life self-report questionnaires, a semi-structured interview regarding and subsequent ratings of current psychiatric symptomatology, measures of verbal and nonverbal learning and memory, executive functioning and processing speed measures, and functional outcome measures.

PUBLICATIONS

Refereed Articles Published

Raines, T. C., Gordon, M., Harrell-Williams, L. M., Diliberto, R. A, & Parke, E. M. (in press). Adaptive skills and academic achievement in Latino students. Journal of Applied School Psychology.

Mayfield, A., Parke, E. M., Barchard, K. A., Zenisek, R., Thaler, N. S., Etcoff, L. M, & Allen, D. N. (2016). Equivalence of mother and father ratings of ADHD in children. Child Neuropsychology, Advanced Online Publication. doi: 10.1080/09297049.2016.1236186

Parke, E. M., Mayfield, A., Barchard, K. A., Thaler, N. S., Etcoff, L. M, & Allen, D. N. (2015). Factor structure of symptom dimensions in Attention-Deficit/Hyperactivity Disorder (ADHD). Psychological Assessment, 4, 1427-37. doi:10.1037/pas0000121

Parke, E. M., Thaler, N. S., Etcoff, L. M., & Allen, D. N. (2015). Intellectual profiles in children with ADHD and comorbid learning and motor disorders. Journal of Attention Disorders, Advanced Online Publication. doi:10.1177/1087054715576343

Thaler, N. S., Barchard, K. A., Parke, E., Jones, W. P., Etcoff, L. M., Allen, D. N. (2012). Factor structure of the Wechsler Intelligence Scale for Children: Fourth Edition in children with ADHD. Journal of Attention Disorders, Advanced Online Publication. doi:10.1177/1087054712459952

Presentations and Published Abstracts
* Denotes presentation has a corresponding published abstract, reference follows entry.
Graves, S. J., Parke, E. M., Etcoff, L. M., & Allen, D. N. (2017, April). The Relationship between the ADHD Symptomatology and BASC-2 Parent Ratings. Poster session presented at the Annual Meeting of the American Academy of Pediatric Neuropsychology, Las Vegas, NV.

*Parke, E. M., Allen, D. N., Mayfield, J. W. (2015, November). Differential impairment of symptoms in children with TBI and ADHD. Poster to be presented at the 35th annual meeting of the National Academy of Neuropsychology, Austin, TX.

*Graves, S., Parke, E. M., Allen, D. N., Mayfield, J. W. (2015, November). The relationship between ADHD symptomatology and BASC-2 parent ratings. Poster to be presented at the 35th annual meeting of the National Academy of Neuropsychology, Austin, TX.

*Parke, E. M., Ross, E., Schuber, P., Bernstein, J., Ikeda, I., & Bello, D. T., PhD. (2015, September). Integrating a neuropsychology program into an ambulatory pediatric oncolog¬¬y clinic. Poster presented at the annual meeting of Nevada Cancer Coalition, Reno, NV.

*Parke, E. M., Etcoff, L. M., & Allen, D. N. (2014, November). Social cognition in adolescents with Traumatic Brain Injury. Poster presented at the 34th annual meeting of the National Academy of Neuropsychology, Farjado, Puerto Rico.

*Reyes, A., Parke, E. M., Allen, D. N., & Mayfield, J. W. (2014, April). Executive functioning in children and adolescents with Traumatic Brain Injury. Poster presented at the 94th annual meeting of Western Psychological Association, Portland, OR.

*Parke, E. M., Hart, J. Barchard, K., Baldock. D., Etcoff, L. M., & Allen, D. N. (2013, October). Discriminate function analysis of WISC-IV and WJ Broad Reading scores in children with ADHD and LD. Poster presented at the 33rd annual meeting of the National Academy of Neuropsychology, San Diego, CA.

*Parke, E. M., Thaler, N. S., Etcoff, L. M., & Allen, D. N. (2012, November). Neurocognitive differences among ADHD and comorbid learning disabilities. Poster presented at the 32nd annual meeting of the National Academy of Neuropsychology, Nashville, TN.

Hart, J. S., Cox, J. L., Woolery, H., Safko (Parke), E. M., Thaler, N. S., Etcoff, L. M., & Allen, D. N. (2012, April). WISC-IV profiles in children with learning disabilities. Poster presented at the 92nd annual meeting of the Western Psychological Association, San Francisco, CA.

*Parke, E. M., Thaler, N. S., Cox, J., Hart, J., & Allen, D. N. (2012, March). Pattern of memory factors differs among age ranges in healthy children and adolescents. Poster presented at the 4th annual meeting of the American College of Professional Neuropsychology, Las Vegas NV.

*Thaler, N. S., Safko (Parke), E. M., Bello, D. T., Wood, N., Etcoff, L. M., & Allen, D. N. (2011, November). Confirmatory factor analysis of the WISC-IV in children with ADHD. Poster presented at the 31st annual meeting of National Academy of Neuropsychology, Marco Island, FL.

*Safko (Parke), E. M., Thaler, N. S, Terranova, J., Mayfield, J., & Allen, D. N. (2011, August). Cognitive and behavioral differences among ADHD subtypes. Poster presented at the 3rd annual meeting of American College of Professional Neuropsychology, Las Vegas, NV.

TEACHING EXPERIENCE

Part-time Instructor 8/2013-5/2015
Psychology 101

- Instructed two sections per semester at University of Nevada, Las Vegas.

LEADERSHIP AND SERVICE

National Academy of Neuropsychology (NAN)
Student Committee Past Chair 1/2017-12/2017
Student Committee Chair 1/2016-12/2016
Student Committee Co-Chair 1/2015-12/2015
Student Committee Member 1/2014-12/2014

- Assisting in developing and implementing plans to increase NAN student membership, planning student activities at annual conference, developing NAN student website and student committee materials, attending and presenting updates at semi-annual NAN board meetings.

NAN Membership Committee 12/2012-1/2015
Committee member

- Assisted in developing and implementing plans to increase NAN membership.
- Served as subcommittee member to increase student membership and form a new student committee.

Outreach Undergraduate Mentoring Program (OUMP) 8/2014-5/2015
Student Mentor

- Mentored underrepresented students in psychology as they prepare for and apply to graduate school in psychology or psychology-related fields.

UNLV Clinical Psychology Doctoral Student Committee
Committee Chair 8/2012-8/2013
Cohort Representative 8/2011-8/2012

- Served as a liaison between clinical faculty and graduate students, coordinated and assisted with interview weekend activities, and organized student-focused events.

NAN Student Volunteer at Annual Conferences
Annual Conference: Farjado, PR 11/2014
Annual Conference: Nashville, TN 11/2012
Annual Conference, Marco Island, FL 10/2011

- Monitored registration and attendees receiving continuing education credits.

Facing the World Medical Charity
London, England 9/2007-12/2007

- Taught English to children with craniofacial conditions from countries with limited medical resources, supported positive activities of daily living, performed administrative duties.

Westmont College Student Mentor 8/2007-5/2007

- Served as mentor to psychology major undergraduates.

PROFESSIONAL AFFILIATIONS

National Academy of Neuropsychology, Student Affiliate
American Psychological Association, Student Affiliate

ADDITIONAL EDUCATION/TRAINING EXPERIENCE

Neuropsychology of Epilepsy and Epilepsy Surgery Summer 2016
National Academy of Neuropsychology (NAN) Distant Learning Course
Instructor: Gregory P. Lee, PhD, ABPP-Cn

- 8-week online course providing graduate-level training in major seizure disorders and syndromes, treatments, cognitive and behavioral consequences of epilepsy syndromes and antiepileptic drugs, and discussion of the role of neuropsychological assessment in epilepsy diagnosis and treatment.

WPS ADOS-2 Training: Toddler-Module 2 6/2015

- Two day training sponsored by Nevada Early Intervention Services.

Dialectical Behavior Therapy Part II:
DBT Skills Training 6/2011

- Alan Fruzetti, Ph.D. 3-day training sponsored by Nevada Psychological Association.

Dialectical Behavior Therapy Part I:
Comprehensive Overview of DBT Therapy 2/2011

- Alan Fruzetti, Ph.D. 3-day training sponsored by Nevada Psychological Association.

SCID Training Program
University of Nevada, Las Vegas Training Supervisor: Daniel N. Allen, Ph.D. 6/2015

- Completed a training program over three months and made up of approximately 40 hours for administration of the Structured Clinical Interview of the DSM-IV-TR Axis I Disorders (SCID).

The Collaborative IRB Training: University of Initiative (CITI) Program 1/2010-Present

RELATED CLINICAL WORK EXPERIENCE

Integrated Support Solutions 1/2011-7/2011
Instructional Aide

- Provided in-home early intervention services for developmentally delayed children age 12-36 months under supervision by a BCBA, occupational therapist, and speech/language pathologist. Treatment goals included development of language, behavior, gross/fine motor, and social skills.

Clinical Solutions 3/2010-7/2011
Psychosocial Rehabilitation and Day Treatment

- Provided in-home implementation of treatment goals provided by the psychologist and/or licensed clinical social worker.
- Taught day treatment curriculum on building social skills and coping strategies.

Cottage Hospital 1/2009-5/2009
Child Life Specialist Practicum Student

- Assisted children adjust to the hospital environment, emotionally prepped them for surgery, and participated in grief counseling.