ADHD and Theory of Mind in School-Age Children: Exploring the Cognitive Nature of Social Interactions in Children with ADHD

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By

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Abstract

Children with Attention Deficit Hyperactivity Disorder (ADHD) experience significant difficulties with social skills (Barkley, 2006; DuPaul & Stoner, 2003; Stormont, 2001). The inhibitory deficit associated with ADHD is typically identified as the cause of these impaired social skills (Barkley, 2006). Additionally, some researchers have suggested that theory of mind (ToM), which is the ability to attribute mental states to oneself and to others, may be involved, but the research on ToM deficits in children with ADHD is limited and the findings are mixed. A key methodological issue in this literature is the use of traditional but problematic measures of advanced ToM. These measures either fail to find developmental changes or do not measure adaptive reasoning, which is more representative of how individuals behave in real social interactions (Hayward, Homer, & Sprung, 2016). The present investigation used a different tool called Flexibility and Automaticity of Social Cognition (FASC), a new measure of advanced ToM (Hayward et al., 2016), as well as the Strange Stories (SS) task to analyze the relation between ToM, ADHD, and social difficulties in children. Results indicated that children with ADHD did not differ in performance from controls on the SS task, or on the FASC dimensions of total responses (TRs), total mental state terms (MSTs), and First Common Response (FASC-FCR). Participants in the ADHD group did demonstrated impairment relative to controls in the number of mental state justifications (MSJs) provided in the FASC. There was also a significant negative correlation between ADHD symptom count and FASC-FCR. Finally, the number of FASC-FCRs significantly correlated with social skills domains on the C3-PRS and the BASC-2-PRS. The current findings suggest that social skills deficits in children with ADHD can partially be explained by difficulties with some aspects of ToM.
Acknowledgments

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Chapter 1: Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is among the most commonly diagnosed childhood disorders. Its prevalence among grade-schoolers is estimated at 3% to 7% (American Psychological Association [APA], 2000). Inattention, impulsivity, overactivity, and significant impairment in multiple domains of functioning are core characteristics of children with ADHD (Barkley, 2006; DuPaul & Stoner, 2003; Langberg, Epstein, Urbanowicz, Simon, & Graham, 2008). These symptoms occur when the environment or situation taxes the individual’s capacity to pay attention, restrain movement, inhibit impulses, and regulate his or her own behavior relative to rules, time, and the future (Barkley, 2006). The symptoms emerge early in life, are developmentally inappropriate, and occur to an excessive degree and across a variety of environments and situations.

Due to these characteristics, children with ADHD frequently suffer greater social and interpersonal problems than typically developing children (Barkley, 2006; DuPaul & Stoner, 2003; Stormont, 2001). Social problems such as impairment in peer functioning and social-cognitive deficits (e.g., hostile attribution bias, lack of social comprehension, and limitations in social problem solving) are common in children with ADHD (Sibley, Evans, & Serpell, 2010). These social problems are often profound, requiring sensitive and systematic interventions to enable children with ADHD to increase their social competence (Stormont, 2001).

The most common explanation of cognitive deficits in this population is to view ADHD as an executive functioning deficit (EFD; Barkley, 2006). Executive functions are generally defined as higher-order mental processes and include inhibition, working memory, cognitive flexibility (set shifting), planning, and fluency (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009; Pennington & Ozinoff, 1996). The executive function deficit model of ADHD
can account for the social skills problems experienced by this population because hyperactive and impulsive behavior as well as inattention are believed to cause social difficulties (Stormont, 2001).

Interventions targeting social skills deficits in children with ADHD have included social skills training (SST) techniques. Strategies such as modeling, behavioral rehearsal, and reinforced practice have been proposed as methods of improving the social skills of children with ADHD (DuPaul & Stoner, 2003). However, SST interventions for children with ADHD have produced mixed results (Barkley, 2006). A key problem with currently available social skills interventions is that they largely focus on social skills and not on social performance. Children with ADHD demonstrate knowledge of social rules and behavior as well as their peers; however, they often do not behave in accordance with this knowledge. Although children with ADHD do not appear to have difficulty with social skills, they have difficulty with performance of these skills when called to action (Barkley, 2006; DuPaul & Stoner, 2003). Consequently, social skills interventions targeting skills, rather than performance, fail to produce lasting behavioral changes.

Furthermore, few social skills interventions for children with ADHD have demonstrated generalization and effectiveness beyond the study context (Barkley, 2006, DuPaul & Stoner, 2003). The generalization of newly acquired social skills to other contexts requires consistent reinforcement across a variety of settings within the child’s natural environment for a significant duration of time (Mrug, Hoza, & Gerdes, 2001). The weak level of generalization achieved in SST programs for children with ADHD may be because the new social behaviors taught during the intervention are not consistently prompted and reinforced by adults outside the intervention (DuPaul & Weyandt, 2006; Gresham, 2002).
The diverse challenges present in social interactions among children with ADHD indicate another critical problem faced by social skills intervention programs for this population: Due to the variable nature of these challenges, children with ADHD are not likely to respond to homogeneous interventions focusing on a single strategy (Hinshaw, 1992). Effective and durable social skills interventions for children with ADHD must target the specific cognitive deficits underlying behavioral manifestations of social skills difficulties.

Another area of research investigating the link between social skills deficits and cognitive deficits has focused on perspective taking. Some researchers have investigated children’s developing ability to attribute mental states to themselves and to others (Buitelaar, van der Wees, Swaab-Barneveld, & van der Gaag, 1999; Flavell, 1999; Frith & Happé, 1999; Gopnik, 1993; Lee & Homer, 1999; Sodian, Hülsken, & Thoermer, 2003). This ability is commonly known as theory of mind (ToM). Executive functioning (EF) accounts posit that an increase in EF ability leads to improvements in ToM through self-monitoring of action and through increased insight into the intentional nature of action (Carlson, Moses, & Hix, 1998; Russell, 1996, 1997; Sodian & Hulsken, 2005). This theory implies that a certain level of EF ability is needed to gain insight into thought and action, and to develop competent social cognition (Sodian & Hulsken, 2005). The presence of an inhibitory control deficit in children with ADHD would thus warrant an investigation of the relationship between ToM and ADHD; however, few studies have examined this relationship, and those few have yielded contradictory results (e.g., Buitelaar et al. 1999; Charman, Carroll, & Sturje, 2001; Happé & Frith, 1996; Perner, Kain, & Barchfeld, 2002; Sodian & Hulsken, 2005).
Study Objectives and Rationale

The present study sought to explore the relationships between ADHD, social skills, and ToM in school-aged children. A key objective of the study was to investigate the theory that impaired ToM in children with ADHD is a disorder of performance, not a skill deficit. The current study was based upon a pilot study in which the principal investigator (PI) used a newly developed task, the *Flexibility and Automaticity of Social Cognition* (FASC; Hayward, Homer, Pace, & Bromley, 2013; Hayward et al., 2016), a more socially representative advanced ToM measure than has been used in previous research with older children and adolescents.

It was hypothesized that children with ADHD would perform more poorly than typically developing children on the FASC. Performance on the FASC was hypothesized to predict scores on the social domains of two behavior rating scales, the *Behavior Assessment System for Children—Second Edition* parent report scale (BASC-2 PRS; Reynolds & Kamphaus, 2004) and the Conners Parent Rating Scale (C3-PRS; Conners, 2008). Additional analyses of the data were conducted to further investigate the relationship between ToM, ADHD, EF, and social skills. Variables such as participant demographics, and the clinical differences between children with ADHD and typically developing peers, were also examined.

Past ToM research has focused largely on young children (preschool age) and has barely addressed children with ADHD. Furthermore, research has shown that ToM ability may be connected to children’s self-conceptions and their social interactions. The social interaction difficulties that children with ADHD experience indicate the need for future research exploring the links between EF and children’s understanding of others’ mental states. Findings in this area of research may provide valuable insight into the cognitive and social experiences of children involving ToM, and may expand research within the larger frame of social cognitive research.
and cognitive neuroscience (Bosacki, 2008). Furthermore, findings may add critical knowledge regarding social skills impairment in children with ADHD. This knowledge can be used to improve the effectiveness of social skill interventions for children with ADHD.
Chapter 2: Literature Review

The goal of the current study was to examine the relation between ToM and ADHD in school-age children. Because executive functioning is central to both ADHD and ToM, this chapter will begin with an overview of the construct. The EF sub-skill of inhibition will be discussed in detail as it applies to the specific constructs investigated in the present study. Next, the chapter will provide an overview of ADHD diagnosis, symptoms, and models of core deficit and etiology. Finally, Theory of Mind and its relationship to ADHD and EF and social skills will be reviewed.

Executive Functioning

Executive functions (EFs) are the components of cognition that allow for the self-regulation and self-direction of our daily and long-term functioning (Kaufman, 2010). These self-regulatory processes are significant to the learning, social, and behavioral domains. As Kaufman (2010) explains, “whenever people purposefully manage their thinking or behavior to achieve some desired outcome…they are engaging the skills of executive function” (p.2).

Executive functions are generally defined as higher-order mental processes and include inhibition, working memory, cognitive flexibility (set shifting), planning, and fluency (Corbett, Constantine, Hendren, Rocke, & Ozonoff, 2009; Pennington & Ozinoff, 1996). The construct of executive function is widely debated in the literature. Within this debate is variation in how best to define executive functioning and its components. For example, in their review, Sergeant, Geurts, and Oosterlaan (2002) found 33 definitions for the construct.

Numerous studies have shown that executive functioning contains several component functions, although there is variation within the literature as to the specific subcomponents. Research on executive functioning has spawned an ongoing and extensive discussion as to what
these components are and how they develop (Barkley, 1997; Best & Miller, 2010; Nigg, 2004; Pennington & Ozinoff, 1996; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

For example, Miyake, Friedman, Emerson, Witzki, and Hoerter (2000) formulated executive functioning as consisting of three executive functions: (a) shifting between mental sets (“shifting”), (b) updating and monitoring of working memory representations (“updating”), and (c) inhibition of dominant or prepotent responses (“inhibition”). The researchers sought to identify commonalities among frequently proposed EF tasks in a sample of 137 college students. Results indicated that shifting, updating, and inhibition were significantly distinguishable executive functions. However, the three executive functions were not fully independent. Therefore, Miyake et al. hypothesized that shifting, updating, and inhibition were subskills of a common underlying factor.

Developmental research investigating components of executive functioning has indicated that significant advances in EF occur between the ages of 3 to 6 (Sodian & Hulsken, 2005). In their study of executive functioning and its components, McAuley and White (2010) investigated the development of working memory, processing speed, and response inhibition. A latent-variables approach was used to analyze data from a sample of 147 typically developing participants ranging in age from 6 to 24. Results indicated that processing speed, response inhibition, and working memory abilities were statistically separable between groups that were 6 years apart in age. The extent of this independence was found to be stable up through age 24. Furthermore, processing speed, response inhibition, and working memory were found to improve most rapidly between early and late childhood, reaching a plateau during early adulthood (McAuley & White, 2010). Although there is variability in the definition and components of
executive functioning, such findings suggest that executive functions are distinguishable and develop in childhood.

**Inhibition.** The executive function concepts of inhibition and inhibitory control have become increasingly central to research in many psychological domains (Barkley, 1997; Carlson, Moses, & Claxton, 2004; Dagenbach & Carr, 1994; Leon-Carrion, García-Orza, & Pérez-Santamaría, 2004; Nigg, 2000; Rommelse et al., 2007). The literature indicates the importance of inhibition in a developmental context and has sparked research aimed at understanding how these abilities develop. Outcomes of this research suggest that components of inhibition may be dissociated (Barkley, 2007; Bernal & Altman, 2009; Blaskey, Harris, & Nigg, 2008; Friedman & Miyake, 2004; Konishi, Jimura, Asari, & Miyashita, 2003). However, the meanings of the term *inhibition* and variations on the term, such as *behavioral inhibition* and *response inhibition*, are poorly defined and inconsistent across authors (Barkley, 2006; Clark, 1996; Friedman & Miyake, 2004). Nonetheless, all theorists identify a component of suppressing, interrupting, or cancelling a prepared motor response, either to accommodate new information coming online or to support a later goal (Nigg, 2006).

In a thorough review on the inhibition construct, Nigg (2000) provided a framework by which research on inhibitory dysfunction can be evaluated and integrated. Nigg identified eight distinguishable kinds of inhibition and, in doing so, laid the groundwork for a mechanism-based taxonomy of types of inhibition to guide research in psychology and cognitive neuroscience. These eight kinds of inhibition fall into three classes: executive inhibition, motivational inhibition, and automatic inhibition of attention (Nigg, 2000). The following discussion will focus on defining the construct of executive inhibition.
In line with Nigg’s (2000) taxonomy, executive inhibitions will be defined here as “processes for intentional control or suppression of response in the service of higher order or longer term goals (as opposed to immediate stimulus incentives)” (p. 238). Blaskey et al. (2008) further explained that executive inhibition refers to “strategic, top-down processes of interrupting a prepared action in response to new information in a rapid-decision context, so as to maintain

### Table 1

*Executive Inhibition Components and Definitions*

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
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<tr>
<td>Executive Inhibition</td>
<td>&quot;Suppressing, interrupting, or cancelling a prepared motor response, either to accommodate new information coming online or to support a later goal&quot; Nigg (2006) p 110.</td>
</tr>
<tr>
<td>Interference Control</td>
<td>&quot;Suppressing a stimulus that pulls for a competing response so as to carry out a primary response, to suppressing distractors that might slow the primary response, or to suppressing internal stimuli that may interfere with the current operations of working memory&quot; Nigg, 2000, p. 22.</td>
</tr>
<tr>
<td>Cognitive Inhibition</td>
<td>“Cognitive processes that suppress information from working memory” and “require the active suppression of mental contents” (Nigg, 2000, pp. 223, 228).</td>
</tr>
<tr>
<td>Behavioral Inhibition</td>
<td>“The automatic or intentional delay of overt motor response” (Nigg, 2000, p. 228).</td>
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progress toward a goal” (p. 354). Thus, executive inhibitions are part of the larger process of cognitive control.

Other theorists refer to “executive inhibition” as “response inhibition” or “response suppression.” Response inhibition and response suppression will be referred to here as executive inhibition for consistency. Table 1 summarizes executive inhibition and its components.

Executive inhibition allows us to suppress actions that are highly prepotent but have been rendered inappropriate. These abilities play an important role during a child’s development, and improvements in these abilities mediate the acquisition of other skills (Friedman & Miyake, 2004; McAuley & White, 2010). Friedman and Miyake (2004) conducted a study using data from 220 adults to examine the relationships among three inhibition-related functions. Results demonstrated that at least two components of inhibition may be dissociated: the ability to resist memory instructions from previously relevant information (i.e., resistance to proactive interference), and the ability to ignore irrelevant information and suppress the expression of dominant, automatic, and prepotent responses (i.e., distractor response inhibition).

Three processes will be considered in defining the construct of executive inhibition: interference control, cognitive inhibition, and behavioral inhibition. These processes require the effortful inhibition of motor or cognitive responses (Nigg, 2000). Interference control refers to:

suppressing a stimulus that pulls for a competing response so as to carry out a primary response, to suppressing distractors that might slow the primary response, or to suppressing internal stimuli that may interfere with the current operations of working memory. (Nigg, 2000, p. 222)

Damage to brain structures responsible for goal-directed inhibitory processes (i.e., interference control) results in failure or extreme difficulty on interference control tasks such as the Stroop
Color–Word Test (Carter, Mintun, Nichols, & Cohen, 1997; Vanderhasselt, De Raedt, & Baeken, 2009). The phenomenon observed in this task is that it takes individuals longer to name the color of a printed word when the actual word is different from the printed color (e.g., saying the word “green” when the word “yellow” is printed in green ink; MacLeod, 1991). Poor performance on tasks such as the Stroop Color–Word Test demonstrates impairment in interference control.

Cognitive inhibition is defined as “cognitive processes that suppress information from working memory” and “require the active suppression of mental contents” (Nigg, 2000, pp. 223, 228). Because cognitive inhibition is not expressed by motor responses, it is difficult to measure through behavioral observations. Nigg posited that cognitive inhibition can be measured through directed ignoring or negative priming tasks. However, it can also be measured through neuroimaging techniques (Bernal & Altman, 2009).

Behavioral inhibition is defined as “the automatic or intentional delay of overt motor response” (Nigg, 2000, p. 228). Behavioral inhibition can be measured through stop-and-go/no-go tasks (Bernal & Altman, 2009; Nigg, 2000). These tasks ask participants to address a visual stimulus (go signal) with a motor response (e.g., pressing a key) as quickly as possible. In approximately one-third of the trials an auditory stimulus (stop signal) immediately follows the visual stimulus. Participants are asked to inhibit their motor response when they hear the stop signal (Kalanthropf, Goldfarb, & Henik, 2012). Difficulty on stop-and-go/no-go tasks may have clinical significance in that it may target the specific type of inhibition impairment. The inhibition-related responses required in social situations appear to involve both cognitive and behavioral inhibition.

Distinct components of inhibition have been verified in empirical research, which suggests that future studies should include a wide variety of measures that capture different
aspects of the inhibitory construct. Furthermore, additional research is needed to identify, define, and measure the distinct forms of inhibition to create a well-defined construct. Currently there is consensus that inhibition, at the neurological level, supports the engagement of cognitive functions and subsequent goal directed behavior. Because inhibition at the neurological and cognitive levels is difficult to observe, inhibition was measured in the present study through overt motor responses (i.e., observable behavior) and behavior rating scales. The model of inhibition adopted in this study is described in further detail in the following section, as it relates to ADHD and related research.

**Attention Deficit Hyperactivity Disorder**

**Diagnosis and etiology of ADHD.** The *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR, American Psychological Association, 2000) identifies three types of ADHD: *ADHD Combined Type* (ADHD-C), *ADHD Predominantly Inattentive Type* (ADHD-PI), and *ADHD Predominantly Hyperactive-Impulsive Type* (ADHD-PHI). The DSM-IV-TR diagnostic criteria for ADHD require that symptoms must be developmentally inappropriate and maladaptive, emerge early, persist for at least six months, and occur across settings. Diagnosis of ADHD also requires evidence of clinically significant social, academic, or occupational functioning impairment. The symptoms cannot occur exclusively during the course of a psychotic disorder, and they cannot be accounted for by another mental disorder (APA, 2000).

Based on DSM-IV-TR diagnostic criteria for ADHD type (see Table 1), a diagnosis of ADHD-PI requires the presence of at least six out of nine symptoms of “inattention,” whereas ADHD-PHI requires the presence of at least six out of nine symptoms of “hyperactivity-impulsivity.” The symptoms of “hyperactivity-impulsivity” are broken into two distinct
Attention Deficit Hyperactive Disorder Combined-type requires the presence of six or more symptoms of “inattention” (i.e., ADHD-PI) and six or more symptoms of “hyperactivity-impulsivity” (i.e., ADHD-PHI; APA, 2000). Therefore, it is also possible for an individual to be diagnosed as ADHD-C without exhibiting any symptoms of impulsivity. Moreover, the ADHD-PI subtype may include a heterogeneous group who share a common attention-deficit diagnosis (inattention symptoms), but who do not all display the same six symptoms. The ambiguity of ADHD subtypes and corresponding symptoms has triggered research attempting to identify core deficits, symptoms, and distinct subtypes of the disorder.
Several models have been proposed to explain the etiology of ADHD. The most common explanation views ADHD as an EFD. Models differ in their attribution of executive functioning to deficits associated with ADHD. Examining EF in children with ADHD poses a challenge, however, due to the overwhelming variety of operationalizations of the EF construct.

Until recently, causal explanations of ADHD’s etiology were based on single, common core dysfunctions such as executive function. The present view of ADHD may be clustering two qualitatively different disorders into a single set of disorders (Barkley, 1997). Nigg and Casey (2005b) noted a problem for the single EF theory with regard to classifying ADHD cases: Across three samples, approximately half of the children with ADHD had significantly slower reaction
times on the stop-signal task, an inhibition measure, compared with 10% of control subjects. Furthermore, nearly 80% of children with ADHD and nearly half of the control subjects had a deficit on at least one EF measure (Nigg & Casey, 2005b). Sonuga-Barke (2005) also supported this distinction in arguing for a multiple-pathways model of ADHD.

Nigg (2004) supported the multiple-pathways model and considered two initial pathways to ADHD. One pathway is that of primary inheritance, which is potentially mediated by genotype, environment, and maintained socialization during development. The other pathway postulates that genetic liability is activated by experiential stressors on the developing neural system (Nigg, 2004). The idea of a multiple-pathway model is also supported by recent literature that separates ADHD cases into those with and without EFD (Lambek et al., 2010).

Sonuga-Barke (2005) reviewed literature on ADHD, and investigated the multiple pathway model of ADHD and separate categories for those with and without EF impairment. Sonuga-Barke contrasted the two leading single core dysfunction models and investigated potential limitations of these paradigms. The two models reviewed were: (a) executive dysfunction caused by a deficit in inhibitory control; (b) impaired signaling of delayed rewards caused by disturbances in motivational processes. Data reviewed indicated that delay aversion and executive functions might each make distinctive contributions to the development of ADHD. Sonuga-Barke, therefore, supported a theoretical model of multiple neurodevelopmental pathways to ADHD.

In contrast to a multiple-pathways model, research attempting to identify a single core deficit for ADHD has led to the proposal of a single EF subtype of ADHD. It has been suggested that ADHD-PI may not involve attention impairment in the same form as is found in the other two types. Attention Deficit Hyperactive Disorder-PI is viewed as entailing a general deficit in
information processing speed and a specific deficit in focused or selective attention. Attention Deficit Hyperactive Disorder-C, on the other hand, is characterized by deficits in the domain of sustained attention (persistence) and distractibility (Barkley, 1997).

The DSM-IV-TR construes neuropsychological/biological dysfunction as a defining feature of mental disorders (APA, 2000). This model led researchers to attempt to identify the defining feature of ADHD. Researchers have been working to answer the question of where within the ADHD brain is the site for “causal” dysfunction (Sonuga-Barke, 2005). From this line of inquiry and related research, causal models of ADHD were constructed.

Two groups of causal models of ADHD have emerged and have frequently been pitted head-to-head in the ADHD core deficit research. Some causal models view ADHD as an EFD due to deficient inhibitory control (e.g., Barkley, 1997). In other causal models, inhibitory deficit has been conceived as emerging from impaired signaling of delayed rewards arising from disturbances in the motivational process (Sagvolden, 1996; Sagvolden, Aase, Zeiner, & Berger, 1998; Sonuga-Barke, 2005). These two models have been traditionally treated as competitive rather than complementary in the ADHD literature.

Barkley (1997) constructed a core deficit theory of ADHD based on a model of self-regulation development that explains many of the cognitive deficits associated with the disorder. This model uses the term ADHD to refer only to ADHD-C and ADHD-PHI. According to Barkley’s model, there are four components or classes of EF, identified by taking an evolutionary perspective on EF development (Barkley, 2001). These components are derived from the four classes of self-directed actions that Barkley posited as having evolved to anticipate future changes in the environment. The four EFs are as follows: (a) working memory; (b) internalization of speech; (c) self-regulation of affect, motivation, and arousal; and (d)
reconstitution. Behavioral inhibition and the four EFs it supports are seen as influencing motor control (Barkley, 2006). In summary, according to Barkley (2006), neurological and genetic factors make a substantial contribution both to symptoms of ADHD and to the occurrence of the disorder. The present study will adopt Barkley’s model of ADHD.

The quantity of EF deficits associated with ADHD has led researchers to differentiate cognitive processes and abilities (e.g., thought, knowledge, sense of time, emotional thought processes, information processing) from general, observable behavior (Barkley, 2006; De Boo, 2007). As a result, theoretical work in ADHD has begun to conceptualize ADHD as “a disorder of performance more than a disorder of skill” (Barkley, 2006, p. 324; see also De Boo, 2007; Nigg, 2000; Reid, Trout, & Schartz, 2005). For example, Barkley’s model conceptualizes ADHD as a deficit in behavioral inhibition, which leads to dysfunction in executive neuropsychological abilities (i.e., EF deficits). These EF deficits, in turn, underlie observable behavioral deficits. According to this definition, “ADHD is not a disorder of knowing what to do, but of doing what one knows” (Barkley, 2006, p. 324).

Data from studies investigating EF and ADHD support the hypothesis that inhibition is the core deficit of ADHD. Aaron et al. (2007) reviewed studies that measured neural activity during tasks where various forms of inhibition were required. Studies investigating the neural circuitry underlying stopping behavior were reviewed—specifically, stop-signal studies, imaging studies of brain lesions impacting the prefrontal cortex and related neural pathways, transcranial magnetic stimulation (TMS) studies of the primary motor cortex, and neural recording studies of the neurophysiological mechanisms of stopping (Aaron et al., 2007). The findings of these studies are described below.
Aaron et al. (2007) also reviewed studies that used transcranial magnetic stimulation (TMS) while participants were engaged in go/no-go and stop-signal tasks. Data from these studies indicated increased neural inhibition in the motor cortex when subjects were required to prevent movement. Lesion studies in rodents revealed that frontal and basal ganglia lesions impair stopping behavior, and that stimulant drugs improved stopping behavior (Aaron et al., 2007). The authors described a conceptual model of response control with regard to go and stop processes (Aaron et al., 2007). A key point in this model is that go/no-go and stop-signal task (measures of inhibition) performance requires motor inhibition, which depends on neural inhibition. Therefore, neural inhibition involves interacting networks supporting both stop and go processes (Aaron et al, 2007).

Wodka et al. (2007) examined response inhibition in children with ADHD. Children with ADHD (n = 58) and age-matched controls (n = 84) completed three go/no-go tests. One test had a high working memory demand (cognitive), one had a low working memory demand (simple), and the third offered opportunity to earn and lose rewards (motivation-linked). A significant effect of group (ADHD or control) for go/no-go errors was found across all three go/no-go conditions, with no significant interaction for group by test. This suggests that ADHD participants exhibited a similar degree of impairment to the control group regardless of working memory load or feedback provided in the tests. For children with ADHD in this study, a response inhibition deficit was observed even when EF demands were minimal. Both groups exhibited decreased accuracy in performance on tasks when working memory demands were increased (Wodka et al., 2007). These findings provide evidence against the theory that working memory is a core ADHD deficit and supports the hypothesis that response inhibition as a primary deficit in children with ADHD.
Boonstra, Kooij, Oosterlaan, Sergeant, and Buitelaar (2010) investigated inhibitory deficit in adults diagnosed with ADHD. The researchers hypothesized that adults with ADHD would exhibit inhibitory difficulties. It was also hypothesized that these EF difficulties would fall into three distinct forms of inhibition in line with Barkley’s (1997) model of inhibition. Furthermore, the researchers hypothesized that these difficulties would be related to difficulties in four areas of EF (i.e., fluency, working memory, planning, and set shifting). Finally, Boonstra et al. predicted that difficulties in EF domains would remain for the ADHD group after rigorous controls for intelligence and non-EF performance.

Forty-nine adults with ADHD between 18 and 55 years of age (26 male, 23 female) participated in the Boonstra et al. (2010) study. The ADHD group was compared to 49 normal control (NC) adults (26 male, 23 female) between 18 and 55 years of age. Participants completed a large battery of tests across five domains of EF. The EF domains assessed were inhibition, fluency, planning, working memory, and set shifting. Participants’ neuropsychological functions for nonexecutive test demands were also assessed.

Results indicated that without controlling for intelligence, significant group differences were found in the areas of prepotent response inhibition, interference control, and set shifting (Boonstra et al., 2010). These domains represent three distinct forms of inhibition in line with Barkley’s (1997) model. Significant between-group differences were also found for verbal working memory and another test of prepotent response inhibition without controlling for intelligence. After controlling for intelligence, only effects for inhibition remained. Also, after controlling for non-EF demands of EF tasks, only effect for inhibition remained (Boonstra et al., 2010).
These results partially confirm the authors’ first hypothesis. That is, adults with ADHD would show inhibitory difficulties, specifically in all three areas of Barkley’s inhibition model. Data indicated that two out of three forms of inhibition outlined in Barkley’s (1997) model distinguished differences between groups. The authors noted that the lack of a distinguishable difference on the third for inhibition may be the result of questionable reliability in how the task was administered (Boonstra et al., 2010).

Boonstra et al.’s (2010) second hypothesis, that inhibitory deficits would be related to deficits in four EF domains (fluency, planning, working memory, and set shifting), was partially supported. Group differences were found for set shifting and verbal working memory. The authors stated that their data indicated that deficits could be established for the ADHD group before controlling for intelligence and non-EF abilities. Finally, after controlling for differences in intelligence and non-EF performance on tasks, the results indicated that only inhibitory difficulties remained. The authors noted that these results are consistent with prior research and literature on children with ADHD (e.g., Doyle, 2006; Nigg, 2005a; Wodka et al., 2007), as well as with literature supporting theoretical explanations for inhibitory deficit as the core deficit of ADHD (e.g., Aaron et al., 2007; Nigg, 2001).

Further support for the inhibitory deficit model comes from recent neurological and genetic research on ADHD. For example, Crosbie et al. (2013) conducted the largest study of the general population to date, which included 16,099 participants between the ages of 6 and 18. Crosbie et al. (2013) investigated whether biological ADHD traits (endophenotypes) were related to ADHD traits in the general population. Results indicated that response inhibition, latency, and variability were significantly correlated with ADHD traits, and that this relation remained even
after controlling for age and gender. This finding supports the validity of response inhibition as an endophenotype of ADHD (Crosbie et al., 2013).

There is an overwhelming amount of evidence supporting behavioral disinhibition, or poor inhibitory regulation of behavior, as a primary deficit of ADHD (Barkley, 1997; Pennington & Ozinoff, 1996; Sergeant et al., 2002). Meta-analyses of EF in children with ADHD have found some clear differences between persons with ADHD and control groups on EF measures. Furthermore, several studies have demonstrated that inhibition deficits are prominent in children with ADHD. Executive-function tasks have also differentiated children with ADHD from control groups as having deficits in working memory, planning, and set shifting (Pennington & Ozinoff, 1996; Sergeant et al., 2002).

**ADHD and language.** A large number of studies have investigated the relationship between ADHD and language development. Barkley’s (2006) review of the literature found that ADHD is not associated with structural problems with language, but with difficulties in story recall and, subsequently, academic achievement. Furthermore, Tannock and Schachar (1996) found that ADHD is also associated with challenges in aspects of narratives requiring EF as well as problems with pragmatic aspects of speech. These findings suggest that challenges with language development in children with ADHD can be attributed to problems with EF, rather than to a true skill deficit.

Children with ADHD have been found to talk more than their typically developing peers, especially during spontaneous conversation (Barkley, Cunningham, & Karlsson, 1983; Zentall, 1988). However, several researchers (e.g., Hamlett, Pelligrini, & Conners, 1987; Purvis & Tannock, 1997; Zentall, 1985) found that when children with ADHD are confronted with tasks requiring them to organize and generate speech in response to a specific task demand, they tend
to talk less, be more dysfluent, and be less proficient in their organization of speech. These difficulties further suggest problems in higher-order cognitive processes (i.e., EF), rather than in speech and language (Barkley, 2006).

**Theory of Mind**

Over the past 25 years, a body of literature investigating children’s developing ability to attribute mental states to themselves and to others has emerged (Buitelaar et al., 1999; Flavell, 1999; Frith & Happé, 1999; Gopnik, 1993; Lee & Homer, 1999; Sodian et al., 2003). This ability is commonly known as theory of mind (ToM). Theory of mind refers to the mind’s ability to “get inside the heads’ of other people and think about what they know, want, intend and believe” (Apperly, 2011, p.1). ToM involves seeing the self and others in terms of mental states; that is, the desires, emotions, beliefs, intentions, and other experiences of the internal mind of the self and others that are manifested in human action (Wellman, Cross, & Watson, 2001).

The development of ToM refers to the child’s emerging ability to recognize mental states in themselves and others. As ToM develops, children acquire the ability to recognize beliefs, desires, and intentions of the self and others (Zelazo, Astington, & Olson, 1999). Several researchers confirmed an empirical connection between EF and ToM (Carlson, 1997; Hughes, 1998; Ozinoff & McEvoy, 1994). This research revealed a correlation between EF and ToM and demonstrated that the developmental trajectories of ToM and EF are related (Apperly, 2011; Carlson et al., 1998; Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002; Hülsken & Thoermer, 2003; Perner & Lang, 1999). From developmental research on ToM, it is well established that there are critical developments in ToM around 4 years of age (Zelazo, 1999). This period coincides with the age range of children’s marked improvement on EF tasks, which
is 3- to 6-years old. Therefore, critical advances in EF occur at around the same age when children are gaining insight into their own and others’ mental states (Sodian et al., 2003).

**The developmental relationship between ToM and EF.** Investigations of the link between EF and ToM have produced two opposing developmental positions. Conceptual change accounts contend that EF development depends on ToM ability (Astington, 1991; Perner, 1991a, 1991b). Conversely, EF accounts posit that an increase in EF ability leads to improvements in ToM through self-monitoring of action and increasing insight into the intentional nature of action (Carlson et al., 1998; Russell, 1996, 1997; Sodian & Hulsken, 2005). The latter theory implies that a certain level of EF ability is needed to develop competent social cognition. Dissociations between EF and ToM development have provided a platform for investigating such theories (Sodian & Hulsken, 2005).

Theories of ToM have been studied in several populations of typically developing individuals as well as impaired populations, especially autism spectrum disorders (ASD; Demurie, De Corel, & Roeyers, 2011). ToM involves understanding that the individual and others have unique mental states such as thoughts, beliefs, and desires that determine behavior. Subsequently, it requires the understanding that people interact with the world based on how they perceive or believe it to be. Tasks designed to assess understanding of false beliefs in others have become a standard tool in the assessment of children’s ToM development (Nielson & Dissanayke, 2000). Due to the developmental and functional relationship between EF and ToM, it is important to consider the role of EF in measures of the ToM construct.

Many components of EF are relevant during a ToM task. For example, a false-belief task requires the individual to keep track of an event sequence, hold in mind a character’s false belief as well as one’s own knowledge of the truth, resist interference between these records, and
formulate a response based on the false belief rather than the individual’s own knowledge (Apperly, 2011). Research investigating which EF subskills are more essential to false-belief tasks indicate a correlation between conflict inhibition and false-belief tasks, even when factors of planning, working memory, and response delay are taken into account (Apperly, 2011; Carlson & Moses, 2001). During conflict inhibition tasks, the child is required to respond in a certain way in the face of a highly salient, conflicting prepotent response. To succeed at this task, the child must withhold a prepotent response and provide a novel response that is incompatible with the prepotent response (Carlson & Moses, 2001).

There are many reasons why leading researchers suspect that the development of inhibitory control and ToM are related. Studies have found that inhibitory control and advances in ToM occur during the preschool years (Carlson & Moses, 2011). Neuroimaging studies have shown that the frontal lobes are the core of both EF (e.g., Alvarez & Emory, 2006; Stuss & Alexander, 2000) and ToM ability (Baron-Cohen et al., 1994; Sabbagh & Taylor, 2000). Finally, individuals with severe ToM impairment, such as individuals with ASD, show marked impairment on EF tasks (Hughes, 1998; Ozinoff & McEvoy, 2004).

**The relationship between ToM and language development.** Theory of mind is also closely related to language, and developments in one seem to help the other. Theorists have argued both that language plays a crucial role in acquiring ToM (see Astington & Baird, 2005), and also that successful linguistic communication requires the ability to recognize differences between perspectives (e.g., Miller, 2006). Empirically, a number of studies have provided evidence linking language and ToM development, although most of them were conducted with English-speaking children and their families (e.g., Apperly, 2011; Astington & Jenkins, 1999; Hughes & Dunn, 1998; Miller, 2006; Ruffman, Slade, & Crowe, 2002).
Other researchers examined language as one of several factors contributing to acquisition of ToM. For example, joint attention, appreciation of intentionality, recognition that different people have different perspectives, pretend play, and the use of mental state words have all been found to be precursors of ToM development (Miller, 2006). One primary reason why language is important for ToM development is that mental states are unobservable (Miller, 2006). For example, one can learn the meaning of *jump* by observing the action or behavior that occurs when the word is said. Such associations cannot be made for a word such as *think*, because one cannot observe the action involved in thinking. Language, therefore, provides valuable information about the meaning of these unobservable mental state terms.

A number of longitudinal studies have indicated that individual differences in early language development explain later differences in ToM, and not vice versa (e.g., Astington & Jenkins, 1999; Hughes & Dunn, 1998; Ruffman et al., 2002). These studies have suggested that children’s ToM development is influenced by exposure to talk about mental-state terms (Apperly, 2011; Miller, 2006). In their influential study, Astington and Jenkins (1999) followed 3-year-old children, measuring ToM three times over a period of 7 months. Language was assessed by the Test of Early Language Development (Hresko, Reid, & Hammill, 1981), and ToM was measured by false-belief tasks and appearance-ready tasks. Astington and Jenkins found that earlier language abilities predicted later ToM performance, but early ToM did not predict later language performance.

Dunn and Brophy (2005) conducted a thorough examination of numerous studies on the relationship between children’s talk and conversations and the development of their ToM abilities. Dunn and Brophy found that the quantity of a child’s conversations and the number of mental states included in conversations are related to current and later ToM ability. Ruffman et al.
(2002) found that the amount of mothers’ talk about mental states and early language ability predicted children’s subsequent ToM performance. However, children’s earlier ToM did not predict mothers’ subsequent mental state talk. This suggests that mothers’ talk about mental states plays a causal role in their children’s ToM development (Ruffman et al., 2002). Further research in this area has provided evidence that children with siblings have advantaged ToM development (Miller, 2006). Miller hypothesized that the presence of siblings gives these children more opportunities for communication related to the thoughts and feelings of others. Language, therefore, seems essential for the acquisition of a ToM, but children also rely on their ToM to further their language skills, including narrative comprehension and semantic development (Miller, 2006; Sabbagh & Baldwin, 2001). Furthermore, both language and ToM play a role in children’s development of social skills.

Social Skills Development and Dysfunction

Social skills can be defined as “specific behaviors that result in positive social interactions,” and they encompass both verbal and nonverbal behaviors required for effective interpersonal communication (Rao, Beidel, & Murray, 2007, p. 353). Smiling, making eye contact, asking and responding to questions, and giving and acknowledging compliments during a social interaction are a few examples (Beidel, Turner, & Morris, 2000). Proficiency in social skills is vital to adaptive development and successful functioning in life. Several benefits of strong social skills have been demonstrated in the literature. For example, strong social skills predict fewer externalizing and internalizing problems, support resiliency in future crises and stressful life events, and are associated with seeking appropriate and safe avenues for aggression and frustration (NASP, 2002).
Children with poor social skills are at risk for social withdrawal, social isolation, and rejection. These negative outcomes can be precursors to many other problems such as aggressive and violent behavior or increased vulnerability to mental health problems (e.g., depression, loneliness, social anxiety), which can have an adverse effect on the child’s behavior and relationships in a school setting (NASP, 2002). Furthermore, children with poor social skills have been shown to experience difficulties in interpersonal relationships with parents, teachers, and peers (Barkley, 2006; NASP, 2002). These children tend to evoke highly negative responses from others, leading to high levels of peer rejection, which has been linked on several occasions with school violence (NASP, 2002). Children with poor social skills exhibit signs of depression, aggression, and anxiety; they also demonstrate poor academic performance and show higher incidences of involvement in the criminal justice system as adults.

**Theory of mind and social skills.** Theory of mind is a crucial cognitive development and plays a critical role in the ability to navigate the complexities of the social world. For this, among many reasons, a sizable body of research has emerged investigating the relationship between performance on ToM measures and other areas of competence, cognition, and behavior (Wellman et al., 2001). In particular, research on ToM and social skills has shown that mental state reasoning ability is related to social cognition development as well as well as to social development and social skills (e.g., Apperly, 2011; Bosacki, 2008; Sodian et al., 2003; Wellman, 2001).

Research has suggested that children become more efficient and flexible in their reasoning about others’ minds as they grow into adults (Apperly & Butterfill, 2009; Baron-Cohen, 1995; Hayward et. al., 2016). Efficiency of mental state reasoning has been argued to stem from automatization as a result of experience. It seems possible that well-practiced situations
employ highly automatic processing. Also, efficiency might improve in adults as a result of learned associations where past experiences inform future expectations. Therefore, it is possible that children become more competent in generating hypotheses to explain others’ behavior as they age.

Studies of individuals with impaired ToM show that impaired ToM is related to social skill deficit. For example, Yirmiya, Erel, Shaked, and Solomonica-Levi (1998) conducted three meta-analyses comparing ToM abilities among children with autism, intellectual disability (ID), and typically developing (TD) children. The authors included 24 independent studies in their comparison of children with autism and ID. Yirma et al. found a significant difference between groups, $d = .84$, indicating that children with autism performed worse on ToM measures than those with ID. In their comparison of children with autism and TD children, Yirmiya et al. included 22 independent studies. Results indicated a significant difference between groups, suggesting that children with autism perform less well than TD children on ToM measures.

Finally, 17 independent studies were included to investigate the relationship between children with ID and TD children. A significant difference between groups was found, however, none of the effect sizes in this analysis suggested that children with ID perform better than TD children on ToM tasks. Only five effect sizes were found demonstrating that children with ID perform worse than TD individuals. These results indicate that ToM impairment is more severe in children with autism than children with ID and suggest that the severity of ToM impairment is unique to autism (Yirmiya et al., 1998).

Theory-of-mind impairment has implications related to social skills and peer relationships. The claim is that children who are skilled at understanding the mental states of others’ will engage in effective social behaviors that result in effective social interactions and
positive peer relationships, and conversely, children who have difficulty with ToM will engage in less effective social behaviors resulting in poor peer relationships. The considerable research investigating this relationship has demonstrated the importance of ToM in social functioning.

In a recent meta-analysis, Slaughter, Imuta, Peterson, and Henry (2015) investigated the relation between ToM and peer popularity in young children. The authors included 20 studies in their examination including 2,096 children ranging in age from 2 years, 8 months to 10 years old. The data revealed a significant effect, indicating that children’s ToM ability is positively correlated with concurrent peer popularity.

In their first sub-analysis, Slaughter et al. (2015) found that children’s ToM was related to both sociometric and perceived popularity with comparable effects. This indicates that children with relatively sophisticated ToM are recognized by their peers and teachers as having a high social status and are well-liked by peers and teachers. The second sub analysis indicated that the positive association between ToM ability and peer popularity did not differ between preschool-aged (2-5 years old) and school-aged (6-10 years old) children. The data did, however, reveal a stronger association between ToM and peer popularity among girls than among boys. Sub-analyses also revealed that children’s ToM understanding were significantly associated with measures of positive and negative peer popularity (i.e., positive and negative peer regard). This is a crucial finding as it indicates that children who have a solidly developed ToM are well liked among their peers and that children with poorly developed ToM are disliked among their peers.

**ADHD and social skills impairment.** Because behavioral inhibition is the central problem underlying EFD in ADHD, skills necessary for proficient inhibition are impaired in a variety of ways. This deficit results in the broad range of dysfunctional behaviors seen in ADHD (Barkley, 2006; Wehmeier et al., 2010). The four functions dependent on inhibitory control
(working memory; internalization of speech; self-regulation of affect, motivation, and arousal; and reconstitution) serve to bring behavior under the control of internally represented information, allowing for self-directed actions toward goals and effective anticipation of the future. Deficient inhibitory control therefore impairs self-regulation of affect, social cognition, and related behavior. Deficient behavioral inhibition is manifested in a variety of ways, several of which impact social skills. Among children with ADHD, poor behavioral inhibition negatively affects the child’s social behavior, social cognition, and social interactions (Stormont, 2001).

As inhibitory deficits affect social behavior, meaning that children with ADHD tend to have poor peer relationships (in 50% to 70% of all cases) and higher rates of social rejection (Barkley, 2006). Researchers also found that these children are more aggressive with their peers; specifically, peers identify children with ADHD as starting fights and arguments more often than other children. The combination of hyperactivity and aggression has been associated with negative social outcomes (Stormont, 2001). Furthermore, Flicek (1992) found that children with ADHD have been rated as more disruptive, inattentive, defiant, and help-seeking and less able to exhibit self-control than their peers.

Emotional difficulties arise as consequences of the aforementioned impairments. These problems can result from the adverse effect that ADHD typically has on daily adaptive functioning and social, educational, and occupational success, among other domains. Demoralization, learned helplessness, low self-esteem, fear, anxiety, increased frustration, and other emotional problems appear in significant domains of major life activities (Wehmeier et al., 2010).

Given the multiple social problems associated with ADHD, it is clearly important to provide intervention as early as possible. Interventions targeting social skills in children with
ADHD have produced inconsistent results (Barkley, 2006; De Boo & Prins, 2007). This may be
due to several limitations: (a) the limited number of studies using sound methodology, (b) the
possibility that social skills training (SST) programs could actually foster antisocial behavior by
placing delinquent youth together, and (c) the impracticality of implementing intensive
interventions, leading to poor generalization and limited long-term effectiveness (Barkley, 2006).
Furthermore, the social problems experienced by children with ADHD are understood as more
than a lack of social skills. Rather, social skill challenges in this population are better understood
as associated with a variety of cognitive deficits, such as inhibitory control, emotional regulation,
and information processing (Matthys, Cuperus, & Van Engeland, 1999; De Boo & Prins, 2007).
Given the importance of social competence for positive long-term adjustment, continued
development of sensitive and systematic interventions to improve social skills for children with
ADHD should be a priority (Barkley, 2006; Stormont, 2001).

**Bridging ADHD, Theory of Mind, Executive Functioning, and Social Skills**

In spite of a hypothesized link between ToM and ADHD, few studies examined this
relationship, and those few have found contradicting results. At least three studies concluded that
poor executive control does not lead to deficits in higher-order ToM reasoning in children with
ADHD. Happé and Frith (1996) found no difference between children ages 6 to 12 with conduct
disorder (CD), which is often comorbid with ADHD, and typically developing children on
second-order false-belief tasks. Charman et al. (2001) confirmed this result, finding no difference
between ADHD children (ages 6 to 10) and typically developing children in advanced ToM
reasoning. The aforementioned authors measured ToM with Happé’s Strange Stories, a task
testing an understanding of nonliteral speech. Perner et al. (2002) found no impairment on four
advanced ToM tasks in children 4.5 to 6.5 years old who were at risk for ADHD. The tasks used
in this investigation were second-order belief tasks (Perner et al., 2002), distinguishing between a joke and a lie, understanding one’s own thought, and understanding consciousness. From these collective findings one may conclude that impaired EF does not result in impaired ToM.

The findings of co-occurring impaired EF and normal ToM raise the question of why children with ADHD have not been found to differ from typically developing children on advanced ToM tasks. One possible explanation involves methodological limitations in the studies described above. Perner et al. (2002) used a sample of children at risk for ADHD. These children may outgrow this risk, however, and therefore they are not an accurate sample of children with ADHD. Happé and Frith (1996) investigated ToM with a sample of children who had CD. Although this disorder is often comorbid with ADHD, results based on children with CD cannot be generalized to all children with ADHD. Furthermore, other studies have found poorer performance on ToM tasks for children with ADHD relative to typically developing control group members.

Buitelaar et al. (1999) were the first to find a significant deficit in ToM in a sample of children with ADHD. The authors tested the hypothesis that weak ToM and/or emotion recognition (ER) abilities are specific to children with autism. Differences in ToM and ER performance were examined among four groups: children with autism, pervasive developmental disorder-not otherwise specified (PDD-NOS), psychiatric control children (i.e., children with other disorders), and typically developing children. Among the psychiatric controls were nine children with a diagnosis of ADHD. Theory of mind and ER performance were measured with six different first-order ToM tasks, including two false-belief tasks. Second-order ToM was measured with four different second-order belief-attribution tasks developed by Perner and Wimmer (1985). The second-order tasks included belief items and six justification questions.
Results indicated that children with ADHD could not be differentiated from children with autism or PDD-NOS on the second-order belief-attribution tasks (Buitelaar et al., 1999). Unfortunately, there is no clear explanation as to why children with ADHD demonstrated weak ToM and ER in this study, especially with such a small sample.

The relation between ADHD and ToM was revisited by Sodian and Hulsken (2003), who investigated the role of EF in the acquisition of advanced ToM in a sample of children with ADHD and typically developing controls. Their study was based on an assumption about interactions between the conceptual content of ToM tasks and their inhibitory demands. The authors hypothesized that when the salient behavior tendency requires inhibition, mental state representation deficits may be caused by inhibitory control deficits. Thus, Sodian and Hulsken predicted that children with EF impairment will tend to neglect mental states of others in situations with high inhibitory demands. Their hypothesis was tested in children ages 6 to 9 with ADHD and typically developing controls, using tasks that were designed to differ in inhibitory demands. The first set of tasks administered to both groups—a second-order false-belief task and Happé’s Strange Stories—required a moderate to low degree of inhibitory control. An epistemic state attribution task was then administered to the groups. The epistemic state attribution task required participants to rate the certainty expressed in a story character’s responses based on mental state inferences of knowing, guessing, and inference versus direct perception. After each task, participants were asked an explanation question such as “Why did Bob say the chicken in here is green?” and a certainty question such as “How sure is Bob that the chicken is green? Can you show me with the arrow? Put it here [happy end of scale] if Bob is really, really sure; and put it here [middle] if Bob is a little bit sure.” (Sodian & Hulsken, 2003, p. 782). Certainty was measured using a visual rating scale depicting five faces ranging from sad to happy. The scale
ranged from zero (sad end) to 30 (happy end). This task was hypothesized to require a high degree of inhibitory control. Finally, measures of inhibition were administered to both groups in order to assess participants’ natural degree of inhibitory control.

Sodian and Hulsken (2003) found no significant effect of group on the second-order belief task and no significant difference between groups on Happé’s Strange Stories. On the inhibition tasks, children with ADHD performed significantly worse than the control group. Finally, children with ADHD attained significantly lower certainty rating scores than typically developing children on the epistemic state attribution task. The correlation of the epistemic state attribution task with the EF tasks points to the inhibitory demands of the certainty rating task. This finding supports the view that impairments in EF, specifically inhibition, have specific consequences for advanced ToM reasoning requiring a high degree of inhibitory control. Based on these results, it is possible that other investigations failed to distinguish children with ADHD from typically developing children on advanced ToM tasks because the tasks used may have differed with respect to inhibitory demands. Further investigation of this hypothesis is necessary to determine the relationship between the inhibitory demands of ToM tasks and task performance by children with ADHD, as well as whether these measures relate to children’s real-world social functioning.

Several limitations of traditional ToM measures have been identified (Hayward, 2011; Miller, 2009). Of particular relevance to the issue of measuring ToM in children with ADHD is the explicit nature of traditional ToM tasks. For example, in Happé’s (1994) Strange Stories (see sample in Figure 1) each vignette is accompanied by a picture, a comprehension question (e.g., “Was it true, what X said?”), and a justification question (e.g., “Why did X say that?”). The unambiguous presentation of these tasks does not resemble the way in which real-life social
dilemmas are presented (Hutchins, Bonazinga, Prelock, & Taylor, 2008). Klin (2000) elaborated on this shortcoming in his outline of the limitations of current ToM measures. He noted that “not only are social demands in naturalistic settings not explicitly formulated as a problem-solving situation, they need to be created and defined as a ‘social demand’ by the person” (p. 832). Thus, individuals who pass or perform well on such measures may be falsely credited with ToM competence, when in fact there is a continuum of competence that is revealed in daily social dysfunction.

This limitation is in line with the reasoning of Sodian and Hulsken (2005), who presented evidence supporting the superiority of the epistemic state attribution task over traditional ToM measures. They hypothesized that the epistemic state attribution task requires a high level of inhibitory demands because a mental state has to be inferred independently of a protagonist’s statement of fact. The authors indirectly implied that inference of mental states is the unique quality in their ToM measure that increases inhibitory demands. Therefore, a deeper look into inhibitory control and inference is necessary to accurately measure ToM competence in children with ADHD and other EF-impaired populations.

The ability to make mental state inferences has been identified as an important aspect of ToM and has been hypothesized in the literature to increase ToM inhibitory demands. In order to investigate the relationship between ToM and ADHD accurately, a measure that is sensitive to the nuanced variations in ToM and inhibitory control is necessary. The newly developed *Flexibility and Automaticity of Social Cognition* (FASC; Hayward, Homer & Sprung, 2016) provides a more nuanced measure of advanced ToM. Hayward et al. (2016) used the FASC to examine the development of ToM in middle childhood and adolescence. The FASC consists of eight cartoons that vary along two factors: language and social scripts. In the FASC, participants
are presented with the cartoon scenario, and are then asked to explain why the character does what he or she does in the story. After the participant gives a response, he or she is asked if they can think of another reason for the character’s action in the story. This continues until the participant can think of no more reasons. Measures in the FASC include scores that assess both flexibility and automaticity. These include Total Responses to FASC vignettes, Mental State Terms, and Mental State Justifications. Preliminary results provide theoretical and empirical support for the FASC, which presents a new, multifaceted measure of advanced ToM, capturing variation in response to language and social scripts.

Past ToM research has focused largely on young children (generally of preschool age) and has barely addressed children with ADHD. According to Barkley’s (2006) theory of EF, behavioral inhibition underlies all other EF abilities. Thus, inhibitory control weaknesses underlie both ToM and ADHD. An inhibitory deficit, as seen in individuals with ADHD, implies that the ToM of these individuals may also be impaired. This may point to inhibitory control and impaired ToM performance as the mechanism underlying social skills difficulties experienced by individuals with ADHD; in other words, a performance deficit rather than a skill deficit. The presence of an inhibitory control deficit in children with ADHD would thus warrant an investigation of the relationship between ToM and ADHD.

Additionally, research has identified that the ability to understand others’ mental states in social contexts enables children to understand multiple perspectives and to communicate with others (Bosacki, 2008). Theory of mind ability may be connected to children’s self-conceptions and their social interactions. The social interaction difficulties experienced by children with ADHD indicate the need for future research exploring the links between EFs and children’s understanding of others’ mental states. Findings in this area of research may provide valuable
ADHD AND THEORY OF MIND

insight into children’s cognitive and social experiences related to ToM, and they may add to our knowledge base within the larger frame of social cognitive research and cognitive neuroscience. Moreover, the findings may provide critical knowledge regarding social skills impairment and performance deficits in children with ADHD. This knowledge could then be used to improve the effectiveness of social skill interventions for children with ADHD.

Current Study

The present study investigated the theory that impaired ToM in children with ADHD is a disorder of performance, not a skill deficit. The current study built on data collected as part of a pilot study. Additional data were collected and additional analyses of the data were conducted to further investigate the relationship between ToM, ADHD, EF, and social skills. Specifically, the present dissertation examined the following research questions and hypotheses:

Q1: Do children with ADHD demonstrate ToM impairment compared to typically developing (TD) controls?

H1: Children with ADHD and TD controls will not differ in ToM based on dependent variables of FASC Total Responses, Mental State Terms, and Mental State Justifications.

Q2: Can social skills deficits in children with ADHD be attributed to a performance deficit?

H2: ToM performance will differ based on ADHD status for total FASC First Common Response (FASC-FCR Sum), a measure of typicality of initial mental state attributions.

Q3: What is the relationship between ToM performance and social skills ability?

H3: The number of FASC-FCRs will negatively correlate with social skills domains on the Conners 3rd Edition–Parent (C3-PRS) and the BASC-2-PRS.

Results may demonstrate that children with ADHD are able to engage in mental state reasoning, but fail to do so in extemporaneous situations. Therefore, support for the performance
deficit theory will be indicated by poor performance on ToM measures requiring inhibitory control (i.e., FASC First Common Response and Strange Stories). Support will also be indicated by typical performance on measures with low inhibitory control demands (e.g., number of FASC Total Responses [TR Sum], Mental State Justifications [MSJ Sum], nor Mental State Terms [MST Sum]).
Chapter 3: Method

The present study was conducted to examine the relationship between ToM, ADHD, EF, and social skills in school-age children. This investigation used the FASC, a more socially representative ToM measure than has been used in previous research. Specifically, I investigated the theory that ADHD is a disorder of performance, not skill. It was hypothesized that children with ADHD are able to engage in mental state reasoning, but fail to do so in extemporaneous situations. Therefore, support for the performance deficit theory would be indicated by poor performance on ToM measures requiring inhibitory control (i.e., the FASC and Strange Stories). Support for the hypothesis would also be indicated by typical performance on measures with low inhibitory control demands, including the number of FASC Total Responses (TR Sum), Mental State Justifications (MSJ Sum), or Mental State Terms (MST Sum).

Participants

Participants were children between the ages of 6 and 11 years old recruited from local community groups (e.g., local chapters of Children and Adults with Attention-Deficit/Hyperactivity Disorder, or CHADD) and from advertisements in the community (e.g., postings on community group and ADHD support group e-mail listservs). All participants were attending school in New York City, NY or Bergen County, NJ.

Whether or not a child met inclusion criteria for either the experimental or control group in the study was established through email or telephone pre-screening with a parent, administration of a background information form (completed by the parent), and two behavior rating scales: the Behavior Assessment System for Children—Second Edition parent report scale (BASC-2 PRS; Reynolds & Kamphaus, 2004) and the Conners Parent Rating Scale (C3-PRS; Conners, 2008). In addition to needing to be between the ages of 6 and 11 years, participants were required to be fluent English speakers with English as the primary language spoken.
Children with conduct disorder, oppositional defiant disorder, mood disorder, pervasive developmental disorders, and psychotic disorders (based on pre-screening and the background information form) were excluded from the study.

Participants were included in the ADHD group based on the following criteria: (a) diagnosis by a clinician as having a current diagnosis of ADHD at the time of referral (as indicated by the parent report); and (b) DSM-IV-TR diagnosis of ADHD, based on qualifying scores on the C3-PRS. Participants with ratings of two or three on at least six out of nine items from either the hyperactivity-impulsivity scale or the inattention scale were considered to have met the diagnostic criteria for ADHD and therefore met the criteria for inclusion in the ADHD group. Children taking stimulation medication for their ADHD symptoms were asked to refrain from medication on the day prior to and the day of testing.

Participants were included in the control group based on the following criteria: (a) no diagnosis by a clinician as having a current diagnosis of ADHD at the time of referral (as indicated on the parent report); (b) not meeting the DSM-IV-TR diagnostic criteria for ADHD, based on C3-PRS scores; and (c) no evidence of behavior or psychiatric disorders as determined by the BASC-2PRS.

Measures

Theory of Mind (ToM).

To assess children’s ToM, two measures were given: The Revised Strange Stories Task and the FASC.

Revised Strange Stories (Revised SS). The Revised SS measured participants’ ability to justify nonliteral speech in the context of social scenarios. Administration and scoring were similar to the procedures used by O’Hare, Bremner, Nash, Happé, and Pettigrew (2009). Twelve
of the original 24 Strange Stories mental-state vignettes developed by Happé (1994) were used to measure participants’ ability to gauge ToM. The 12 stories employed were selected to represent one of each story type: lie, white lie, misunderstanding, sarcasm, persuasion, contrary emotions, pretending, joke, figure of speech, double bluff, appearance/reality, and forgetting (O’Hare et al., 2009). The researcher read the stories to participants. Participants were first asked a comprehension question to confirm that the speech in the story was truly nonliteral (e.g., “Is it true what Emma says?”) and then asked to justify their answer (e.g., “Why does Emma say this?”). While justification questions can be answered in a variety of ways, they allow for mentalizing states to be used in the justification response. Thus, the scoring of interest was applied to the justification question responses. These responses were scored based on whether or not they reflected errors about facts in the story or a misinterpretation of the story events. Specifically, scores were allocated into categories based on O’Hare et al. (2009). In the present study, the categories were scored as follows: $0 = \text{incorrect}$, $0 = \text{physical state}$, $1 = \text{partial psychological state}$, $2 = \text{full psychological state and accurate answer}$ (based on Hayward et al., 2016). See Table 13 for sample justification question response scoring.

**FASC: Flexibility and Automaticity of Social Cognition (FASC).** The FASC is a new ToM measure designed to capture developmental trends in conventional narratives and ambiguous narratives. Hayward et al. (2016) examined two factors that might influence the efficiency of processing social stimuli: automaticity and language. Authors assessed automaticity in ToM reasoning by measuring the time it takes to generate hypotheses about mental-state information, while varying the presence of social-scripts and language in the scenarios presented.

The FASC consists of eight cartoons that vary along two factors: language and social scripts (see Appendix). Four vignettes have text (verbal) and four do not (nonverbal). Two of the
verbal vignettes are ambiguous (verbal-ambiguous; the intentions of the characters are not clear) and two vignettes are nonambiguous (verbal-nonambiguous; the intentions of the characters are clear). The same is the case for the four nonverbal vignettes (i.e., two are ambiguous and two are not). The FASC authors also introduced a novel scoring schema in order to investigate developmental changes in *automaticity* and *flexibility* in reasoning about mental states Hayward et al., 2013; Hayward et al., 2016).

Table 3

<table>
<thead>
<tr>
<th>Measure</th>
<th>Construct/purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental State Terms (MST)</td>
<td>This score was included to investigate broader trends in age-related increases in responses, as older children may use more physical and mental state responses overall. This score provided a point of comparison to help identify developmental trends that were unique to mental state reasoning (Hayward et al., 2016).</td>
</tr>
<tr>
<td>Mental State Justifications (MSJ)</td>
<td>This measure assessed flexibility of ToM reasoning by measuring the number of plausible hypotheses about mental states participants can generate in response to social scenarios that differ in ambiguity and (Hayward et al., 2016).</td>
</tr>
<tr>
<td>Total Responses (TR)</td>
<td>This score was a relevant measure used to calculate other FASC measure scores. For example, the total responses were used to calculate the ratio of mental state justifications (Hayward et al., 2013). This measure was also included as a measure of comparison between groups and other variables in the present study.</td>
</tr>
</tbody>
</table>

The FASC was under development when the data for the present study were collected. Therefore, the present FASC measures and related scoring were derived from Hayward et al. (2013). Although the following FASC measures are different from how these measures were used in the Hayward et al. (2016) study, these measures are in line with Hayward et al. (2013).
Hayward et al. (2013), ToM performance was measured on the FASC across three dimensions of flexibility: (a) Total Responses (TR), (b) Total Mental State Justifications (MSJ), and (c) Mental State Terms Used (MST). Table 3 presents a description of these FASC measures, their corresponding constructs, and purposes.

The FASC was designed to capture flexibility of mental state reasoning through prompting participants to generate multiple explanations of the motivations of the character’s behavior. Generating multiple solutions involves flexible, higher-level reasoning and therefore requires higher levels of cognitive processing and cognitive resources. When cognitive demands are high, the capacity for efficient cognitive reasoning diminishes. However, the FASC was not explicitly designed to capture the degree of active cognitive processing involved in mental state reasoning. As inhibitory deficits negatively affect social cognition, social behavior, and social interactions in children with ADHD, the involvement of cognitive demands in mental state reasoning is important to consider on the FASC (Barkley, 2006; Stormont, 2001).

One interpretation of cognitive demands and constructs measured in social stories and similar ToM tasks is that these tasks assess a child’s ability to use conventional social knowledge or social scripts in order to make inferences about behavior. However, these social scripts are highly rehearsed, and become increasingly routine with development (Hayward et al., 2016). It could be argued that two different processes are involved in these tasks: a) low-level reasoning that is efficient but inflexible (because it is practiced), and b) higher level reasoning that is flexible but inefficient (generating novel, lesser or unrehearsed reasoning). Therefore, these vignettes require children to consider highly practiced social scripts that may or may not involve active cognitive processing. The present study’s original measure sought to determine the involvement of active executive functioning in social reasoning.
As previously stated, EF is important to consider as it relates to ADHD, the FASC and overall social reasoning. In light of the inhibitory deficit theory of ADHD, inhibitory demands of the FASC are a valuable area of examination. When considering the conventionality of responses to FASC vignettes, it is possible that additional time to reason could alleviate cognitive demands and increase efficiency. Alternatively, it is possible that the cognitive demands involved in providing an initial response to a FASC vignette are high as it involves cognitive inhibition and supported EF. Such reasoning in children with inhibitory deficit might result in a faulty or unlikely interpretation of a social situation yielding an unconventional response. Furthermore, if a child’s initial interpretation of social situation is incorrect, the child’s behavioral response to the faulty interpretation can derail a social interaction. Therefore, the conventionality of the first response to FASC vignettes was investigated as an original measure in this study.

In line with both Hayward et al. (2013) and Hayward et al. (2016), vignettes were presented to participants one at a time. Participants were instructed to read the cartoon and to tell the researcher when they were done. The vignette was then removed from the participant’s sight by the researcher, who then asked the participant to describe why the characters behaved as they did. Prompts varied based on the vignette. The researcher prompted the participant for more responses by saying, “Can you think of another reason?” until the participant could no longer provide responses (Hayward et al., 2013).
Table 4

**Scoring of FASC measures**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental State Terms (MST)</td>
<td>Total number of internal state terms, related to thought, desire, or emotion, used across responses</td>
</tr>
<tr>
<td>Mental State Justifications (MSJ)</td>
<td>Total number of responses that involve mental states and are unique from one another (the same general justification that is reworded is only counted once.)</td>
</tr>
<tr>
<td>Total Responses (TR)</td>
<td>Total number of responses to prompts, regardless of whether they are unique from one another or involve mental states.</td>
</tr>
<tr>
<td>First Common Response Sum (FCR-Sum)</td>
<td>The sum of common first responses to each initial FASC vignette prompt.</td>
</tr>
</tbody>
</table>

*Note:* MST, MSJ, and TR measures and scoring were adapted from Hayward et al., 2013. Adapted with permission.

Table 4 summarizes FASC measures and scoring procedures used in the present study.

Each vignette was scored in the following manner. Total responses was determined by the total number of responses to prompts, regardless of whether they were distinct from one another or involved mental states. Total mental state justifications were determined by the total number of responses for each prompt that involved mental states and were distinct from one another. Total mental state terms was determined by the total number of internal state terms related to thought, desire, or emotion, used across responses (Hayward et al., 2016; Jenkins et al., 2003; LaBounty, Wellman, Olson, Lagatutta, & Liu, 2008; Lagattuta & Wellman, 2002). Each term was counted regardless of whether it was repeated in the response (Hayward et al., 2016). The commonality of responses was scored for each participant’s first response to each vignette prompt (FASC-CR).
Scores were then summed to provide a total FASC-CR (FASC-CR Sum). Participants received a score according to whether a common response was evident (0 = no common response evident, 1 = common response evident; Hayward et al., 2013). A sample of FASC vignettes, responses, and scoring is presented in Figures 3 and 4.

Table 5

Descriptive Statistics of FASC Flexibility by age group and cartoon type

<table>
<thead>
<tr>
<th>Measure</th>
<th>8 yrs</th>
<th>12 yrs</th>
<th>16 yrs</th>
<th>Verbal Scripted Cartoons</th>
<th>Verbal Ambiguous Cartoons</th>
<th>Nonverbal Scripted Cartoons</th>
<th>Nonverbal Ambiguous Cartoons</th>
</tr>
</thead>
<tbody>
<tr>
<td>(per cartoon)</td>
<td>M(SD)</td>
<td>M(SD)</td>
<td>M(SD)</td>
<td>M(SD)</td>
<td>M(SD)</td>
<td>M(SD)</td>
<td>M(SD)</td>
</tr>
<tr>
<td>Total Responses</td>
<td>1.53</td>
<td>1.85</td>
<td>2.15</td>
<td>1.85</td>
<td>1.88</td>
<td>1.82</td>
<td>1.81</td>
</tr>
<tr>
<td></td>
<td>(.56)</td>
<td>(.76)</td>
<td>(.92)</td>
<td>(.89)</td>
<td>(.97)</td>
<td>(.88)</td>
<td>(.86)</td>
</tr>
<tr>
<td>Mental State Justifications</td>
<td>1.06</td>
<td>1.31</td>
<td>1.61</td>
<td>1.61</td>
<td>1.18</td>
<td>1.31</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>(.37)</td>
<td>(.51)</td>
<td>(.67)</td>
<td>(.78)</td>
<td>(.76)</td>
<td>(.71)</td>
<td>(.69)</td>
</tr>
<tr>
<td>Mental State Terms</td>
<td>2.12</td>
<td>2.26</td>
<td>2.39</td>
<td>3.21</td>
<td>1.71</td>
<td>2.11</td>
<td>1.96</td>
</tr>
<tr>
<td></td>
<td>(.86)</td>
<td>(1.12)</td>
<td>(1.00)</td>
<td>(1.71)</td>
<td>(1.23)</td>
<td>(1.45)</td>
<td>(1.27)</td>
</tr>
</tbody>
</table>

Note. Adapted from Hayward et al. (2013).

Hayward et al. (2016) validated the FASC on a sample of 102 children (53 females) ages 7 years 8 months to 17 years 7 months. All participants were typically developing and proficient English speakers. There was excellent agreement between coders on total conventional response scores, ICC = .92. Results also demonstrated that the FASC captures developmental trends. Table 5 presents descriptive statistics of the Flexibility measures on the FASC from Hayward et al. (2013).
Regarding flexibility, there was a main effect for age group in the number of responses \((p = .012)\) and mental state explanations \((p = .001)\) produced. In terms of efficiency, main effects for age indicated that older participants spent less time generating responses \((p < .001)\) than younger participants. Across age groups, language and social scripts influenced the flexibility and efficiency of responses. Social scripts facilitated mental state explanations of behavior \((p < .001)\) and produced faster responses \((p = -.009)\) relative to ambiguous stimuli. Finally, scores of typical interpretations of a given social interaction were significantly correlated with performance on the Strange Stories \((r = .33, p = .001)\) and increased with age \((p < .001;\) Hayward et al., 2013).

**Behavior rating scales.**

**Conners 3rd Edition–Parent.** The Conners 3rd Edition–Parent (C3-PRS) is an assessment tool used to obtain a parent’s observations of his or her child’s behavior (Conners, 2008). The C3-PRS is designed to assess ADHD and related problems in children and adolescents ranging from 8 to 18 years old. The measure has three rating scale forms: self-report, parent report, and teacher report. The C3-PRS contains multiple scales to assess ADHD and related problems. These include six content scales (inattention, hyperactivity/impulsivity, learning problems, executive functioning, defiance aggression, and peer relations) and four DSM-IV-TR symptom scales: ADHD-PI type, ADHD-PHI type, ADHD-C type, Conduct Disorder, and Oppositional Defiant Disorder. Items are rated on a 4-point Likert-type scale \((0 =\) not at all, \(1 =\) just a little true, \(2 =\) pretty much true, \(3 =\) very much true) where higher scores indicate a greater number and/or frequency of concerns (Conners, 2008; Kao & Thomas, 2010). The C3-PRS content scales include items such as “Mood changes quickly and drastically” and “Has trouble keeping friends.” The C3-PRS DSM-IV-TR symptom scales contain items such as
“Interrupts others (for example, butts into conversations or games),” “Doesn’t pay attention to
details; makes careless mistakes,” and “Has difficulty waiting for his/her turn” (Conners, 2008,
pp. 361-363).

On the C3-PRS, raw scores are summed and converted into standardized $T$-scores ($M = 50; SD = 10$) for interpretation. Conners-3 $T$-scores greater than 70 are “very elevated” (many
more concerns than are typically reported); scores of 65 to 69 are “elevated” (more concerns than
are typically reported); scores of 60 to 64 are “high average” (slightly more concerns than are
typically reported); scores from 40 to 59 are “average” (typical levels of concern); and scores
below 40 are “low” (fewer concerns than are typically reported; Conners, 2008).

The C3-PRS has items representing each of the DSM-IV-TR symptoms for ADHD, CD,
and Oppositional Defiant Disorder (ODD). From these items, total DSM-IV-TR symptom counts
for each of the symptom scales are provided (Conners, 2008). The DSM-IV-TR diagnostic
criteria for ADHD require six or more symptoms of either (a) inattention or (b) hyperactivity-
impulsivity persisting for at least 6 months to a maladaptive degree and inconsistent with
developmental level (APA, 2000).

Overall, reliability and validity scores of the C3-PRS are high and meet appropriate
reliability and validity assessment criteria (Kao & Thomas, 2010). Convergent and divergent
validity data were compared and contrasted with scores from several rating scales, including the
BASC-2. Correlations indicate that the constructs converged and diverged in expected directions.
Analysis of correlations for six versions of the BASC-2 with ratings from the C3-PRS forms
show that, overall, correlations converged and diverged in a meaningful direction.

Of specific interest to this study are the correlations between the C3-PRS scales of
inattention, hyperactivity/impulsivity, learning problems, executive functioning, peer relations,
and family relations and the related BASC-2 PRS scales. The C3-PRS inattention scale was highly correlated with the BASC-2 PRS attention problems scale \( (r = .72, \ p < .01) \). The C3-PRS hyperactivity/impulsivity scale was highly correlated with the BASC-2 PRS hyperactivity scale \( (r = .77, \ p < .01) \). The C3-PRS executive-functioning scale was highly correlated with the BASC-2 executive functioning scale \( (r = .50, \ p < .01) \). Finally, the C3-PRS peer relations scale was moderately correlated with the BASC-2 PRS social skills scale \( (r = -.37, \ p < .01; \ Conners, 2008) \).

Correlations between the BASC-2 PRS scales and the Conners-3 DSM-IV-TR symptom scales were also strong. The Conners-3 ADHD inattentive symptom scale was highly correlated with the BASC-2 PRS attention-problems scale \( (r = .64, \ p < .01) \). The Conners-3 ADHD-HI symptom scale was highly correlated with the BASC-2 PRS hyperactivity scale \( (r = .79, \ p < .01) \). Additionally, the C3-PRS accurately discriminated between youth with ADHD and youth in the general population groups (Conners, 2008).

**Behavior Assessment System for Children—Second Edition, Parent Rating Scales (BASC-2 PRS).** The BASC-2 is a multimethod, multidimensional system used to evaluate clinical and adaptive aspects of behavior and personality. It was designed to aid in assessment and treatment for a range of DSM-IV-TR disorders.

The BASC-2 PRS items form nine clinical scales (aggression, anxiety, attention problems, atypicality, conduct problems, depression, hyperactivity, somatization, and withdrawal) and five adaptive scales (activities of daily living, adaptability, functional communication, leadership, and social skills). The nine clinical scales and five adaptive scales generate four composite scales: externalizing problems, internalizing problems, behavioral symptoms index, and adaptive skills (Reynolds & Kamphaus, 2004).
The parent report scale (PRS) is available for three age ranges: preschool (2-5 years), child (6-11 years), and adolescent (12-21 years). Parent report scale items are rated on a four-point frequency scale (0 = never, 1 = sometimes, 2 = often, 3 = almost always). Raw scores are summed and converted into standardized T-scores ($M = 50; SD = 10$) for interpretation. The BASC-2 PRS contains items such as, “is easily distracted,” “responds accurately when asked question,” and “shows interest in others’ ideas” (Reynolds & Kamphaus, 2004, pp. 99-102).

Overall, the BASC-2 PRS’s psychometric properties are considered strong (Volker et al., 2010). Measures of reliability and validity were solid and met appropriate assessment criteria (Reynolds & Kamphaus, 2004, pp. 163-196). Composite score internal consistency, test-retest reliability, and inter-rater reliability were high. For example, composite score reliability for children ages 6-11 ranged from .90 to .95 within the general norm sample and from .92 - .95 in ADHD norm group (Reynolds & Kamphaus, 2004, pp.164-165).

On all the BASC-2 scales, the average T-score range is 41 to 59. For the BASC-2 clinical scales, scores above 70 indicate clinically significant levels of maladaptive behavior or problems; scores of 60 to 69 are in the “at risk” range. At the other end of the scale, scores between 31 and 40 represent low levels and scores below 30 indicate extremely low levels of maladaptive behavior or problems. On the BASC-2 Adaptive scales, scores below 30 indicate clinically significant levels of maladaptive behavior or problems; scores of 31 to 40 are “at risk”; scores of 60 to 69 and 70 or above indicate high or extremely high levels of adaptive behavior, respectively.

**Executive Functioning (EF).** The Stroop task and the Digit Span subtest of the *Wechsler Intelligence Scale for Children—Fourth Edition* (WISC-IV) were chosen as measures of EF because they are well-established, laboratory-based neuropsychological tests that are sensitive to
variation in EF (Sergeant et al., 2002). Stroop tasks (Stroop, 1935) are useful for measuring inhibitory control (Bernal & Altman, 2009; Carter et al., 1997; Nigg, 2000; Vanderhasselt et al., 2009). For the current study, a computer adaptation of the Stroop task was used. This version of the Stroop task contains three conditions administered in a fixed order: neutral, congruent, and incongruent. The prompt for each condition is the same and reads as follows: “You will be shown a word and two colored boxes. **As Quickly As Possible** press the RIGHT ARROW or LEFT ARROW to indicate which **BOX** best indicates the **MEANING** of the word. When you are ready, press the RIGHT ARROW to continue.” In the neutral condition, participants are shown color words printed in black. Next, in the congruent condition, participants are shown color words printed in colors congruent with the meaning of the word (e.g., the word “blue” printed in blue). Finally, in the incongruent condition, participants are shown color words printed in colors incongruent with the meaning of the word (e.g., the word “blue” printed in yellow). Each condition consists of 24 word–color box prompts. Each prompt is shown individually, and color–word combinations are randomized.

The Digit Span (DS) subtest of the WISC-IV is a measure verbal working memory (Wechsler, 2003). It consists of two parts: Digit Span Forward (DSF) and Digit Span Backward (DSB). In DSF, the child is required to repeat numbers verbatim as stated by the examiner. In DSB, the child repeats numbers in the reverse order of that stated by the examiner (Flanagan & Kaufman, 2009). For both DSF and DSB, the child repeats increasingly longer strings of numbers. Numbers are read by the examiner at a rate of one number per second. Administration is discontinued when the child fails both items of a given digit string pair (Flanagan & Kaufman, 2009; Weschler, 2003). For each DS item, the child receives one point for a correct response and
zero points for an incorrect response (or no response). The DS raw score is calculated by summing the item scores for DSF and DSB (Flanagan & Kaufman, 2009).

**Procedure**

The study was approved by the City University of New York (CUNY) Institutional Review Board and conducted in compliance with approved procedures. The study took place at the CHILD Lab in the CUNY Graduate Center. The researcher tested participants individually. Prior to the beginning of the experiment, informed consent, parental permission, and child assent were obtained. The procedure was explained to each child and any questions asked by the participants and parents were addressed. Parents were then given the option to remain in the lab or wait in a lounge across the hall from the CHILD lab during administration. Parents who chose to remain in the lab were asked to sit quietly on the opposite side of the room (as far as possible from the child) with their body oriented away from the child. The experimenter, participant, and parents who chose to remain in the lab were present during administration of the tests.

Parents completed a brief demographic information form, the BASC-2 PRS, and the C3-PRS. Parents were asked to answer all questions to the best of their ability. To prevent interference with the child’s performance, parents were encouraged to refrain from asking non-urgent questions during task administration. The experimenter routinely checked in with parents to answer questions when the participant requested a break and again after all experimental tasks were completed.

Participants’ ToM was assessed with two measures: a revised version of Happé’s Strange Stories (Revised SS) and the FASC. Participants’ EF was measured across two areas: working memory and inhibition. To measure working memory, participants were given the Digit Span subtest of the Wechsler Intelligence Scale for Children—Fourth Edition (WISC-IV). Inhibition
was measured with the Stroop Color–Word Test. Because one objective of the study was to validate the FASC, it was administered first to all participants. A random number generator was used to determine the order of vignettes within the FASC as well as the administration order of the remaining tasks (i.e., Revised SS, Stroop, and Digit Span). All participants received travel compensation and a $20 gift card to Barnes & Noble for their participation.
Chapter 4: Results

Descriptive statistics are presented on the demographic and clinical characteristics of the sample population, and analyses were conducted to identify any differences between the ADHD and TD control groups. Analyses were then conducted to test the hypotheses and analyze the relationship among ADHD, ToM, EF, and related behavior. Finally, exploratory analyses were conducted to examine additional variables.

Descriptive Analyses

Table 6 shows participants’ demographic characteristics by group membership. In all, 32 children (15 male, 17 female) with ages between 6.25 and 11.5 years ($M = 8.99, SD = 1.54$) participated in this study with their mothers and/or fathers. Twelve children (7 male, 5 female) age 7 to 11.5 years ($M = 9.48, SD = 1.67$) were included in the ADHD group. Within this group, six children satisfied DSM-IV diagnostic criteria for ADHD Combined Type, five satisfied DSM-IV diagnostic criteria for ADHD Hyperactive-Impulsive Type, and one met criteria for ADHD Predominantly Inattentive Type. Sixteen children (5 male, 11 female) age 6.25 to 11.25 years ($M = 8.78, SD = 1.57$) were included in the control group. Table 7 includes the descriptive data by age and clinical characteristics. Across groups, the age of participants ranged from 6.25 years to 11.5 years. The range of scores by group as reported on the BASC-2 PRS and the C-3 PRS are presented in Table 7.
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<td>%</td>
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### Table 7

*Participants' Age and Clinical Characteristics*

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<td></td>
<td>Mean (SD)</td>
<td>Range</td>
<td>Mean (SD)</td>
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<tr>
<td>Age (months)</td>
<td>105.38 (18.88)</td>
<td>75.00 - 135.00</td>
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<td><strong>BASC-2 PRS</strong></td>
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<td>Social Skills T-score</td>
<td>54.56 (9.65)</td>
<td>41.00 - 69.00</td>
<td>37.17 (6.16)</td>
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<td>Functional Comm. T-score</td>
<td>53.81 (8.88)</td>
<td>33.00 - 66.00</td>
<td>40.36 (8.57)</td>
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<td><strong>C3-PRS</strong></td>
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<td>ADHD PI DSM-IV-TR Symptom Count</td>
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<td>ADHD PHI DSM-IV-TR Symptom Count</td>
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<td>7.42 (1.44)</td>
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<td>EF T-score</td>
<td>48.81 (10.32)</td>
<td>36.00 - 73.00</td>
<td>74.64 (10.30)</td>
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<td>Learning Problems T-score</td>
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<td>Peer Relations T-score</td>
<td>50.81 (9.57)</td>
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<td>71.08 (14.79)</td>
<td>53.00 - 90.00</td>
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*Note.* BASC-2 T-scores: $\leq 30$ = “clinically significant,” 31-40 = “at risk,” 41-59 = “average range,” 60-69 = “high levels of adaptive behavior,” $\geq 70$ = “extremely high levels of adaptive behavior.” DSM-IV-TR diagnostic criteria for ADHD require (a) six or more symptoms of inattention or (b) six or more symptoms of hyperactivity-impulsivity. Conners-3 T-scores: $\geq 70$ = “very elevated,” 65-69 = “elevated,” 60-64 = “high average,” 40-59 = “average,” $< 40$ = “low.”

A series of independent sample $t$-tests were conducted to identify any significant differences between groups on relevant demographic and clinical characteristics. Age did not
significantly differ between the TD Control group ($M = 105.37, SD = 18.88$) and the ADHD group ($M = 113.75, SD = 20.01$), $t(26) = -1.13, p < .05$. Participants in the TD Control group did have higher BASC-2 PRS Functional Communication $T$-scores ($M = 53.81, SD = 8.88$) than the ADHD group ($M = 40.36, SD = 8.57$), $t(3.92), p > .001$.

A chi-square test of independence was performed to examine the relation between gender and group membership. Although the gender ratio of the ADHD sample group in the present was not representative of the clinical population, significant gender differences were not indicated between groups, $X^2(1, N = 28) = 2.05, p > .05$. The relationship between participants’ number of siblings and group membership were also examined with a chi-square test of independence. There were no statistically significant differences based on number of siblings between groups, $X^2(3, N = 28) = 1.35, p > .05$.

Theory of Mind, Executive Functioning, and Behavior

A series of Pearson correlations were used to examine the relationships among key variables related to ToM, EF, and behavior. Correlations between age, EF, and ToM are shown in Table 8. Age was significantly correlated with Digit Span and Strange Stories Total, with no statistically significant correlations with the Stroop and FASC measures. There was a statistically significant correlation between the number of siblings and the Strange Stories Total score. There were no significant correlations between number of siblings and other measures of ToM on the FASC. A statistically significant correlation between Digit Span and Strange Stories Total score was observed. However, Digit Span did not significantly correlate with ToM Measures on the FASC. Furthermore, there was not a statistically significant correlation between the Stroop and all measures of ToM.
### Table 8

**Correlations between Age, Siblings, EF and ToM**

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<th>2</th>
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<td>7. FASC MSJ Sum</td>
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<td>8. FASC MST Sum</td>
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*Note. *p < .05; **p < .01.*

To examine the relationship between age and performance on the various cognitive tests across participants, Pearson correlations were conducted. Table 9 includes the results of these correlations. The analysis revealed a statistically significant correlation between Strange Stories Total and FASC-FCR Sum. Strange Stories Total was not significantly related to FASC TR Sum, FASC MSJ Sum, or FASC MST Sum.

Correlations between the FASC variables and related behavior as measured by the BASC-2 PRS and the C-3 PRS were examined. A Pearson correlation established that FASC-TR Sum was not significantly related to behavior nor the Strange Stories Total. The FASC- MSJ Sum was negatively correlated with C-3 PRS Peer Relations T-score and the BASC-2 PRS Behavioral Symptoms Index T-score. MST Sum was significantly negatively correlated with
both MST Sum and C-3 PRS Peer Relations T-score and BASC-2 PRS Behavioral Symptoms Index T-score.

The FASC FCR Sum was significantly correlated with many variables of behavior. A negative correlation was found between FASC FCR Sum and C-3 PRS Peer Relations T-score, BASC-2 PRS Behavioral Symptoms Index, and BASC-2 PRS Attention Problems T-score. Furthermore, FASC FCR Sum was significantly related to BASC-2 PRS Social Skills T-score, BASC-2 PRS Functional Communication T-score, and SS Total.
ADHD AND THEORY OF MIND

Table 9

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<td>-.07</td>
<td>-.30</td>
<td>-.18</td>
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<td>.22</td>
<td>.32</td>
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<td>11. MSJ Sum</td>
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<td>-.32</td>
<td>-.36</td>
<td>-.29</td>
<td>-.42*</td>
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<td>.81**</td>
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<td>13. FCR Sum</td>
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<td>.54**</td>
<td>.66**</td>
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</table>

**Note.** * p < .05; ** p < .01. BASC-2 T-scores: ≤ 30 = “clinically significant,” 31-40 = “at risk,” 41-59 = “average range,” 60-69 = “high levels of adaptive behavior,” ≥ 70 = “extremely high levels of adaptive behavior.” DSM-IV-TR diagnostic criteria for ADHD require (a) six or more symptoms of inattention or (b) six or more symptoms of hyperactivity-impulsivity. Conners-3 T-scores: ≥ 70 = “very elevated,” 65-69 = “elevated,” 60-64 = “high average,” 40-59 = “average,” < 40 = “low.”
ADHD and ToM Impairment

To test for ToM performance differences based on ADHD status (control group versus ADHD group), a series of ANCOVAs were conducted with ADHD status as the independent variable, age as a covariate, and the following dependent variables: FASC Total Responses sum (TR Sum), FASC Mental State Justifications sum (MSJ Sum), FASC Mental State Terms sum (MST Sum), and Revised SS justification question response score sum (SS Total). Age was used as a covariate because EF ability varies by age. The results of these ANCOVAs are presented in Table 10.

There was a statistically significant effect of ADHD status on the total number of mental state justifications provided on the FASC (MSJ Sum). Pairwise comparisons indicated that the average number of MSJs was significantly higher in the TD Control group ($M = 11.63, SE = 1.25$) than in the ADHD group ($M = 7.62, SE = 1.46$) with a mean difference of 4.02, $p < .05$.

Subsequent analyses revealed that ToM performance did not significantly differ based on ADHD status for the number of FASC Total Responses (TR Sum), Mental State Terms (MST Sum), Strange Stories (SS Total), and FASC First Common Response (FASC-FCR Sum).
Table 10

**ANCOVAs on Predictor Variables Controlling for Age**

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<td>MSJ Sum</td>
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<td>164.49</td>
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<td>3.39</td>
<td>2.88</td>
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*Note. *p* < .05.

Additional analyses were conducted to examine the relationship between ADHD total symptom count and FASC/ToM measures. To further test the hypothesis that children with ADHD would demonstrate impaired ToM when compared to controls as measured by the FASC, correlational analysis were used. A partial correlation controlling for age was conducted to examine the relationship among the total number of ADHD symptoms as measured by the C3-PRS and ToM scores as measured by the FASC and Strange Stories (Table 11). C3-PRS ADHD Total Symptom Count was significantly correlated with MSJ Sum and FASC-FCR Sum. These data indicate that as ADHD symptom counts increased, fewer mental state justifications were generated. Furthermore, as ADHD symptom counts increased, commonality of first responses to FASC vignettes decreased. C3-PRS ADHD Total Symptom Count was not significantly correlated with TR Sum, MST Sum, or SS Total.
Table 11

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<td>.317</td>
<td>.660**</td>
<td>.672**</td>
<td></td>
</tr>
<tr>
<td>6. SS Total</td>
<td>-.268</td>
<td>.134</td>
<td>.321</td>
<td>.184</td>
<td>.345</td>
</tr>
</tbody>
</table>

Note. * p < .05; ** p < .01.

Exploratory Analyses on ToM, Social Skills, and ADHD

Regression analyses were used to test if ToM performance as measured by the FASC-FCR Sum predicted parent ratings of participants’ social skills and related functioning (i.e., BASC-2 PRS Social Skills T-score, BASC-2 PRS Functional Communication T-score, and C3-PRS Peer Relations T-score). To test if ToM performance on the FASC-FCR predicted social skills functioning, a linear regression was used. The results of the regression indicated that the FASC-FCR accounted for 23% of the variance ($R^2 = .23$, $F(1,30) = 9.14$, $p < .01$). The analysis revealed that the FASC-FCR significantly predicted social skills functioning ($\beta = .48$, $p < .01$). FASC-FCR performance significantly predicted functional communication skills ($\beta = .48$, $p < .01$). Analyses indicated that the FASC-FCR accounted for 23% of the variance ($R^2 = .23$, $F(1,30) = 8.81$, $p < .01$). Finally, a linear regression revealed that performance on the FASC-
ADHD AND THEORY OF MIND

FCR did not significantly predict peer relations ($\beta = -.333, p > .05$). The FASC-FCR accounted for 11% of the variance ($R^2 = .11, F(1,30) = 3.73, p > .05$).

Additional regression analyses were conducted to further examine the relationship between ToM performance (FASC-FCR Sum) and ADHD symptoms as measured by BASC-2 PRS and C3-PRS sub-scales. A linear regression established that FASC-FCR performance significantly predicted BASC-2 PRS Attention Problems ($\beta = -.43, p < .01$) and accounted for 19% of the variance ($R^2 = .19, F(1,30) = 6.83, p < .05$). However, the FASC-FCR was not found to significantly predict hyperactivity on the BASC-2 PRS ($\beta = -.21, p < .05$). Results indicate that the FASC-FCR accounted for 4% of the variance ($R^2 = .04, F(1,30) = 1.33, p > .05$).

A series of simple linear regression analyses were conducted to examine the relationship between ADHD symptoms and ToM performance. Results established that Attention Problems on the BASC-2 PRS significantly predicted ToM performance on the FASC-FCR ($\beta = -.43, p < .05$). Attention problems accounted for 19% of the variance ($R^2 = .19, F(1,30) = 6.83, p < .05$). However, hyperactivity (as measured by the BASC-2 PRS) was not found to be predictive of FASC-FCR performance ($\beta = -.21, p > .05$). Hyperactivity accounted for 4% of the variance ($R^2 = .04, F(1,30) = 1.33, p > .05$).

To determine the influence of language on ToM performance, a simple linear regression was conducted. Results established that functional communication (measured by the BASC-2 PRS) significantly predicted ToM performance ($\beta = .48, p < .01$). Functional communication accounted for 23% of the variance ($R^2 = .23, F(1,29) = 8.82, p < .01$). A linear regression was also conducted to test for the influence of siblings on ToM as measured by the FASC-FCR. Results determined that siblings accounted for 1% of the variance ($R^2 = .01, F(1,29) = .24, p > .05$) and did not predict FASC-FCR performance ($\beta = -.09, p > .05$). Furthermore, an
ANOVA determined that the number of siblings did not vary significantly among groups, $F(2, 29) = .384, p = .684$.

Table 12

<table>
<thead>
<tr>
<th>Research Question Number</th>
<th>Research Question</th>
<th>Research Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>Do children with ADHD demonstrate ToM impairment compared to typically developing (TD) controls?</td>
<td>Significant differences were not found between groups on the number of FASC responses provided nor on the number of mental state terms used. A significant difference was found between groups on the number of mental state justifications. The ADHD group provided fewer explanations when mental state reasoning involved high-level, flexible reasoning about a character's intent.</td>
</tr>
<tr>
<td>Q2</td>
<td>Can social skills deficits in children with ADHD be attributed to a performance deficit?</td>
<td>Children with ADHD did not demonstrate social skills impairment compared to typically developing controls on the conventionality of initial responses to FASC vignettes.</td>
</tr>
<tr>
<td>Q3</td>
<td>What is the relationship between ToM performance and social skills ability?</td>
<td>Significant correlations were found between ToM performance and social functioning. The conventionality of first responses to FASC vignettes significantly correlated with functional communication and peer relations. The number of mental state terms used was significantly correlated to peer relations.</td>
</tr>
</tbody>
</table>
Chapter 5: Discussion

This discussion will focus on interpreting the findings of the present study and drawing related conclusions. The results will be interpreted as they relate to the research questions and hypotheses, and the exploratory analyses will be reviewed. Limitations of this study will be discussed, followed by implications and conclusions of the present study for theory and practice.

Summary of Findings

This study examined the relationship between ToM and ADHD in school-aged children, and investigated the theory of ADHD as a performance deficit. While discussing the results of this study, it is important to note that positive correlations with BASC-2 PRS variables in this analysis do not indicate improved FASC, clinical, or adaptive performance. As previously mentioned, elevated scores on the BASC-2 clinical scales indicate increased levels of impairment. Conversely, on the BASC-2 PRS adaptive scales, lower scores indicate lower levels of adaptive behavior (i.e., increased impairment).

ADHD and Theory of Mind Impairment

Q1: Do children with ADHD demonstrate ToM impairment compared to typically developing (TD) controls?

It was hypothesized that children with ADHD and typically developing controls would not differ in ToM based on dependent variables of FASC total responses, mental state terms, and mental state justifications. In partial support of Hypothesis 1, children with ADHD did not differ in performance from controls on FASC dimensions of total responses and total mental state terms. However, the results partially challenge Hypothesis 1 as children in the ADHD group demonstrated impairment relative to typically developing controls in the number of mental state justifications provided. That is, children with ADHD in this study provided fewer responses with
distinct mental states than their typically developing peers. This finding suggests that children with ADHD have difficulty with generating multiple solutions to a problem, a skill involving cognitive flexibility. ToM performance also did not differ between groups on a traditional ToM measure— the Strange Stories task. Furthermore, ToM performance did not differ on this study’s original measure— the FASC First Common Response (FASC-FCR Sum), a measure of typicality of initial mental state attributions.

These findings are consistent with previous research, which has found mixed results for whether or not children with ADHD have impaired ToM. For example, Charman et al. (2001) examined advanced ToM, EF, and social competence in boys with ADHD. Participants’ performance on an advanced ToM task, Happe’s Strange Stories, and two EF tasks were measured. Social competence was measured by the Vineland Adaptive Behavior Scales Survey Edition [VABS] and select subtests of the Wechsler Intelligence Scale for Children – Third Edition [WISC-III]. Charman et al. found no difference between ADHD and typically developing controls in advanced social understanding. However, children with ADHD scored more poorly on measures of inhibition. Furthermore, social competence ratings correlated with ToM and EF for the control group, but not for the ADHD group.

In another study, Sodian and Hulskesen (2005) investigated the developmental relationship between ToM and EF in children with ADHD. The results of this study indicated no difference between children with ADHD and typically developing controls in second-order false belief understanding and advanced social understanding (as measured by Happe’s Strange Stories). The researchers also found that children with ADHD were delayed, relative to controls, on advanced understanding of epistemic states. Children with ADHD were impaired on their advanced understanding of epistemic states; a task requiring real-time mental state representation when a
character’s mental states conflict with the character’s statements (a task high in inhibitory demand). These findings indicate that inhibitory control may be more important for online mind reading than for ToM reasoning in general.

The results of the present study are consistent with these outcomes and add to research suggesting that social skills challenges in children with ADHD are related to cognitive deficit rather than skill. The current findings suggest that for children with ADHD, social skills challenges are related, in part, to difficulties in cognitive flexibility and not from a fundamental deficit in conceptual understanding of mental states. These findings provide evidence of more precise social skill difficulties related to cognitive issues associated with ADHD. Specifically, inhibitory deficit lends itself to cognitive flexibility dysfunction, which impairs subsequent social skill functioning and development. Therefore, results of this study are in support of previous research indicating that ToM deficit in children with ADHD is not an “across the board” deficit. These results support the theory that ToM challenges occur for children with ADHD in specific instances involving high inhibitory demands, such as cognitive flexibility.

One advantage of the FASC is that it allows for assessment of different components of ToM, specifically flexibility and automaticity. Results from the current study indicated no group differences with regard to two of three dimensions measuring flexibility on the FASC: Children with ADHD did not differ in the amount of total responses, mental state terms, or conventionality of first responses. However, contrary to the hypothesis, children with ADHD did demonstrate impairment in generating multiple solutions to FASC vignettes. One possible explanation for these findings considers the nature of the FASC’s administration procedures. As previously described, the researcher prompted the participants for more responses to FASC vignettes until the participant could no longer provide replies. The participants were not under a
time constraint during this task and were permitted to take as much time as needed to reply. Therefore, when provided with additional prompts, participants were afforded additional time to think and reason about the vignette as well as organize speech prior to speech production.

With time to think and organize speech, children with ADHD resembled controls, however, additional time did not have the same impact on flexibility of social problem solving (i.e., mental state justifications). This finding is in support of the inhibitory deficit theory of ADHD, which asserts that inhibition serves as the primary cognitive deficit of ADHD (Barkley, 2006). The cognitive demands of the FASC are high, as the task requires the coordination of many executive functions (Hayward et al., 2016). It is possible that as a result of an inhibitory deficit, participants with ADHD had difficulty inhibiting higher-order cognitive processes required for the task. Specifically, inhibiting cognitive demands to support shifting thought and generating multiple solutions to a problem was necessary. This unexpected finding is valuable, indicating that cognitive flexibility is related to social skills deficits in children with ADHD. This outcome is in line with research demonstrating that children with ADHD experience challenges with cognitive flexibility and social problem solving (e.g., Sibley et al., 2010) and provides theoretical support for the inhibitory deficit theory of ADHD.

**ADHD and Social Skills Impairment**

Q2: *Can social skills deficits in children with ADHD be attributed to a performance deficit?*

It was hypothesized that ToM performance would differ based on ADHD status for total FASC First Common Response (FASC-FCR Sum), a measure of typicality of initial mental state attributions. However, analysis revealed that children with ADHD did not demonstrate impairment compared to typically developing controls on this measure. This finding is contrary to the hypothesis, and potentially challenges the performance deficit theory of ADHD.
Barkley (2006) argued that as a function of inhibitory deficit, ADHD can be conceptualized as a disorder of doing (performance), rather than knowing (skill). Children with ADHD speak less, are more dysfluent, and are less proficient when confronted with tasks requiring them to organize and generate speech in response to a specific task demand. If a disorder of knowledge exists, the ADHD group would have deficient social knowledge and would consequently be more likely to provide unconventional responses to FASC vignettes. However, the conventionality of initial responses did not differ between groups.

One possible explanation for this lack of group difference is that inhibitory demands on the FASC-FCR were not strong enough to impede performance of conventional social knowledge and ToM. Children with ADHD experience significant difficulty inhibiting prepotent responses (Barkley, 2006). While the task demand of responding to FASC vignette prompts requires organization and generation of speech, it lacks social pressure to respond quickly (unlike real-world situations). The lack of social pressure on higher-lever cognitive processes on the FASC-FCR might have alleviated cognitive demands, thus improving relative performance in participants with ADHD. It is therefore plausible that a performance deficit in participants with ADHD was present, but not evident on the FASC-FCR.

It should be noted that this study did not investigate variables related to response time and time constrains. In light of the present findings, it is suggested that future research using the FASC to investigate ToM in children with ADHD evaluate the impact of time constraints on ToM performance. It may be the case that no differences are found when there are no time constraints, but that children with ADHD take longer to generate initial responses to the FASC questions, and may give fewer typical initial first responses with time constraints. In real-life situations, even if children with ADHD are able to make the correct mental state attribution,
taking longer to do so could result in impaired social functioning. These questions should be addressed in future work. Such investigations would shed more light on the cognitive relationship between ADHD, ToM, and inhibitory deficit.

**ToM Performance and Social Skills**

**Q3: What is the relationship between ToM performance and social skills ability?**

It was hypothesized that the number of first common responses to FASC vignettes (FASC-FCRs) would correlate to social skills domains on the behavior rating scales. A core research question underlying this study investigated the relationship between ToM performance, inhibition, and social skills ability. In support of Hypothesis 3, the number of initial common responses significantly correlated with social skills domains on the C3-PRS and the BASC-2-PRS. Results indicated that as the conventionality of responses increased, participants reported better peer relations, social skills, and functional communication. Additionally, the commonality of initial responses to FASC vignettes was related to performance on a conventional measure of ToM, the revised Strange Stories (SS). Consistent with Hayward et al. (2016), as performance on the FASC was significantly correlated to performance on the Strange Stories suggesting that both are capturing similar aspects of advanced ToM.

The FASC-FCR is high in inhibitory demands as it requires inhibiting less-common or less-plausible explanations that may initially come to mind. When inhibitory demands of mental state reasoning were high (i.e., the first response to a FASC vignette), participants were more likely to report experiencing social dysfunction. Inhibitory deficit is thought to be the core deficit of ADHD, and, as previously discussed, it is plausible that in the current study inhibitory deficit in the ADHD group was masked on the FASC first common response measure. These results
suggest that inhibitory deficit is involved in ToM challenges experienced by children with ADHD and provide support for the performance deficit theory of the disorder.

Adaptive ToM ability is critical to successful social interactions, subsequent development, and overall well-being. Research on ToM and social skills has shown that ToM is related to development in social cognition (e.g., Apperly, 2011; Bosacki, 2008; Sodian et al., 2003; Wellman, 2001). Studies have also shown that children with ToM impairment have social skills challenges and are rated as less popular by their peers and teachers (Slaughter et al., 2015; Yirmiya et al., 1998). The development of ToM is also critical to language development, and subsequently, the development of social skills (Miller, 2006; Sabbagh & Baldwin, 2001). Given the importance of ToM in its contribution to adaptive development and functioning, understanding the specific nature of ToM deficits in children with ADHD facilitates the development of effective interventions and treatment. With improved treatment, outcomes for children with ADHD will improve.

**Relationship Between ToM Performance and ADHD**

The previous section discussed results of the present study indicating no significant differences between the ADHD group and the typically developing control group on four out of five measures of ToM ability. Although this lack of group difference could be due to study limitations, such as small sample size, it may also have to do with treating ADHD as a dichotomous variable. There has been debate as to whether or not ADHD can be conceived as a qualitatively distinct classification, or as existing on a continuum (Marcus & Barry, 2011; Sonuga-Barke, 2005). Many researchers have suggested the use of dimensional approaches to ADHD (e.g., Barkley, 2006; Nigg, 2005; Nikolas & Burt, 2010; Sonuga-Barke, 2005). Much support for a dimensional account of ADHD has emerged in the related research (e.g., Frazier,
Consequently, it is important to consider the dimensional approach when interpreting the results of the present study. Correlational analyses were therefore conducted in which ADHD was treated as a continuous variable by looking at symptom count.

The results of the correlation analyses, which looked at ADHD symptom count, revealed some significant relations. In the current study, as more ADHD symptoms were endorsed, participants were less likely to have provided mental state justifications and initial conventional responses. This finding makes sense when considering the cognitive skills required for responding to the prompts for these tasks (i.e., cognitive reasoning required to make inferences about a character’s behavior). As Barkley (2006) explained, inhibitory control supports the engagement of Executive functions. Interpreting the social story, holding it in mind, and organizing speech in response to a specific task demand all require Executive functioning. Therefore, it is logical that when ADHD symptoms increased (indicating degree of Executive function impairment), ToM performance on these two FASC measures declined. The finding that ADHD symptom count was not significantly correlated with total responses, mental state terms, or Strange Stories performance further supports this hypothesis. This indicates that ADHD symptom count is not related to the quantity of responses on the FASC, nor the quality of responses on the Strange Stories. Rather, ADHD symptom count is related to the quality of a response as measured by mental state justifications and conventionality of responses on the FASC.

Further correlational analyses revealed that conventionality of responses as measured by the FASC was significantly related to participants’ functional communication and peer relations as measured by the BASC-2 PRS. Increased impairment on the behavior rating scales was
associated with poorer performance on the original FASC first common response measure. The FASC first common response measure was also significantly related to attention problems, with attention problems increasing as the commonality of participant’s first responses decreased. These findings indicate that social scenarios requiring high inhibitory demands are related to poorer peer relations, functional communication, and attention.

Results also demonstrate that ToM, as measured by the number of mental state terms used on the FASC, is related to peer relations, as measured by the BASC-2 PRS. Even though mental state terms did not vary between the ADHD group and the control group, for both groups, participants’ peer relationships improved as more mental state terms were used during the ToM task. As previously discussed, research has indicated that EF is related to both ToM and social skills ability (e.g., Apperly, 2011; Barkley, 2006; Nigg, 2011). These correlational findings contribute to the current literature and are in line with research indicating that the development of these cognitive and social skills are related.

Additional exploratory analyses allowed for examination of the FASC’s ability to predict social skills capacity in the present sample. The results of this study support inhibitory deficit explanations for social skills deficits in children with ADHD. As Stormont (2001) explained, because deficient executive inhibition impacts social skills, for children with ADHD, poor executive inhibition negatively affects the child’s social behavior, social cognition, and social interactions. In the present study, this was seen in analyses of the typicality of initial responses to FASC vignettes. When inhibitory demands were high, participants were more likely to be rated as having social skills problems. This was seen when the first common response measure predicted performance on social skills domains of the behavior rating scales. Participants who provided fewer common initial responses were rated as being more impaired in the development
of social skills and functional communication. These findings add to the existing empirical research indicating that inhibitory deficit is an underlying mechanism of social skills problems in children with ADHD.

Research demonstrates that the impulsive behaviors displayed by children with ADHD impair social performance (Stormont, 2001). Guevremont (1990) identified the social performance deficits seen in children with ADHD. The most common deficits include inappropriate attempts to join in peer group activities, poor conversation skills (e.g. interrupting), employing aggressive solutions to social problems, and being prone to losing emotional control in response to frustration during social conflict. Impairments in “social performance” related to inhibitory weakness do not create a skill deficit per se. Many children with inhibitory deficits, such as those with ADHD, might fail to behave in accordance with known social rules (DuPaul & Stoner, 2004).

Kaufman (2010) reviewed research on EF and social learning, and found a consensus in that children with EF deficits lag behind their typically developing peers with regard to inhibiting their own automatic perceptions and social options in working memory. Children with EF weakness, such as children with ADHD, often fail to accurately interpret social cues and tend to respond impulsively with prepotent responses. These impulsive responses are often maladaptive and self-hindering. The present study found that high inhibitory demands were related to social skills problems. This result is of significant importance because it provides evidence linking ToM to social skills problems in children with ADHD.

Exploratory analyses also examined if ADHD symptoms predict ToM performance on the FASC. Clinical scales from the BASC-2 PRS were selected for this examination because the BASC-2-PRS captures a wide range of clinical and adaptive aspects of behavior. The C3-PRS,
however, is a more-narrow measure specific to capturing DSM-IV-TR ADHD symptomology. The BASC-2-PRS measures domains of functioning often impaired in children with ADHD. Many of these clinical domains are not measured on the C3-PRS (e.g., social skills and functional communication). Additional information about the adaptive functioning and performance of participants in the present study can be uncovered by examining scores derived from the BASC-2-PRS clinical scales.

Results indicated that BASC-2 PRS attention problems predicted ToM performance. Specifically, increased impairment in attention predicted declining ToM performance. These results are consistent with the hypothesized finding that ADHD symptom count was negatively correlated to ToM performance. However, these correlations contradict the results of analyses treating ADHD as a dichotomous variable from typically developing controls. This conflict, in addition to the finding that BASC-2 PRS Hyperactivity did not predict ToM performance on the FASC, further emphasizes problems with treating ADHD as a discrete rather than continuous condition. Finally, small sample size might also contribute to these inconsistent findings.

The literature on language development and ToM indicates that exposure to language at an early age is a predictor of later ToM ability (e.g., Astington & Jenkins, 1999). Language delays are often associated with ADHD (e.g., Purvis & Tannock, 1997; Zentall, 1985). Therefore, analyses were conducted to explore the role of language in the present study. Results indicated that participants’ ability to communicate effectively with others predicted ToM ability. It is unclear if this is a confound because ToM was also found to predict functional communication. However, the correlational analysis revealed a relationship between functional communication and ToM ability.
Literature on siblings has suggested that children with siblings show superior ToM development compared to children without siblings (Miller, 2006). This is hypothesized to be a result of increased exposure to mentalizing state terms through interactions with siblings (Miller, 2006). Therefore, the potential influence of siblings and increased exposure to mental state terms in early language development was also tested. Results found that although number of siblings did positively relate to performance on the Strange Stories task, number of siblings did not differ between groups. Therefore, any between groups difference in ToM performance cannot be accounted for by number of siblings.

Overall, the findings from the current study suggest that there are some significant differences in ToM between children with ADHD and typically developing controls. These differences do not appear to indicate a conceptual deficit associate with ADHD – there were no significant difference on 4 of the 5 FASC measures. Instead, it appears to be explained by a performance deficit: ADHD symptom count was negatively associated with producing common first responses in the FASC. Furthermore, this performance deficit is associate with negative social functioning (e.g., Peer relations as measured by the by the BASC-2 PRS).

**Limitations**

A number of limitations exist in the current study. First, it should be noted that the present data are based on a relatively small number of participants. Therefore, it is possible that children diagnosed with ADHD have ToM deficits compared to typically developing controls, but because of the small sample size in the current study, there is not enough power to detect these differences. Determining the precise nature of the various ToM deficits across children with ADHD requires future research involving additional participants.
Another limitation of this study is related to the pitfalls of treating ADHD by diagnostic categories. It is plausible that ToM deficits seen in children with ADHD are not present in all children with the disorder. Until more is understood about discrete profiles of ADHD and EF, research cannot yet be sure of how ADHD type relates to ToM performance. Future work should investigate the relationship between specified types of ADHD and related inhibitory deficit.

It should also be noted that EF measures of the Stroop and Digit Span did not correlate with ADHD symptomology. This could be due to several factors. It may be that those particular measures were not the best for identifying deficits in EF in the current sample of children. Additionally, the relatively small sample size may have contributed to the low correlation. Future research using the FASC to study ToM in children with ADHD could be expanded by including a comprehensive battery of cognitive assessments. An in-depth evaluation of inhibition and related EF can shed more light on the relationship between inhibitory deficit, ADHD, and ToM.

Homogeneity of the study’s participant population presents an additional limitation. Children and families of participants in this study were quite homogeneous on variables of race and socioeconomic status (SES). Therefore, the present sample might not provide a valid representation of the population of children studied. Future studies should continue to make an effort to include participants who are representative of the demographic diversity of the population.

The validity of the FASC presents a final limitation of the present research. The FASC is a new measure, which has not yet been thoroughly validated in the research. However, this is a problem with advanced measures of ToM in general, which tend to have low levels of internal consistency and do not capture developmental change in adolescence (Hayward & Homer, 2017). Hayward et al. (2016) have found that the FASC captures significant developmental change with
typically developing children and adolescents. The current study is the first to examine FASC within the ADHD population, and adds to the research of this new ToM measure. Further validation of the FASC in this population would benefit from including multiple raters when scoring the FASC. Furthermore, given the relatively small number of participants; the proposed implications are presented as a preliminary framework requiring further validation through future studies.

Implications and Future Research

The results of the present study have valuable theoretical and clinical implications. The outcomes can inform empirical research and clinical practices related to ADHD, ToM, social skills, executive functioning, and related interventions. The findings of this study should be used to improve future research and practice in light of its findings and limitations.

Results of this investigation provided support for the performance-deficit theory of ADHD and underlying EF deficit. These implications are especially evident when applying a continuous account of ADHD. Overall, participants’ increased ADHD symptomology, which implies increased EF impairment, was related to poorer social skills functioning across measures. Furthermore, participants with increased ADHD symptomology provided fewer socially conventional responses on the FASC-FCR, a task presumably requiring a higher degree of inhibitory control. The deficit of performance is evidenced when the participants responded in line with their typically developing peers on the other FASC measures; measures which afford time for cognitive processing to occur. That is, participants with higher degrees of ADHD symptomology had greater difficulty when called to perform on the first response, rather than when called to demonstrate skill by exhibiting adaptive knowledge of social convention. Additionally, ADHD symptom count was related to participants providing fewer distinct, viable
responses to FASC vignettes. This finding demonstrates EF deficit in cognitive flexibility. That is, as ADHD symptoms increased, participants had more difficulty generating multiple solutions to the problem.

The outcomes of this study provide further evidence that executive functioning is a key variable contributing to ToM and social skills ability. These findings support the performance deficit theory of ADHD and suggest a broad impact of EF on ToM functioning. Regardless of group, poorer performance on ToM tasks involving high inhibitory demands predicted poorer social skills. As discussed, deficient cognitive inhibitory skills may play a role in the observed social difficulties experienced in children with ADHD (de Boo & Prins, 2007). Therefore, inability to effectively solve social problems due to these cognitive limitations may impede optimal social functioning and emotional functioning.

The present study adds to the existing research supporting the critical role of executive functioning in social skills development. This study found that problems with attention predicted poor ToM performance on a high-inhibitory-demand ToM task (i.e., FASC-FCR). This finding is in line with the inhibitory-deficit theory of ADHD. According to Barkley’s core deficit theory of ADHD, inhibition is required to demonstrate attention. Consequently, it makes sense that increased attention problems correlate with inhibitory challenges on this ToM task.

This study also demonstrated that poor performance on the FASC-FCR predicted social skills and peer relations. These outcomes demonstrate that social skills development and consequential social relationships are related to inhibition and broader EF ability. The relationship between attention deficit and inhibitory challenges in this study predicted social skills challenges. This relationship suggests that social skills challenges in children with ADHD are primarily a result of poor executive performance rather than lack of social skills ability. To
further identify cognitive correlates between ADHD and social skills development, future research should include more robust social competency measures.

In light of the present findings, the performance deficit of ADHD, and specifically, the EF involved, can be applied to treatment programs for children diagnosed with the disorder. As previously discussed, social skills training programs (SSTs) for children with ADHD have not been largely effective. Future interventions incorporating recent research supporting the relationship between EF and social skills functioning would provide valuable benefits to the clinical and research fields. These interventions could build upon existing EF training programs.

Executive function training interventions for children with ADHD is a relatively new area of research and intervention, and requires ongoing study to determine effective programs. Overall, research testing the effectiveness of EF training programs for children with ADHD has produced promising results. Studies have demonstrated that interventions targeting EFs such as inhibition, cognitive flexibility, and working memory produced improvement of targeted EFs (e.g., Chacko et al., 2014; Dovis, Van der Oord, Wiers, & Prins, 2015; Kray, Karbach, Haenig, & Freitag, 2012; Yu, Li, Liu, An, & X. Liu, 2015). Future social skills interventions for children with ADHD should therefore consider linking EF training programs with social skills training programs. An interesting line of research would be to investigate the effectiveness of incorporating targeted EF interventions with effective SSTs. Such examination would provide significant contributions to the research and treatment of social skills impairment in children with ADHD.

Conclusion

This was the first study to investigate ADHD, social skills, and ToM using a more-nuanced socially representative measure of ToM, the FASC. It is also one of the few current
studies to directly investigate ToM in a population of children with ADHD. The findings of this study have demonstrated that when called to action in the moment, children with increased ADHD symptomology are more likely to have ToM challenges; specifically, they are more likely to have atypical initial interpretations of social situations. These ToM challenges result in negative, real-world consequences associated with poor social skills. Adequate social functioning is a primary factor contributing to a child’s optimal development and functioning (NASP, 2002). Children with poor social skills are at increased risk of experiencing adverse social, emotional, and academic outcomes. These impairments can have a debilitating effect on quality of life.

Currently, limited information exists about the cognitive processes involved in social incompetence in ADHD. This study sheds light on this important, yet under-researched area, and provides insight into the cognitive basis of ToM and social functioning in children with ADHD. Experts have asserted that future social interventions must contain approaches and methods based on theoretical and empirical evidence about ADHD (De Boo & Prins, 2007). Social skills interventions aimed at teaching inhibitory skills can help improve the social-emotional well-being of children with ADHD. The present findings in support of the performance-deficit theory have significant implications for social skills interventions and treatment of social skills challenges in children with ADHD. By providing greater insight into the relationship among ADHD, ToM, EF, and social skills, this study is an important step toward creating more effective social skills interventions for children with ADHD and EF impairment.
Appendices

6. Today, Katy wants to go on the swings in the playground. But to get to the playground she knows she has to pass old Mr. Jones’ house. Mr. Jones has a nasty fierce dog, and every time Katy walks past the house the dog jumps up at the gate and barks. It scares Katy awfully, and she hates walking past the house because of the nasty dog. But Katy does so want to play on the swings. Katy’s mother asks her, “Do you want to go out to the playground? Katy says, “No.”

Is it true, what Katy says?

YES  NO  Don’t Know

Why does she say she doesn’t want to go to the playground, when she so wants to go on the swings that are there? ___________________________________________

*Figure 1. Strange Stories.*
Table 13

*Strange Stories sample justification response scoring.*

<table>
<thead>
<tr>
<th>Category</th>
<th>Score</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incorrect</td>
<td>0</td>
<td>“He liked the hat.”</td>
</tr>
<tr>
<td>Physical State</td>
<td>0</td>
<td>“It looked horrible.”</td>
</tr>
<tr>
<td>Partial Psychological State</td>
<td>1</td>
<td>“He didn’t like the hat.”</td>
</tr>
<tr>
<td>Psychological State Full and Accurate</td>
<td>2</td>
<td>“He didn’t want to tell her he hated it.”</td>
</tr>
</tbody>
</table>
FASC Cartoon Types and Prompts

A. Verbal Unambiguous Cartoon

Based on: (Happe, 1994) Strange Stories Vignettes

Figure 3. Verbal Unambiguous Cartoon (Hayward et al., 2013).
B. Verbal Ambiguous Cartoon


*Figure 4. Verbal Ambiguous Cartoon (Hayward et al., 2013).*
C. Nonverbal Unambiguous Cartoon

Based on: *(Happe, 1994) Strange Stories Vignettes*

*Figure 5. Nonverbal Unambiguous Cartoon (Hayward et al., 2013).*
D. Nonverbal Ambiguous Cartoons

Based on: Bosacki (2000) Ambiguous Scenarios

*Figure 6. Nonverbal Ambiguous Cartoon (Hayward et al., 2013).*
Table 14

*Sample FASC responses and scoring*

<table>
<thead>
<tr>
<th>Story</th>
<th>Prompt</th>
<th>Response #</th>
<th>Verbatim Response</th>
<th>Total Responses</th>
<th>Number of Mental State Justifications</th>
<th>Number of Mental State Terms Used</th>
<th>Common Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Explain why Peter does what he does in this story</td>
<td>1</td>
<td>He doesn’t want to be rude to his aunt even though he doesn’t like the aunt—even though he doesn’t like the hat so he just says “oh yeah, I like it” even though he didn’t really like it</td>
<td>4</td>
<td>4</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Another reason … um, another reason is because like he knows that his aunt, that his aunt got the new hat and he wants to like, he doesn’t want to hurt her feelings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Hmm … um … he … he um … he … knows that, um, his aunt wouldn’t be like proud of him for being rude</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>Hmmm … he knows that it’s polite to … to be nice and say “yeah, I like it” even if you don’t</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note:* FASC transcription and scoring for a participant’s responses to vignette A. Words in bold within the “Verbatim Response” column represent mental state terms.
References


ADHD AND THEORY OF MIND


