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The Understanding of Teaching in Children with Autism Spectrum Disorder

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Abstract

Current interventions to improve the social, academic, and behavioral skills in children with Autism Spectrum Disorders (ASD) all require teaching activities. A central component of being able to engage in and benefit from teaching activities is the ability to recognize and understand when and how teaching occurs. The emergence of an understanding of teaching as a means by which we acquire knowledge from others is a key feature of socio-cognitive development. However, it is not known whether children with ASD develop the ability to understand the fundamental concept of teaching. Understanding what children with ASD know about the concept of teaching is important in order to optimize interventions that incorporate teaching as a method of learning.

This dissertation examines the understanding of teaching in children with ASD compared to typically developing children. Specifically, we investigate the two defining features of an understanding of teaching: 1) that teaching requires a knowledge difference between teacher and learner, and 2) that teaching is an intentional activity. We use a cross-sectional design to assess whether the understanding of these two components is intact or impaired in high functioning children with ASD compared to typical children individually matched on verbal ability. This study also investigates the interrelations among the understanding of teaching, theory of mind acquisition, and concurrent understanding of intention in others in this population.

Our results indicate that the understanding of the two core components that underlie the concept of teaching is impaired in high functioning children with ASD, compared to matched controls. The role that intention and theory of mind play in the understanding of teaching in high functioning children with ASD is also discussed. This work has broad implications for improving teaching and teaching-based interventions for children with ASD

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AUTISM SPECTRUM DISORDER

John Douglas Knutsen

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THE UNDERSTANDING OF TEACHING IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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ABSTRACT

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Douglas A. Frye

Current interventions to improve the social, academic, and behavioral skills in children with Autism Spectrum Disorders (ASD) all require teaching activities. A central component of being able to engage in and benefit from teaching activities is the ability to recognize and understand when and how teaching occurs. The emergence of an understanding of teaching as a means by which we acquire knowledge from others is a key feature of socio-cognitive development. However, it is not known whether children with ASD develop the ability to understand the fundamental concept of teaching. Understanding what children with ASD know about the concept of teaching is important in order to optimize interventions that incorporate teaching as a method of learning.

This dissertation examines the understanding of teaching in children with ASD compared to typically developing children. Specifically, we investigate the two defining features of an understanding of teaching: 1) that teaching requires a knowledge difference between teacher and learner, and 2) that teaching is an intentional activity. We use a cross-sectional design to assess whether the understanding of these two components is intact or impaired in high functioning children with ASD compared to typical children individually matched on verbal ability. This study also investigates the interrelations among the understanding of teaching, theory of mind acquisition, and concurrent understanding of intention in others in this population.

Our results indicate that the understanding of the two core components that underlie the concept of teaching is impaired in high functioning children with ASD, compared to matched controls. The role that intention and theory of mind play in the understanding of teaching in high functioning children with ASD is also discussed. This work has broad implications for improving teaching and teaching-based interventions for children with ASD.

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CHAPTER 1: Introduction

The Understanding of Teaching in Autism Spectrum Disorders

The core symptoms of autism spectrum disorders (ASD) include social and communication impairments, as well as restricted repertoires of behaviors and interests (American Psychiatric Association, 2000, *Diagnostic and Statistical Manual of Mental Disorders*). These impairments manifest in early childhood and can severely affect social integration and learning. Over the past two decades, a wide range of behavioral and developmental interventions have been designed and implemented to improve the various symptoms associated with ASD. Without appropriate intervention, the resulting deficits in social understanding, basic functional communication skills, and appropriate social behavior can limit the educational progress of children with ASD (National Research Council, 2001).

A wide array of ASD treatment approaches exist; however, psycho-educational interventions have been and continue to be the gold standard (Filipek, Steinberg-Epstein, & Book, 2006; Howlin, 2005). The majority of current comprehensive psycho-educational intervention programs for children with ASD are based on one of three models: the Treatment and Education of Autistic and Communication Handicapped Children (TEACCH) program, Applied Behavior Analysis (ABA), and The Denver Model. TEACCH provides a framework for teaching which emphasizes structure and targets characteristic traits of ASD (Schopler, 1997; Schopler & Reichler, 1971). A central component of TEACCH includes employing the restricted special interests of a child with ASD to engage them in learning (Mesibov & Shea, 2010). In comparison, ABA is designed to target specific impairments identified in an individual's diagnosis (Ferster & DeMyer, 1961; Lovaas & Simmons, 1969). The Denver Model is an expansion of ABA that integrates developmental, behavioral, and relationship-based interventions (Rogers et al., 2006; Rogers, Hall, Osaki, Reaven, & Herbison, 2001). Although there are differences between each model's primary philosophical orientation and relative emphasis on particular strategies, they all place primary importance on some form of systematic instruction or structural teaching (Callahan, Shukla-Mehta, Magee, & Wie, 2010).

These and other interventions use teaching methods to address different symptoms of ASD. However, whether children with ASD understand the teaching situation itself has not been studied. This raises many testable questions, including: Do children with ASD understand that teaching is an intentional activity? Do they recognize that the purpose of teaching is to impart knowledge to another? Can they recognize teaching as an identifiable activity that is qualitatively distinct from other observable behaviors such as imitation? Do specific core impairments of ASD impact a child's understanding of instruction? For example, do social cognitive deficits and delays in ASD play a role in autistic children's ability to recognize the activity of teaching? Answers to these questions about whether children with ASD understand teaching are important because they may affect ASD intervention outcomes and may shape the design of new interventions.

Theoretical claims have been made that link the understanding of teaching with theory of mind—the ability to predict and explain human behavior in terms of underlying mental states (Kruger & Tomasello, 1996; Olson & Bruner, 1996). To test these hypotheses, typically developing preschool-aged children have been evaluated for their understanding of teaching. For instance, preschoolers' theory of mind have been shown to be related to their understanding that the teaching process is an intentional activity (Ziv, Solomon, & Frye, 2008) and that it depends on a knowledge difference or 'gap' between teacher and learner (Astington & Pelletier, 1996; Ziv & Frye, 2004). Together, these studies suggest that, 1) teaching should be recognized as a general means by which we acquire knowledge and that 2) the understanding of teaching can be examined though theory of mind. Although mental state understanding in ASD is well studied, and is generally regarded to be impaired (Volkmar, Lord, Bailey, Schultz, & Klin, 2004), the understanding of teaching in this population has not been explored.

Given the social deficits and delays fundamental to ASD, and the developmental link between understanding teaching and theory of mind in typically developing children, we hypothesize that the understanding of teaching in high functioning children with ASD may be impaired compared to typically developing children. This study seeks to examine the understanding of teaching in children with ASD. Specifically, the goal of the proposed project is to evaluate whether high functioning children with ASD understand teaching as an activity designed to reduce the 'gap' in knowledge between teacher and learner, and that it is an activity that is performed intentionally. By investigating the understanding of teaching in high functioning children with ASD, we will be better prepared to design interventions with approaches to teaching that are tailored to the manner in which children with ASD acquire knowledge.

CHAPTER 2: Literature Review

Autism Spectrum Disorder

Autism spectrum disorders (ASDs) are a heterogeneous group of neurodevelopmental conditions, characterized by impairments in social skills, verbal and nonverbal communication, and restricted repetitive stereotyped patterns of behavior (American Psychiatric Association, 2000). The term 'ASDs' refers to a specific group of pervasive developmental disorders (PDD), listed here in order from least common to most common: Pervasive Developmental Disorder not otherwise specified (PDD-NOS), Asperger Syndrome (AS), and Autistic Disorder (AD). For the remainder of this dissertation, "Autistic Disorder", "AD", and "childhood autism" will be used interchangeably. At present these subtypes are differentiated by age and symptom onset, severity and comprehensiveness of symptoms, and association (or lack thereof) with language delay and intellectual disability (Lord, 2010). However, proposed changes to the nosology of having an ASD in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V) and the eleventh edition of the International Classification of Diseases (ICD-11) will impact current subtype classifications (Lord & Jones, 2012). The children examined in this study received a putative diagnosis of ASD according to DSM-IV-TR classifications. For this reason, it is important to understand the distinctions among the ASD subtypes that were used to diagnose children who participated in this project.

ASDs are found in all socioeconomic, ethnic, and age groups. However, males are almost five times more likely to have an ASD than females (NIH Autism Fact Sheet, 2012). Prevalence rates based on recent findings by the Autism and Developmental Disabilities Monitoring (ADDM) Network at the Centers for Disease Control and Prevention (CDC) indicate that ASDs affects approximately one in 88 children in the United States, and one in 54 boys (ADDM, 2012). The majority (62%) of children identified as having ASDs do not have intellectual disability (IQ $\leq$ 70; ADDM, 2012). Current estimates predict that the children diagnosed with autism this year will outnumber the children diagnosed with diabetes, AIDS, and cancer combined (Autism Speaks, 2013).

The etiology of ASDs is currently not known, nor does a cure or preventative measure exist. While there is growing evidence that autism is a neurodevelopmental disorder with a very strong genetic component (Yates, 2012), there is not yet a validated biomarker or biological test (Abrahams & Geschwind, 2008). ASDs cannot be detected or diagnosed by physiological testing. Therefore, behavioral observation and detection of autistic signs and symptoms is the only existing method of diagnosis. The diagnosis of an ASD can be made as early as 14 months (Kleinman et al., 2008). However, diagnoses typically occur between ages 3 and 5 because those made prior to age 3 are less reliable (Charman & Baird, 2002).

Criteria set in the DSM-IV-TR (American Psychiatric Association, 2000) and ICD-10 (World Health Organization, 1993) for a clinical diagnosis of ASD requires significant dysfunction in three domains: social interaction, communication, and presentation of restricted repetitive stereotyped behaviors. A diagnosis of ASD also requires onset in at least one domain and presentation of a minimum of six symptoms (within or across domains; e.g., failure to develop peer relationships appropriate to developmental level, lack of social or emotional reciprocity, or lack of social imitative play appropriate to developmental level) by age 3 years (American Psychiatric Association, 2000). There is a marked range of syndrome expression in ASD. The lowest functioning children are largely or entirely nonverbal, make few social overtures, and remain socially isolated. In contrast, higher functioning children engage in social interaction, but cannot initiate or sustain it in a typical manner. Individuals with AD on the end of syndrome expression with least dysfunction fall into the normal IQ range (≥ 80) and are referred to as having high-functioning autistic disorder (HFA). Current prevalence rates indicate that the majority (62%) of children identified as having ASDs do not have intellectual disability (IQ ≤ 70; ADDM, 2012). Therefore, over half of all children diagnosed with an ASD fall into the HFA category.

This dissertation focuses on HFA exclusively for the following reasons: 1) the high prevalence rates—HFA affects a majority of children diagnosed with ASD; 2) previous developmental literature deals almost exclusively in studies of children with HFA; and 3) the socio-cognitive measures used in this study have only been used to examine children who have normal verbal abilities (i.e., verbal IQ ≥ 80).

The children mentioned in the current study have been diagnosed with HFA and not AS. However, at the time of writing, there is in ongoing debate about whether there is a symptomatic difference between them, and whether they are simply quantitative manifestations of the same disorder (e.g., see Matson & Wilkins, 2008; but see also Sanders, 2009). There is no consensus as to whether these two syndromes represent different disorders or are variants of one condition. Asperger Syndrome (AS) like HFA also requires IQ within the normal range ($\geq$ 70) and is characterized by qualitative impairment in social interaction, communication, and restricted repetitive stereotyped behaviors. However, children with AS have no clinically significant delay in language, cognitive development, or in the development of age-appropriate self-help skills and adaptive behavior (other than social interaction) (Dawson et al., 2010). The diagnostic difference between AS and HFA is the absence of clinically significant delays in the three domains in AS. Another difference is that the average age of diagnosis for AS is not made until 6-11 (CDC, 2008; Schaefer & Mendelsohn, 2008). However, because HFA and AS share similar symptoms and both conditions employ the same treatment approaches, they are often referred to as the same diagnosis.

Unlike autism and AS, Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) does not have specific diagnostic criteria (however, see proposed changes to the classification of ASD in DSM-V and ICD-11; Lord & Jones, 2012). PDD-NOS is diagnosed when an individual fails to meet specific criteria for AD or another explicitly defined PDD (e.g., AS). Commonly referred to as "atypical Autism", PDD-NOS is similar to AD in that it also is characterized by mild to severe impairments in social interaction and communication, as well as specialized interests. However, these impairments may differ in severity or occur in a distinct pattern (American Psychiatric

Association, 2000). For example, age of onset for PDD-NOS may occur after age 3 and have fewer than six symptoms in total. In general, individuals with PDD-NOS have fewer autistic symptoms than individuals with AD or with AS, particularly in the domain of repetitive, stereotyped activities.

Impaired social interaction, found in essentially all children with an ASD, is the most common and fundamental feature of this spectrum of disorders. This core characteristic has been of particular interest in developmental research that examines social cognitive development in children with ASD.

Theory of Mind

Cognitive Models of ASD. Psychological description of core impairments in individuals with ASD plays a critical role in the search for factors involved in the etiology and pathogenesis of ASDs. Over the past two decades, various psychological models of autism have been developed in the effort to account for the observed early onset social deficits or delays (Volkmar et al., 2004). There are three prevailing cognitive theoretical models of autism: Theory of Mind (Baron-Cohen, 1995), Weak Central Coherence (Frith, 1989; Happé & Frith, 2006), and Executive Dysfunction (Hughes, Russell, & Robbins, 1994; Russell, 1997) (however, see also social motivation theory; Chevallier et al., 2012). These theories are based on the findings that individuals with ASD perform differently compared to matched groups of neurotypical (and, in certain cases, non-autistic atypical) individuals on specific psychological tasks. For example, theory of mind approaches are known to use false belief and intention understanding tasks (e.g., Baron-Cohen, Leslie & Frith, 1985, 1986), executive function approaches may employ a 'Wisconsin Card Sort' task (e.g., Ozonoff, Pennington, & Rogers, 1991), and weak central coherence approaches have utilized 'embedded figures' tasks (e.g., Happé & Frith, 2006). Of these three accounts of ASD, this study adopts a theory of mind approach because the aim of this study is to investigate the understanding of the concept of teaching in ASD. Measures used here and in the literature to explore the understanding of teaching are based on findings that show a relation between children's developing theory of mind and their understanding of teaching (e.g., Ziv & Frye, 2004). Therefore, we chose to use a theory of mind approach in this study of the novel population of ASD to compare our findings to the established literature on the topic of theory of mind in teaching.

For the studies presented in this dissertation, we focus on children with HFA who consistently demonstrate delays or deficits in mental state attribution tasks compared to typically developing (TD) children matched for verbal mental and chronological age (see Baron-Cohen, 2001 for a review). Mental state attribution, or 'theory of mind', refers to the ability to ascribe mental states to oneself and to others, and to appreciate that another person's mental state can be different from one's own. Therefore, having a 'theory of mind' means being able to: 1) infer others' mental states such as their beliefs, desires, knowledge, intentions, emotions, etc.; and 2) predict their behavior based on those inferences. Recognizing that actions result from beliefs, whether those beliefs are true or false, plays a significant role in how we evaluate the actions of others (e.g., Astington, 2001). TD adults readily employ this ability. Indeed, most social interaction relies upon it (e.g., Malle, 1999; Wellman, 1990). Having a 'theory of mind' is beneficial for social interactions because it allows one to understand the grounds for another's action. For example, understanding the reason why someone shows you how to do something (e.g., tie a shoe) depends upon recognizing that s/he thinks that you do not know how to do what is being performed (tying a shoe, a perceived knowledge difference), and therefore s/he is trying to teach this specific sequence of actions to you (how to tie a shoe, on purpose or 'intentionally'). In this case, recognizing a perceived knowledge difference and intention in others allows us to make sense of another person's action (teaching you how to tie a shoe).

False Belief. Theory of mind understanding undergoes significant changes in TD children across the preschool years (e.g., Astington, 1994; Moore & Dunham, 1996; Wellman, Cross, & Watson, 2001, or see Flavell, 2004 for a review). During preschool age, false belief understanding is considered by many to be the watershed in theory of mind development (Perner, 1991; Repacholi & Slaughter, 2003; Wellman, 1990). Understanding false belief means recognizing that a person's belief can be either true or false relative to the current state of affairs. A full understanding of this concept includes recognition of false belief in self and in others. A false belief can be betrayed by reality since beliefs are only a person’s representation of the actual state of affairs. We experience betrayal by the current state of affairs anytime our beliefs do not match to reality. Examples of this mismatch abound, such as when you wave at someone believing to know them, but then discover in reality that it is a stranger, at which point you likely blush and walk away in embarrassment of your mistake, in recognition of your own false belief.

Assessing children’s first-order false belief understanding (i.e., only inferring one other person’s mental state) has been traditionally measured with a variety of adaptations of two tasks: a change-of-location false belief task (Wimmer & Perner, 1983) and an unexpected contents false belief task—also known as a misleading container task (Hogrefe, Wimmer, & Perner, 1986; Perner, Leekam, & Wimmer, 1987). In the change-of-location task, an object is placed by an Agent in location *A* who then leaves the scene. While the Agent is absent, the object is moved to another location *B* unbeknownst to the Agent. The Agent then returns to collect the object. Two questions follow: a memory question is asked to ensure that the facts of the story are correctly understood, and then (if the memory question is answered accurately) the false belief question asks where the Agent will look to retrieve the object. The correct answer is location *A* (i.e., Agent’s false belief) whereas an incorrect answer is location *B* (current state of affairs).

In the unexpected contents false belief tasks, a child is shown a familiar container whose label indicates its original contents (e.g., M&M’s, Band-Aids, Crayola Crayons, etc.) and asked what s/he believes is inside. Then the container is opened to reveal that something other, and usually surprisingly different, than the labeled item is inside (e.g., toy animal, pencils, buttons, etc.). The container is then closed and the child is asked to report his/her original belief about the contents of the container as well as the belief of another absent individual who has seen the closed container for the first time. A correct answer is that the initial belief was whatever had been originally said by the child and absent individual (almost always it's the specific or generic name of the labeled item on the container, e.g., "chocolate", or "M&M's"). An incorrect response is that both child and the ignorant other always expected to find what actually had been discovered to be in the container (i.e., the surprising content(s)). For the remainder of this discussion, all false belief tasks will be considered 'first-order' false belief tasks unless stated otherwise.

TD children's success on these first-order false belief tasks undergoes a fundamental transition between 3 and 5 years of age. During this period, the probability of a child being able to pass a false belief task shifts from statistically below chance at about age 3 to statistically above chance from about age 4 onwards. This pattern of results has been replicated across numerous studies that varied considerably in task format. A meta-analysis of studies utilizing a variety of false-belief paradigms concluded that children do not reliably pass false-belief tasks until around the age of four (Wellman, Cross, & Watson, 2001). This consistent finding serves as reliable evidence that a major conceptual change in theory of mind occurs in TD children during the preschool years (Wellman, Cross, & Watson, 2001).

Performance on false belief tasks in children with ASD is notably different from TD children. Children with ASD are consistently observed to be significantly delayed compared to TD children in passing false belief tasks. In one of the first demonstrations of this delay, Baron-Cohen, Leslie, and Frith (1985) found that 80% of HFA children failed the false belief task, while control groups of either of TD preschoolers or children with Down's syndrome matched for verbal mental age (VMA) passed. This finding has been highly influential and, similar to the above pattern of findings for TD preschoolers, has been widely replicated across a range of studies using various task formats. In a meta-analysis of studies employing a variety of false belief paradigms, Happé (1995) concluded that HFA children on average do not reliably pass false-belief tasks until they have an estimated VMA of at least 11 years. Moreover, the meta-analysis indicated that HFA children perform significantly worse on false belief tasks than do children matched for verbal mental or chronological age (CA). To date, there have been no reported cases of a group of children with ASD whose mental age is equivalent to TD preschoolers that pass standard false belief tasks (Baron-Cohen, 2001; Lombardo & Baron-Cohen, 2010).

Steps in Theory of Mind Development. Although false belief may be an important milestone in theory of mind development, it is not the only cognitive process that determines whether one has a theory of mind. Theory of mind can be viewed as a progression of mental state understanding that develops well before age 4 and continues to develop well after. Infants, for instance, show signs of recognizing mental state activity by engaging in joint attention and using symbolic gestures to represent emotion concepts such as happy and sad (e.g., Vallotton, 2008). At about 2 years of age, children begin to participate in pretend play which may also be connected to theory of mind development downstream (e.g., Leslie, 1987; Sobel, 2004). Additional theory of mind developmental precursors include the employment of mental state terms such as “know”, “think”, and “remember” (Astington & Gopnik, 1991), and being able to distinguish such terms from non-mental state terms like “throw”, “eat”, and “run” (Baron-Cohen et al., 1994). Moreover, children at about age 3 are able to understand desires and simple emotions, predict action based on true beliefs, distinguish between real and mental experiences (e.g., petting a dog versus thinking about petting a dog) (Wellman & Estes, 1986), and distinguish between simple intended and unintended actions (e.g., jumping into a pool to get wet vs. falling into a pool when not wanting to get wet) (Joseph & Tager-Flusberg, 1999; Shultz, Wells, & Sarda, 1980).

To investigate the developmental progression of children’s understanding of mental states, Wellman and Liu (2004) created a theory of mind scale. They conducted a meta-analysis of theory of mind research that examined both precursors to, and post-false belief changes in, theory of mind development. Tasks were selected across different categories of mental states that have been shown to progress developmentally and were then only chosen provided that “the formats and demands were similar and parallel” (Wellman & Liu, 2004, p. 524). Seven tasks were tested on a theory of mind battery, based on mental state category type and the developmental complexity of the task-specific components. Confirmed through Rasch (1960) modeling and Guttman scaling procedures, the following five tasks were found to form a strict developmental scale: 1. diverse desires, 2. diverse beliefs, 3. knowledge access, 4. contents false belief, and 5. real-apparent emotion. Specific task descriptions can be found in Chapter 3: Methods; actual tasks can be found in Appendix B.

1. Diverse desires refers to one's ability to appreciate that other people's desires may differ from one's own (e.g., you want a glass of milk to drink, but I want a glass of orange juice). Children are thought to develop this understanding in the first few years of life (e.g., Rakoczy, Warneken, & Tomasello, 2007). For instance, research has shown that 18-month-olds are able to appreciate that people can have different desires toward different objects, even when the desire differs from the child's own preferences (Repacholi & Gopnik, 1997). Wellman (1991) maintains that as early as 24 months, children make sense of other's behavior by utilizing a "simple desire" psychology (as opposed to a belief-desire psychology) wherein they recognize that people have desires and that those desires may differ across people. However, children at this age have yet to apply this recognition and logic to beliefs (Wellman, 1991).

2. Belief understanding is thought to develop after desire understanding. Diverse beliefs refers to one's ability to recognize that other people's beliefs may differ from one's own. Unlike one's desires, though, one's beliefs can be false. The diverse belief task in Wellman and Liu's (2004) theory of mind scale examines the ability to recognize that people can have different beliefs and that these beliefs influence one's behavior.

However, it does not distinguish between true and false beliefs because the ability to appreciate true beliefs and the ability to appreciate false beliefs does not develop in unison. True beliefs are distinct from false beliefs in that they do not demand reconciling the difference between belief and reality when making sense of a belief or a belief-based behavior. Understanding a true versus a false belief requires recognizing that a belief corresponds with reality and that a person's behavior is, in part, a reflection of their corresponding belief about reality. In the Wellman and Liu (2004) scale, false belief is tested in stage number 4 (see below).

3. Between when children develop an understanding of diverse beliefs and an understanding of false beliefs, they typically develop the ability to appreciate the difference between knowledge and the absence of knowledge, or ignorance. Children younger than 3 years of age struggle to understand that others may lack knowledge about something, especially when they themselves have that particular knowledge (e.g., Robinson et al., 2006). Children are competent at identifying ignorance in others before they are competent at identifying the false belief in others that results from the other person's ignorance (Hogrefe et al., 1986). The knowledge access task in the Wellman and Liu (2004) scale assesses children's ability to recognize that perceptual access to an object or event is thought to be a necessary condition for knowledge concerning it—that is, the "seeing leads to knowing" principle (e.g., Pratt & Bryant, 1990). Specifically, the task investigates whether a child who has seen the contents of a box will recognize that a character who has not seen inside the box will not know its contents.

4. False belief understanding typically develops after understanding knowledge access (i.e., the causal relation between seeing and knowing). On average, children become competent on false belief tasks 0.5-1.5 years after the age at which children are competent on perceptual access understanding (e.g., Fabricius & Khalil, 2003; Hogrefe et al., 1986). The false belief task that Wellman and Liu (2004) utilize in the theory of mind scale is a contents false belief task, similar to the contents false belief example described above. The task explores children's ability to judge whether a character's belief about the mistaken contents of a readily identifiable container is false or a character's belief is in accord the current state of affairs (i.e., the actual contents of the container).

5. The scale's fifth and final item is the real-apparent emotions task. The task is designed to investigate children's ability to recognize that people's displays of emotions may not reflect their actual feelings (e.g., a person can smile but still feel sad) as a result of interpersonal constraints. During the preschool years, children are able to connect basic mental states to emotions, such as recognizing that getting what one wants elicits happiness and not getting what wants leads to sadness (e.g., Harter & Whitesell, 1989). At this age, children tend to understand emotions in behavioral terms and as a response to one's environment. However, it is not until they are slightly older that they begin to connect social rules to emotions and grasp that social and moral constraints influence emotions (e.g., Lagattuta, 2005). Emotional display rules are social norms that dictate the appropriateness of expressing an emotion in specific situations (e.g., smiling to hide disappointment when receiving a gift that fails to meet expectations) (Saarni, 1999). To a

certain degree, such display rules are particularly difficult for young children because they depend on recognizing that a single external event can be represented internally (i.e., mentally) in more than one way (Flavell, Miller & Miller, 2002). It is not until age 5 or 6 that children begin to grasp the corollary concepts of emotional display rules (producing mistaken beliefs in others about one's feelings) and social deception.

Universality of Theory of Mind Scale in TD Children. Collectively, these five components of theory of mind paint a much broader picture of theory of mind development than could any single type of task—such as a false belief type of task—suggesting that mental state understanding is embodied by a protracted and progressive set of conceptual acquisitions. The developmental order this scale represents has since been replicated among TD preschoolers not only in the United States (Woodburn, 2008) but also across a variety of cultures and in languages other than English (Hofer & Aschersleben, 2007; Peterson, Wellman, & Liu, 2005; Wang, 2010; Wellman & Liu, 2004; Wellman, et al., 2006). The fact that theory of mind seems to develop in the particular progression depicted by Wellman and Liu's (2004) scale across distinct cultures and in different languages highlights the potentially universal nature of this basic developmental sequence among TD children.

So far, we have seen that across the preschool years, children undergo sweeping changes in their theory of mind development. In contrast to TD children, HFA children exhibit profound impairments across a range of these socio-cognitive processes. HFA children have delays or deficiencies in aspects of theory of mind development and related factors that have not been mentioned here, such as deception (Baron-Cohen, 1992; Sodian & Frith, 1992; Yirmiya, Solomonica-Levi & Shulman, 1996), second-order false belief (Baron-Cohen,1989b; Happé 1993; Ozonoff et al., 1991), self–other differentiation (Lee, Hobson, & Chiat, 1994), face-processing and emotion recognition (Baron-Cohen et al, 2000), and imagination (Low, Goddard, & Mesler, 2009; Scott & Baron-Cohen,1996) to name but a few. An exhaustive review of cognitive impairments in ASD that may be associated with theory of mind development is beyond the scope of this dissertation. However, interested readers may refer to studies of HFA children's cognitive impairments in a review by d'Arc and Mottron (2012) or Happé and Ronald (2009), or social cognitive delays or deficiencies by Baron-Cohen (2001). We will now focus our attention on the theory of mind scale and precursors to mental state understanding in children with HFA.

Theory of Mind Scale in ASD. Children with ASD represent a group in which the theory of mind developmental pattern is not upheld. In one study, three groups of verbal ability matched Australian children (TD, deaf, and HFA) were given Wellman and Liu's (2004) five-item theory of mind scale (Peterson et al., 2005). Although the order of theory of mind acquisition for deaf children was the same, albeit delayed, as that observed in TD preschoolers, the sequence observed for HFA children was different. As has been found in previous research, the TD (and deaf) children found the last task (real-apparent emotion task) most difficult (i.e., they performed significantly worse on this task than they did on the other four tasks). However, the autistic sample found the penultimate task (false belief task) most difficult. Given this outcome, Peterson and colleagues (2005) also performed Rasch analyses to confirm that the reversal of the last two items on the battery formed a new scaled sequence of tasks for the HFA group. The HFA children in this study had a mean CA of 9.32 years (range: 6-14) and a mean VMA of 7.86 years, and were on average still failing a standard false belief task. This lends further support to the above empirical summary by Happé (1995) indicating that HFA are not generally successful on false belief tasks until they have reached a VMA of about 11-years-old.

In a recent follow-up study Peterson and colleagues presented to a group of TD, deaf, HFA, and AS children an augmented five-item scale that included a sixth, sarcasm task (Peterson, Wellman, & Slaughter, 2012). All four groups found the sarcasm task most difficult and the pattern of performance on the first five-items was replicated for the HFA group. Together with findings from the original study (Peterson et al., 2005), they concluded that children with ASD also conform to a scalable pattern of theory of mind development, but one that is different and delayed compared to typical preschoolers.

Developmental Precursors to Theory of Mind in ASD. Prior to the above false belief understanding impairments observed in elementary and middle school aged children, HFA children also exhibit delays and deficits compared to TD children in early emerging abilities that are considered to be developmental precursors to theory of mind.

One example of this delayed ability is joint attention (coordinating attention with another about an object or event). Theoretical claims have linked joint attention to later theory of mind development (e.g., Baron-Cohen, Tager-Flusberg, & Cohen, 1994; Carpenter et al., 1998; Hobson, 2002). Substantial evidence indicates that HFA children are impaired in both the production and comprehension of joint attention (e.g., Baron–Cohen, 1989a, 1993; Mundy et al., 1986, 1993, 2009). Impairments in joint attention are among the earliest signs of ASD, such that absence of or deficits in joint attention abilities are used in the diagnosis of ASD in young children (Osterling & Dawson, 1994). Studies have also observed that HFA children show impoverished spontaneous pretend play compared to matched control groups. However, difficulty with engaging in pretense is shown to decrease by providing substantial structure to the play situation (see Jarrold, 2003 for a review). Still, HFA children in general are found to have an impaired competence in their capacity for pretense (e.g., Bigham, 2010; Carter et al., 2005). Taken together, this evidence suggests that joint attention and symbolic play skills are deficient in the majority of young HFA children, and that these abilities may be important predictors of later socio-cognitive competencies.

Another impairment in the development of theory of mind related skills observed in HFA children is the ability to differentiate between mental and physical events. Young preschool-aged children appear to have a rudimentary understanding of the ontological distinction between mental and physical events. This has been demonstrated in their ability to distinguish between thinking about an object and physically interacting with it (e.g., Astington & Gopnik, 1991; Wellman & Estes, 1986). Studies show that 3-5-year-old children understand that mental phenomena such as dreams or 'pictures in your head' cannot be acted upon directly in the same way (e.g., touched) as physical objects such as a rock or even a photograph of a rock (e.g., Estes, Wellman, & Wooley, 1989). Children as young as 3 also appreciate that although perceptual input is necessary for knowledge formation, it is not necessary for mental images or representations (e.g., Wooley & Wellman, 1993). However, HFA children with an average mental age older than TD preschoolers' (6.9 yrs) are shown to be significantly impaired at making such judgments, suggesting that they have difficulty separating a mental phenomenon from its physical counterpart (e.g., Baron-Cohen, 1989a).

Another key component in theory of mind development is the ability to determine where knowledge comes from so that it becomes possible to determine who knows what, and especially, who does not know what. Young preschoolers seem to grasp the basic understanding that "seeing leads to knowing" given that they can correctly predict between two agents, one of whom looks into a box, and the other of whom merely touches a box, that only the agent who has seen what's inside box knows its contents (Pratt & Bryant, 1990). HFA children with an average VMA of 7, though, have been found to be just as likely to predict either agent when questioned about which of them knows the contents of the box (Baron-Cohen & Goodhart, 1994; Leslie & Frith, 1988).

While it is important that young preschoolers begin to show an appreciation for how perceptual access to information leads to knowledge in others, it is also important to understand the role that one’s own perceptual access to information plays in knowledge acquisition. TD children between 3 and 5 years of age develop the ability to distinguish reliably between what something looks like and what it really is (i.e., its appearance vs. reality). For example, when TD preschoolers from about age 4 onwards are presented with a sponge made to look like a rock, they tend to say that it looks like a rock but is really a sponge (Flavell, Green, & Flavell, 1986). But children with HFA presented with the same sorts of tests do not appear to appreciate the appearance-reality distinction. Rather, they tend to say that the object really is a rock, or really is a sponge. Their descriptions tend to refer to just one feature of the object (e.g., the sponge “looks like a sponge and really is a sponge”) and thus fail to capture the object’s dual identity (Baron-Cohen, 1989a).

We have seen that HFA children exhibit delays and deficits in theory of mind development. This progression also may come about in a pattern distinct from TD populations. These delays and differences in mental state understanding in themselves and others may have ramifications on their ability to understand the concept of teaching.

The Understanding of Teaching

Mental state understanding impairments in children with HFA may play a critical role in their understanding of teaching. Several theoretical arguments claim that the understanding of teaching is related to theory of mind (e.g., Astington & Pelletier, 1996, 2005; Kruger & Tomasello, 1996; Olson & Bruner, 1996; Tomasello, Kruger & Ratner, 1993). For example, Kruger and Tomasello (1996) define teaching in terms of its intention (to bring about learning), which suggests that the understanding of teaching is linked to theory of mind through the understanding of intention. Specifically, the implication is that the understanding of teaching relies on social cognition. Similarly, Ziv and Frye (2004) postulate that the ability to understand teaching as a means of knowledge acquisition or belief formation may largely be predicated by theory of mind. They define teaching as “an intentional activity designed to increase the knowledge (or understanding) of another, thereby reducing the knowledge difference between teacher and learner” (2004, p.458). Defined in this way, teaching, and more importantly, the understanding of teaching, is contingent on the understanding and ascription of mental states to oneself and to others.

To begin with, teaching cannot occur unless one is able to attribute knowledge differences between individuals (Olson & Bruner, 1996). You will only try to teach something if you believe that you know something that another person does not know or is mistaken about. Teaching involves determining whether the individual is ignorant (lack of knowledge), possesses incomplete knowledge, or has a false belief (Olson & Bruner, 1996; Ziv & Frye, 2004). Appreciating the level or accuracy of an individual’s knowledge allows one to estimate whether it is required to impart unknown knowledge to the individual, or to try to correct their mistaken belief. Finally, teaching requires recognizing that the activity is designed on purpose to change the knowledge difference between oneself and another individual. In other words, the act of teaching is an intentional endeavor performed in an attempt to bring about learning in a less knowledgeable other (Ziv & Frye, 2004; Ziv, et al., 2008). At its core, understanding the fundamental notion of teaching, as defined above, requires one to understand the two pillars on which it rests: 1) the ability to appreciate knowledge differences between people, and 2) being able to judge when an action is being performed intentionally (Ziv & Frye, 2004; Ziv et al., 2008).

The Understanding of Teaching in TD Children. Recent research has demonstrated a link between theory of mind and the understanding of teaching in typical development (e.g., Woodburn, 2008; Ziv & Frye, 2004; Ziv et al., 2008). To test the understanding of the first pillar of teaching, 1) understanding of the knowledge difference between teacher and learner, Ziv and Frye (2004) presented six teaching tasks to a group of 3-to 4-year-old, and a group of 5-to 6-year-old, Israeli preschoolers. The tasks examined whether the children could detect knowledge differences *per se*, whether their judgments about teaching were predicated by those knowledge differences instead of other aspects of the agents involved (e.g., personal attributes), and whether they appreciated the impact of false beliefs on the learner's and teacher's own knowledge. Specific task descriptions and actual tasks adapted for this study can be found in Chapter 3: Methods and Appendix A, respectively. They observed that while the 3- to 6-year-olds understood that a knowledge difference between two agents is necessary for teaching, only the 5- and 6-year-olds were able to appreciate that an agent's beliefs about that knowledge difference determines whether or not teaching takes place (Ziv & Frye, 2004). Additionally, changes in children's understanding of teaching were found to align with changes in their false belief understanding, which suggests that preschooler's theory of mind relates to their understanding of teaching.

In a related set of studies, Ziv and colleagues (2008) explored whether preschooler's judgments of intention factor into their understanding of teaching. Over the course of two experiments, they presented nine teaching-related stories that varied according to the "agent's intention and the outcome of the agent's act for another's learning" (2008, p. 1240). Specific task descriptions and actual tasks adapted for this study can be found in Chapter 3: Methods and Appendix A, respectively. The agent's action in each story represented either an intention to teach or not. Results indicated that 3- and 4-year-olds tended to judge whether or not teaching occurred based on outcome (e.g., when learning occurred, it must have been brought about by teaching/or the attempt to teach; when learning did not occur though, neither did teaching). However, 5-year-olds' recognition of intention allowed them to determine when teaching occurred regardless of whether or not it was successful. Results in both studies also showed that 3- and 5-year-olds' performance on a false belief task was related to their performance on the 'successful imitation' teaching task specifically. In the successful imitation story, the knowledgeable agent does not have the intention to teach, but learning still occurs in the ignorant other through successful imitation. Similar to the above findings (Ziv & Frye, 2004), changes in the preschooler's theory of mind again aligned with changes in their understanding of teaching. Specifically, false belief understanding is related to being able to differentiate non-intentional teaching (imitation) from intentional teaching.

Taken together, results from the above understanding of teaching studies suggest a conceptual link between theory of mind and the two conceptual pillars of teaching: being able to appreciate 1) awareness of the knowledge difference between teacher and learner, and 2) the attempt to change the knowledge difference process that is brought about on purpose (intentionally). The ability to appreciate these two components of teaching has been consistently reported in typical preschoolers. A battery of tasks used in both studies but adapted for a U.S. Head Start population have produced similar findings compared to the originals (Woodburn, 2008). However, to date, the understanding of teaching has not been investigated in children with ASD.

The Understanding of Teaching in HFA Children. Children's understanding of knowledge differences and knowledge acquisition depend heavily on theory of mind (e.g., Baldwin, 2000; Miller, 2000). Individuals with ASD exhibit fundamental impairments in social cognitive abilities that include understanding the absence of knowledge or ignorance in others (Perner et al., 1989), and understanding inaccurate knowledge or false belief in others (Baron-Cohen et al., 1985). In particular, HFA children on average have a VMA that is slightly more than twice that of TD children before reaching a similar probability of success on both types of false belief tasks

(Happé, 1995). Since understanding of the knowledge difference between teacher and learner is the first pillar in the development of an understanding of teaching, we predict that HFA children who struggle to understand the difference in knowledge states between two agents may be limited in their ability to see the reason for one to attempt to teach the other. In other words, HFA children may have impaired understanding of teaching in concert with their impaired theory of mind. Developing an understanding of teaching in typical children is linked with their theory of mind development. Therefore, HFA children may be impaired in their understanding of teaching compared to matched typical controls. This is a reasonable prediction because if false belief understanding is related to appreciating the existence of a knowledge difference between teacher and learner, then HFA children's general deficits and delays in the former might generate similar impairments in the latter. Alternatively, it is also possible that HFA children are able to recognize particular knowledge differences between teacher and learner despite their false belief impairments. Although there may be difficulty with recognizing inaccurate knowledge in others, there still could be an understanding of ignorance in another. This would allow one to identify slightly easier teaching tasks such as 'who should be taught', 'who can teach', and 'can a teacher be taught' (Ziv & Frye, 2004).

Our alternative prediction is that HFA children grasp the relation between knowledge and teaching when there is an explicit difference in knowledge states, but that they do not understand that an agent's appreciation of that knowledge difference is required for teaching. The expectation (null hypothesis) here is that HFA children *do* understand both ignorance and inaccurate knowledge in others in a teaching situation between two agents and are competent at reliably determining when teaching will occur based on the teacher's awareness of the knowledge difference between him/herself and learner. This would mean that age-matched HFA children recognize, as did the above 5- and 6-year-olds, that teaching is an activity designed to impart knowledge from one person to another.

The Understanding of Intention

Intention Understanding in TD Children. The second pillar in the development of an understanding of teaching is the ability to recognize intentional action. Similarly, understanding the relation of intention to behavior and mental states is an essential feature of theory of mind development (e.g., Feinfield et al., 1999). Children develop different interrelated components in understanding this relation early in life (e.g., Moses, 2001). A young child's understanding that actions can only be goal-directed indicates this early competence. For instance, infants and toddlers might not understand that an intended action can produce a desired result by accident. At this age, intention understanding would be based on the observable outcome or actions they may generate (e.g., Carpenter, Akhtar, & Tomasello, 1998; Scultz & Wells, 1995; however, *cf*. Olineck & Poulin-Dubois, 2005; Brandone & Wellman, 2009).

Children's developing understanding of intention is likely to be constrained by earlier developing mental states such as desires and beliefs (e.g., Moses, 1993, 2001). It also may be difficult to understand intentions until we develop an understanding of beliefs, because we do not intend to do things that we fail to believe we can do. Beliefs can be true or false whereas desires and intentions cannot; they can be fulfilled or unfulfilled (Searle, 1984). Consider, for example, my desire for a glass of milk. Wanting milk might motivate me to go into the kitchen to get it. However, whether or not my belief that there is milk in the refrigerator is in reality true or false plays no role in my seeking to get it. An understanding of intention that forms before we have developed an understanding of the true/false nature of beliefs would, as a result, be based primarily on outcome (i.e., on some component of the current state of affairs). Here, the outcome is whether I was able to have a glass of milk, not the accuracy of my belief about whether there was milk.

Different approaches have been used to investigate young children's developing understanding of the relation between intentions and the actions they generate. For example, Baird and Moses (2001) investigated preschooler's intentionality judgments about two characters who performed the same action (e.g., running) but had different motivating desires (e.g., to get somewhere fast vs. to get some exercise). Although task complexity was reduced across four experiments, 4-year-olds tended to impute the same intention to both characters' identical actions despite the fact that their desires clearly differed. However, 5-year-olds were successful at attributing different intentions to two characters performing the same action. These findings suggest that 4-year-olds struggle to appreciate that different intentions may be used to conduct an identical action.

A similar discrepancy between 4- and 5-year-olds' judgments of intention was observed by Schult (2002). Young children's ability to distinguish desires and intentions was explored by asking them to judge whether the outcome of a single character's action was performed on purpose. Tasks involved characters stating a desire and then forming an intention to carry out an action that will bring about their desire. Four possible outcomes were tested that combined a desire and an intention being either fulfilled or unfulfilled. Four-year-olds were highly successful at correctly identifying both the desire and intention on the two outcomes where the desire and intention matched (i.e., both fulfilled/both unfulfilled; e.g., wanting a snack, getting a snack, and then eating a snack). However, when the outcome resulted from a contrasted desire and intention (one fulfilled, the other unfulfilled; e.g., wanting a snack, getting a snack, but then having your dog come in and take your snack before you can eat it), 4-year-olds, unlike the 5-year-olds, were not able to judge correctly whether the action (of getting a snack) was intentional (Schult, 2002). The pattern of judgments that emerged from the study was that only when the outcome and both mental states matched did the 4-year-olds consistently judge correctly whether the action was performed on purpose. The findings suggest that it is not until about 5 years of age that children start to recognize that the intention of an action is not based on its outcome and that desired outcomes can be brought about by either intentional or non-intentional actions (Schult, 2002).

As mentioned in the *Understanding of Teaching in TD Children* section, developing an understanding of intention is central to a full understanding of teaching. If teaching is an activity that is performed on purpose, then being able to recognize when an intentional activity is being performed is essential to understanding teaching. For example, the Ziv et al. (2008) study found that 5.5-year-old's, but not 3.5-year-old's, appreciation of intention enabled them to distinguish teaching from learning in situations that did not involve teaching (e.g., imitation) and in situations in which it was ambiguous whether the intention was to teach (e.g., guided discovery). Therefore, children such as these that have not developed a full understanding of intention may be missing out on important opportunities to be taught.

Judgments of intention examined in Ziv et al.'s (2008) understanding of teaching tasks can be linked to judgments of intention observed in both Baird and Moses's (2001) and Schult's (2002) studies. For example, in an embedded teaching task, preschoolers were asked to judge the intent of the instructor's action (Ziv, et al., 2008). Children in this condition had to determine whether a given action is brought about by one of two intentions (e.g., play a game or teach). In a same action-different intention task, children were similarly required to make judgments about a given action being performed based on different intention (Baird & Moses, 2001). In both studies, 4-year-old's responses to the teaching and intention question, respectively, were at or below chance and significantly worse than the 5-year-olds. The 'successful imitation' teaching tasks (Ziv et al., 2008) involves a satisfied outcome (learning how to tie a knot) that is brought about by a non-intentional action of the teaching character. This task may be related to Schult's (2002) intention-unfulfilled/desire-satisfied task as it too involves a satisfied outcome brought about by an unintentional action.

Intention Understanding in HFA Children. Relatively little research has been conducted that examines the understanding of intention in HFA children. Moreover, the research that has been conducted in this area has produced discordant findings (e.g., Colombi, Liebal, Tomasello, Young, Warneken, & Rogers, 2009; Phillips et al., 1998; Russell & Hill, 2001; Williams & Happé, 2010; Zalla, Labruyére, Clemént, & Georgieff, 2010). It is therefore difficult to predict whether, or to what degree, HFA children understand that teaching is an intentional activity given that none of the above mentioned intention tasks (teaching or otherwise) have been presented to this population.

In one of the earliest studies that examined HFA children's judgments of intention, Phillips and colleagues (1998) tested the ability to distinguish between one's own intentional actions from unintentional ones in a target-shooting task. The HFA children were matched for verbal ability with a group of TD preschoolers as well as a group of non-ASD but developmentally delayed (DD) children and adolescents. Both comparison groups were significantly better than the HFA children at recognizing accidental outcomes. The game was designed to look at performance on a task when there was a discrepancy between the participant's desire and intention—that is, the child accidentally hit a target s/he did not aim at, but claimed after unintentionally hitting it that

that was what s/he originally aimed at. Under these conditions, the HFA children tended to report (mistakenly) that they intended to hit the target significantly more than either of the other two groups. The authors suggested that the results indicate that HFA children have difficulty separating their own intentions from desires (Phillips et al., 1998).

In a related set of studies, Russell and Hill (2001) sought to replicate and extend Phillips et al.'s (1998) findings by testing HFA children's judgments of their own intentions-in-action as well as testing judgments of others' intentions-in-action using the same target-shooting task. In contrast to Phillips et al., they found no differences between HFA children, and the DD and TD children matched on verbal ability on the either first- or third-person versions of the target-shooting task. In addition, they tested participants on a first- and third-person version of a 'Transparent Intentions task' which examines judgments of one's own and other's prior intentions on an incomplete drawing they are asked to complete (e.g., in the first-person version of the task, children were asked to fill an incomplete part of a drawing, however, by doing so they unknowingly had actually completed a different picture and are shown this after finishing the drawing of the picture they thought they were completing; see Russell et al., 2001 for details). On this task about half of the HFA participants recognized that they had unintentionally brought about the actual outcome, but there were no significant between-group differences on the third-person version (Russell & Hill, 2001).

Citing methodological confounds in Russell and Hill's (2001) drawing tasks, Williams and Happé (2010) presented HFA children, a DD comparison and TD control group matched on VMA with a revised version of the Transparent Intentions task. The revised task incorporated two sets of stimulus pictures that were markedly distinct from one another (e.g., teacup with a missing handle and a choir boy with a missing ear), as opposed to Russell and Hill's use of multiple sets of pictures that depicted two similar objects (e.g., drawing a face on a boy and drawing a face on a girl). Children were also given the traditional unexpected transfer and unexpected contents false belief tasks (Perner et al., 1989). In contrast to Russell and Hill's findings, Williams and Happé observed that the HFA children performed significantly worse than either comparison or control groups on both first- and third-person tasks. Performance on both false belief tasks was related to performance on both self and other intention tasks (Williams and Happé , 2010). Based on these results, and in conjunction with the confounding design of Russell and Hill (2001), Williams and Happé claimed that their results serve as evidence to support the idea that children with ASD are impaired in the understanding of first- and third-person judgments of intention in action.

Together these sets of findings that show HFA children have and have not performed worse than matched controls on tasks that examine judgments of intention-in-action in themselves and others. Note: conflicting results have also been found in a handful of studies that test judgments of non-verbal intention-in-action (see Aldridge et al., 2000; Carpenter, Pennington, & Rogers, 2001; Hornbeck, 2001; but also see Huang, Heyes, & Charman, 2002, 2006). However, these simple non-verbal motor acts are not reviewed here because the intentional teaching tasks that we will use are verbal story-comprehension tasks. These realistic verbal tasks most closely resemble the types of judgments of intention represented in teaching conditions. The types of intention judgments that this study will investigate are those that test the ability to distinguish between intention and desire in others, and those that test the understanding that a given action may be motivated by different intentions.

Research Questions and Goals

This review of the literature served to present the following to the reader: 1) an introduction to ASD; 2) the role of mental state understanding in ASD; and 3) an overview of the understanding of teaching and its relation to theory of mind and intention in the context of ASD. Given that socio-cognitive developmental differences define a core component of this set of neurodevelopmental disorders, the present project aims to examine whether HFA children are delayed or impaired in their understanding of the concept of teaching as compared to matched typical controls. This goal will be carried out by examining the understanding of teaching, theory of mind, and understanding of intention-in-action in others among a sample of HFA children and a sample of typical children individually matched on verbal ability. We will also investigate the interrelationships between HFA children's understanding of teaching, theory of mind, and intention-in-action in others. The proposed project has five questions upon which the research is based:

Research Question 1: *Is the understanding of teaching intact or impaired in high functioning children with autism spectrum disorder (ASD) as compared to matched typical controls?*

Interventions that target the social, academic, communicative, and behavioral skills of children with ASD (see Machalicek et al., 2008; Matson & LoVullo, 2008; and Rao, Beidel, & Murray, 2008 for reviews), all involve teaching activities. However, research has yet to explore the understanding of teaching in an autistic population. Without knowing how teaching is understood by children with ASD it remains difficult to make instructional decisions that are developmentally appropriate. For instance, if the concept of teaching is impaired in children with ASD, they may not perceive an instructional situation when it occurs and then may not be fully benefiting from the knowledge that the teaching situation tries to impart. Moreover, difficulty in recognizing that the awareness of a knowledge difference between two people is required for teaching to occur, may inhibit understanding that when teaching does occur it is done so to convey knowledge from one person to another. Consequently, a child may be missing out on the knowledge transfer that a teaching moment tries to bring about. Establishing HFA children's level of understanding of teaching is paramount to gain insight on how they make sense of the teaching process.

Young typically developing (TD) children's concept of teaching has been found to depend on their appreciation of the knowledge and intentional features of teaching (e.g., Woodburn, 2008; Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008). Ziv and Frye (2004) observed that although 3- to 6-year-olds understood that a knowledge difference between two agents is necessary for teaching, only 5- and 6-year-olds were able to appreciate that an agent's beliefs about that knowledge difference determines whether or not teaching takes place. A related study (Ziv et al., 2008) showed that 3- and 4-year-olds tended to judge whether or not teaching occurred based on outcome (e.g., when learning occurred, what was learned was brought about by teaching/or the attempt to teach; when learning did not occur, though, neither did teaching). However, 5-year-olds' recognition of intention allowed them to determine when teaching occurred regardless of whether or not it was successful. Taken together, the findings suggest that TD preschoolers' concept of teaching reflects their ability to attribute mental states to others.

The studies that examined the understanding of these aspects of teaching have included TD preschoolers in Israel (Ziv & Frye, 2004; Ziv et al., 2008) and a Head Start population in the US (Woodburn, 2008). However, studies exploring the understanding of teaching have not been extended to children with ASD. Considering the mental state attribution impairments observed in HFA children (e.g., Baron-Cohen, 1995) it is reasonable to suspect that they also may be impaired in their understanding of certain underlying mental state components of teaching. This study will use seven tasks that assess the understanding of the knowledge based and intentional elements of teaching in HFA children and matched typical controls (Ziv & Frye, 2004; Ziv et al., 2008). Children in the autism group will be individually matched with TD children in the comparison group on verbal mental ability using the Differential Ability Scales-II (DAS-II) (Elliot, 1990b; 2007). The understanding of the concept of teaching in children with autism is unknown; utilizing the teaching understanding tasks in this study will provide data on how this population conceptualizes teaching.

Research Question 2: *Is the understanding of teaching related concurrently to overall theory of mind, or specific mental state attribution understanding in high functioning children with ASD and matched controls?*

TD preschooler's understanding of teaching has been shown to relate to their ability to appreciate false beliefs in others (Woodburn, 2008; Ziv & Frye, 2004; Ziv et al., 2008). Children's success on tasks which test the understanding that an agent's beliefs about the knowledge difference between teacher and learner determines whether teaching takes place paralleled their success on traditional false belief tasks. Given the empirical evidence indicating impairments in children with ASD's ability to recognize false belief in others (e.g., Happé, 1995), it is important to verify whether this, or other related mental state attributions play a role in their understanding of teaching.

In this study a seven-item understanding of teaching battery (Woodburn, 2008; Ziv & Frye, 2004) and Wellman and Liu's (2004) theory of mind scale will be used to assess the level of teaching understanding and mental state attribution, respectively, in HFA children and TD matched controls. It may be the case that HFA children's ability to understand mental states in others is related to their overall understanding of the various conditions for teaching because those components of teaching (i.e., perceptual access, knowledge change, intention understanding) rely on mental state attributions. But it also may be that an understanding of particular components of teaching is related to an understanding of particular components of theory of mind, such as false belief. For example, the elements of teaching that entail recognition of knowledge (or ignorance) in another may specifically relate to false belief understanding. It is possible then that children with ASD impaired in attributing false belief to others would also be impaired in their understanding of the awareness of the knowledge difference process in teaching. Employing the understanding of teaching tasks and the Wellman and Liu (2004) theory of mind battery will allow us to examine whether performance in one is related to performance in the other in children with HFA.

Research Question 3: *How is the understanding of teaching related to understanding particular intentions-in-action in high functioning children with ASD and matched controls?*

Young TD children's understanding of the intentional component of teaching has been found to change across the preschool years. Ziv et al., (2008) observed that 3- and 4-year-olds tend to ascribe teaching based on outcome (i.e., whether or not learning occurred). However, 5-year-olds judged that the activity of teaching was intentionally brought about whenever there was a recognized attempt to teach, regardless of outcome (i.e., learning was successful or not). Studies that examine the ability to distinguish between intentions and desires (Schult, 2002), and between intentions and actions (Baird & Moses, 2001) also show what may be a similar change in preschool aged children's understanding of intentions. These studies observed a tendency in 3- and 4-year-olds to judge an action to be intentional based on either outcome (e.g., failure or success, Schult, 2002) or action (Baird & Moses, 2001), to 5-year-olds' judgments of intention that take into account both an agent's desire and goal.

Children with ASD have demonstrated impairments in the ability to attribute intentions to others compared to typical and developmentally delayed matched controls (Boria et al., 2009; D'Entremont & Yazbek, 2006; Williams & Happé, 2010; Zalla et al., 2010). A lack of awareness of other's intentions may impact the ability to grasp the intentional component in teaching. For example, it may be that teaching is assumed to take place whenever learning is the outcome despite whether an actual attempt to teach did, or did not (i.e., imitation), occur. Likewise, an impaired judgment of other's intentions may influence the ability to determine that an attempt to teach can occur despite whether or not learning is achieved (i.e., failed teaching).

This study seeks to examine in HFA children and TD controls, the understanding of other's intentions in action using judgment-of-intention tasks adapted from Schult (2002), and Baird and Moses (2001). Previous studies investigating intentional action understanding in children with ASD have focused on imitation (D'Entremont & Yazbek, 2006), intentional judgments of non-human objects (Castelli, 2006), awareness of one's own intentions (Phillips et al., 1998; Russell & Hill, 2001), and predicting the outcome in a series of a goal-directed actions (Zalla et al., 2010). However, research has not investigated the ability in HFA children to differentiate between desires and intentions in others, or to recognize that different intentions can be used to carry out a given action.

Tasks adapted from Schult (2002) involve a scenario in which a desired outcome occurred even though the intentional action failed, and one in which an intentional action was carried out, but because of another event, the desired outcome failed. Performance on the former task may relate to performance on a successful imitation teaching task given that both conditions involve a successful outcome that is brought about by either a failed intentional or a non-intentional act. Performance on the latter task may relate to performance on the failed teaching task because both conditions involve an unsatisfied desire despite performing the intended action. A task adapted from Baird and Moses (2001) involves two agents that have different desires for performing an identical action. Performance on this type of task may relate to performance on a teaching embedded in a game task because both stories involve carrying out an action for different reasons. Assessing knowledge of these judgments of intention understanding in HFA children may provide information regarding how they conceptualize the intentional components of teaching. In turn, HFA children's awareness of these features of intention may relate to their recognition of the intentional or knowledge based components of teaching.

Research Question 4: *Is the pattern of theory of mind attainment in high functioning children with ASD similar to the developmental pattern observed in high functioning children with ASD by Peterson, Wellman, and Liu (2005)?*

Although a wealth of replicated findings have demonstrated impaired mental state understanding in childhood autism (e.g., Frith, 2003; or see Tager-Flusberg, 2007, for a review), there remains a paucity of information about the basic progression of theory of mind development in HFA children. Theory of mind development has been observed in TD preschool-aged children to come about in a sequence. Wellman and Liu's (2004) battery of scaled theory of mind tasks has shown that TD 3- to 5-year-old's attainment of mental state understanding follows a systematic progression. The sequential order of the tasks is: diverse desires, diverse beliefs, knowledge access, false belief, and real-apparent emotion (see Chapter 2: Literature Review for a full description and Appendix B for an example of each task). The developmental order this scale represents has been shown to replicate among TD preschoolers across a variety of cultures and in languages other than English (e.g., Hofer & Aschersleben, 2007; Wellman, Fang, Liu, Zhu, & Liu, 2006; Peterson, Wellman, & Liu, 2005; Wellman & Liu, 2004).

Wellman and Liu's (2004) scale has also been used to investigate the progression of mental state understanding in atypical populations. A group of Australian HFA and deaf children have been presented with their five-item battery (Peterson et al., 2005) and augmented battery that included a sixth, sarcasm task (Peterson, Wellman, & Slaughter, 2012). Across both studies, although the order of theory of mind acquisition for deaf children was delayed, the sequence was the same as that observed in TD preschoolers. However, the sequence that emerged for the HFA group was different. Consistent with previous research, the deaf and TD groups both found the real-apparent emotion task most difficult, while the HFA sample found the false belief task most difficult (Peterson et al., 2005). In the follow-up study (Peterson et al., 2012), even though all three groups found the sarcasm task most difficult, the pattern for the first five-items was replicated. Based on these data, the authors claimed that "the unique genetic and neurobiological features associated with the autism disorder (e.g., Tager-Flusberg, 2003) might be contributing factors [that explain the alternative sequence]; for example, understanding FB [false belief] may constitute a representational ToM [theory of mind] achievement of special neurocognitive processing difficulty," (Peterson et al., 2012, p. 481).

The evidence indicating that HFA children's theory of mind development comes about in an order different from typical preschoolers is suggestive but not definitive. Because Peterson et al.'s two studies are the only reported cases that have used a theory of mind scale to examine the progression of mental state understanding in HFA children, it remains unknown whether these data replicate in different populations. Moreover, in both studies Peterson et al. (2005; 2012), the age range for both groups of children with ASD was dramatic (6-14, and 5-12, respectively) and had a mean age of 9.32 (2005) and 9.02 (2012). It remains unknown in a more restricted age range of younger children with ASD whether the progression observed in both studies would hold. Since no supporting research can confirm/disconfirm Peterson et al.'s (2005, 2012) findings—that unlike the typical and late signing deaf children, the false belief task was more difficult for the HFA children than the real/apparent emotion task—additional data, regardless of outcome will provide evidence about the sequence of mental state attainment in HFA children. Knowledge about the developmental order of mental state understanding in HFA children might then be expanded to research that examines the interplay between theory of mind and other potentially related factors (e.g., executive function, visual perception, peer and non-peer relation, etc.).

Research Question 5: *Is the understanding of the distinction between desires and intentions, or actions and intentions, intact or impaired in high functioning children with autism spectrum disorder (ASD) as compared to matched controls?*

TD children at about age 5 begin to show competence on tasks that contrast desires and intentions in others (Schult, 2002). Schult (2002) investigated TD children's understanding of other's intentions in action by separating the satisfaction of one's desire from the fulfillment of their desire-driven intention. While 4- and 5-year-olds were able to separate and identify desires from intentions, only the 5-year-olds were above chance when it came to correctly determining when an agent's intention was fulfilled. This suggests that the understanding that an intention can be satisfied only by carrying out the intended act begins to manifest at around age 5. Children at this age also begin to demonstrate an understanding that intentions and actions are not isomorphic (i.e., actions and intentions stand in a "many-to-many" relation to one another (Baird & Moses, 2001;

Baldwin & Baird, 1999; Searle, 1984)). Baird and Moses (2001) found that TD children younger than about 5 years of age were not above chance on tasks that have two identical actions that are brought about by different intentions. Based on the results, the authors suggested that "children's early concept of intention is intimately tied to action" (p. 441). Taken together, these studies show that TD children younger than age 5 struggle separating fulfilling an intention from satisfying a desire, and understanding that intentions are distinct from the actions the bring about.

We know that HFA children have been shown to be impaired in the understanding of intentions compared to matched controls (e.g., Williams & Happé, 2010). However, we do not know whether the ability to distinguish between desires and intentions, or actions and intentions in others is intact or impaired in this population. The seven intention tasks this study will use, borrowed from Schult (2002) and Baird and Moses (2001), are designed to test the understanding of intentional actions in others. It is possible that developing an understanding of other's intentions in actions in HFA children is similar to what has been observed in TD children—that initially, actions and intentions are conceptually intertwined. But, given the different theory of mind developmental pattern Peterson et al., (2005; 2012) found, it remains possible that HFA children's understanding of this particular mental state is also distinct from typical children. In either case, looking at whether HFA children's ability to distinguish desires from intentions in others is intact or impaired as compared to matched typical controls, will provide important evidence about how this population interprets other people's actions. For example, knowledge gained from HFA children's developing awareness of the action-intention relation may help to further our understanding in the development of their social competence and moral understanding.

CHAPTER 3: Methods

Research Questions of the Current Study

The purpose of the present study is to examine the understanding of teaching in children with HFA. Specifically, we use the following questions and methods to investigate in children with HFA: 1) the understanding of teaching, 2) the understanding of teaching and its relation to theory of mind development, 3) the understanding of teaching and its relation to the understanding of intentions-in-others, 4) the pattern of theory of mind development, and 5) the understanding of particular intentions in action.

Research Question 1: *Is the understanding of teaching intact or impaired in high functioning children with autism spectrum disorder (ASD) as compared to matched typical controls?*

> **Method and analysis:** Seven-item understanding of teaching battery. The tasks are drawn from three studies (Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008; Woodburn, 2008). Chi square tests, ANOVAs, and item response theory (IRT) procedures are used for analyses.

Research Question 2: *Is the understanding of teaching related concurrently to overall theory of mind, or specific mental state attribution understanding in high functioning children with ASD and matched controls?*

> **Method and analysis:** Wellman and Liu's (2004) five-item theory of mind scale and seven-item understanding of teaching battery. Correlations are computed to

look at possible relations between performance overall and at the task level between the theory of mind scale and the teaching battery.

Research Question 3: *How is the understanding of teaching related to understanding particular intentions-in-action in high functioning children with ASD and matched controls?*

Method and analysis: The intention-desire distinction measure from Schult (2004, Study 1), the same action-two intention measure from Baird and Moses (2001, Study 4), and the seven-item understanding of teaching battery. Correlations are computed to look at possible relations between performance overall and at the task level between the two intention measures and the teaching battery.

Research Question 4: *Is the pattern of theory of mind attainment in high functioning children with ASD similar to the developmental pattern observed in high functioning children with ASD by Peterson, Wellman, and Liu (2005)?*

Method and analysis: Wellman and Liu's (2004) five-item theory of mind scale. Chi square, ANOVA and Item Response Theory (IRT) procedures are used for analyses.

Research Question 5*: Is the understanding of the distinction between desires and intentions, or actions and intentions, intact or impaired in high functioning children with ASD as compared to matched controls?*

Method and analysis: The intention-desire distinction measure from Schult (2004, Study 1) and the same action-two intention measure from Baird and Moses (2001, Study 4) were used. Chi square tests, t-tests, and ANOVA procedures were used for analyses.

These behavioral methods will address unanswered questions about the understanding of teaching, theory of mind development, the understanding of intentions in others, and the interrelations between understanding teaching and theory of mind, and intention-in-action understanding. Together, our research will fulfill an unmet need in the literature and will have broad implications for improving teaching and learning outcomes for children with ASD.

Preliminary Work

In the summer of 2010, a small sample (n = 6) of TD children was recruited to pilot the understanding of intentions-in-action tasks and a small sample (n = 4) of HFA children was recruited to pilot the understanding of teaching battery and the understanding of intention stories. The goal of pilot testing was to help familiarize the student researcher with the tasks and to determine if they were feasible and appropriate for the HFA children in terms of time, general coherence, and attention level. The understanding of teaching battery and understanding of intention stories were each administered individually to half of the recruited participants given that neither measure has been used on HFA children. Question and wording were be based on procedures suggested by Woodburn (2008) who adapted story content and format from Ziv and Frye (2004) and Frye and Ziv (2005). As a result of the pilot testing outcomes, content and format was deemed appropriate for the participants in this study. For example, a child with HFA correctly answered memory and control questions for all of the teaching tasks (e.g., “Does Erin really know how to write her name or not?”) indicating an understanding of story content and salient details. The administration of the tasks allowed the researcher to become very familiar with the administration procedures and protocols, an important aspect of data collection fidelity for the main project.

Participants and Context

Participants. The total proposed sample size for this study was N = 80 children, with 40 HFA children and 40 matched control participants. A total of 45 HFA participants who met criteria consented to participate. However, for logistical reasons beyond the researchers control 10 participants did not take part in the study. In the end, a total of 35 HFA participant’s data was used in the study. A total of 50 TD control participants consented to participate. However, 37 of the 50 consented controls met all matching criteria. Two matched TD children did not wish to participate at the day of testing. In the end, data from a total of 35 TD children were used in the study.

Participants in the current study included 63 children attending elementary schools in the Philadelphia School District, and 7 children attending The University of Pennsylvania's Child Care Center (PCC). Forty percent of the participating HFA children were identified by their parent or caregiver as African American, 32% as Caucasian, 23% as Latino/Hispanic, and 5% as Asian. Forty percent of the participating TD matched control children were identified by their parent or caregiver as Caucasian, 29% as African American, 11% as Latino/Hispanic, 11% as Arab American, and 9% as Asian. Dates of birth (DOB) were recorded at the time of testing. HFA children ranged in age from 75 to 106 months (M = 93.23) and TD children ranged in age from 38 to 92 months (M = 72.29).

Age Groups. Age groups were based on inclusion criteria for the target population. Inclusion criteria for the entire population were that each child has a verbal IQ in the normal range ($\geq$ 80) and English as their first language. Additional inclusion criteria for the target population were that each high-functioning child has a putative classification of autism spectrum disorder (ASD) and has a VMA ranging from 3.80 to 8.50 years (as assessed by the DAS-II). Additional inclusion criteria for the TD control population are that each child’s chronological age ranged from 3.20 to 7.50 years and VMA—also assessed by the DAS-II—ranged from 3.75 to 8.25 years of age. Children were also matched on sex and both groups were primarily drawn from the School District of Philadelphia.

The two groups were designed to approximate the age ranges found in the Baird and Moses (2001), Peterson, Wellman, and Liu (2005), Schult (2002), Woodburn (2008), Ziv and Frye (2004), and Ziv, Solomon, and Frye (2008) studies in order to allow for as direct of a comparison as possible between children's performance on the measures in these studies and in the current study.

Participant Recruitment. Recruitment of HFA participants resulted from cooperation by the Center for Autism Research at the Children's Hospital of Philadelphia and the University of Pennsylvania's Graduate School of Education. Specifically, HFA participants were selected from Dr. David Mandell's Philadelphia Autism Instructional Methods Study (AIMS) participant database. The AIMS project represents an academic-public partnership designed to improve intervention quality for elementary school children with autism in the School District of Philadelphia. It also constitutes the largest randomized trial to date of a behavioral intervention for children with autism, having enrolled 494 children in 73 classrooms. The database allowed us to determine which schools HFA participants attend thereby making it possible to match primarily from the School District. Participant recruitment occurred in the form of mailing letters of invitation to the parents/guardians of potential child participants that have agreed in the AIMS original consent form to be approached about additional research. Letters of invitation outlined in lay terminology the aims of the proposed study and included compensation information for the parents who consented their child to participate.

TD children were recruited through the same elementary schools that the HFA participants attended. However, due to an insufficient number of matched consented participants across these schools, TD children were also recruited through PCC. A total of 7 control participants from PCC matched and were included in the study.

Consent Process. The consent process was conducted in the form of mailing recruitment letters and informed consent forms to families of children with HFA. As above mentioned, parents of TD participants were approached at their respective elementary or preschool to receive recruitment letters and consent forms.

Incentives. Parents of all participating children that required a home visit were given $25 gift cards to a local store to thank them for participating and be respectful of their time. The principals of the elementary schools where testing occurred each received a check for $150 issued from the University of Pennsylvania to thank them for participating and be respectful of their time.

Feedback.. At the completion of all data collection, feedback on all measures was provided to the parents of participating children. Feedback on children's performance by group was presented to parents as well as a brief description of the findings. Given that the participating sample of HFA children represents a clinical subpopulation of children with atypical neurodevelopment, recommendations, suggestions, or individual findings were not reported to parents.

Measures: Individually Administered Assessments

Theory of mind battery. Five tasks form the Wellman and Liu's (2004) scale. The tasks were selected on the basis of a meta-analysis of recent theory-of-mind research and then tested with a sample of 75 preschoolers. Guttman scaling (Guttman, 1944) procedures were used to determine the scalability of the seven selected items. Guttman scaling is a procedure whereby items are hierarchically arranged so that they progress in difficulty. That is, if a person fails one item, then s/he should fail all subsequent items; if s/he passes an item, then s/he should have passed all previous items. This type of scaling allows for the prediction of all item responses once the cumulative score is known. Guttman scaling is particularly helpful in measures of abilities that change developmentally, as higher scores indicate more advanced development in the particular area being measured. Five of the seven tasks have been found to form a Guttman scale with high reproducibility (Green's index = .96) and strong correlations with age ($r = .64$).

The five tasks are: 1) Diverse desires—the child judges that the self and another have different desires about the same object; 2) Diverse beliefs—the child judges that the self and another have different beliefs about the same object, when the veracity of the belief is unknown to the child; 3) Knowledge access—the child sees what is in a box and judges the knowledge of another who has not seen the contents of the box; 4) Contents false-belief—the child judges another's false belief about what is in a distinctive container, when the child knows what is in the container; 5) Real-apparent emotion—the child judges that a person can have one emotion internally but can display a different emotion externally (see Chapter 2: Literature Review for a full description and Appendix B for an example).

The same sequence has been shown to replicate exactly for English-speaking preschoolers in Australia (Peterson & Wellman, 2009; Peterson et al., 2005) and for preschoolers in Germany (Kristen et al., 2006). Current research has also confirmed the scale in two different populations of English-speaking children in Australia with HFA who pass the same total number of scale steps but in a different order (Peterson, et al., 2005; 2012). In both studies, Guttman scaling procedures were conducted to analyze task performance for the HFA group, indicating a different but consistent scale that showed a reversal between the fourth (false belief) task and the fifth (real-apparent emotion) task (Peterson et al., 2005; 2012).

Understanding of teaching stories. Seven tasks form the understanding of teaching battery. The tasks are drawn from three studies (Woodburn, 2008; Ziv & Frye, 2004; Ziv et al., 2008) that examined both the knowledge and intentional aspects of teaching in TD children. From the knowledge stories, the battery includes a simple knowledge task (e.g., Who should be taught), a teacher's misestimation of own knowledge task, and a teacher misestimation of the learner's knowledge task. From the intention stories, the tasks include a successful (intentional) teaching task, a failed (intentional) teaching task, a successful (non-intentional by the teacher) imitation task, and a teaching embedded in a game (guided discovery learning) task. The content of what is learned or taught varies across the tasks (see Appendix A for an example).

Determinations made about specific question wording, story content and ordering procedures were based on the tasks Woodburn (2008) used to examine the understanding of teaching in a sample of TD preschool and Kindergarten children. Findings indicated that the potential scalability of the tasks was high (based on Green's (1956) index). More importantly for purposes of the current study though, scaling analyses indicated a progression in difficulty among the teaching tasks (Woodburn, 2008). Results from the proposed battery will be analyzed to determine whether (1) performance by the TD group on a selection of the tasks show a progression in difficulty similar to the one observed by Woodburn (2008), (2) performance by the HFA group indicates a progression in difficulty among the tasks, and, if so, whether the pattern is similar to the pattern identified by Woodburn (2008), and (3) the HFA group or TD group can form a scale similar to the one identified by Wellman and Liu (2004) for theory of mind.

Understanding the distinction between desire and intention measure. Eight tasks comprise the intention-desire distinction measure. The items were drawn from a study that examined TD children's ability to distinguish between intentions and desires (Schult, 2002, Study 1). Short stories describe four possible outcomes from a situation in which a person states a desire and forms an intention to carry out an action to bring about that desire. Both the intention and desire in each story are related to the character's end goal.

The four possible outcomes are: 1) the intention is fulfilled and the desire is satisfied; 2) the intention is unfulfilled and the desire is unsatisfied; 3) the desire is satisfied but the intention is unfulfilled; and 4) the desire is unsatisfied but the intention is fulfilled. Each of the four conditions includes two tasks, one involving a boy protagonist and one involving a girl protagonist. Story content and theme varies across all eight tasks (see Appendix C for an example).

The original sample consisted of 51 TD children (eighteen 4-year-olds, fifteen 5-year-olds, and eighteen 7-year-olds; Schult, 2002). Prior to testing, the eight conditions used were pilot tested on 20 adults. They performed at ceiling on three of the four conditions and were near ceiling on the intention-unfulfilled, desire-satisfied condition. Preliminary analyses revealed no differences across the three age groups for sex, story order on the desire question and intention question between story pairs within condition, or on condition order between conditions. Four-year-olds' answers were not above chance on the forced choice intention question for the two pairs of stories in which the desire and intention outcomes conflicted (the desire was satisfied but the intention was unfulfilled and vice versa). The 4-year-olds performed significantly worse than either the 5- or 7-year-olds (Schult, 2002) on these tasks. Findings suggest that 4- and 5-year-old TD children recognize and correctly distinguish between desires and intentions when the outcome for both mental states are concordant, but struggle to recognize and correctly identify intentions from desires when the outcome for both mental states are discordant.

Two intentions-identical action measure. Six tasks form the two intentions-identical action measure. The items were drawn from a study that investigated TD children's ability to recognize that different intentions may be used to perform one and the same action (Baird & Moses, 2001, Study 4). Vignettes were used to tell two stories in which both characters performing the same action have markedly different desires and intentions. The six tasks comprise three conditions to satisfy the possible intention-action outcome combinations: 1) same intention-same action—both characters perform the same action and have the same intention but different desires; 2) same intention-different action—both characters perform the same action but have different intentions and different desires; and 3) different action-different intention—both characters perform different actions and have different desires and intentions. The character's desires and intentions were kept conceptually distinct in each story by having the desire represent an outcome and the intention represent an action. For each set of six stories, three stories involved girl characters, and three involved boy characters. Six story types were used that each contained variations of the story to meet the specifications of the three story conditions (see Appendix D for an example).

A sample of twenty-four TD 4-year-olds heard six stories, two in each condition (Baird & Moses, 2001, Study 4). Preliminary analyses found no differences based on sex, story, story order, or condition order. Participants performed worse in the same action-different intention condition than in the same action-same intention condition and the different action-different intention condition. Moreover, preschoolers performed above chance on the latter two conditions, but did not perform above chance on the same action-different intention condition. The authors concluded that 4-year-old children who fail to ascribe different intentions to characters performing the same action think that that action rather than the stated desire determines the character's intention (Baird & Moses, 2001).

Research Design and Procedures

This project implemented a cross-sectional design for a sample of HFA children and TD controls individually matched on verbal ability. HFA children were seen individually a total of two times for assessment at their respective places of residence. However, TD participants were seen a total of three times in order to match each target participant with a control on VMA. To match for verbal ability, TD children were given the verbal section of the Developmental Ability Scales-II (DAS-II) which was used in the AIMS study to measure cognitive ability.

Developmental Ability Scales-II (DAS-II). The DAS-II is a clinical instrument used to measure intellectual ability and academic achievement (Elliott, 1990a), and has been shown to produce reliable and valid indicators of cognitive ability (Aylward, 1992; Reinehr, 1992). It consists of a cognitive battery of 20 subtests, covering an age range of 2 years, 6 months through 17 years, 11 months (2;6 through 17;11). The battery is divided into two overlapping age levels: 1) The Early Years battery is normed from age

2;6 through 8;11, with a usual age range of 2;6 through 6;11; 2) The School-Age battery is normed from age 5;0 through 17;11, and has a usual age range of 7;0 through 17;11. Because of those overlaps between the Early Years and the School Age batteries, the DAS-II Early Years and School-Age batteries were co-normed for children ages 5;0 through 8;11 and therefore have a four-year normative overlap. The Early Years battery is further divided into two levels, lower and upper. The Lower Early Years level is most appropriate for young children ages 2;6 through 3;5 (although it may also been used with older children with developmental differences). The Upper Early Years level is suitable for children normally in the age range of 3;6-6;11, (although it may also be used with children up to age 8;11 if they have difficulty with the materials in the School-Age battery).

Two subtests form the verbal section of the DAS-II: 1) Naming Vocabulary; and 2) Verbal Comprehension. The Naming Vocabulary subtest assesses the spoken vocabulary of young children. It measures expressive language ability; ability to match; general language development; and word retrieval from long-term memory. The Verbal Comprehension subtest assesses the child’s understanding of the language through the receptive mode. None of the items on this subtest requires an oral response. Items tap a child's ability with syntax and prepositional and relational concepts; the ability to formulate and test hypotheses; the ability to follow verbal directions; and short-term auditory memory. Raw scores on each subtest can be converted into mental age equivalents, to gain an estimate of VMA.

For individual matching purposes, a researcher trained on administering the DAS-II verbal section presented the two verbal subtests to consented TD participants. To match, the average of the TD child's estimated VMA had to be within a 2 month approximation of the average of an HFA participant's reported estimated VMA. Upon confirming a match, the control child was then tested on all four cognitive measures within 2 months of being given the DAS-II.

Measure Administration. Each child was individually administered four measures across two sessions: the Understanding of Teaching stories, Theory of Mind Scale, the Intention-Desire Distinction measure, and the Two Intentions-Same Action stories. Two measures were presented at each session. The Theory of Mind Scale and one of the two Understanding of Intentions measures were presented during one session. The Understanding of Teaching stories and other Intention measure were administered during the other session. A 5-10 minute break was given between each measure during each session.

All 35 HFA children were tested on all four measures at their respective homes. Upon entering the family's residence, the child's parent/guardian would introduce the researcher to their son/daughter and would then tell their child that the researcher has come to read stories with him/her. The researcher would then sit in a quiet location of the house with the participant and based on the participant's preference, the parent/guardian would either remain in the room, but out of eye sight of the child, or excuse themselves to an adjoining room. Parents were asked not to participate if they remained in the room. Most of the target participants' parents/guardians left the room during testing, but remained in sight. None of the participants interacted with his/her parents during testing for those who stayed in the room. Each testing session took approximately 30-45 minutes. At the start of each session (after the parent/guardian had excused him/herself) the researcher would ask what the participant was doing before he arrived and then asked the participant's permission to read stores together as a way to further warm up to the activity. Most children were immediately comfortable and those that were not spent more time talking with the researcher and parent/guardian before being administered the assessment. No HFA participants refused to consent to participate or discontinued participating before the session had finished.

Twenty-five of the 35 TD children were tested at their respective schools, 8 were tested at their respective homes, and 2 on the third floor of the University of Pennsylvania's Graduate School of Education (GSE). When testing occurred at school, the child was individually excused from his/her classroom at a time that was convenient for the teacher and minimized instructional interruption. Children were tested in a quiet room or hallway at their school. When testing occurred at GSE, parents waited either in the room (and were asked not to participate or interact during testing) or outside of the classroom where testing took place. Home visits followed the same procedure as the home visits for HFA participants. At the start of each session, children spent a few minutes "helping" the researcher fill out basic information (name, birth date, classroom number, etc.) as a way to warm up to the activity. Each testing session took approximately 20-30 minutes. Most children were immediately comfortable and those that were not spent more time talking with the researcher before being administered the assessment.

Assessments were presented to children with props. The *two intentions-identical action* tasks were presented with an 18″ x 30″ felt board that folded in half forming a clear separation of its two sides and the same laminated pictures used in the Baird and Moses study (2001, Study 4, personal communication and permission). The *intention-desire distinction* stories were presented with colored copies of the exact laminated pictures used in the Schult study (2002, personal communication and permission). The Theory of Mind Battery and Understanding of Teaching stories were presented with small plastic dolls (i.e., the "characters" in the tasks) and laminated pictures (e.g., of the stories contents) or other props (e.g., clay in the "teaching to make a bowl" story) in order to maintain children's attention and maximize story comprehension. At the end of each assessment session, children were given stickers as a "thank you" for helping the researcher.

Order of presentation. Several steps were taken to control for any possible order effects within the measures or across children. To control for fatigue effects, the four measures were administered across two sessions with two measures presented at each session. The order in which each child received each measure within and across each session was counterbalanced. To control for carryover effects, neither the Theory of Mind Scale and the Understanding of Teaching stories, nor the intention measures were administered together during the same session. Therefore, each session always contained either the Theory of Mind Scale or the Understanding of Teaching stories *and* one of the two intention understanding measures. Order effects of tasks within each measure were resolved in the following ways:

Understanding of Teaching Stories. The understanding of teaching stories was presented in a pseudo-random order, following procedures suggested by Woodburn (2008). The “Who will be taught” story was always presented first (as it is considered the least difficult story) and the “Overestimate self” (most difficult) story was always presented last. The remaining five stories were presented in random order and administered in between the “Who will be taught” and “Overestimate self” stories. The decision to start and end with these particular stories is based on the work by Ziv and Frye (2004), Ziv, Solomon and Frye (2008), and Woodburn (2008) that provided data which suggested these were both the easiest and the most difficult stories for children. Although, Woodburn (2008) found that both the “Overestimate self” and “Overestimate learner” tasks were the two most difficult tasks and that performance on “Overestimate learner” was slightly worse than “Overestimate self”, there was not a significant difference in performance between the two. Therefore, the decision to keep the original order of “Who will be taught” first and “Overestimate self” last was based on: 1) the fact that this study being the first of its kind to present the understanding of teaching tasks to a sample of children with autism had no supporting data for this population to justify the order of the teaching stories, and 2) the combination of findings from both the pilot work Woodburn conducted that found “overestimate self’ to be the most difficult and the above mentioned overall findings from the study.

Children were asked control and experimental questions after each story (see Appendix A for an example of each task). Control questions required children to state the story characters' knowledge state and were always asked before the experimental question (which asked children if teaching took place). Experimental questions presented children with a choice (e.g., Did Nicole try to teach Emma how to tie a knot or did she tie a knot for herself?) and the order of this choice (i.e., "try to teach" or "for herself) was counterbalanced across the set of stories.

Theory of Mind Battery. The theory of mind battery was presented in one of three pseudo-random orders following procedures suggested by Peterson, Wellman and Liu (2005). Each of the three possible orders of presentation begins with the diverse desires task (considered to be the least difficult task) and ends with the real-apparent emotion task (considered to be the most difficult task) while randomizing the remaining three tasks (diverse beliefs, knowledge access, and false belief). According to procedures used by Peterson et al. (2005) the order of questions and content of tasks was not changed.

Understanding the Distinction between Desire and Intention Stories. The understanding of the intention-desire distinction stories were presented in random order following procedures suggested by Schult (2002, personal communication). Children heard eight stories, two in each condition. The order of the two tasks within each condition was counterbalanced and the order of each of the four conditions was randomized. Children were asked four test questions after each story was presented: 1) "What was X's plan?", 2) "Did X do what s/he planned to do?", 3) "What did X want?" and 4) "Did X get what s/he wanted?". This order was held constant and the force choice yes/no format was maintained as a result of personal communication with the author about the original design confirming question order and format, and for comparison purposes with the TD control sample in this study.

Two Intentions-Identical Action Stories. The two intentions-identical action stories were presented in random order following procedures from Baird and Moses (2001, personal communication). Children heard six stories, two in each condition. Three stories involved boy characters and three stories involved girl characters. Children were first asked an action question about both characters in each condition. This followed with asking a desire question (e.g., “Which boy wants to be home for dinner in just a few minutes?) and an intention question (e.g., “What is Michael trying to do? Is Michael trying to get some exercise or is he trying to get somewhere fast?”) for each story for each condition. Condition order followed the Latin Square design used by Baird and Moses (2001, Study 4) which ensured that each condition type appeared in each position order. Condition order fell into sets of three. Story order within sets were counterbalanced (i.e., condition order remains the same but story order is reversed) as were order of character presentation and order of intention questions.

CHAPTER 4: Results

Analytic Methods

Given the aim of the current study was to investigate the understanding of teaching in high functioning children with autism spectrum disorder (HFA children), the present project assessed HFA children's understanding of teaching, theory of mind, and others' intentions. We were also interested in investigating the possible interrelations between the understanding of teaching, and theory of mind and the understanding of intentions in others. Results were analyzed pursuant to the five research questions this study addressed. Analyses used to examine the research questions involve relations and variation among the four social cognitive measures examined.

Analyses are based on a single test trial per measured item.[1] ANOVA procedures are used to test for differences within and between groups among the conditions and items for all four measures. Correlations were calculated for the entire sample and for the two groups separately to determine relations among the four measures overall and by item. Descriptive statistics and scoring information are presented first. This follows with analyses for each research question in turn.

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[1] Many matched case-control studies involving children with ASD do not include model parameters for the matched pairs of children (e.g., Kaland et al., 2008; Luyster & Lord, 2009; McDuffie, Yoder, & Stone, 2006). Because the matching process equates the samples overall (in this dissertation study, the distributions of VMA are identical), including matched pair parameters (either fixed or random) may account for some of the otherwise unexplained variation in outcomes; but in so doing, it can mask relationships associated with the variables used to create the pairs. For example, if matched pair parameters were included in these analyses, any developmental relationships between predictors and outcomes that are related to VMA would be impossible to estimate. Thus, matched pair parameters were not included in the models estimated here, and the results should not be interpreted as having the influence of VMA controlled in these analyses. Instead, the results reflect developmental relationships and differences between ASD and TD children from samples that have identical distributions of VMA.

Overall Results

Descriptive Statistics and Scoring by Measure. Before addressing the specific research questions of the current study, descriptive statistics were examined for the data set that follows with scoring information about each of the measures. Variables were examined for each group separately. Table 1 displays the characteristics of the sample by group. These data show the sampling recruitment strategy this study used. The TD comparison sample was individually matched with the HFA sample on verbal mental age (VMA) (see Chapter 3: Methods for a full description). All of the comparisons made below were performed having already matched on VMA.

Table 2 displays information about the number of participants with ceiling or floor levels of performance on and across the four measures. This table is important because it indicates that although a few HFA children performed at floor on two measures, the theory of mind scale and understanding of teaching battery, no HFA participants performed at floor across all four measures. Moreover, the HFA participant who did perform at floor on the theory of mind scale was not one of the two HFA children who performed at floor on the understanding of teaching battery. This pattern indicates that no child performed at floor on more than one measure. As a result, data analyses included all 35 HFA and 35 matched TD participants. Table 3 presents overall descriptive statistics for the understanding of teaching battery and theory of mind scale,

Table 4 for the intention-desire distinction measure, and Table 5 for the two intentions-identical action measure.

Table 1.

Characteristics of Children by Group

	HFA	TD
No. of Children	35	35
Mean age (Mo.)	93.2	72.3
Age range (years;months)	6;3 to 8;10	3;3 to 7;6
Ratio of boys:girls	32:3	32:3
Mean Est. VMA (Mo.)	72.2	73.2
Range Est. VMA (Mo.)	47 to 103	46 to 100

Note. HFA = High Functioning Children with Autism, TD = Typically Developing Children, VMA = Verbal Mental Age.

Scoring. Test questions for each item on all four measures used a dichotomous forced-choice question format. For each test question, participants received a “1” if they answered correct and “0” if incorrect.

Scoring overall performance on the understanding of teaching measure followed procedures suggested by Woodburn (2008). The understanding of teaching battery was calculated by summing the total number of correct items (*range* = 0-7). Similar to the understanding of teaching battery and following procedures by Wellman and Liu (2004), the theory of mind measure scores were also calculated by summing the total number of correct items (*range* = 0-5).

Overall performance for the two intention-in-action measures was calculated by summing the total number of correct responses for each condition. In line with procedures set by Schult (2002; and personal communication), overall performance on the intention-desire distinction measure was calculated by summing the total number of correct items for each of the four conditions (*range* = 0-4). Performance by condition was calculated by summing the total number of correct items for each question type (*range* = 0-2). Overall performance on the two intentions-identical actions measure was also calculated by summing the total number of correct items for each of the three conditions (*range* = 0-2), as suggested by procedures from Baird and Moses (2001).

Table 2.

Participants with Floor or Ceiling Performance Overall and by Measure

	Overall	ToM Scale	UoT Battery	Intention-Desire	Two Intention-Same Action
HFA Floor	0	1	2	0	0
HFA Ceiling	0	2	1	0	6
N = 35					
TD Floor	0	0	0	0	0
TD Ceiling	0	11	3	0	18
N = 35					

Note. ToM = Theory of Mind, UoT = Understanding of Teaching, Figures = Number of participants, Floor = All items wrong, Ceiling = All items correct.

Table 3.

Descriptive Statistics by Group for Overall Understanding of Teaching Scores and Theory of Mind

						95% Confidence Interval for Mean			
Measure	Group	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Min	Max
Understanding of Teachin	HFA	35	3.54	1.56	0.26	3.01	4.08	0	7
	TD	35	5.00	1.19	0.20	4.59	5.41	3	7
Theory of Mind	HFA	35	2.77	1.19	0.20	2.36	3.18	0	5
	TD	35	3.89	1.02	0.17	3.53	4.24	1	5

Table 4.

Descriptive Statistics by Group for Intention-Desire Distinction Measure

Condition	Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
Intention Fulfilled/Desire Satisfied	HFA	35	3.66	0.87	0.15	3.36	3.96	0	4
	TD	35	3.89	0.68	0.11	3.65	4.12	0	4
Intention Unfulfilled/Desire Unsatisfied	HFA	35	2.03	1.76	0.30	1.42	2.63	0	4
	TD	35	3.17	1.29	0.22	2.73	3.62	0	4
Intention Unfulfilled/Desire Satisfied	HFA	35	2.29	0.67	0.11	2.06	2.51	2	4
	TD	35	2.63	0.77	0.13	2.36	2.89	2	4
Intention Fulfilled/Desire Unsatisfied	HFA	35	2.17	0.75	0.13	1.91	2.43	1	4
	TD	35	2.57	0.85	0.14	2.28	2.86	1	4

Table 5.

Descriptive Statistics by Group for Two Intentions-Same Action Measure

						95% Confidence Interval for Mean			
Condition	Group	N	Mean	Deviation	Std. Error	Bound	Upper Bound	Min	Max
Same Action-Different Intention	HFA	35	1.46	0.61	0.10	1.25	1.67	0	2
	TD	35	1.77	0.43	0.07	1.63	1.92	1	2
Different Action-Different Intention	HFA	35	1.74	0.51	0.09	1.57	1.92	0	2
	TD	35	1.94	0.24	0.04	1.86	2.02	1	2
Same Action-Same Intention	HFA	35	1.40	0.74	0.12	1.15	1.65	0	2
	TD	35	1.66	0.64	0.11	1.44	1.88	0	2

Understanding of Teaching Tasks. **Research Question 1**: *Is the understanding of teaching intact or impaired in high functioning children with autism spectrum disorder (ASD) as compared to matched typical controls?*

The primary goal of this study was to investigate the understanding of teaching itself in children with HFA. To examine differences between HFA participants and TD controls in overall performance on the understanding of teaching battery and across the seven teaching tasks, responses were compared in a (2 (group) X 7 (task)) repeated measures ANOVA, modeling group as the between-subjects factor, task question as a within-group factor, and the interaction between the two.[2] Because the assumption of sphericity was not met (Mauchly's $W = .554$, $p < .005$), the degrees of freedom for tests of within-subjects effects were conservatively adjusted using the Greenhouse–Geisser F test. For all subsequent repeated measures ANOVAs, where the assumption of sphericity is not met (Mauchly's $p < .05$), the degrees of freedom for tests of within-subjects effects will be conservatively adjusted using the Greenhouse–Geisser F test. A main effect of group ($F(1, 68) = 19.33$, $p < .001$) and task ($F(1,68) = 21.55$, $p < .001$) was found (Table

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[2] In certain cases it might be preferable to use a repeated measures log-linear model to analyze dichotomous data. However, using a log-linear model with data for which there are empty cells can result in severe estimation problems (Wainryb, Shaw, Laupa, & Smith, 2001). Empty cells represent a fundamental constraint for log-linear models, because the log of zero is undefined. In the current study, empty cells were present due to children's overwhelmingly high and overwhelming low responses on several teaching tasks (see below). Wainryb et al. (2001) note that the standard strategy of deleting empty cells by excluding levels of the dependent or independent variable, would compromise the integrity of the data. In contrast, empty cells tend not to represent a serious concern for ANOVA models where parameters are estimable even with only minimal variance in the data. Other researchers have noted the use and robustness of ANOVA with dichotomous data (e.g., Gaito, 1980; Lunney, 1970; Smetana, Campione-Barr, & Yell, 2003). Therefore, ANOVA models are used in the current study to analyze both the understanding of teaching and theory of mind measures.

3). This indicates that the HFA children performed worse than the TD children on the understanding of teaching battery.

Table 6 shows performance on each of the task items by group for the understanding of teaching battery. The failed teaching task was the only item in which HFA children's performance was above chance. TD children performed significantly above chance on the failed teaching task, the successful teaching task, the who should be taught task, and the embedded teaching task.

Table 6.

Understanding of Teaching Task Item Performance, Pass Rates by Group

	HFA	TD	Woodburn, 2008
Failed Teaching	.69*	.97*	.86
Successful Teaching	.63	.94*	.89
Who Should be Taught	.63	.91*	.99
Embedded Teaching	.57	.86*	.74
Overestimate Self	.51	.60	.25
Observational Learning	.34	.43	.65
Overestimate Learner	.17	.29	.19

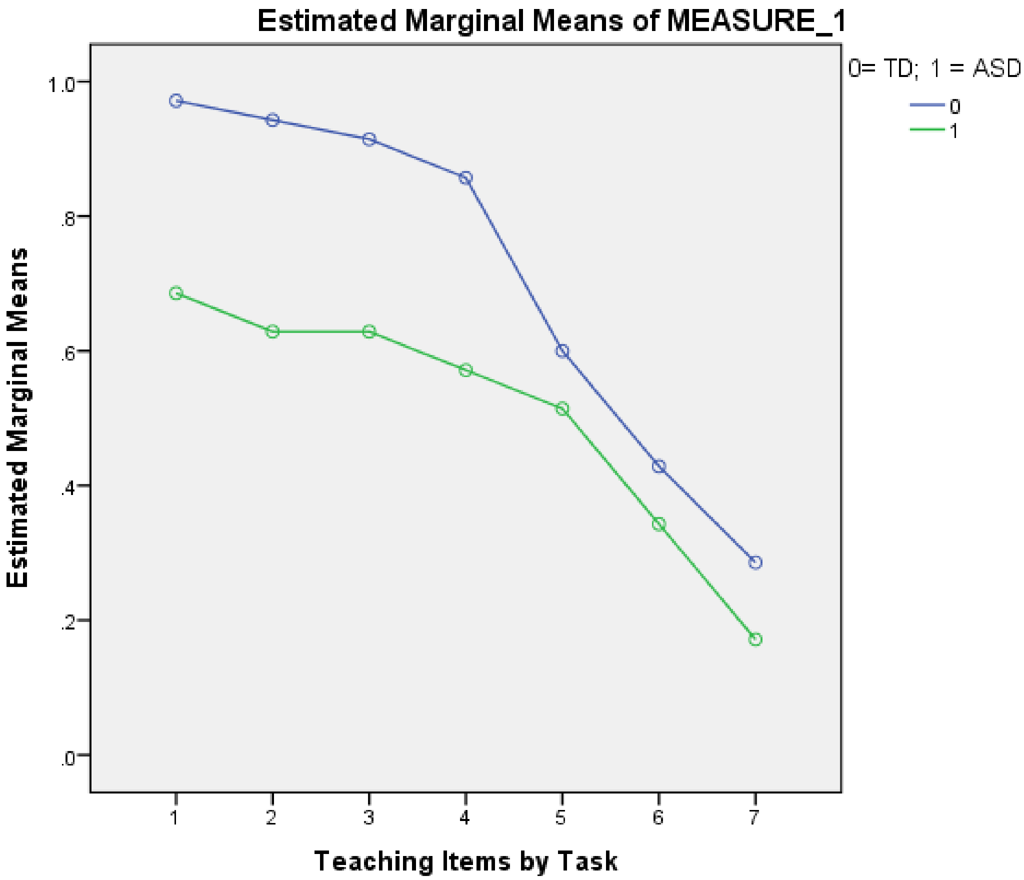
Note. Asterisks (*) indicate above-chance (50%) performance.

McNemar's chi square tests were conducted to test group differences by item. Analyses revealed differences between HFA and TD groups were significant for the failed teaching task ($\chi^2(1) = 10.06$, $p < .001$), the successful teaching task ($\chi^2(1) = 8.10$, $p < .01$), the who should be taught task ($\chi^2(1) = 10.25$, $p < .001$), and the embedded teaching task ($\chi^2(1) = 7.00$, $p < .01$). There were no significant differences between the groups on the observational learning task, the overestimate-self task, or the overestimate-learner task.

Chi square tests were also conducted to test within group differences by item. For the HFA participants, differences were observed between the successful teaching task and overestimate-self task ($\chi^2(1) = 6.65$, $p < .01$) as well as failed teaching and observational learning ($\chi^2(1) = 4.52$, $p < .05$). Chi square tests were not computed for the following comparisons due to below threshold cell count frequencies: 'successful teaching' and overestimate-learner; 'who should be taught' with 'observational learning' and both overestimate-self/learner; and 'failed teaching' and overestimate-learner. Chi square tests were also not computed for a majority of the tasks for the TD group because the combination of high pass rates on the first four tasks and low pass rates on the last task resulted in below threshold cell count frequencies. There were no differences found between the few tasks that were analyzed.

Figure 1 illustrates the difference between groups on each of the teaching tasks when presented in descending order based on pass rates. The x-axis represents the teaching tasks and the y-axis represents the mean pass rate. The lack of interaction indicates that the group average by task for the HFA children echoes the group average by task for the TD children. This suggests that although the HFA group performed worse across the tasks than controls, the pattern of performance did not differ from the TD group. The findings show that HFA children performed worse than TD children on their overall teaching score and on most of the teaching tasks. Taken together, the data suggest that compared to TD children, the understanding of the core components that underlie teaching are delayed in HFA children.

Figure 1.



Scaling. Item response theory (IRT) was used to examine scalability. IRT uses both item parameters and respondent characteristics to determine the probability of passing an item given one's score on all other items. For the seven-item teaching battery, Woodburn (2008) used Guttman procedures and Rasch modeling to determine whether the understanding of teaching tasks form a scale. Following procedures from Woodburn (2008), Guttman and Rasch analyses were also used in the current study to determine whether the seven-item battery formed a scale similar to the Wellman and Liu (2004) theory of mind scale in both HFA and TD children.

Guttman scaling is a procedure in which items are arranged hierarchically so that they progress in difficulty—a person who fails an item should fail all subsequent items and a person who passes an item should have passed all previous items. Scaling of this sort allows for the prediction of all item responses once the cumulative score is known. Guttman scaling is useful in examining measures of abilities that are thought to change developmentally, as higher scores indicate developmental progress in the particular area being measured. Calculating the scale produces two statistics: a coefficient of reproducibility, which indicates how progressively difficult, or ‘scalable’, items are; and an index of consistency, which indicates whether the pattern derived differs significantly from one that could be obtained by chance. A scale is determined by a coefficient of reproducibility greater than or equal to .90 and an index of consistency greater than or equal to .50 (as specified by Green's (1956) method of estimation; Guttman, 1950).

After several attempts at different item combinations for the seven-item teaching battery, the following task order was found to have the best Guttman fit in our HFA sample: 1) failed teaching; 2) successful teaching; 3) who should be taught; 4) embedded teaching; 5) overestimate-self; 6) observational-learning; and 7) overestimate-learner. Guttman procedures revealed that the seven-item battery had an index of reproducibility = .88, but with Green’s (1956) index of consistency = .65. This indicated that the observed response pattern occurred above chance, but that the items fell just below the threshold for scalability (.90). Thus, the seven tasks here did not form a reliable scale.

Data for the seven items in the HFA group were subsequently analyzed using a Rasch model. The Rasch IRT measurement model is a one-parameter logistic model for dichotomous items that models the probability of a specified response (e.g., correct/incorrect answer) to any given item as a function of item difficulty and person ability levels (Rasch, 1960; Wright & Masters, 1982; Wright & Stone, 1979). When item difficulty and a person's ability are equal, the chance of answering the item correctly is 0.5. As an individual's ability increases or decreases relative to item-difficulty, so does the probability of correct performance, respectively. Rasch models are less conservative than the more stringent and deterministic Guttman model because they employ probability in determining scale progression rather than demanding exact fit in scale progression.

In a Rasch model, the degree of agreement between the pattern of observed responses and the modeled expectations is described using mean square (MNSQ) infit and outfit goodness-of-fit statistics. Infit mean-square statistics are sensitive to irregular patterns of response. Outfit mean-square fit statistics (MNSQs) are equivalent to a chi-square statistic; values greater than 2.0 indicate outliers or unexplained randomness throughout the data (Linacre, 2004; Smith, 1996). Values between .75 and 1.33 MNSQ are considered acceptable; a value below .75 suggests the item fits too well and above 1.33 indicates noise (Wilson, 2005). Item fit indicates the extent to which the use of a particular item is consistent with the way the participants have responded to the other items. Person fit indicates the extent to which the person's performance is consistent with the way the items are used by the other participants

Table 7 shows ordered solutions from least difficult to most difficult for item and person for the HFA group. The Rasch model confirmed the Guttman scaling findings that the items did not form a reliable scale for this sample of respondents. Fit statistics for items all fell within the acceptable range between .75 and 1.33 MNSQ expect for outfit MNSQ for the embedded teaching task and the overestimate-learner task. Cronbach's alpha for overall item fit was .89. Cronbach's alpha for overall person fit was .37. The item fit results suggest valid item parameters for only five of the seven items. The poor person fit (i.e., coefficient less than .50) indicates the item-score response pattern is statistically "improbable" (Meijer & Sitsma, 2001). That is, the HFA children's response patterns did not conform to the model. Therefore, the seven-item understanding of teaching battery did not scale for this particular sample of HFA children.

Table 7.

Rasch Analysis Results for Teaching Battery Item and Person in HFA Group

Item Difficulty-Fit Statistics			Infit		Outfit	
	Meaure	Error	MNSQ	ZSTD	MNSQ	ZSTD
Failed Teaching	-1.02	0.42	0.87	-0.60	0.81	-0.50
Successful Teaching	-0.69	0.40	0.94	-0.30	0.85	-0.50
Who Should be Taught	-0.69	0.40	0.90	-0.50	0.92	-0.20
Embedded Teaching	-0.38	0.39	1.17	1.10	1.40	1.70
Overestimate Self	-0.08	0.38	0.94	-0.40	0.86	-0.60
Observational Learning	0.83	0.40	1.00	0.10	1.31	1.00
Overestimate Learner	2.02	0.52	1.00	0.10	2.33	1.80
M	0.00	0.42	0.98	-0.10	1.21	0.40
SD	1.00	0.04	0.09	0.50	0.51	1.00
Person Difficulty-Fit Statistics (33 non-extreme cases)						
M	-0.02	0.97	0.99	0.00	1.21	0.10
SD	1.33	0.25	0.32	0.80	1.43	0.90

Guttman procedures and Rasch modeling were also used to examine scalability in the TD group. Table 8 shows ordered solutions from least difficult to most difficult for item and person for the TD group. Guttman procedures revealed that the seven-item battery of teaching tasks had an index of reproducibility = .95, but with Green's (1956) index of consistency = .22, which indicates that the observed response pattern did not occur above chance. Thus, the seven tasks here did not form a reliable scale. Rasch modeling confirmed the Guttman scaling findings that the items did not form a reliable scale for our sample of TD respondents. Cronbach's alpha for overall item fit was .89. Person infit and outfit statistics fell between .75 and 1.33 MNSQ for only two tasks: the observational learning task and the overestimate-self task. Cronbach's alpha for overall person fit was .25.

Table 8.

Rasch Analysis Results for Teaching Battery Item and Person in TD Group

Item Difficulty-Fit Statistics			Infit		Outfit	
	Meaure	Error	MNSQ	ZSTD	MNSQ	ZSTD
Failed Teaching	-2.62	1.03	0.86	0.10	0.26	-0.30
Successful Teaching	-1.85	0.75	0.91	0.00	0.49	-0.20
Who Should be Taught	-1.37	0.64	1.10	0.40	0.70	-0.10
Embedded Teaching	-0.71	0.53	0.94	-0.10	1.88	1.30
Overestimate Self	1.10	0.42	1.06	0.40	1.26	1.10
Observational Learning	2.16	0.44	1.10	0.60	1.22	0.70
Overestimate Learner	3.29	0.53	0.74	-0.80	0.48	-0.80
M	0.00	0.62	0.96	0.10	0.90	0.30
SD	2.05	0.20	0.13	0.40	0.53	0.70
Person Difficulty-Fit Statistics (30 non-extreme cases)						
M	1.77	1.26	1.00	-0.10	0.90	0.10
SD	1.60	0.29	0.78	1.20	1.25	0.80

In Woodburn's (2008) study, Guttman procedures revealed that the seven-item battery of teaching tasks had an index of reproducibility = .94 but an index of consistency of only .38. While the potential scalability of the teaching battery was significant (as evidenced by the index of reproducibility), the TD participants in Woodburn's (2008) study did not form a reliable scale according to Guttman procedures. In the current study, Rasch modeling applied to the seven tasks confirmed our Guttman findings, indicating that the items were progressive in difficulty, but that the pattern of responses was not reliably greater than chance. Rasch modeling applied to the seven tasks confirmed the Guttman findings in Woodburn (2008) as well. However, while the TD participants in both studies observed a significant index of reproducibility, the order of the seven-item task found to have the best Guttman fit in the current study is distinct from the order found to have the best Guttman fit in Woodburn (2008), making comparisons less valid.

Relation between the Understanding of Teaching and Theory of Mind. ***Research Question 2***: *Is the understanding of teaching related concurrently to overall theory of mind, or specific mental state attribution understanding in high functioning children with ASD and matched controls?*

It was speculated that the understanding of teaching would be related to theory of mind in both HFA and TD populations. Bivariate correlations were used to examine the relation between the understanding of teaching score and theory of mind score by group. Table 9 shows the Pearson product-moment correlations for overall performance on the teaching measure and the theory of mind measure. As hypothesized, the teaching and theory of mind measures significantly correlated with each other for both HFA and TD populations ($r(33) = .42$, $p < .05$; $r(33) = .56$, $p < .01$, respectively).[3] These data are important because they represent novel findings that suggest a conceptual relation between theory of mind and the understanding of teaching may be present in HFA children. For the TD group, these data replicate Woodburn's (2008) findings of a significant correlation between overall performance on the teaching and theory of mind measures in a sample of TD children. Replicating these results provides additional data

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[3] Splitting each group into two subgroups based on whether they fell above or below the mean chronological age for that group in order to run age partialled correlations was not performed. Doing so would have resulted in comparing groups that did not have enough power to find a statistically significant difference.

pointing to the possibility that these two measures are conceptually related in TD children.

Table 9.

Pearson Product Moment Correlations by Group for Overall Theory of Mind and Understanding of Teaching Scores

HFA	Teaching
Theory of Mind	.42*

TD	Teaching
Theory of Mind	.56**

***Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

To determine which task items in the teaching battery were related to overall theory of mind performance, a polyserial correlation was used where the score on each of the teaching tasks (a dichotomy) was correlated with the overall theory of mind score (an ordinal variable). The procedure was then used in the reverse situation, where each theory of mind tasks are correlated with the overall understanding of teaching score. Given the novelty of examining the understanding of teaching in HFA children, correlations between the teaching battery and theory of mind score, and vice versa, were performed for exploratory purposes in the event that certain tasks on one measure in this population relate to overall performance on the other.

Table 10 shows the correlations for the teaching tasks and theory of mind score. Both the failed teaching task and the embedded teaching task significantly correlated with overall theory of mind performance for the HFA children (*rs*(33) = .45 and .37, *ps* < .01

and .05, respectively). The failed teaching task correlation is interesting as this task was the one item in the teaching battery that HFA children's performance was above chance. For the TD children, the embedded teaching task and the overestimate-learner task was significantly related to overall theory of mind score (*rs*(33) = .44 and .39, *ps* < .01 and .05, respectively).

Table 10.

Correlations between Teaching Task Items and Theory of Mind

	HFA	**TD**
Variables	Theory of Mind	Theory of Mind
Successful Teaching	.15	.07
Who Should be Taught	.20	.09
Failed Teaching	.45**	.15
Successful Imitation	-.01	.33
Embedded Teaching	.37*	.44**
Overestimate Learner	.09	.39*
Overestimate Self	.10	.20

*** Correlation is significant at the 0.01 level (2-tailed).*

** Correlation is significant at the 0.05 level (2-tailed).*

Table 11 shows the correlations for the theory of mind tasks and overall understanding of teaching score. The diverse desire tasks and the knowledge access task correlated with teaching for HFA children (*rs*(33) = .36 and .49, *ps* < .05). For the TD children, the diverse beliefs task, the false belief task and the real-apparent emotions task were significantly related to the understanding of teaching score (*rs*(33) = .44, .36, and .40, *ps* < .01, .05, and .05, respectively). The pattern of correlations differed between groups. This difference could simply be a difference in how these two groups solved, or did not solve, the tasks. However, a richer interpretation is that the distinct pattern suggests that there is a difference between HFA children and TD children in the understanding of the mental states the theory of mind tasks address and their relation to overall performance on the understanding of teaching battery.

Table 11.

Correlations between Theory of Mind Tasks and Teaching Score

	HFA	**TD**
Variables	Teaching	Teaching
Diverse Desires	.36*	–
Diverse Beliefs	-.16	.44*
Knowledge Access	.49**	.26
False Belief	.23	.36*
Real-Apparent Emotion	.16	.40*

— Performance on this item 100%
*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*

Phi correlation coefficients were used to measure the degree of association (correlation) between each task in the understanding of teaching battery and each task in the theory of mind scale. Table 12 shows the interrelations among the theory of mind variables and teaching variables. For the HFA children, a significant inverse correlation was found between the diverse beliefs task and the successful imitation teaching task ($r(33) = -.47$, $p < .01$). The failed teaching task significantly correlated with the knowledge access task and false belief task ($rs(33) = .53, .43$, $ps < .01$ and .05, respectively).

For TD children, performance on the diverse beliefs task significantly correlated with the 'who should be taught' teaching task, the embedded teaching task, and the overestimate-self teaching task (*rs*(33) = .36, .46 and .38, *ps* < .05, .01, .05, respectively). False belief significantly correlated with the embedded teaching task ($r(33) = .39$, $p < .05$) and the real-apparent emotion task significantly correlated with the successful imitation teaching task ($r(33) = .35$, $p < .05$). Children performed at ceiling (100%) on the diverse desires task, therefore correlations were not computed.

Table 12.

Correlations between Theory of Mind and Understanding of Teaching by Task

HFA

Variables	DD	DB	KA	FB	RA
Successful Teaching	0.28	0.15	0.17	-0.04	-0.12
Who Should be Taught	0.12	-0.14	0.17	0.22	0.14
Failed Teaching	0.18	-0.22	0.53**	0.43*	0.19
Successful Imitation	-0.15	-0.47**	0.26	0.08	0.16
Embedded Teaching	0.22	0.08	0.30	0.16	0.21
Overestimate Learner	0.21	-0.11	0.09	0.05	0.02
Overestimate Self	0.32	0.15	0.08	-0.15	-0.08

TD

Variables	DD	DB	KA	FB	RA
Successful Teaching	–	-0.09	-0.09	0.21	0.04
Who Should be Taught	–	0.36*	-0.08	0.08	-0.05
Failed Teaching	–	-0.05	-0.05	0.24	0.14
Successful Imitation	–	0.06	0.27	0.14	0.35*
Embedded Teaching	–	0.46**	0.17	0.39*	0.17
Overestimate Learner	–	0.19	0.19	0.32	0.26
Overestimate Self	–	0.38*	0.17	-0.10	0.19

*** Correlation is significant at the 0.01 level (2-tailed).*

** Correlation is significant at the 0.05 level (2-tailed).*

– Performance on this item 100%.

Note. DD = Diverse Desires, DB = Diverse Beliefs,KA = Knowledge Access, FB = Contents False Belief, RA = Real-Apparent Emotion.

The relatively few associations observed for both groups between the teaching tasks and theory of mind tasks could be accounted for by the limited variability in each group's high and low performance on several items. For instance, besides TD children's ceiling performance on the diverse desires task (100%), group pass rates on the diverse beliefs and knowledge access tasks were also quite high (91%, respectively) (see Table 15). HFA children performed poorly on the observational learning task (34%), and both groups performed poorly on the overestimate-learner task (29% and 17%, respectively, see Table 6).

For the tasks with greater variability in each group's performance, the pattern of relations between the two groups is important to note. For the handful of correlations observed in both groups, none of the associated pairs in the HFA group matched with the associated pairs in the TD group. The different correlational patterns suggests that the relation between theory of mind and the understanding of teaching in HFA children may differ from the relation between theory of mind and the understanding of teaching in TD children.

Relation between the Understanding of Teaching and Intentions-In-Action. ***Research Question 3***: *How is the understanding of teaching related to understanding particular intentions-in-action in high functioning children with ASD and matched controls?*

It was also speculated that the understanding of teaching may be related to the understanding of other's intentions in both HFA and TD populations. Bivariate correlations were used to examine the relation between overall teaching score and intention task scores by group. Table 13 shows the interrelations by group among total teaching score and each of the intention-in-action task scores.

Table 13.

Correlations by Group between Overall Understanding of Teaching Score and Intention Tasks

HFA							
Variables	I+D+	I-D-	I-D+	I+D-	SD	DD	SS
Teaching	0.21	0.53**	0.41*	0.09	0.23	0.26	0.11
TD							
Variables	I+D+	I-D-	I-D+	I+D-	SD	DD	SS
Teaching	0.29	0.42*	0.10	0.17	0.17	0.21	0.19

*** Correlation is significant at the 0.01 level (2-tailed).*
** Correlation is significant at the 0.05 level (2-tailed).*
Note. I+D+, intention-fulfilled/desire-satisfied; I-D-, intention-unfulfilled/desire-unsatisfied; I-D+, intention-unfulfilled/desire-satisfied; and I+D-, intention-fulfilled/desire unsatisfied; SD = same action-different intention; DD = different action-different intention; and SS = same action-same intention.

For the HFA group, two of the four intention-desire distinction tasks (intention-unfulfilled/desire-unsatisfied and intention-unfulfilled/desire-satisfied) were significantly correlated with the total teaching score ($r(33) = .53, .41$, *ps* < 01 and .05, respectively). The intention-unfulfilled/desire-unsatisfied task was significantly correlated to the teaching score for the TD group ($r(33) = .42$, $p < .05$). It was interesting that the same intention-in-action task was related to teaching in both groups given that HFA children and TD children performed significantly different on the intention-unfulfilled/desire-unsatisfied task and on teaching. However, due to the difference in task format and characteristics between both the teaching items and two intention measures, it could have been the case that the intention tasks did not correlate with teaching.

It is also possible that the lack of significance for many of the correlations was due to the overall lack of variability across several of the intention conditions (e.g., overall high performance or low performance). Nevertheless, two intention task scores correlated with the total teaching score in the HFA group and one intention task score correlated with the total teaching score in the TD group. These findings point to the possibility that there is a relation between the intention-in-action tasks and the understanding of teaching battery in HFA and TD children.

A more detailed examination of whether the understanding of teaching battery is related to the understanding of other's particular intentions-in action tasks requires investigating interrelations among the individual teaching tasks and the individual intention tasks. Phi correlation coefficients were used to measure the degree of association (correlation) between each task in the understanding of teaching battery and each of the intention tasks. Table 14 shows the interrelations by group among each of the teaching items and each of the intention-in-action task scores.

Table 14.

Correlations by Group between Understading of Teaching Tasks and Intention-in-Action Tasks

HFA

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Successful Teaching	1.00													
2. Who Should be Taught	0.27	1.00												
3. Failed Teaching	-0.01	0.24	1.00											
4. Successful Imitation	-0.07	-0.07	0.36*	1.00										
5. Embedded Teaching	-0.07	0.05	0.16	0.14	1.00									
6. Overestimate Learner	0.19	0.04	-0.02	0.15	-0.22	1.00								
7. Overestimate Self	0.44**	0.20	0.08	-0.14	-0.03	0.14	1.00							
8. Intention-Fufilled/Desire-Satisfied	0.18	0.04	0.30	-0.13	0.13	0.09	0.08	1.00						
9. Intention-Unfufilled/Desire-Unsatisfied	0.22	0.22	0.22	0.16	0.31	0.04	0.51**	0.16	1.00					
10. Intention-Unfulfilled/Desire-Satisfied	0.06	0.24	0.29	0.05	0.29	0.15	0.25	0.17	0.19	1.00				
11. Intention-Fulfilled/Desire-Unsatisfied	0.10	-0.14	0.41*	0.08	0.12	-0.21	-0.08	0.09	0.02	-0.10	1.00			
12. Same/Different	-0.01	0.09	0.11	0.15	0.18	0.41*	-0.12	-0.03	-0.01	0.03	-0.05	1.00		
13. Different/Different	0.08	0.43**	0.27	-0.11	-0.10	0.24	0.07	0.33	0.08	-0.13	0.04	0.30	1.00	
14. Same/Same	0.26	-0.15	-0.14	-0.15	0.00	0.06	0.46**	0.04	0.17	0.06	0.09	-0.16	-0.19	1.00

TD

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Successful Teaching	1.00													
2. Who Should be Taught	-0.08	1.00												
3. Failed Teaching	-0.05	-0.04	1.00											
4. Successful Imitation	-0.15	-0.04	0.15	1.00										
5. Embedded Teaching	-0.13	0.25	0.42*	-0.14	1.00									
6. Overestimate Learner	0.19	0.16	0.11	0.48**	0.08	1.00								
7. Overestimate Self	0.17	0.05	-0.14	0.00	0.00	0.13	1.00							
8. Intention-Fufilled/Desire-Satisfied	-0.05	-0.04	1.00**	0.15	0.42*	0.11	-0.14	1.00						
9. Intention-Unfufilled/Desire-Unsatisfied	0.28	-0.06	-0.11	0.11	0.38*	0.26	0.29	-0.11	1.00					
10. Intention-Unfulfilled/Desire-Satisfied	0.12	0.04	-0.31	-0.03	0.02	0.23	0.06	-0.31	0.27	1.00				
11. Intention-Fulfilled/Desire-Unsatisfied	-0.04	0.17	0.12	0.03	0.08	0.10	0.14	0.12	0.02	-0.12	1.00			
12. Same/Different	0.56**	0.16	-0.09	-0.08	-0.22	0.04	0.25	-0.09	0.23	0.00	0.21	1.00		
13. Different/Different	-0.08	0.47**	-0.04	-0.04	0.25	0.16	0.05	-0.04	-0.06	-0.12	0.02	-0.13	1.00	
14. Same/Same	0.26	-0.15	-0.14	-0.15	0.00	0.06	0.46**	0.04	0.17	0.06	0.09	-0.16	-0.19	1.00

Note. ** *Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).*

Several correlations were observed for the HFA children. A significant relation was found between the ‘who should be taught’ task and the different action-different intention task, the ‘failed teaching’ task and the intention-fulfilled/desire-unsatisfied task, the ‘overestimate-learner’ task and the same action-different intention task, and the ‘overestimate-self’ task with both the intention-unfulfilled/desire-unsatisfied task and the same action-same intention task. Correlational analyses at the task level of each measure revealed several associations between the teaching items and the Baird and Moses (2001) tasks in the HFA group.

For the TD children there were also several significant relations between the two measures’ items: the successful teaching task correlated with the same action-different intention task; the ‘who should be taught’ task correlated with the different action-different intention task; the ‘failed teaching’ task perfectly correlated with the intention-fulfilled/desire-satisfied task; and the ‘embedded teaching’ task correlated with the intention-fulfilled/desire-satisfied task, the intention-unfulfilled/desire-unsatisfied task, and the same action-same intention task. The correlations between the Baird and Moses (2001) tasks and several teaching task items is interesting given that these intention tasks did not correlate with overall teaching. However, the increase in variability among the variables simply by comparing teaching tasks to intention tasks rather than overall teaching score to intention tasks could certainly account for the increase in observed correlations. It is also possible that the resulting correlations indicate that in TD children there is a relation, at the task level, between the teaching battery and the intention-in-action measures.

The pattern of correlations observed between the two groups was also of interest. To begin with, there were few similarities. Both groups showed a correlation between teaching and the intention-unfulfilled/desire-unsatisfied task. An increase in associations among the variables occurred, for target and controls, when both measures were analyzed at the task level. And in both groups, the failed teaching task correlated with the different action-different intention task. However, there were several differences between the two groups. Six correlations were observed in the teaching tasks and intention-in-action task analyses for the HFA group, whereas five correlations were observed for the TD group. Of the six correlations reported, only one relation matched between the two groups. The other five correlations in the HFA group involved pairs of related variables either for the teaching task, the intention-in-action task, or both that were distinct from the correlated pairs in the TD group. This pattern suggests that certain teaching tasks are related to certain intention-in-action tasks differently for HFA children and TD children.

Theory of Mind Developmental Sequence. ***Research Question 4***: *Is the pattern of theory of mind attainment in high functioning children with ASD similar to the developmental pattern observed in high functioning children with ASD by Peterson, Wellman, and Liu (2005)?*

An important question in children with HFA is whether their theory of mind development compared to TD children is simply delayed and so follows the same sequence but at a later age, or whether their pattern of theory of mind development is altogether different and thus forms a distinct sequence. Peterson and colleagues (2005) used a five-item theory of mind scale to address this question and found that theory of mind development among HFA children produced a scale of theory of mind development that was different from TD children. The pattern of theory of mind development that Peterson et al. (2005) found in their HFA sample has been replicated only once in a follow-up study that examined performance of HFA children and slightly older children with Asperger's Syndrome on an augmented version of the theory of mind scale that included the same five-item battery with an additional sixth sarcasm understanding task (Peterson, Wellman, & Slaughter, 2012).

Therefore, if the original scale is retained in the HFA participants in this study, it would provide evidence supporting Peterson et al.'s (2005) suggestion that theory of mind in HFA children not only follows a particular progression, but also a different developmental pattern than TD children. Moreover, the five-item scale itself has only been examined once in a sample of 36 Australian HFA children. Therefore, it is important to determine whether or to what degree this scale replicates in a similar, slightly younger population. What's more the data will provide novel evidence about the particular pattern of theory of mind development in younger HFA children. And employing a scale of theory of mind development offers an opportunity to address both the question of developmental delay and sequence.

Table 15 shows overall performance on the five-item theory of mind scale for our sample of HFA and TD children, and Peterson et al.'s (2005, 2012) sample of HFA children for comparison purposes. HFA children in our study performed above chance on the diverse desires task and diverse beliefs task. TD children performed at ceiling on the diverse desires task, were highly successful on the diverse beliefs task and the knowledge access task, and were above chance on the false belief task. Overall, HFA children's pass rate on each of the tasks was lower than the corresponding rate for the TD group. This pattern was also the case for the HFA group when compared to the pass rates in Peterson et al.'s (2005) HFA sample.

However, it should be noted that compared to the HFA children in our study, the Peterson et al. (2005) sample's mean chronological age (CA) was approximately 1.5 years older (M = 7.77 vs. 9.32, respectively), age range was identical on the young end but was approximately six full years older on the old end (6;3-8;10 vs. 6;3-14;2, respectively), and average verbal mental age (VMA) was approximately 22 months older (72.23 vs. 94.31, respectively). The age range and average VMA for the HFA sample in Peterson et al. (2012) is not available. However, the mean CA was also more than one full year older than the HFA children in this study (approximately 1.25 years older, M = 9.02 and 7.77, respectively). Therefore, exact comparisons between our study and either Peterson et al. (2005, 2012) are not possible. Nevertheless, because this study represents one of only two samples of HFA children to be given the five-item theory of mind scale, it remains important to use the original and follow-up studies as an approximate guide for comparison purposes.

Table 15.

Theory of Mind Performance by Task

Task	% passing	% passing	Peterson et al., (2005) % passing	Peterson et al., (2012) % passing
	HFA	TD	(HFA)	(HFA)
Diverse Desires	83*	100*	86	93
Diverse Beliefs	77*	91*	86	86
Knowledge Access	57	91*	75	70
False Belief (Contents)	29	66*	47	43
Real-Apparent Emotions	31	40	64	52

*Note. * indicates above-chance (50%) performance.*

A 2 (group) X 5 (task) repeated measures ANOVA, modeling group as the between-subjects factor, task question as a within-group factor, and the interaction between the two yielded a main effect of group ($F(1, 68) = 28.02$, $p < .001$) and task ($F(1, 68) = 17.65$, $p < .001$). These analyses indicated that the mean scores on three out of the five of the theory of mind tasks were lower in the HFA group than their corresponding task in the TD group.

Chi square analyses were used to test group differences by item to determine whether the mean score differences were significant between the HFA and TD groups on each of the five theory of mind tasks. Fisher's exact test was reported for all cases with expected frequencies less than 5 (two-sided). Analyses revealed differences between HFA children and TD children were significant for the diverse desires task ($\chi^2(1) = 6.56$, $p < .05$), the knowledge access task ($\chi^2(1) = 10.77$, $p < .01$), and the false belief task ($\chi^2(1) = 9.69$, $p < .01$). There were no significant differences between groups on the diverse beliefs task and the real-apparent emotions task; however, the diverse beliefs task was approaching significance ($p = .09$).

Given the chronological and verbal age differences between our HFA sample and the HFA samples in Peterson et al. (2005), it is not surprising that the observed pattern of performance on the pass rates for several of the tasks in the HFA group did not line up with the pass rates in Peterson et al.'s (2005) HFA group. Both groups tended to perform well on the first three tasks. However, the Peterson et al. sample performed better on the real-apparent emotion task than the false belief task (64% correct and 47% correct, respectively). HFA children in the Peterson et al. (2005) sample also performed significantly better than the study's TD controls on the real-apparent emotions task and significantly worse on the false belief task. These same patterns between our HFA sample and the HFA sample in their follow-up 2012 study were also observed. Moreover, HFA children in their follow-up study also performed significantly better than the study's TD controls on the real-apparent emotions task (Peterson et al., 2012).

However, the HFA children in our study performed well below chance and equally poorly on both the false belief task and the real-apparent emotion task (29%

correct and 31% correct, respectively), and did not perform significantly better than TD children on the real-apparent emotions task. It entirely possible that the difference observed between these two patterns of performance can be accounted for by the significantly larger age range (on the older end), older mean CA, and older mean VMA in the Peterson et al. (2005) sample, and older mean CA in Peterson et al. (2012). That is, our younger sample may not be as far along developmentally as Peterson et al.'s HFA samples, which would explain why our sample's similar performance on the false belief task and the real-apparent emotion task. Although scaling analyses were performed and are reported below, the fact that the HFA children in this study's performance on the false belief task and the real-apparent emotions task did not differ indicates that the pattern of performance for the theory of mind scale did not entirely match the pattern of performance observed in the Peterson et al.'s original (2005) or follow-up (2012) samples of HFA children.

Scaling. Scaling analysis for the theory of mind battery followed procedures used for the Peterson et al. (2005) HFA sample. This was done to determine if the HFA children in the current study follow the same developmental pattern as Peterson et al.'s (2005) HFA sample. The five tasks that form the theory of mind scale in Peterson et al.'s (2005) sample of HFA children in which the order of scaled items had the false belief task and the real-apparent emotions task reversed formed a Guttman scale with an index of reproducibility of .95 and an index of consistency of .55, both of which were statistically significant (Peterson et al., 2005, p.510). Rasch analyses confirmed Guttman scaling structure for the HFA group.

Guttman scaling procedures for the HFA children in this study found the five items significantly increased in difficulty, with an index of reproducibility = .92. However, Green's (1956) index of consistency = .12, indicating that the observed response pattern did not occur above chance. The battery also did not scale when the last two items were not reversed and kept in the original Wellman and Liu (2004) order. Therefore, the five-item theory of mind scale with the false belief task and the real-apparent emotions task reversed did not scale for this particular sample of HFA children.

Data for the five items in HFA group were subsequently analyzed using a Rasch model. Table 16 shows ordered solutions from least difficult to most difficult for item and person for the HFA group. Following procedures by Peterson et al. (2005), item difficulty and person ability measures in the Rasch model were rescaled so that the diverse desires task (considered to be the least difficult item; therefore, it was arbitrarily considered to be the anchor task) had an item difficulty score of 0.0.

Table 16.

Rasch Analysis Results for Item and Person in HFA Group

Item Difficulty-Fit Statistics			Infit		Outfit	
	Meaure	Error	MNSQ	ZSTD	MNSQ	ZSTD
Diverse Desires	0.00	0.52	0.75	-0.80	0.66	-0.50
Diverse Beliefs	0.32	0.48	1.18	0.70	1.14	0.40
Knowledge Access	1.65	0.41	1.03	0.20	1.12	0.60
Real-Apparent Emotion	3.21	0.45	1.05	0.30	0.81	-0.30
False Belief	3.42	0.47	0.84	-0.60	0.82	-0.20
M	1.72	0.46	0.97	0.00	0.91	0.00
SD	1.42	0.04	0.15	0.60	0.19	0.40
Person Difficulty-Fit Statistics (31 non-extreme cases)						
M	1.88	1.15	0.99	-0.10	0.91	0.00
SD	1.15	0.06	0.75	1.20	1.00	1.00

The Rasch model confirmed the Guttman scaling findings that the items did not form a reliable scale for this sample of respondents. Fit statistics for each of the five items all fell within the acceptable range, except for outfit MNSQ for the diverse desires task; however, this outcome was expected given that this item was arbitrarily anchored as the least difficult task. Cronbach's alpha for overall item fit was .89. The person infit and outfit statistics also fell between .75 and 1.33 MNSQ, but Cronbach's alpha for overall person fit was .01. The item fit results suggest valid item parameters. However, both fit statistics are important and poor person fit (i.e., coefficient less than .50) indicates the item-score response pattern is statistically "improbable" (Meijer & Sitsma, 2001). That is, the HFA children's response patterns did not conform to the model. Therefore, the five-item theory of mind scale with the false belief task and the real-apparent emotions task reversed did not scale for this particular sample of HFA children.

Guttman procedures and Rasch modeling were also used to examine scalability in the TD group. Table 17 shows ordered solutions from least difficult to most difficult for item and person for the TD group. Guttman procedures for Wellman and Liu's (2004) original five-item scale found the tasks significantly increased in difficulty, with an index of reproducibility = .97, but with an index of consistency = .40. Thus, the observed response pattern did not occur above chance. Rasch modeling confirmed the Guttman scaling findings that the items did not form a reliable scale for this sample of TD respondents. Cronbach's alpha for overall item fit was .89. The person infit and outfit statistics also fell between .75 and 1.33 MNSQ; however, Cronbach's alpha for overall person fit was .25.

In Wellman and Liu's (2004) original study, the five tasks formed a Guttman scale with an index of reproducibility = .96 and an index of consistency = .56, indicating that the five items formed a highly scalable set (see order and descriptions in Chapter 2: Literature Review). In our study, the low index of consistency for the TD participants indicates a lack of uniformity in response patterns across the group. This result was not surprising, though, given that a significant portion of the children (54%) in this sample are at least one year older than the oldest group of children (5-year-olds) in the Wellman and Liu (2004) sample, making comparisons less valid.

Table 17.

Rasch Analysis Results for Item and Person in TD Group

Item Difficulty-Fit Statistics			Infit		Outfit	
	Meaure	Error	MNSQ	ZSTD	MNSQ	ZSTD
Diverse Desires*	0.00	1,58	0.23	-0.70	0.03	-1.00
Diverse Beliefs	2.73	0.79	1.34	0.80	0.73	0.30
Knowledge Access	2.73	0.79	0.40	-1.40	0.14	-0.50
False Belief	5.97	0.53	1.06	0.30	0.95	0.10
Real-Apparent Emotion	8.54	0.64	0.96	0.00	0.56	0.10
M	4.00	0.87	0.80	-0.20	0.48	-0.20
SD	2.96	0.37	0.42	0.70	0.35	0.50
Person Difficulty-Fit Statistics (24 non-extreme cases)						
M	6.96	1.75	0.94	-0.20	0.48	-0.30
SD	2.30	0.25	1.27	1.00	0.67	0.60

*Note. *Performance on this item 100%.*

It is important to note here that when the responses in the HFA sample in the Peterson et al.'s (2005) original study were ordered as in Wellman and Liu (2004), their index reproducibility was .90 and their index of consistency was .29. When the HFA children's responses in the current study were ordered as in Wellman and Liu (2004), their index of reproducibility was .92 and their index of consistency was .15. Given the HFA children's similar performance between the false belief task and the real-apparent emotions task in this study, it was understandable that their response pattern did not fit either the original Wellman or Liu (2004) or Peterson et al. (2005) ordered scale. However, the first three tasks did form a pattern similar to the pattern observed in Peterson et al. (2005, 2012) raising the possibility that the difference between the two samples lies in performance on the false belief task and the real-apparent emotions task.

Given the age and design differences between the current study and Wellman and Liu (2004), it was expected that the TD group here would not fit the original Wellman and Liu (2004) scale. The sample in our study performed at ceiling on the diverse desires task and 11 or 31% of the TD participants performed at ceiling in their overall scale score. This accounts for the 24 non-extreme measures that the Rasch model reported above for the overall person difficulty fit statistics. Moreover, the TD children performed equally well and near ceiling on both the diverse beliefs task (91%) and the knowledge awareness task (91%). Finally, a majority of the children (54%) in our sample were at least one year older than the oldest group of children (5-year-olds) in the Wellman and Liu (2004) sample. Together, these various factors make comparisons between the sample of TD in the current study and Wellman and Liu's (2004) original sample is less valid and meaningful.

The Understanding of Intentions-In-Action. ***Research Question 5***: *Is the understanding of the distinction between desires and intentions, and actions and intentions intact or impaired in children with autism spectrum disorder (ASD) as compared to matched controls?*

The research that has investigated the ability to understand intentions in others in HFA children has yielded dissimilar results (e.g., Phillips et al., 1998; Russell & Hill, 2001; Williams & Happé, 2010). This study presented a battery of intention tasks that provided a novel paradigm to examine HFA children's judgments of intentions in others.

Four tasks adapted from Schult (2002, Study 1) examined the ability to distinguish between desires and intentions. Three tasks used in Baird and Moses (2001, Study 4) explored the ability to understand that different intentions may be used to carry out one-and-the-same action.

Preliminary analyses were conducted to determine if there were any effects of story, story order, or condition order. For the HFA group, there were no effects in either intention measure of story, story order, or condition order, with one exception: McNemar's chi-square test found a significant difference for the HFA children between the two desire questions for the male/female versions of the intention-unfulfilled, desire-unsatisfied condition (χ^2(1, = 10.75, p < .01) (see Chapter 3: Methods for a full description and Appendix C for task examples). However, this difference is not meaningful for the questions this study addresses given the following: HFA participants performed poorly on both desire questions—Eighteen (51%) HFA participants correctly answered the desire question in the female story while 22 (63%) answered the desire question correctly in the male story, and neither response proportions were above chance. More importantly though, this was the only case for either group in which four out of the thirty-five responses differed between the male and female intention questions for any one condition and the male and female desire questions for any one condition. That is—no significant differences were found within the target or control groups, between any of the other desire questions or intention questions for any of the male-female stories across the other three conditions. Therefore, this factor was not included in the main analyses.

For the TD group there were no effects in either intention measure of story, story order, or condition order.

Intention-Desire Distinction Measure. This study was concerned with two overarching questions for the intention-desire distinction measure: 1) whether there was variation between groups (a) across the four tasks, (b) between the concordant and discordant story types, (c) at the task level within each story type, and (d) at the level of question type; and 2) whether there was variation within each group between the two question types for each of the story types.

To examine overall performance between the groups across the four tasks, a 2 (group) X 4 (task) repeated measures ANOVA was performed, modeling group as the between-subjects factor and task (i.e., combined intention and desire question) as the within-group factor, and the interaction between the two (see Table 18 for overall performance by group for all four tasks). There was a main effect of group ($F(1, 68) = 16.37$, $p < .001$) and task ($F(2.25, 152.85) = 30.43$, $p < .001$), and the interaction of group and condition ($F(2.25, 152.85) = 3.07$, $p < .05$).

Between group performance on the two concordant (*both* intention and desire do or do not come about) and two discordant (either the intention *or* the desire comes about but not both) story types was also of interest. A 2 (group) X 2 (task: concordant vs. discordant) repeated measures ANOVA revealed an effect of group ($F(1, 68) = 46.73$, $p < .001$), indicating there was a difference between the groups on the concordant and discordant story types. One-way ANOVAs for group were then used to analyze collapsed scores for the intention and desire question across the two concordant tasks and the two discordant tasks. The groups were found to significantly differ on the concordant story types ($F(1, 68) = 10.49$, $p < .01$) and on the discordant story types ($F(1, 68) = 9.34$, $p < .01$), indicating that HFA children performed worse than on the TD children overall for each story type.

To determine differences at the task level, group interaction by condition was decomposed using independent samples t-tests with a Bonferroni correction at $p < .025$ (the Bonferroni-adjusted two-tailed t test significance value was calculated by dividing the threshold value of .05 by the number of comparisons (2), resulting in an adjusted threshold of significant group differences of $p < .025$). HFA children's score for the intention-unfulfilled/desire-unsatisfied condition was significantly lower than the TD group ($t(68) = 3.10$, $p < .01$). There was also significant variation between groups with the HFA group being outperformed by TD controls on scores for both the intention-unfulfilled/desire-satisfied condition ($t(68) = 1.99$, $p < .05$, unadjusted) and the intention-fulfilled/desire-unsatisfied condition ($t(68) = 2.10$, $p < .05$, unadjusted). There were no differences for the intention-fulfilled/desire-satisfied condition.

Table 18 shows pass rates for the intention question and the desire question by group and story type. The number of correct or "yes" responses was summed separately for the intention question and for the desire question for each task (*range* = 0-2). A 2 (group) x 4 (task) repeated measures ANOVA on the intention question revealed a significant main effect of task ($F(1.99, 135) = 33.17$, $p < .001$) and group ($F(1, 68) =$

7.02, p = .01). For the desire question, a 2 (group) x 4 (task) repeated measures ANOVA revealed a main effect of task (F(2, 137.5) = 27.21, p < .001) and group (F(1, 68) = 14.18, p < .001).

Table 18.

Intention-Desire Distinction Task Performance, Pass Rates by Group and Condition

Condition	HFA		TD		Schult (Study 1, 4-year-olds, 2002)	
	Intention	Desire	Intention	Desire	Intention	Desire
I+D+	.93*	.90*	.97*	.97*	1.00	1.00
I-D-	.44	.57	.71*	.87*	.86	.97
I-D+	.21	.93*	.31	1.00*	.50	.92
I+D-	.63	.46	.59	.70*	.61	.75

Note. Asterisks (*) indicate above-chance (50%) performance. I+D+, intention-fulfilled/desire-satisfied; I-D-, intention-unfulfilled/desire-unsatisfied; I-D+, intention-unfulfilled/desire-satisfied, and I+D-, intention-fulfilled/desire-unsatisfied .

Thus far, analyses have examined whether there was variation between the two groups on overall task performance, as well as performance on the intention question and the desire question. These analyses provide information about group response patterns across the four conditions for the intention and desire questions separately. However, it is also essential to explore the response patterns within each group between the intention questions and the desire questions for the concordant and discordant story types.

For both groups, one-way ANOVAs with question (plan versus want) as a repeated measures factor was computed to determine whether there was variation in performance between the number of correct responses to the intention question and to the desire question for the concordant stories. Analyses revealed a significant effect for the intention-unfulfilled/desire-unsatisfied story for the HFA children ($F(2, 32) = 7.36$, $p < .01$) and TD children ($F(2, 32) = 6.70$, $p < .05$). There were no differences in either group for the intention-fulfilled/desire-satisfied condition.

For the discordant stories, analyses revealed a significant effect for the intention-unfulfilled/desire-satisfied condition for the HFA children ($F(1, 34) = 62.96$, $p < .001$) and TD children ($F(1, 34) = 111.96$, $p < .001$). There were no differences in either group for the intention-fulfilled/desire-unsatisfied condition. The pattern of performance within each group is similar for the concordant and discordant story types. However, it is important to recall that the TD group performed significantly above chance on both the intention question and desire question in the intention-unfulfilled/desire-unsatisfied condition. Moreover, the TD group's performance on the desire question for both the intention-unfulfilled/desire-unsatisfied condition and the intention-fulfilled/desire-unsatisfied story parallels the performance observed in Schult's (2002) 4-and 5-year-old groups who also performed above chance on the desire question for both conditions.

Unlike the 4-year-olds observed in Schult's (2002) study and the TD controls in this study, the HFA participants performed poorly (below chance) on the desire question for both the concordant and discordant story type in which the desire was not satisfied. This response pattern deviates from the similar pattern observed between the TD children in this study and Schult's (2002) 4- and 5-year-old groups in which children performed well above chance on the desire question across all four tasks. These findings are interesting given that they provide novel information about HFA children's understanding of the intention-desire distinction in others. The 4- and 5-year-old groups in Schult's (2002) sample, as well as both HFA and TD groups in the current study struggled with the intention question in the discordant stories. However, only the HFA children also struggled with the desire question for the same type of concordant and discordant story—*viz*., stories in which the desire did not come about.

The difference between the two groups in their respective response patterns to the intention question and the desire question in the concordant and discordant story types is also worth noting. In contrast to Schult's (2002) findings that 4- and 5-year-old children answered the intention question and the desire question differently for both the discordant story types, the HFA children in this study did not. And unlike the HFA children, it was also the case that the responses to the two questions were not different for the concordant stories for the two age groups in Schult's (2002) sample.

Two Intentions-Identical Actions Measure. Performance on the two intentions-identical actions measure can be seen in Table 19. Pass rates are shown by group and condition. Consistent with Baird and Moses (2001, Study 4), participants correctly answering the first intention question of each story was ensured because if they answered it incorrectly they were reminded of the character's intention and desire for that story and then the intention question was asked again (see Appendix D for an example of this task). Therefore, a child scored one point for each correct answer on the second intention question of each story. Scores ranged from 0 to 2 in each condition.

Table 19.

Two Intentions-Identical Actions Task Performance, Pass Rates by Group and Condition

Condition	HFA	TD	Baird & Moses (Study 4, 2001)
Same Action-Different Intention	0.73*	0.89*	0.63
Different Action-Different Intention	0.87*	0.97*	0.92
Same Action-Same Intention	0.70*	0.83*	0.81

Note. Asterisks (*) indicate above-chance (50%) performance

The two questions that are of primary interest to this measure are whether there was variation between the groups across the three conditions and how each group performed on the intention questions for each condition. Between-group performance across the conditions was examined in a 2 (group) X 2 (story: story 1 vs. story 2) X 3 (condition: Same-Different vs. Different-Different vs. Same-Same) repeated measures ANOVA modeling group as the between-subjects factor, story and condition as the within-group factors, and the interaction between the two. Analyses revealed main effects of group ($F(1, 68) = 12.98$, $p < .001$) and condition ($F(2, 67) = 7.98$, $p < .001$). HFA children performed significantly worse than TD children in the same action–different intention condition ($t(68) = 2.50$, $p = .01$, Bonferroni-adjusted) and in the different action–

different intention condition ($t(68) = 2.12$, $p < .05$, unadjusted), but not significantly different in the same action–same intention condition p > .10.

Within group performance on this measure was also examined. A one-way ANOVA revealed that the HFA participants performed significantly worse in the same action-same intention condition than in the different action-different intention condition ($F(1, 34) = 4.39$, $p < .05$), but not in the same action-different intention condition. The HFA group also performed significantly worse in the same action-different condition than in the different action- different condition ($F(1, 34) = 6.42$, $p < .05$). For the TD group, a one-way ANOVA revealed that children performed significantly worse in the same action-same intention condition than in the different action-different intention condition ($F(1, 34) = 5.67$, $p < .05$), but not in the same action-different intention (p < .40). As well, they performed significantly worse in the same action-different condition than in the different action- different condition ($F(1, 34) = 3.90$, $p < .05$). Although there was variation within each group across the conditions, both groups performed significantly above chance on all three conditions. This suggests that HFA children and TD children were able to distinguish between the intentions in these stories and the actions they brought about.

The findings for our group of TD children are inconsistent from the results observed by Baird and Moses (2001, Study 4) who found that 4-year-olds performed significantly better on both the same action-same intention condition and the different action-different intention condition than the same action-different intention condition.

The sample in Baird and Moses (2001) also did not perform above chance on the latter condition, but did perform above chance on the two former conditions. Compared to the performance from their sample of 4-year-olds, the performance of the TD children in the current study was both expected and unexpected. It was not surprising that the TD children with a mean age of 72 months performed better than a sample of TD children with a mean age of 53 months (Baird & Moses, Study 4). However, it was somewhat surprising that despite the 1.5 year difference between the mean age of these two groups, and that this study's population was the older sample, the TD children's performance in our study on the same action-same intention condition and the same action-different intention condition was approximately the same. Further, the children's performance in the original study on the same action-same intention condition and the TD children's performance in this study were strikingly similar (81% versus 83% correct, respectively).

The HFA children's performance on this measure, though, was of central interest. The findings indicate that the HFA children in this sample were able to differentiate successfully between actions and intentions across all possible combinations of two stories in which two actions that are brought about by two intentions are the same or different (see Chapter 5: Discussion for a detailed treatment of these results).

Exploratory Data. Exploratory data was collected on the last ten participants in the HFA group and on all TD controls. The reason exploratory work was conducted partway through data collection for the HFA children was based on the observation that about 80% of the first 16 HFA children tested responded correctly to the embedded teaching task test question. Preliminary analyses indicated that the proportion of correct answers on this task was significantly above chance ($p < .05$). The correct answer was “teach”; the incorrect answer was “play”. Given the near chance performance on other tasks that have been found to be easier in TD populations, such as the successful teaching task and the ‘who should be taught’ task, the pattern of performance seemed rather peculiar and worth investigating.

We speculated that this performance could have been attributed to a ‘*Teach bias*’ (i.e., the children were simply saying “teach” as form of ‘yes bias’ rather than to indicate an understanding of the intentions of the teacher in the context of a game). In light of this observation, an embedded teaching control task was constructed and tested on the remaining final 15 HFA children and on all 35 TD controls (see Appendix E for an example of all exploratory tasks). The control task required the correct answer to be “play”. It was hypothesized that if HFA children were falsely getting the embedded teaching task question correct, then good/poor performance on this task might provide some evidence to the claim that they were either exhibiting a “Teach bias” (poor performance) or that they were not exhibiting a “Teach bias” (good performance). What’s more, if the remaining 15 HFA children performed well on the embedded teaching control task, and the trend in the results remained in a larger sample, then it would lend supportive evidence that they did in fact appreciate the intention in an ambiguous situation. Performance on the task by the TD group was also thought to provide additional support for or against the use of this task as a control.

In addition to the embedded teaching control task, exploratory controls for the overestimate-learner and overestimate-self were also designed and tested. We decided to include these two tasks as a matter of convenience (i.e., since we were already testing one task at the end, we thought to as well test a few others) and for pure exploratory purposes. Similar to the embedded teaching task control, these two control items presented the opposite outcome to the original task as the correct answer, (e.g., in the *under*estimate-learner task, the correct answer is “Not try to teach”). All three measures were randomized and question order was counterbalanced. Both groups were given the exploratory set after all four measures had been tested (i.e., at the end of the second visit). Table 20 shows performance by group on each of the understanding of teaching exploratory control tasks. Both HFA and TD children performed well on the underestimate-learner control task (67% and 74%, respectively). The HFA group, though, performed at floor on the underestimate-self task and poorly on the embedded teaching control task (13%). TD children also performed poorly and below chance on these tasks (14% and 40%, respectively).

Table 20.

Exploratory Understanding of Teaching Items Pass Rates by Group

	HFA	**TD**
Underestimate-Self (Control)	0.00	0.14
Underestimate-Learner (Control)	0.67	0.74*
Embedded Teaching (Control)	0.13	0.40

Note. N (HFA) = 10; N (TD) = 35
Asterisks (*) indicate above-chance (50%) performance.

HFA children did not perform above chance levels (57%) on the embedded teaching task (see Table 15) and the HFA group also performed poorly on the embedded teaching control task (13%). Should the trend observed here hold in a larger sample of HFA children that uses a balanced design, then the implications of these results suggest that HFA children found the embedded teaching task slightly easier than its control and that this may have been due to the fact that "Teach" was not the correct answer in latter task.

The HFA children's poor performance on the other two tasks is also of note. The floor performance on the underestimate-self exploratory task stands in stark contrast to the group's overall performance on the original overestimate-self task (51%, see Table 6). However, there were differences between the over-and underestimate-self tasks which could have accounted for the at floor performance. The underestimate-self task involved an additional character and additional content. This difference could have overwhelmed participants and simply been too complex of a story to follow to solve the task. It also could have been more difficult to conceptualize someone underestimating their own knowledge (i.e., thinking they do not know something that they in fact do know). It is also worth highlighting that the HFA group's pass rate on the underestimate-learner (67%) was greater than the entire sample's pass rate on the overestimate-learner (17%). Should these trends be upheld with the same caveats described above, then these findings would lend evidence to the idea that HFA children struggle with teaching tasks that require an appreciation of an awareness of the knowledge difference between teacher and learner.

The TD group's performance across the three tasks was of interest as well. As a result of the poor performance on the embedded teaching task, the underestimate-self task, and the overestimate-learner task, expected frequencies were not sufficient for chi square analyses to examine within group differences for each of these tasks and the embedded teaching control task, the overestimate-self task, and the underestimate-learner task, respectively. However, the pass rates between each of the three sets of task comparisons show several stark differences. TD children performed well above chance on the embedded teaching task (86%) and the underestimate-learner (74%) task whereas they performed below chance on the embedded teaching control task (40%) and the overestimate-learner (29%) task. Although TDs performed below chance on both of the over/underestimate-self task, there was a qualitatively large difference between performance on the two tasks—the group performed slightly below above chance on the overestimate-self task (60%) whereas they performed near floor on the underestimate-self task (14%). Similar to the reasoning for the HFA group on this task, the complexity of the underestimate-self task could be the reason the TD group also performed more poorly on this task compared to their performance on the overestimate-self task.

The descriptive differences seen in these data between the TD group's performance on the original versus control embedded teaching tasks, the over- versus underestimate-learner tasks and the over- versus underestimate-self tasks is interesting. The observed patterns very well may be informative and provide further insight to young TD children's understanding of teaching. However, the age range, and design confounds would all have to be controlled for in order to infer meaningful outcomes from the data.

CHAPTER 5: Discussion

This study investigated the understanding of teaching in high functioning children with Autism Spectrum Disorder (HFA). Specifically, the aim of the study was to examine whether HFA children were delayed or impaired in their understanding of the concept of teaching compared to typically developing (TD) children individually matched on verbal ability. Our results indicate that HFA children are delayed in their understanding of the concept of teaching. Compared to TD children, HFA children are also delayed in theory of mind understanding and the understanding of particular intentions-in-action in others. Our results also suggest that HFA children's understanding of particular intentions-in-action is not only delayed, but also differs from TD children's understanding of intentions-in-action.

In the following chapter, we discuss key findings and implications for each of the socio-cognitive measures. This follows with a discussion of the limitations of our study and future directions. The chapter concludes with the implications the current project has for studying and improving the ability of a child with HFA to learn from others.

Understanding of Teaching in HFA Children

The current study is unique as it is the first of its kind to examine the understanding of teaching in HFA children. Our results confirmed our expectations for ***Research Question 1*** that the understanding of teaching is delayed in children with HFA. Specifically, our data indicate that HFA children are delayed in understanding the two pillars that support the concept of teaching: 1) the awareness of a knowledge difference between teaching and learner; and 2) that teaching is an intentional activity.

For our study, HFA children were given a seven-item understanding of teaching battery of tasks. They responded at or below chance on six out of the seven tasks (see Table 6). The one item they performed reasonably well on (i.e., significantly above chance) was the failed teaching task, with a pass rate of 69%. In contrast, the TD matched controls outperformed their HFA counterparts and were well above chance on four out of the seven tasks. The three tasks that TD children performed poorly on are the same three tasks that previous studies have found to be the most difficult for similarly aged TD children (e.g., Woodburn, 2008; Ziv & Frye, 2004; Ziv, Solomon, & Frye, 2008). Taken together, this overall finding suggests that HFA children with an average VMA of 6 years, 0 months (6;0) and CA of 7 years, 9 months (7;9) are delayed in the understanding of the concept of teaching compared to TD children with the same average VMA (6;0) and younger CA (6;1).

Pillar I. Knowledge Difference. The first major conclusion of our study is that HFA children do not appreciate that teaching requires a knowledge difference between teacher and learner. In other words, this aspect in the understanding of teaching is developmentally delayed in HFA children compared to younger TD children with the same verbal ability. Previous research has not directly investigated the understanding of teaching in HFA children. Therefore, direct comparisons between our sample of HFA children and the literature are not possible. However, previous research has provided evidence that lends indirect support to our findings on the knowledge-difference based teaching tasks. A wide range of studies using various false belief paradigms have demonstrated that HFA children are not above chance at passing false belief tasks until they have an average estimated VMA of 9;2 (Happé, 1995). Consistent with this general finding, we also observed a group of HFA children with an average estimated VMA younger than 9;2 whose performance fell below chance at passing a standard false belief task (29% pass).

Performance on false belief tasks in TD children has been found to relate to performance on the overestimate-self and overestimate-learner teaching tasks (Ziv & Frye, 2004). Success on the overestimate-self and the overestimate-learner tasks in the teaching battery requires an appreciation of the awareness by the teacher, whether true or false, of a knowledge difference between him/her and learner. Success on these tasks in the teaching battery requires recognizing the teacher's false belief about either his/her own knowledge (overestimate-self) or the learner's knowledge (overestimate-learner) as what determines whether teaching will occur. The HFA children in the current study performed poorly on the overestimate-self task (51% pass) and the overestimate-learner task (17% pass). Poor performance is not likely attributable to confusion about the basic story contents as children were near ceiling on the memory checks for each task. Although these tasks were not correlated with the false belief task, HFA children's overall performance on the teaching battery did significantly correlate with overall performance on the theory of mind scale. Given the poor performance on the false belief task, the overestimate-self task and the overestimate-learner task, as well as the overall relation between performance on the teaching battery and theory of mind scale, it is still reasonable to suspect that the HFA children's poor performance on the false belief task, plays a role in their lack of success (i.e., below chance) at solving these tasks.

Interestingly, the HFA group also performed poorly on the 'who should be taught' task, a teaching task in which success does not demand an understanding of false belief. The 'who should be taught' task is designed to test whether children understand that a person who has a particular skill (e.g., how to read) will teach a person who does not have that skill (does not know how to read) rather than a person who does have that skill (knows how to read), when determining whom to teach (Ziv & Frye, 2004). In the teaching battery, the story involves an adult teacher who has the option of teaching two children how to read, one of whom does not know how read and the other who does know how to read. The participant is asked which child knows how to read as a memory check and then asked which of the two children will the teacher teach how to read. Although nearly all of HFA participants answered the memory question correctly, they still failed to respond above chance on the test question (63% pass), which is in contrast to the TD controls who performed quite well (91% pass) on the task. A previous cohort of TD 3-and 4-year-olds also performed over 90% on a similar version of the task (Ziv & Frye, 2004). The HFA children's poor performance cannot be attributed to the possibility of a simple confusion between the two characters' abilities in the story given the overwhelming majority of correct responses to the memory question. Rather, it may be the case that the HFA children's understanding of teaching relied only on the knowledge of the teacher and did not consider the knowledge of the learner. If this was the case, then it might explain why they were not above chance in selecting who the teacher will teach. This is interesting because HFA children's inability to recognize that teaching is specifically designed to convey knowledge to another who lacks knowledge or possesses mistaken information suggests that they may not recognize teaching as a distinct means of knowledge acquisition.

The previous findings in younger TD children, together with the results observed in the current study, suggest that HFA children struggle to appreciate that having a knowledge difference between teacher and learner is required for teaching to occur. This finding has implications not only for the understanding of the knowledge difference aspect of teaching in HFA children, but also for teaching itself in HFA children with a VMA of 6;1 or below. If HFA children have not grasped the teacher-learner knowledge difference, then this omission may play a role in their understanding of when, and possibly how, knowledge is transmitted between people. This lack of understanding could impair HFA children's ability to learn from others. For example, if I do not understand that the teacher, who knows the alphabet, is going to teach me *because* I do not know the alphabet, why would I expect him/her to teach me the alphabet? Or I might be confused and get bored or even frustrated because I know the alphabet, but I do not understand that the teacher who knows the alphabet is going to teach others in my class *because* they do not know the alphabet, and so I stop attending to the teachers instruction. A child with this perspective could be missing out on situations in which learning skills develop. The result also warrants future research to be conducted with a larger sample of two groups of HFA children—one with the approximate age of the children in the current study and another, slightly older group, to determine whether children with HFA are delayed and have not arrived developmentally at being able to solve this task, or whether there is a deeper lasting impairment in their understanding of this component of teaching.

HFA children struggle to appreciate the basic teacher-learner knowledge difference. Therefore, it is unsurprising that compared to the 'who should be taught' task, pass rates were lower on the knowledge-based teaching tasks that not only required an understanding of this knowledge difference but also that it is the *awareness* of the difference that determines whether teaching will occur. This result is also important because it further supports the conclusion that HFA children do not recognize teaching as a specific means of knowledge acquisition. Given the poor performance on these two teaching tasks, additional studies should be conducted with a sample of HFA children whose VMA approximates the age at which they tend to pass false belief tasks (i.e., 9;2, see above). Since HFA children at this verbal age are known to pass false belief tasks, then they also might appreciate that the awareness of a knowledge difference matters when determining whether teaching will occur.

Relation between the Understanding of Teaching and Theory of Mind in HFA Children. Our study is the first to examine the relation between the understanding of teaching and theory of mind in HFA children. Our results confirmed our prediction for ***Research Question 2*** that the understanding of teaching is related to theory of mind in children with HFA. We were interested in learning whether the understanding of teaching is related concurrently to overall theory of mind, or to specific mental state attribution understanding in HFA children. Our data established that HFA children's understanding of teaching is concurrently related to their theory of mind understanding. Specifically, HFA children's overall performance on the teaching tasks significantly correlated with their overall performance on the theory of mind tasks. There were few relations between performance on the individual teaching tasks and each of the theory of mind tasks. However, the relatively few associations observed for the HFA children between the teaching tasks and theory of mind tasks can be accounted for by the limited variability in the group's high and low performance on the majority of items.

Our interest, though, is that overall performance on the understanding of teaching battery is associated with the overall performance on the theory of mind scale in HFA children. Although we cannot determine the direction of effects between these two measures, we now have evidence indicating that they are related in this population as they are in typically developing children. Moreover, the relation suggests that there is a conceptual overlap between the understanding of teaching and theory of mind in HFA children. This connection has broad implications for the understanding of teaching in

HFA children given that theory of mind impairments are a core characteristic of autism. Future work should examine the relation we observed between the understanding of teaching and theory of mind. Additional testing of each measure in an experimental design would allow us to examine further the role that theory of mind development plays in understanding the role of knowledge attribution in teaching understanding in HFA children.

Pillar II. Intention. Our results indicate that HFA children struggle to understand that teaching is an intentional activity. Specifically, HFA children did not perform above chance on three of the four intention-based teaching tasks when TD controls did perform above chance on three of the four intention-based teaching tasks. Interestingly, the HFA children did respond at above chance levels to one of the intention based teaching items, the failed teaching task (69%, see above).

A dearth of evidence exists in the literature for drawing comparisons to our observation that HFA children's understanding of the intentional component of teaching is impaired. And as reviewed in Chapter 2, findings from the existing research on intention understanding in HFA children are inconsistent (e.g., Phillips et al., 1998; Russell & Hill, 2001; Williams & Happé, 2010). However, previous studies have examined TD children's understanding that teaching is an intentional activity (Frye & Ziv, 2005; Woodburn, 2008; Ziv et al., 2008). Therefore, the only comparisons available to the current study derive either from conflicting findings with HFA children, or from consistent findings with typical children. Although neither of these comparisons is ideal, we have chosen to focus our discussion on the previous work on the intention based component of teaching in TD children because it is free from methodological confounds and can be directly related to our findings in HFA children.

Our results are based on four intention-in-teaching tasks also used by Ziv et al., (2008). In our study, HFA children's pass rate was slightly lower on the successful teaching task (63%) than the failed teaching task (69%) and was below chance on the embedded teaching task (57%) and the observational learning task (34%). In contrast, Ziv et al. (2008) found that TD 5-year-olds significantly outperformed their younger counterparts (3- and 4-year-olds) on a failed teaching task, an embedded teaching task, and an observational learning task. However, all three age groups performed quite well (i.e., near ceiling) on a successful teaching task (Ziv et al., 2008).

The failed teaching task is designed to investigate children's understanding of intention when the outcome in an attempt to teach is that the learner fails to acquire new knowledge/skill (Frye & Ziv, 2005; Ziv et al., 2008). In the task, a teacher tries to teach a student how to perform a new skill (e.g., tie a shoe). However, after several attempts the learner still does not know how to perform the new skill (tie a shoe). If children recognize that the attempt to teach is an intentional action, regardless of the outcome (i.e., whether or not the learner successfully learns to tie a shoe), then they will correctly state that the teacher tried to teach. In our study, 69% of the HFA children correctly answered this test question, a pass rate that is significantly above chance. Taken out of context from the rest of the battery of tasks, this finding suggests that HFA children appreciate that the intentionality of teaching is based on the attempt to teach, rather than the success of the outcome in teaching. However, since HFA children failed to perform above chance on the three other intention-based teaching tasks it is worth giving pause to such a conclusion.

HFA children's performance on the successful teaching task (63%) was trending towards responding significantly above chance ($p = .06$). However, they did perform at chance on this task, suggesting that they may not have arrived developmentally at being able to solve this task. This is interesting because 3- and 4-year-old TD children have been found to perform quite well on this task (Woodburn, 2008; Ziv et al., 2008). Developmentally, this task represents one of the initial tasks children comprehend (i.e., one that is reliably passed before most others) within the seven-item understanding of teaching battery as evidenced by TD children's high level of performance as early as age 3 (Ziv et al., 2008). In our study, the difference between the failed teaching task and the successful teaching task was not significant and pass rates were approximately the same. The close proximity in pass rates between these two tasks amounts to a difference of two or three respondents answering correctly for the failed teaching task and incorrectly for the successful teaching task. One interpretation of these data is that chance alone could account for the observed pattern.

However, there is an alternative and possibly richer account for this difference. Looking at individual differences, we see that two HFA children performed at floor on the teaching battery (see Table 2). If these two children are eliminated as outliers when examining pass rates on the teaching tasks, then the HFA group's overall pass rate not only increases for failed teaching, but also, and more importantly, for the successful teaching task. The increase drives performance to a level that is significantly above chance, which suggests that these two children alone may be negatively skewing the HFA groups' overall level of performance on the successful teaching task. Further bolstering this claim is the fact that the HFA group's pass rate on the 'who should be taught' task is equal to the successful teaching task. 'Who should be taught' rounds out the trio of tasks that TD children developmentally are able to solve reliably at an earlier age (3 years) than the other four tasks, indicating that these items represent the least difficult tasks in the teaching battery (Woodburn, 2008; Ziv & Frye, 2004; Ziv et al., 2008). The same pattern for the 'who should be taught' task occurs when discarding the two floor performances on the teaching battery, which also brings the HFA group's overall performance on this task to above chance levels.

Therefore, it is reasonable to suspect that the HFA sample's above chance performance on the failed teaching task is a valid indicator of their ability to solve this task. This heterogeneity is also interesting because the two HFA children did not perform at floor on any of the other measures indicating that they were not outliers for the entire study. To determine whether the variability we observed here is something particular 1) to the actual teaching tasks, 2) to a diagnostic subset of HFA children we have not identified, or 3) simply random variation, requires additional research with a larger sample of HFA children of similar verbal ability.

In contrast, all HFA participants struggled with the embedded teaching task and the observational learning task, the other two intention-based teaching tasks. In the embedded teaching task, the instructor has the intention to teach, but the instructional activity is embedded in a game. The intention to teach is ambiguous because in the task, the teacher does not explicitly state what s/he is trying to do. Participants are asked whether the teacher is using the activity to play or to teach. Our HFA sample did not perform above chance on this task (57%). Poor performance could be attributed to excessive task demands because this item is the only task in the teaching battery that involves more than three characters and teaching to more than one person. For example, if the HFA children failed to appreciate that one can teach more than one person at any given time, then this may have confounded their ability to recognize embedded teaching in a game.

Additional evidence supporting HFA children's poor performance on the embedded teaching task is found in their performance on the embedded teaching control task, one of exploratory data items tested. Only 15 HFA participants were tested, but nearly all of them failed to answer the test question correctly (13%). Recall that the correct answer to this task is "Play" as opposed to "Teach" in the original task. The aim was to explore whether HFA children were erroneously getting the embedded teaching task question correct as a result of the fact that "Teach" may have been thought to be the correct answer regardless of story content. If these results hold in an independent sample of HFA children that uses a balanced design and if there is a difference found between performance on the two tasks, then the implications of their poor performance would suggest that the HFA children found the original embedded teaching task easier than its control. This, then, may have been due to the fact that “Teach’ was not the correct answer in latter task. It is unlikely that the poor performance was due to confusion about the task, because, similar to the embedded teaching task, nearly all of the participants answered the memory question correctly in the embedded teaching control task. However, poor performance certainly could have been due to characteristics of the story itself. This is also possible given the poor performance by the TD children on this task and the fact that they performed well above chance on the original task (87%) and below chance on the control task (40%). The design confounds, though, would have to be controlled for in order to infer valid outcomes from the data.

However, our HFA group also performed poorly on the observational learning task, which involves only two characters, with a pass rate that was lower than the embedded teaching task (57% vs. 34%, respectively, see Table 6). In the observational learning task, a novice imitates an expert performing a skill that s/he does not know how to do (e.g., tie a knot). The expert does not see the novice observing him/her. By observation, and without the expert’s knowledge, the novice learns the new skill (e.g., ties a knot). Therefore, there is no intention to teach by the expert. This task is asking children to understand that it is intention that distinguishes teaching from imitation as distinct forms of knowledge acquisition. If children appreciate the distinction, then they should recognize that teaching occurs only when someone performs a task with the goal of bringing about a knowledge change in another. Our HFA sample failed to understand that imitation and teaching are distinct forms of knowledge acquisition.

The embedded teaching task and observational learner task examine the understanding of intention in teaching in situations where teaching itself is enigmatic. The intention to teach is ambiguous in embedded teaching and absent in observational learning. HFA children may struggle on the embedded teaching task because they fail to recognize that teaching is intentional even when the teaching act is opaque. Taken together, our major finding for the intention-in-teaching tasks is that HFA children seem to recognize, albeit tenuously, intention in teaching when teaching is evident (successful/failed teaching), but do not appreciate the importance of intention when teaching is veiled (embedded in a game) or nonexistent (observational learning).

This conclusion has broad implications for HFA children's ability to engage in and understand intentional teaching activities, particularly in situations where the activity of teaching is hidden in a game. If children with HFA struggle to appreciate that a teacher is engaging in an activity with them in order to teach them something, then those children may be missing out on valuable teaching experiences. Future research should delve more deeply into HFA children's understanding of intention in teaching to determine whether the overall pattern we observed here is upheld. Performance on successful and failed teaching tasks also warrants additional work that looks at the basic understanding in HFA children between an agent's intention and the outcome of the agent's action for learning in another. This could be done by presenting intention-based teaching tasks to different age groups. Studies should incorporate tasks similar to embedded teaching, but that involve a single learner, and teaching tasks such as failed and successful teaching that involve more than one learner. This might help to determine whether HFA children understand that teaching does not necessarily require a one-to-one ratio between teacher and learner. A fundamental approach to teaching toddlers is to use games to make teaching more fun, interactive, and engaging. This may do a disservice to HFA children because they selectively lose the ability to understand teaching when it is embedded in a game. Our study shows that we need to reconsider how we teach HFA children so that they can most benefit from those intentional teaching activities.

Understanding of Teaching in TD Children. So far we have discussed the understanding of teaching in our sample of HFA children. It is also important to highlight the TD children's performance on the teaching battery in our study with respect to previous research as a means of verifying that our control population outcomes are consistent with the literature.

The patterns of performance between the TD group in our study and Woodburn (2008) who presented the same seven-item teaching battery to a group of TD children were extremely similar. Overall, the similarities between the two samples suggest that the pattern of performance for the TD group in our study replicated a majority of the patterns observed in Woodburn (2008, time two) considering the following corresponding findings: 1) a significant correlation between overall performance on the understanding of teaching and theory of mind measures was found in both our sample of TD children and Woodburn's sample; 2) our TD participants and the participants in Woodburn's study both performed above chance on the same four teaching tasks (see Table 6); 3) both samples found the overestimate-learner task to be the most difficult (i.e., both samples' pass rates were lowest for this task); and 4) TD children in both studies were not above chance on the overestimate-self task. On this last similarity, 60% percent of our TD sample passed this task compared to 25% of the children in the Woodburn (2008) study. Based on previous findings, this task is considered to be one of the most difficult tasks in the battery (Woodburn, 2008; Ziv & Frye, 2008). However, although neither sample's pass rate for this item was above chance, our TD group pass rate is considerable higher than Woodburn (2008). The differences in pass rates warrant additional investigation to determine what may be accounting for the possibility of a distinct outcome.

On only one of the seven tasks did our results differ from those found by Woodburn (2008). The Woodburn sample performed above chance on the observational learning task (65% pass) whereas our TD sample did not (43% pass). However, there is a major difference in the study designs that may have implications for comparing the findings: the TD participants in our study were individually matched based on their VMA with the HFA children. As a result, our TD sample consists of a different age range than

Woodburn (3;3 to 7;6 vs. 4;4 to 8;0). We predict that the full year difference on the young end is likely to account for the differences seen in the observational learner task.

However, it should also be noted that a similar version of the observational learning task was presented to a group of TD 5 year-olds with an 80% pass rate (Ziv & Frye, 2004). One should be cautious, though, about comparing this finding to our study because the group of TD children we tested varied in age from 3;3 to 7;6 as opposed to Ziv and Frye who tested children that were approximately the same age within each group. This age discrepancy also likely accounts for the differences between the TD children in our study and the 5- and 6-year-olds in Ziv et al. (2008) who were given similar versions of the overestimate-self task. Additional studies need to be conducted that examine the effects that false beliefs about the teacher's and learner's own knowledge have on teaching to resolve this discrepancy in the literature.

Relation between the Understanding of Teaching and Intentions-in-Action in TD Children. It should also be mentioned that the overall understanding of teaching score correlated with one intention-in-action task for our sample of TD children (see Table 13). These findings, which provide an answer to ***Research Question 3***, were not surprising given the control population's characteristics. One should be cautious about interpreting the lack of associations here to indicate that the understanding of teaching and intentions-in-actions are not developmentally related in TD children. The overwhelmingly high performance on the majority of the teaching tasks, low performance on one of the teaching tasks, and overall good performance on the majority of the intention-in-action tasks (see below) could explain the low variability between the tasks and likely accounts for the lack of correlations found in TD children. It is also important to remember that our sample of TD children was selected as matched individual controls for our HFA sample.

Theory of Mind

Theory of Mind in HFA Children. Our sample of HFA children's theory of mind development is delayed compared to matched TD controls. This finding supports previous research demonstrating theory of mind delays in children with HFA (e.g., Baron-Cohen, Leslie & Frith, 1985; Frith, 1989; Peterson, Wellman, & Slaughter, 2012; for reviews, see Baron-Cohen, 2000; Happé, 1995; Yirmiya, Erel, Shaked, & Solomonica-Levi, 1998). The group of HFA children in our study performed below chance on three of the five mental state understanding tasks in Wellman and Liu's (2004) five-item theory of mind scale. Specifically, HFA participants were successful at solving the first two of the scale's five tasks with response rates at above chance levels (diverse desires, 83% and diverse beliefs, 77%, see Table 15). However the group did not perform above chance on the remaining three tasks (knowledge access, 57%, false belief, 29% and real-apparent emotion, 31%).

Our results confirmed our expectations for ***Research Question 4*** that the pattern of theory of mind performance in our HFA participants differed from the pattern of theory of mind performance observed in a sample of HFA children by Peterson, Wellman, and Liu (2005). The scale used in the current study has been presented to one other group of HFA children (Peterson et al., 2005). However, the five tasks have been used in conjunction with additional social cognitive tasks (Ames & White, 2011; Hamilton, Brindley, & Frith, 2007, 2009) and recently, an augmented version of the original five-item scale that included a sixth understanding of sarcasm task was also presented to a group of HFA children (Peterson et al., 2012).

Performance in our sample of HFA children correspond with three of the tasks that Peterson and colleagues (2005) found in their original study and with four tasks in the follow-up six-item (2012) scale. Across all three studies, HFA participants succeeded at solving the diverse desires task and the diverse beliefs task, and did not succeed (below chance) on the false belief task. However, the HFA group in our study was also not above chance on the knowledge access task or real-apparent, or 'hidden', emotions task. This contrasts with the HFA group in Peterson et al. (2005) who performed above chance on the knowledge access task, and the HFA group in Peterson et al. (2012) who were also above chance on this task, but not on the hidden emotions task.

Looking at the three studies, a general pattern appears for the five items: successful performance on the first two tasks and unsuccessful performance on the last two tasks. Peterson and colleagues (2005, 2012) do have slightly contrasting pass rates for HFA children’s performance on the hidden emotions tasks between their two studies, (64% and 52%, respectively). However, the follow-up study involves a larger sample size, resulting in a lower overall pass rate which hints at a trend towards HFA children performing at, rather than above, chance on this task (Peterson et al., 2012). Additional research is required to determine whether HFA children of a similar age with similar verbal abilities are performing at or above chance on the hidden emotions task.

The divergence in findings is informative because the average VMA of the HFA children was 94 months in Peterson and colleagues’ two studies (2005, 2012). This average verbal age is nearly two full years older than the average VMA of the HFA children in the current study (72 months). The age difference is significant given research that shows that HFA children with an average VMA of 88 months (Leslie & Frith, 1998) and 81 months (Lind & Bowler, 2010) are not above chance on passing ‘limited knowledge’ tasks. These tasks have been used to test HFA children’s understanding of the “seeing-leads-to-knowing” principle (e.g., Baron-Cohen & Goodhart, 1994). Consistent with the seeing-leads-to-knowing literature, our finding further supports the suggestion that HFA children with a VMA of 72 months are not developmentally far enough along to appreciate this principle, and therefore are unable to reliably solve the knowledge access task. Moreover, our result, together with the results from Peterson et al. (2005, 2012) suggests that the period in which HFA children transition from failing to passing this type of task may occur between developing a verbal ability of approximately 72 and 94 months.

Additional evidence for a lack of understanding this principle in our HFA sample may be their poor performance on the observational learning task. As discussed above, HFA children may struggle to distinguish between teaching and imitation as a means of acquiring knowledge when the intention to teach does not occur. However, if these children also have not developed an understanding that “seeing leads to knowing”, then this may affect their understanding that an expert is nevertheless “trying to teach” a novice how to perform a skill, despite the fact that the expert does not see the novice or know that the novice is imitating them. It is important to note that our results from the observational learning task did not correlate with the knowledge access task, which could simply have been due to the low variability in the HFA group’s performance on the observational learner task. Either way, poor performance by the HFA children on the knowledge access task and observational learning task warrants further investigation to determine whether an understanding of one plays a role in the understanding of the other in HFA children.

Based on these data, we would hypothesize that the VMA range of 70-90 months marks the verbal ability age range at which HFA children develop an understanding of the seeing-leads-to-knowing principle. Establishing whether this verbal age range does in fact mark the ‘seeing leads to knowing’ transition in HFA children should be pursued in future longitudinal studies. Confirming this prediction with future studies could provide important information to educators about how to select appropriate teaching methodologies for HFA children who fall below or are within this ability range.

The aim of Peterson et al.'s (2005) study was to see whether HFA children's sequence of theory of mind development was delayed compared to TD children, and whether the sequence followed a similar pattern to TD children. As discussed above, they found that HFA children were delayed compared to matched TD controls and the response patterns formed a distinct scale from the original Wellman and Liu (2004) five-item theory of mind scale. In a follow-up study, Peterson and colleagues (2012) replicated their findings in HFA children and added an additional sixth item to the scale. The pattern of pass rates for the first three tasks (diverse desires, diverse beliefs, and knowledge access) across all three studies is similar. All three groups had pass rates for the first two tasks that were higher than each group's respective rate for the third task. In our study, the similar response pattern up through the knowledge access task suggests that our sample was also following a similar developmental sequence.

However, in contrast to the findings in both Peterson et al.'s (2005, 2012) studies for HFA children's response patterns on the five-item scale, the HFA children in our study presented a different response pattern to the last two tasks by performing equally poorly on both the false belief task and the hidden emotion task. As a result, the overall response pattern we found did not form a reliable scale. As noted above, HFA children's performance on the hidden emotions task in the current study deviates from both samples of HFA children in Peterson et al. (2005, 2012). Given that our HFA groups' pass rate on this task and the false belief task is approximately the same (31% and 29%, respectively), it is understandable that the sample does not form a reliable scale of the five-item battery.

It is likely that the significant difference between our sample of HFA children and the two groups used in Peterson et al. (2005, 2012) is the age difference between our study population and theirs. As noted above, the average VMA in both of Peterson et al.'s two samples is nearly two full years older than the average VMA in our sample of HFA children. Moreover, the age range in Peterson et al. (2005) is significantly larger than our sample (see Table 15) (age ranges are not available in Peterson et al., 2012). Therefore, it is possible that verbal ability and age differences account for the discrepancy between our findings and Peterson et al. (2005; 2012). Given our younger sample of HFA children, it is also possible that the reason they did not show a difference between the false belief task and the hidden emotions task is that they have not developmentally arrived at being able to solve these tasks.

We claimed that our HFA sample struggled with the knowledge access task on account of their overall VMA. If these children perform at chance on a task that has been found to be developmentally easier than false belief and hidden emotion understanding in both TD and HFA children (e.g., Peterson et al., 2005; Wellman & Liu, 2004), then it is developmentally reasonable that our sample of HFA children performed worse on these two latter tasks than the knowledge access task. Further evidence supporting this conclusion is the statistically significant difference between the knowledge access task and both the false belief task and the hidden emotions task for our HFA participants. The wide age range and small sample size for the HFA group in Peterson et al. (2005), their slightly discrepant findings on the hidden emotion task when compared to Peterson et al.

(2012), coupled with the poor performance on the false belief and hidden emotion task and unreliable scaling in our younger HFA sample, calls for additional research to investigate the developmental sequence in HFA children's theory of mind. Presenting the five-item scale to two groups of HFA children, 1) with a restricted age range similar to or less than our study, and 2) a VMA slightly older than the children in our sample would provide us with a better understanding of the sequence of HFA children's developing theory of mind. The finding from our study that theory of mind abilities, including false belief understanding, are delayed in HFA children replicates previous studies and supports the well-established literature showing theory of mind delays in children with HFA.

Theory of Mind in TD Children. We now turn to performance on the theory of mind scale in our study's TD control population. Our results are discussed in terms of previous research as a means of verifying that our control population outcomes are consistent with the literature. Doing so supports our data collection and adds credence to our HFA results.

The overall response pattern on the theory of mind scale for the TD children in our study is consistent with prior research findings that suggest typical preschooler's social cognitive development follows a certain sequence of conceptual achievements (Peterson et al, 2005, 2012; Wellman & Liu, 2004, see also Chapter 2: Literature Review for a thorough description). TD controls across the five tasks, (1.diverse desires, 2.

diverse beliefs, 3. knowledge access, 4. false belief, and 5. hidden emotion) performed at ceiling on task 1 (100%), equally well and near ceiling on tasks 2 and 3 (91%), above chance on task 4 (66%) but worse than tasks 1-3, and finally below chance on task 5 (40%) and worse than all four previous tasks (see Table 15). Woodburn (2008, time 2) also shows a similar overall response pattern in TD children, although pass rates for tasks 3 and 4 are slightly different and the children in Woodburn's sample are not above chance on the false belief task. However, these discrepancies do not change the fact that the overall response patterns between the two groups is highly similar and that this pattern fits the general pattern observed elsewhere in the literature.

There is a difference, though, between the theory of mind results in our TD sample and previous research. Due to the overall high performance on the first three tasks, the five items did not form a reliable scale. This deviation from the literature is understandable, however, because our selection of TD controls was based on VMA as they were individually matched with our HFA population. For this reason, the TDs overall verbal ability (which is approximately equivalent to their CA, see Table 1) exceeds the typical age range of children tested in previous studies that find the five-item battery forms a reliable scale (Peterson et al, 2005, 2012; Wellman & Liu, 2004). However, for the purposes of the current study, it was critical that our TD population obtained a response pattern similar to previous work that has found the same response pattern across these five tasks. Our results indicate that this was the case for our TD controls which provides additional support for our HFA results.

Understanding Intentions-in-Others

Confirming our predictions to ***Research Question 5***, HFA children in our study are delayed in the understanding of intentions in others compared to TD controls matched on verbal ability. Specifically, HFA participants performed the same or worse than their TD counterparts on tasks that measure the ability to distinguish desires from intentions, and on tasks that measure the ability to recognize that identical actions may be motivated by different intentions.

Available data are contradictory with regard to HFA children's understanding of intentions in others (e.g., Colombi et al., 2009; Phillips et al., 1998; Russell & Hill, 2001; Williams & Happé, 2010; Zalla, et al., 2010). However, these studies investigated HFA children's understanding of failed intentions (Colombi et al., 2009), the ability to predict the outcome of a sequence of goal-directed actions (Zalla et al., 2010), or the ability to distinguish between intentional and unintentional actions (Phillips et al., 1998; Russell & Hill, 2001; Williams & Happé, 2010). Therefore, our study is the first to investigate HFA children's understanding of the following two features that underlie the concept of intention: 1) the intention-desire distinction; and 2) that different intentions can be used to generate identical (intentional) actions. Results from our study for these two aspects of intention-in-action understanding are discussed in turn.

Intention-Desire Distinction Understanding in HFA Children. These response patterns in our study suggest that the HFA children do not reliably distinguish between desires and intentions. The patterns also suggest that their judgments of desire are outcome-based as evidenced by the fact that HFA children can only correctly identify a desire when that desire is fulfilled. HFA children's response pattern to the intention-desire distinction measure differs from TD controls. For the concordant tasks (i.e., controls), HFA participants performed quite well and no different than the TD children on either the intention question or the desire question on the intention-fulfilled/desire-satisfied control task. However, they performed poorly on and significantly worse than TD controls on both questions for the intention-unfulfilled/desire-unsatisfied condition (see Table 18). For the discordant tasks, there were no differences on either question between groups for the intention-unfulfilled/desire-satisfied condition, but the HFA children performed differently and worse than TD controls on the intention-fulfilled/desire-unsatisfied condition. The HFA children, as did the TD children (see below), struggled to recognize an intention when it contrasts with a desire. Both groups also appeared to answer the desire question correctly in the two stories when it was brought about, but only the HFA children struggled with the desire question when the desire was not brought about.

We believe that our results suggest that HFA's judgments about the success of an intention or a desire question are based solely on the desire's outcome. HFA children's use of a "satisfied desire equals satisfied intention and desire" strategy accounts for the response pattern across all four tasks. HFA children responded well above chance on the desire question to the two tasks in which the desire was brought about. On one of these tasks (intention-fulfilled/desire-satisfied), the intention was also brought about, and on the other task (intention-unfulfilled/desire-satisfied) the intention was not brought about. If responses to the intention question and the desire question for these two tasks are based on the success of the desire (i.e., if the desire came about then so did the intention), then the response pattern would look exactly as was found—overall correct responses to the intention question in the control task and incorrect responses to the intention question in the target task. This response pattern suggests that the HFA children do not understand the distinction between intentions and desires.

It is also possible that HFA children are exhibiting a “yes” bias, which might affect their overall pattern of performance. The desire and intention questions were presented in our study in a forced choice “yes/no” format, in keeping with the original study’s procedures. This might account for the difference in performance by HFA participants between the two control tasks and their performance on the intention-unfulfilled/desire-satisfied task. However, if this was the case, then we also should have expected them to answer above chance on the intention question in the intention-fulfilled/desire-unsatisfied condition (which they did not). Of course it remains possible that HFA children indeed are displaying a “yes” bias and the poor performance on the intention-fulfilled target task question results from random guessing for this one particular question. To determine whether HFA children exhibit a “yes” bias on these types of tasks, additional research is required. This could include using a dichotomous forced choice answer format that involves acknowledging the fulfillment/unfulfillment of the mental state in question instead of a “yes/no” format.

The ability to distinguish intentions from desires is an important development in young children’s social cognitive growth. If HFA children are not able to recognize the difference between intentions and desires, then this could have a dramatic effect on their ability to understand and interact with others. Everyday accidents, for example, might be misconstrued as intentional sleights if you conflate intentions with desires. Such a conflation could ruin an everyday social interaction. Consider the following scenario as an example. Sue tells Mark that she intends to bring him a wrapped birthday present even though she wants to unwrap it herself. However, when Sue arrives at the birthday party she drops the present by accident and it comes out of its wrapping. Mark, who conflates intentions and desires, then gets angry at Sue because he believes that Sue acted on her desire to unwrap Mark’s present. This type of conflation could affect HFA children’s ability to recognize accidents and may play a role in their ability to develop relationships with others. It could also affect their ability to understand and follow classroom instruction, considering that a desire to learn a new skill is different from forming the intention to learn a skill.

A strength of our study is that it represents the first instance in which the intention-desire distinction has been examined in HFA children. Therefore, whether HFA children develop an understanding of the distinction between intentions and desires at a later (verbal ability-based) age still needs to be explored. An immediate next step might be to investigate the same four intention desire outcome combinations but controlling for a possible "yes" bias (see above) and as well incorporating different story types for each task. This approach would further control for the possibility of a story type bias. Additional work should also investigate HFA children's understanding of this distinction not just for others, but also for self.

Intention-Desire Distinction Understanding in TD Children. TD children begin to distinguish between intentions and desires between the ages of 4 and 5 years (Schult, 2002). Across a group of TD 4-, 5-, and 7-year-olds, only the 7-year-olds successfully differentiated between intentions and desires in situations that had either the outcome of the intention or the outcome of the desire occur, but not both. Our results for the TD children for the same intention-desire distinction measure as in Schult (2002) are highly consistent with the original study's findings for the 4-and 5-year-olds. The findings suggest that young TD children recognize both desires and intentions when their outcomes are concordant (both desire/intention do or do not come about). However, our results also suggest that young TD children may recognize desires in discordant tasks (either desire/intention comes about but not both), but that they struggle to understand intentions when they contrast with desires.

In our study, four tasks tested children's ability to understand the intention-desire distinction. Our sample of TD children performed near ceiling on the intention-fulfilled/desire-satisfied task and well above chance on the intention-unfulfilled/desire-unsatisfied task (see Table 18). But for the intention-unfulfilled/desire-satisfied task, TDs struggled to separate intentions and desires by performing poorly (31% pass) on the intention question. They also performed poorly (59% pass) on the intention question for the intention-fulfilled/desire-unsatisfied task. The results suggest that TD children struggle to separate intentions and desires when the outcome of one's intention and the outcome of one's corresponding desire are discordant as evidenced by the above chance performance on the desire question in both conditions.

One difference between our results and the original study is that 5-year-olds in the original study performed well above chance (83%) on the intention question in the intention-unfulfilled/desire-satisfied task (Schult, 2002). The difference between groups on this question may be attributable to a story bias. The two story types involved 1) a character getting a doll she wanted but not by buying it as she intended to do, and 2) a character getting lunch that he wanted but not by making himself as he intended to do. It could be the case that these two specific events used to separate the intention and desire in these two stories are not entirely clear to our TD sample and therefore the tasks may not have be as stable as we had thought. Although Schult pilot-tested each of these stories with adults and got rid of any perceived complex intention interpretations, the specific type of story used in this particular task may still have been confusing to our TD children.

Another possibility is that the two stories involved what the character intended to do in the immediate future, not what the character was intentionally doing. The fact that the intention question asks about a future action that was thwarted even though the desire underlying that action was still fulfilled (e.g., getting the doll and getting lunch) may have perplexed our participants. Performance on the other task that involved a contrasting intention-desire outcome in our TD group was similar compared to Schult's 4-and 5-year-olds. Thus, it is also possible that random or natural variation in these two data sets explains the discrepancy.

Independent of this one discrepancy, though, our control population's response pattern supports Schult's (2002) findings that children younger than 7 years struggle to consistently separate intentions from desires. Because this is only the second instance in which these stories have been tested, the age at which young TD children develop the ability to appreciate the difference between intentions and desires remains to be tested. Future research should investigate the developing understanding of the intention-desire distinction in TD children and investigate this understanding both for others and self. Similar story types across contrasting conditions should also be used to control for the possibility of a story bias

Two Intentions-Identical Actions Understanding in HFA Children. Participants in the current study were presented with the same two intentions-identical action measure found in Baird and Moses (2001, Study 4). Our HFA children were delayed, but not impaired, in their understanding that more than one intention can be used to generate a given action, compared to TD controls. The overall performance by the HFA children suggests that they recognize, in others, that two different intentions can be used to carry out one and the same action.

We used three tasks to measure this understanding (see Chapter 3: Methods for a full description and Appendix D for an example). Both the HFA group and the TD controls (see below), performed above chance across all three conditions. Although both groups performed well on all tasks, there was a slight difference in the overall passing scores, with the HFA group performing worse on two of the three tasks than TD children. Specifically, HFA children did not perform as well as TD children on the same action–different intention task and on the different action–different intention task. No difference was observed between groups on the same action-same intention task. Within the HFA group, participants performed better on the different intentions-different action task than the same-same ask and same-different task.

One interpretation of our results is that HFA children performed well on the same action-different intention task not because they understood the core concepts being tested but because they used low-level associative cues to figure out the correct answer. If participants answered the first intention question in the task wrong, then they were retold what that character wants and what s/he is doing in an attempt to fulfill that desire, and the intention question was asked again. This procedure ensures that the participant gets the first intention question correct (of course a child could answer incorrectly again, but this did not happen for any participant in the current study). Questions were presented in a forced-choice dichotomous format that asked about each character's intention. The

HFA children who answered the first intention question (A) incorrectly on the first pass meant that they chose the intention for the other character and by default the correct answer to the test question—that is, the second intention question (B). Therefore, they could have considered the correct answer to (B) to be “not intention A” or “B because I was corrected.” However, we do not believe this interpretation is correct because then they would have performed poorly in the same intention-same action condition in which case the “not intention A” strategy would have resulted in answering (B) incorrectly. This factor lends support to the conclusion that our sample of HFA children recognized that an identical action may be motivated by different intentions.

These results are the first of their kind to provide information about HFA children’s basic understanding of the relation between a person’s intention and the action it engenders. HFA children’s understanding of this relation between internal mental states and external behavior is a hotly debated topic. Recent research has shown that compared to typical and atypical controls, children with HFA struggle to predict the outcome of a sequence of familiar and non-familiar goal-directed actions in others (Zalla et al., 2010). The authors suggest that HFA children have an impaired “means-end analysis” processing system which affects the ability to predict behavioral outcomes in others (Zalla et al., 2010).

Results from our study suggest that HFA children may have some basic understanding that intentions and the resulting actions are not isomorphic—that is, they share a “many-to-many” relation (term borrowed from Baird & Moses, 2001). HFA children may develop an understanding of this basic idea—that one and the same intention may beget any number of actions, and likewise, an identical action may be motivated by different intentions. However, they may nevertheless struggle to understand what intentions are, other than something that seems to be related to actions, but are themselves not actions.

Evidence from our study suggests that HFA children do not appreciate the difference between intentions and desires in others (see above). This weakness could be because they take descriptions of desires and intentions to be the same thing. If HFA children struggle to disentangle desires from intentions, then this problem could play a role in predicting the intentional (i.e., goal-directed) outcome of an incomplete action (e.g., Zalla et al., 2010). Consider the following scenario as an example. Sue and Mark are playing together at Mark's house. Mark just got a new toy fire truck and Sue wants to play with it. However, Mark does not want anyone to play with his new toy and tells Sue this. So Sue knows that playing with the fire truck will upset Mark and even though she still wants to, she decides not to play with the fire truck. Instead, Sue walks to get a different toy, which is behind the fire truck. Now imagine that someone who does not recognize the difference between desires and intentions sees this event unfold. If we were to ask whether they predict that Sue will pick up the fire truck to play with it (desire) or pick up the fire truck to move it (intention) to get at a different toy to play with, they may expect that Sue picks up the fire truck to play with it simply because she wants to, despite having formed the intention not to play with it. In this case, the ensuing action and formed intention would be incorrectly related due to the observer's inability to separate desires from intentions.

Further research is needed to explore the understanding of the intention-action relation in HFA children. Although we found that HFA children were successful at solving the same action-different intention task, additional studies should investigate the understanding of the many-to-many relation between intentions and actions in children with HFA. In addition to a replication study to confirm/disconfirm our findings, an immediate next step might be to investigate the role that belief understanding plays in appreciating that multiple intentions can be used to motivate an identical action. It would also be interesting to explore whether a morally valenced intentional action may affect HFA children's ability to separate intentions from the actions they engender, based on whether the action deserves praise or blame.

Two Intentions-Identical Actions Understanding in TD Children. In our study, TD children performed uniformly well across all three of the two intentions-identical actions tasks. In the different action-different intention task, TD children's response rates were approaching ceiling levels (97%, see Table 19). They also performed rather well in the same action-same intention (83%) and same action-different intention (89%) tasks. Although differences were found within the group between the different action-different intention task and the other two tasks, controls nevertheless demonstrated a high level of competence across all three conditions. Therefore, we did not think these differences were meaningful for purposes of our study.

Results from the TD children in our study support previous findings that typical children can differentiate between two different intentions that are being performed by an identical action by the age 5 (Baird & Moses, 2001). There was a small methodological difference between the measure used in our study and the measure used in the original study for the group of 5-year-olds. The measure we used was taken from Study 4, a simplification in the task design that was presented to 5-year-olds (Baird & Moses, 2001). We chose the method from Study 4 because of this simplification, as our goal was to assess the understanding of the ‘two intention-same action’ concept to a novel group of atypically developing children. Therefore, findings for our TD participants are from tasks that were only used on a group of 4-year-olds (Baird & Moses, 2001). Our results differ from those for Study 4 in that the TD children in the current study performed well across all three conditions and the preschoolers in Study 4 were not above chance in the same action-different intention condition. This difference notwithstanding, our results for the TD children suggest that our sample also understood that different intentions may be used to motivate an identical action. These findings are not surprising given the average age of our TD sample was a full year older than the 5-year-olds in Baird and Moses (2001).

Limitations and Future Directions

A virtue of our study is that it provided initial data regarding HFA children's understanding of 1) teaching, 2) the distinction between intentions and desires, and 3) the relation between intentions and the actions they engender. However, an unavoidable cost of this is that the measures we used were originally designed for TD children. Alternative methods for testing many of the tasks measured in our study should be incorporated in future research. For example, given the chance that a "teach" bias could have affected our HFA sample's performance on the teaching measure, it would be worthwhile adjusting the tasks' test questions to a forced-choice dichotomous format that did not use the word "teach" akin to the format highlighted above to alleviate the potential for a "yes" bias in the intention-desire distinction measure.

Since this is a novel area of study, it is important that future studies have increased sample sizes. Despite the current ASD incidence, autism is still a relatively rare disorder from a population standpoint. Therefore it is not as easy to obtain large sample sizes as done in studies with TD children. Nevertheless, larger sample sizes should be used. Although relatively small sample sizes in ASD research are standard, the number is increasing (Hall, Chung, & Navidi, 2010). A priori statistical estimates of power conducted to test for the minimum detectable effect size for matched pairs suggested that the current study's sample size (N = 70) was adequate to detect moderate effects (Cohen's d = .54-.59). Our sample was deemed adequate to protect against the probability of committing a Type II error. However, optimizing sample size, which in our case would mean an increase in *N*, decreases the probability of committing a Type I or Type II error and increases the ability to detect important effects or associations.

Moreover, because our study used a cross-sectional design, future longitudinal studies should be conducted to track development of these socio-cognitive measures in HFA children. Understanding when developmental changes occur is critical to research that examines cognitive growth. Therefore, it is also important to restrict age/ability range in studies that examine children with ASD. The age range in the current study was rather narrow relative to comparison studies in the literature (e.g., Happé, 1995; Peterson et al., 2005; Russell & Hill, 2001). However, further restricting the verbal ability age range would increase the precision of findings in terms of the verbal ability age of HFA children and their performance.

As was discussed previously, a possible interpretation of our results is that HFA children used alternative cognitive strategies to solve the tasks that they performed well on (e.g., two intentions-same actions measure). Similarly, alternative cognitive strategies could have accounted for poor performance on other measures that HFA children did not perform well on (e.g., intention-desire distinction, understanding of teaching). Non-verbal mental abilities (NVMA) were not examined in our experimental measures and were not used as part of the matching design. The current study followed standard practices of matching on overall verbal ability because our tasks were verbal in design (e.g., Happé, 1995; Pexman et al., 2011). Nevertheless, it is conceivable that NVMA in the same way as executive function could have been related to task performance in the target population.

Executive function includes abilities such as planning, working memory, mental flexibility, response initiation, response inhibition, impulse control and monitoring of action (Stuss & Knight, 2002). These abilities are known to be impaired in children with ASD (e.g., Jones, Webb, Estes, & Dawson, 2013) and have been shown to relate to theory of mind abilities in HFA children (e.g., Pellicano, 2010). However, numerous studies have shown that theory of mind task performance is related to verbal ability (e.g, Bowler, 1992; Eisenmajer & Prior, 1991; Fombonne, Siddons, Achard, & Frith, 1994; Happé, 1995; Prior, Dahlstrom, & Squires, 1990; Yirmiya et al., 1998) and that verbal ability is not related to executive function in children with HFA (e.g., Bennetto, Pennington, & Rogers 1996; Landa & Goldberg, 2005; Lopez, Lincoln, Ozonoff, & Lai, 2005). Moreover, research investigating performance on tasks that require verbal mediation such as emotion sorting, matching, and naming tasks that did not match on verbal ability found group differences between HFA children and TD controls (e.g., Hobson, 1986; MacDonald et al., 1995; Weeks & Hobson, 1987). But in follow-up replication studies, group differences disappeared when HFA and non-HFA groups were matched on verbal ability (e.g., Hobson, Ouston, & Lee, 1988, 1989a; Loveland et al., 1997).

To circumvent these concerns, matching can be done individually (Harms, Martin, & Wallace, 2010), which was the method employed in the current study.

Additional studies that investigate the social cognitive measures used in our study should match on verbal ability but also should include tasks that test NMVA. Moreover, future work that investigates the understanding of teaching in HFA children should match using TD children *and* control populations of non-autistic but developmentally delayed children.

In studying the understanding of teaching in HFA children, there are numerous avenues to pursue next, given the novelty of this research. Therefore, the following research questions are meant only as a list of examples that might follow directly from the current project: 1) How do children with HFA learn from teaching in relation to their understanding of it? 2) How does the understanding of teaching change (develop) in early childhood and how does this relate to how children with HFA learn? 3) How do HFA children teach others, and how do their teaching skills relate to their understanding of the concept of teaching? 4) What role do executive functions play in HFA children’s understanding of teaching? 5) How do HFA children understand their own intentions? 6) What are the educational implications of HFA children’s understanding of teaching for school readiness?

Implications for Learning from Others in Children with ASD

The findings from our study of the understanding of teaching in HFA and TD children have practical implications for practitioners, teachers, and families of children with HFA. A wide variety of diverse and intricate treatments have been designed to improve the quality of lives of individuals with autism spectrum disorders (ASD) (e.g., Ascroft, Argiro, & Keohane, 2010; Mesibov & Shea, 2010; Sancho et al., 2010, or see Dawson & Burner, 2011 for a review). Teaching in some capacity is integral to each of the interventions currently used to help children with HFA learn everything from everyday skills (such as brushing one's teeth), to social skills (such as how to make and maintain friendships), to cognitive skills (such as how to read). Many of the more well-known and widely used interventions like ABA, the Denver Model, or TEACCH (see Chapter 1: Introduction for a full description) use teaching strategies with the goal of targeting the strengths and abilities of children with an ASD and then using those strengths to help them learn and develop.

Fortunately, some of the evidence-based interventions have shown to be effective in reducing diagnostic severity in young children with an ASD (e.g., Dawson et al., 2010) and improve learning outcomes (e.g., Mesibov & Shea, 2010). However, even the most effective models have yet to determine whether gains made are temporal or permanent (Dawson et al., 2010). Therefore, interventions for children with an ASD can and should be improved. A method of making interventions more effective might involve adjusting how the teaching activity is performed based on how children with HFA understanding the concept of teaching.

The TEACCH program, for example, is based on the notion of "structured teaching" (Mesibov, Shea, & Schopler, 2004) which use visual supports in a controlled, structured setting to help teach children with HFA. Part of the TEACCH philosophy is that “teaching activities are most successful when they are matched to a child's current developmental level”(TEACCH Autism Program, 2013). However, the method and philosophy do not take in account the HFA child’s understanding of teaching when using visual aids or matching an activity to a child’s ability. So while the use of structured settings and visual supports in TEACCH have been found to be helpful, these methods may be better served if the way in which information is actually presented and taught is based on HFA children’s understanding of teaching.

The understanding of teaching in HFA children may also play a role in how they are taught in family and peer settings. Learning occurs just as frequently, if not more frequently outside of the classroom setting as it does inside the classroom. We learn from our relatives and from our friends. A teaching moment arises any time someone else recognizes a knowledge difference between you and them, and that person decides to try to reduce that knowledge gap. Knowing what children with HFA understand about the concept of teaching may help to create or make more effective a teaching moment in every one of these instances. This dissertation provides the first step towards translating evidence into practice regarding HFA children’s understanding of teaching.

APPENDIX: Examples of Task Items by Measure

A: Understanding of Teaching Measure

Successful Teaching:

Need: Trevor
Bill
Play Dough

Here are Trevor and Bill. (introduce toy figures)
Bill does not know how to make a bowl from clay. (show clay)
Trevor knows how to make a bowl from clay.
Every day Trevor shows Bill how to make a bowl from clay, so that he learns how to do it. 'Look (demonstrate making the bowl), first you role the clay to a ball, then you stick your thumb into the ball, there, you have a bowl.'

Now Bill also knows how to make a bowl. (Bill makes bowl)

Knowledge Question: Does Bill know how to make a bowl? Yes No

Teach Question:
Did Trevor try to teach Bill how to make a bowl from clay or did he try to make a bowl for himself?

Yes, try to teach Bowl for himself

Correct = Yes to knowledge question; Yes to teach question

Who should be taught?

Need: Sarah
Dana
Karen
Mini-book for reading

Here are Sarah and Dana. (introduce toy figures)
Sarah knows how to read. (show mini-book)
Dana does not know how to read. (no book)
This is Karen. (Show toy figure)
Karen is a teacher who teaches children how to read. (use same mini-book)

Knowledge question: Who knows how to read, Sarah or Dana (point at each)

Sarah Dana

Teach question: Who will Karen teach to read, will Karen teach Sarah or Dana?

Sarah Dana

Correct = Sarah to knowledge question, Dana to teach question

Failed Teaching

Need: Sam
Jackson
Animal Dominos ? pictures…

Here are Sam and Jackson.
Sam does not know how to play Animal Dominos.
Jackson knows how to play Animal Dominos.
Every day Jackson shows Sam how to play Animal Dominos, so that he will know how to play.

'See, (*enact Jackson demonstrating)*, first you look for the same picture as here, and then you put the picture right next to this one. There, now you have two pictures that are the same right next to each other'.

Sam tried and tried to play, but he still does not know how to play.
(*Experimenter enacts Sam putting pictures next to the wrong target picture.)*

Knowledge question: Does Sam know how to play? Yes No

Teach question:
Did Jackson try to teach Sam how to play Animal Dominos or didn't he try to teach him?

Yes, try to teach No, didn't try to teach

Correct = No to knowledge question; Yes to teach question

Successful Imitation/observation

Need: Emma
Nicole
string
Table

Here are Emma and Nicole. (introduce two toy figures)
Emma does not know how to tie a knot.
Nicole knows how to tie a knot.
Every day Emma watches Nicole when she ties a knot.
(enact Emma hiding behind the table)
See, she sits here, behind the table, watches Nicole, (enact Nicole tying knot) and tries to do just what she does.
Nicole does not see Emma.
Nicole does not know that Emma is watching her.
Look, now Emma knows how to tie a knot. (enact Emma tying knot)

Knowledge question: Does Emma know how to tie a knot?
Yes No

Teach question:

Did Nicole try to teach Emma how to tie a knot or did she tie a knot for herself?

Teach Not Teach

Correct = Yes to knowledge question, Not Teach to teach question

Embedded Teaching

Need: Karen
Several toy figures (to be children in the class)
Spinner with numbers

Here is Karen. (introduce toy figures)
Karen is a teacher.
Every day Karen, the teacher, teaches the children in her class how to read numbers.
Today Karen brings a game to class. (show game)
Karen says to the children: ‘we are going to play a number game now. In this game, every child spins the spinner and has to say the name of the number that it lands on. A child who reads the number correctly gets a sticker and gets to play again.
(enact spinning the spinner)

Knowledge Question: Does Karen, the teacher, know how to read numbers?
Yes No

Teach Question: When the teacher plays the game, what does the teacher really want - does the teacher really want to play with the children or does the teacher really want to teach numbers? Play Teach

Correct = Yes to knowledge question, Teach to teach question

Overestimate Learner

Need: **Erin**
Ada
Cards to write on

Here are Erin and Ada (introduce figures)
Ada is a teacher who teaches children how to write their names.
Erin does not know how to write her name, but Ada, the teacher, thinks that Erin knows how to write her name.

Knowledge Question: Does Erin really know how to write her name or not?

Yes No

(Right, Erin doesn't know how to write her name but Ada, the teacher, thinks that she knows.)

Teach Question: So, what will the teacher do? Will the teacher try to teach Erin to write her name or not?"

Teach Not Teach

Correct=No to knowledge question; Not teach to teach question

Overestimate Self

Need: Jake
Jake's little sister
Toy Cow

Here is Jake. (introduce toy figure)
Jake thinks this is a dog (show cow).
Control Question: Is this really a dog? No, it's a cow.
But Jake thinks this is a dog.
Here is Jake's little sister. (introduce toy figure)
Jake's little sister doesn't know what this animal is.
She says to Jake, 'Please, teach me the name of this animal.' (enact)

Knowledge Question: Does Jake really know what this animal is called? Yes No

Teach Question: Will Jake try to teach his little sister the name of this animal?

Try to teach Not try to teach

Correct = No to knowledge question; Yes try to teach to teach question

B: **Theory of Mind Scale**

Wellman & Liu, University of Michigan

ANY USE OF THIS SCALE OR TRANSLATIONS OF IT SHOULD CITE WELLMAN & LIU (2004) AND PERMISSION FROM WELLMAN & LIU (H.M. Wellman & D. Liu, 2004, Scaling of theory of mind tasks. *Child Development*, *75*, 523-541)

These tasks are presented in order of least to most difficult (for preschoolers). They should NOT be presented in exactly this order, BUT Not-Own Desire should come first (so children begin with an easy task to understand) and Appearance-Reality Emotion should come last. We suggest the order: Diverse- Desire, Knowledge-Access, Contents False Belief, Diverse Belief, Explicit False Belief, Real-Apparent Emotion. If two orders are needed then we recommend the following for a second order: Diverse- Desire, , Explicit False Belief, Diverse Belief, Contents False Belief, Knowledge-Access, Real-Apparent Emotion

Note: Explicit False Belief is NOT an item in the "official" 5-item scale. So it is often omitted. (It is included here just for those who want to include two false-belief tasks, one within the scale itself and one additional in a format comparable to the rest of the scale. See Wellman & Liu 2004 for details.)

All tasks use small toy figurines and pictures, to present the contents.

Task 1: Understanding Diverse Desires

Not-Own Desire (X)
Props: Small figurine. 8.5x11 piece paper (laminated) with colored realistic drawing of carrot on one half and cookie on the other.

Story: Here's Mr. Jones (place figure next to picture, midway between two items). It is his snack time. So, Mr. Jones wants a snack to eat. Here are two different snacks: a carrot (point) and a cookie (point).

Own Desire: Which snack would YOU like best? Would you like a carrot (point) or…a cookie (point) best?

___ If carrot: Well, that's a good choice, BUT…Mr. Jones REALLY LIKES cookies (don't point). He doesn't like carrots. What he likes best are cookies.

___ If cookie: Well, that's a good choice, BUT…Mr. Jones REALLY LIKES carrots (don't point). He doesn't like cookies. What he likes best are carrots.

Question: So, now it's time to eat. Mr. Jones can only choose one snack, just one. Which snack will Mr. Jones (point to Mr. Jones) choose?…A carrot or…a cookie?

___ carrot ___ cookie

SCORING: To be scored as correct, or to "pass" this task, the child must answer the *target* question opposite from his/her answer to the *own-desire* question.

Task 2: Understanding Diverse Beliefs
Not-Own Belief (X)
Props: Small figurine of girl. Plus 8.5x11 piece paper (laminated) with colored realistic drawing of bushes on one half and garage on the other.

Story: Here's Linda (place figure on table next to picture midway between two items). Linda wants to find her cat. Her cat might be hiding in the bushes (point) or…it might be hiding in the garage (point).

Own Belief: Where do YOU think the cat is? In the bushes (point) or…in the garage (point)?

___ If bushes: Well, that's a good idea, BUT…Linda THINKS her cat is in the garage (don't point). She thinks her cat is in the garage.

___ If garage: Well, that's a good idea, BUT…Linda THINKS her cat is in the bushes (don't point). She thinks her cat is in the bushes.

Question: So…where will Linda (point to Linda) look for her cat?…In the bushes or…in the garage?

___ bushes ___ garage

SCORING: To be scored correct the child must answer the *target* question opposite from his/her answer to the *own-belief* question.

Task 3: Understanding knowledge requires perceptual access:
Knowledge Access (X)
Props: Small nondescript rectangular container with a single drawer. Toy dog to fit in drawer. Small figurine of girl.

Experimenter: Here's a drawer (keep finger over drawer).

Question to child: What do you think is inside the drawer (point to drawer)?
(If child gives an answer): ________________

Experimenter: (With drama) Let's see…it's really a DOG inside!
(Pull out drawer to show dog)
(Close the drawer to restrict view again after a pause)

Post-view Question: Okay…what is in the drawer? ________________
(If child makes an error here, show contents inside again until child gets this question correct)

Experimenter: Polly has never ever seen inside this drawer. (Take Polly out) Now here comes Polly.

Question: So…does Polly KNOW what is in the drawer?

___ yes ___ no

Did Polly see inside this drawer?

___ yes ___ no

SCORING: To be scored correct the child must answer the *target* question "no" and answer the *memory* control question (the last question about seeing) "no."

Task 4: Standard FB task

Contents False-Belief (X)

Props: standard Band-aid box with picture of band-aid prominently on front. Toy pig to fit in box. Small figure of a boy.

Experimenter: Here is a Band-Aid box.

Question to child: What do you think is inside the Band-Aid box? _______________
(Prompt child to say Band-Aids if necessary: for example,
first prompt, "Does it look like there would be Band-Aids inside?"
second prompt, "What kind of box is this? What should be in here?"
third prompt, "Should there be Band-Aids in here or books in here?")

Experimenter: (With drama) Let's see…it's really a PIG inside!
(Pour pig out)
(Close the lid to restrict view again after a pause)

Post-view Question: Okay…what is in the box? _______________
(If child makes an error here, show contents inside again until child gets this question correct)

Experimenter: Peter has never ever seen inside this Band-Aid box. (Take Peter out) Now here comes Peter.

Question: So…what does Peter THINK is in the box? Band-Aids or a Pig?
(Reiterate choice again if child still does not answer)

___ Band-Aids ___ Pig

Did Peter see inside this box?

___ yes ___ no

SCORING: To be scored correct the child must answer the *target* question "Band-Aids" and answer the *memory* question (the last question about seeing) "no."

Task 5: Understanding Display Emotions

Appearance-Reality Emotion Scale Pre-training (X)

Props: Picture (about 3x3) showing drawing of back of a boy's head (not face or expression). Emotion scale: a strip (about 3x10) of three simple "faces" (bare-bones "smiley"-type black-and-white faces of just circular outline plus simple eyes and line-like mouths): one happy, one sad, and (in middle of strip) one neutral.

Experimenter: Now, I'm going to tell you a story about a boy. (Take out emotion scale) In this story, the boy might feel happy (point). He might feel sad (point). Or He might be not feel happy or sad, just OK (point).

Can you point to the face that is:

___ Sad?
___ OK?
___ Happy?

(Train child again if child makes a mistake)

Experimenter: Okay, now about the story: After I've finished the story, I'm going to ask you about how the boy really feels, inside (pat own chest), AND how he looks on his face (pat own cheek). How he really feels inside (pat own chest) may be the same as how he looks on his face (pat own cheek), or they may be different.

(At this point the emotion scale is pushed to one side. The child does not have to answer the target questions by pointing at the scale. The scale remains in sight but out of the way just to provide a visual reminder of the warm up, unless child is unusually nonverbal.)

Appearance-Reality Emotion Task

Experimenter: This story is about Matt. Matt's friends were playing together and telling jokes. One of the older children, Rosie, told a mean joke about Matt and everyone laughed. Everyone thought it was very funny, but *not* Matt. But, Matt didn't want the other children to see how he felt about the joke, because they would call him a baby. So, Matt tried to *hide how he felt*.

Memory Check: What did the other children do when Rosie told a mean joke about Matt?

____

(Correct answer: laughed or thought it was funny… if the child gets the answer wrong, tell the story again)

In the story, what would the other children do if they knew how Matt felt?

____

(Correct answer: Call Matt a baby or tease him …if the child gets the answer wrong, tell the story again)

Question: So, how did Matt really feel, when everyone laughed? Did he feel happy, sad, or okay?

___ Happy ___ Sad ___ Okay

How did Matt try to look on his face, when everyone laughed? Did he look Happy, Sad, or Okay? (Note: the examiner should not show any feelings)
(Reiterate choice again if child still does not answer)

___ Happy ___ Sad ___ Okay

SCORING: Scoring rests on answers to the last two questions. To be scored correct the child's answer to the *really-feel* question must be *more negative* than his/her answer to the *look* question (i.e., sad for really-feel and happy or OK for look, or OK for really-feel and happy for look).

C: Intention-Desire Distinction Measure
Schult (2002)

Intention-Fulfilled/Desire-Satisfied

Alison is at the pool and she's getting ready to swim. She wants to get wet all at once, not little by little. Alison makes a plan. She decides she's going to jump off the diving board into the pool. Alison walks out to the end of the diving board, and jumps into the water. Now she's all wet.

(1) What was Alison’s plan?

(2) Did Alison do what she planned to do? Yes No

(3) What did Alison want?

(4) Did Alison get what she wanted? Yes No

Brian has a puppy and he takes care of it very well. His parents let him feed the puppy by himself sometimes. Brian wants to feed the puppy now. He makes a plan. He's going to get the food out of the cupboard and put it in the puppy's bowl. Brian goes over to the cupboard and gets out the puppy food. He puts it in the bowl, and the puppy eats the food.

(1) What was Brian’s plan?

(2) Did Brian do what he planned to do? Yes No

(3) What did Brian want?

(4) Did Brian get what he wanted? Yes No

Intention-Unfulfilled/Desire-Unsatisfied

Carrie has a big kite. She really likes flying kites, and she wants to fly this one right away. She can't fly her kite in her backyard, because there are too many trees. Carrie makes a plan. She decides she's going to go to the park and fly her kite. Just then, it started to rain, and Carrie had to stay inside.

(1) What was Carrie’s plan?

(2) Did Carrie do what she planned to do? Yes No

(3) What did Carrie want?

(4) Did Carrie get what she wanted? Yes No

When Marty wakes up, there's snow outside on the ground. Marty wants to build a snowman. He really likes building things with snow. Marty makes a plan. He decides he's going to roll up all the snow in the backyard so he can make a big snowman. Marty puts on his snowsuit and boots and goes outside. The sun has melted all the snow.

(1) What was Marty’s plan?

(2) Did Marty do what he planned to do? Yes No

(3) What did Marty want?

(4) Did Marty get what he wanted? Yes No

Intention-Unfulfilled/Desire-Satisfied

Becky really likes playing with dolls. She would like a new doll to play with. There's a doll at the toy store that Becky wants. Becky's been saving up her money, and she has just enough to buy the doll. Becky makes a plan. She decides she's going to go to the toy store and buy the doll. That day, before she went to the store, her mother gave her the doll. Now Becky has the doll.

(1) What was Becky's plan?

(2) Did Becky do what she planned to do? Yes No

(3) What did Becky want?

(4) Did Becky get what she wanted? Yes No

Andrew is playing outside, and he's getting hungry. He wants to have soup for lunch. Soup is Andrew's favorite lunch. It warms him up when it's cold outside. Andrew makes a plan. He decides he's going to make some soup in the microwave. When Andrew comes inside for lunch, his mother has already made lunch. Andrew's mother gives him a warm bowl of soup.

(1) What was Andrew's plan?

(2) Did Andrew do what he planned to do? Yes No

(3) What did Andrew want?

(4) Did Andrew get what he wanted? Yes No

Intention-Fulfilled/Desire-Unsatisfied

Sarah is hungry and she wants a snack. She wants to have graham crackers and a glass of milk for snack. That's her favorite. Sarah makes a plan. She decides she's going to get out the crackers first, then pour herself a glass of milk. When Sarah is putting the milk away, her dad comes in and eats all the crackers.

(1) What was Sarah’s plan?

(2) Did Sarah do what she planned to do? Yes No

(3) What did Sarah want?

(4) Did Sarah get what she wanted? Yes No

It's a rainy day, and Mark has to walk home from school. He wants his shoes to stay dry, because he doesn't like having wet shoes. Mark makes a plan. He decides he's going to walk around all the puddles. Mark walks very carefully, and doesn't step into a single puddle. When he gets home, his shoes are still dry. Just then, his little brother spills water on his shoes.

(1) What was Mark’s plan?

(2) Did Mark do what he planned to do? Yes No

(3) What did Mark want?

(4) Did Mark get what he wanted? Yes No

D: Same Action-Different Intention Story Example (Order 1)
Baird and Moses (2001)

Running Story: Order 1 EXERCISE (Same/Diff)
This is Michael. Michael wants to be home for dinner in just a few minutes, so he is running.

This is Christopher. Christopher wants to be healthy and strong when he grows up, so he is running.

Action: Is Michael running, is Christopher running, or are they both running? That's right. Michael and Christopher are both running. They are both doing the same thing.

Desire 1: Which boy wants to be home for dinner in just a few minutes? (Michael) That's right. Michael wants to be home for dinner in just a few minutes, so he is running.
Intention 1: What is Michael trying to do? Is Michael trying to get some exercise or is he trying to get somewhere fast?
(*Fast*) That's right. Michael is trying to get somewhere fast b/c he wants to be home for dinner in just a few minutes.
(*Exercise*) Actually, Michael is trying to get somewhere fast b/c he wants to be home for dinner in just a few minutes. So what is he trying to do? Is he trying to get some exercise or is he trying to get somewhere fast?

Desire 2: Which boy wants to be healthy and strong when he grows up? (Christopher) That's right. Christopher wants to be healthy and strong when he grows up, so he is running. Intention 2: What is Christopher trying to do? Is Christopher trying to get some exercise or is he trying to get somewhere fast?

Hose Story: Order 1 GARDEN (Same/Diff)
This is Susan. Susan wants her dog to look pretty, so she is filling up a bucket.

____

This is Jessica. Jessica wants to have a beautiful backyard, so she is filling up a bucket.

____

Action: Is Jessica filling up the bucket, is Susan filling up the bucket, or are they both filling up the bucket? That's right. Jessica and Susan are both filling up the bucket. They are both doing the same thing.

Desire 1: Which girl wants to have a beautiful backyard? (Jessica) That's right. Jessica wants to have a beautiful backyard, so she is filling up the bucket.
Intention 1: What is Jessica trying to do? Is Jessica trying to water the garden or is she trying to prepare a bath?
(*Water*) That’s right. Jessica is trying to water the garden b/c she wants to have a beautiful backyard.
(*Bath*) Actually, Jessica is trying to water the garden b/c she wants to have a beautiful backyard. So what is she trying to do? Is she trying to trying to water the garden or is she trying to prepare a bath?

Desire 2: Which girl wants her dog to look pretty? (Susan) That's right. Susan wants her dog to look pretty, so she is filling up the bucket.
Intention 2: What is Susan trying to do? Is Susan trying to water the garden or is she trying to prepare a bath?

Closet Story: Order 1 VACUUM (Same/Same)

This is John. John wants a hole in his backyard, so he is opening the closet. ____This is Max. Max wants a sandcastle at the beach, so he is opening the closet. ____Action: Is John opening the closet, is Max opening the closet, or are they both opening the closet? That's right. John and Max are both opening the closet. They are both doing the same thing.

Desire 1: Which boy wants a hole in his backyard? (John) That's right. John wants a hole in his backyard, so he is opening the closet. Intention 1: What is John trying to do? Is John trying to find the vacuum or is he trying to find a shovel?

(*Shovel*) That's right. John is trying to find a shovel b/c he wants a hole in the backyard. (*Vacuum*) Actually, John is trying to find a shovel b/c he wants a hole in the backyard. So what is he trying to do? Is he trying to find the vacuum or is he trying to find a shovel?

Desire 2: Which boy wants a sandcastle at the beach? (Max) That's right. Max wants a sandcastle at the beach, so he is opening the closet. Intention 2: What is Max trying to do? Is Max trying to find the vacuum or is he trying to find a shovel?

Toy Story: Order 1 CLEAN UP (Same/Same)

This is Jenny. Jenny wants her friend in California to have these toys, so she is putting the toys in a box.

This is Sally. Sally wants to have these toys when she's away on vacation, so she is putting the toys in a box.

Action: Is Sally putting toys in the box, is Jenny putting toys in the box, or are they both putting toys in the box? That's right. Sally and Jenny are both putting toys in the box. They are both doing the same thing.

Desire 1: Which girl wants to have these toys when she's away on vacation? (Sally) That's right. Sally wants to have these toys when she's away on vacation, so she is putting the toys in the box.

Intention 1: What is Sally trying to do? Is Sally trying to clean up the toys or is she trying to pack the toys?

(*Pack*) That's right. Sally is trying to pack the toys b/c she wants to have them when she's away on vacation.

(*Clean up*) Actually, Sally is trying to pack the toys b/c she wants to have them when she's away on vacation. So what is she trying to do? Is she trying to clean up the toys or is she trying to pack the toys?

Desire 2: Which girl wants her friend in California to have these toys? (Jenny) That's right. Jenny wants her friend in California to have these toys, so she is putting the toys in the box.

Intention 2: What is Jenny trying to do? Is Jenny trying to clean up the toys or is she trying to pack the toys?

Wood/Cake Story: Order 1 FIRE (Diff/Diff)

This is Jeffrey. Jeffrey wants his house to be warm tonight, so he is chopping wood. ____This is Tom. Tom wants to have a birthday party, so he is mixing chocolate in a bowl.

____

Action: Is Jeffrey chopping wood, is Tom chopping wood, or are they both chopping wood? That's right. Jeffrey is chopping wood and Tom is mixing chocolate. They are doing different things.

Desire 1: Which boy wants his house to be warm tonight? (Jeffrey) That's right. Jeffrey wants his house to be warm tonight, so he is chopping wood. Intention 1: What is Jeffrey trying to do? Is Jeffrey trying to make a fire or is he trying to make a cake?

(Fire) That's right, Jeffrey is trying to make a fire b/c he wants his house to be warm tonight.

(Cake) Actually, Jeffrey is chopping wood b/c he wants his house to be warm tonight. So, what is he trying to do? Is he trying to make a fire or is he trying to make a cake?

Desire 2: Which boy wants to have a birthday party? (Tom) That's right. Tom wants to have a birthday party, so he is mixing chocolate in a bowl. Intention 2: What is Tom trying to do? Is Tom trying to make a fire or is he trying to make a cake?

Music/Hat Story: Order 1 WARM (Diff/Diff)

This is Anne. Anne wants to be a good dancer, so she is pressing a button on the stereo. ____This is Sarah. Sarah wants to be outside playing in the snow, so she is putting a hat on. ____Action: Is Sarah pressing a button, is Anne pressing a button, or are they both pressing a button? That's right. Sarah is putting a hat on and Anne is pressing a button. They are doing different things.

Desire 1: Which girl wants to be outside playing in the snow? (Sarah) That's right. Sarah wants to be outside playing in the snow, so she is putting a hat on.
Intention 1: What is Sarah trying to do? Is Sarah trying to stay warm or is she trying to turn the music on?

(Warm) That's right, Sarah is trying to stay warm b/c she wants to be outside playing in the snow.
(Music) Actually, Sarah is trying to stay warm b/c she wants to be outside playing in the snow. So what is she trying to do? Is she trying to stay warm or is she trying to turn the music on?

Desire 2: Which girl wants to be a good dancer? (Anne) That's right. Anne wants to be a good dancer, so she is pressing a button on the stereo.
Intention 2: What is Anne trying to do? Is Anne trying to stay warm or is she trying to turn the music on?

E: Understanding of Teaching Stories (Controls)

Underestimate Self

Need: Lisa
Mom
Danielle
M&Ms

Here is Lisa. (introduce toy figure)
Lisa doesn't think she knows how to count
But when Lisa's mom asks her to split these M&Ms in half so they can have the same amount now and the same amount later, Lisa gives her mom two M&Ms, which means she knows how to count. (enact)
Control Question 1: Does Lisa know how to count? Yes No
(Right/Remember that), she does know how to count.
Control Question 2: Does Lisa think she knows how to count? Yes No
(Right, but/Remember that) Lisa doesn't think she knows how to count.
Here is Lisa's friend Danielle. (introduce toy figure)
Danielle doesn't know how to count.
She says to Lisa 'Please teach me how to count.' (enact)

Knowledge Question: Does Lisa really know how to count? Yes No

Teach Question: Will Lisa try to teach her friend how to count?

Try to teach Not try to teach

Correct = Yes to knowledge question; Not teach to teach question

Underestimate Learner

Need: Daniel
Richard
Card to write on

Here are Daniel and Richard. (introduce figures)
Richard knows how to draw a happy face,
and he teaches other children how to draw a happy face.
Daniel knows how to draw a happy face,
but Richard thinks that Daniel doesn't know how to draw a happy face.

Knowledge Question: Does Daniel know how to draw a happy face or not? Yes No

(Right, Daniel knows how to draw a happy face, but Richard thinks that Daniel doesn't know how to draw a happy face.)

Teach Question: So, what will Richard do? Will Richard try to teach Daniel to draw a happy face or not?

Teach Not Teach

Correct = Yes to Knowledge question; Yes teach to Teach question

Embedded teaching Control

Need: Marty
Several toy figures (to be children in the classroom)
Dinosaur soccer and map

Here is Marty. (introduce toy figure)
Marty is a teacher.
Every day Marty, the teacher, teaches the children in his class how to read a map.
Today Marty brings a game to class. (show game)
Marty says to the children: ‘we are going to play the dinosaur soccer game now. In this game, every child uses a dinosaur to put the ball in the goal. A child who uses a dinosaur to put the ball in the goal gets a sticker and gets to play again.
(enact dinosaur soccer game)

Knowledge Question A: Does Marty, the teacher, know how to read a map?
Yes No

Knowledge Question B: Does Marty, the teacher, know how to play dinosaur soccer?
Yes No

Teach Question: When the teacher plays the game, what does the teacher really want - does the teacher really want to play with the children or does the teacher really want to teach the children how to read a map? Play Teach

Correct = Yes to knowledge question, Play to teach question

BIBLIOGRAPHY

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

Ames, C. S., & White, S. J. (2011). Brief report: Are ADHD traits dissociable from the autistic profile? Links between cognition and behaviour. *Journal of autism and developmental disorders*, *41*(3), 357-363.

Ascroft, W., Argiro, S., & Keohane, J. (2010). *Success strategies for teaching kids with autism*. Waco, TX: Prufrock Press Inc.

Astington, J. W. (1994). *The Child's Discovery of the Mind*. Cambridge, MA, US: Harvard University Press.

Astington, J. W. (2001). *The paradox of intention: Assessing children's metarepresentational understanding*. Cambridge, MA, US: The MIT Press.

Astington, J. W. & Gopnik, A. (1991). Theoretical explanations of children's understanding of the mind. *British Journal of Developmental Psychology*. *Special Issue: Perspectives on the child's theory of mind: I*, *9*(1), 7-31.

Astington, J. W., & Lee, E. (1991, April). *What do young children know about intentional causation?* Paper presented at the biennial meeting of the Society for Research in Child Development, Seattle, WA.

Astington, J. W. & Pelletier, J. (1996). The language of mind: Its role in teaching and learning. In D. R. Olson &N. Torrance (Eds.), *The handbook of education and human development* (pp. 593–620). Oxford, UK: Blackwell.

Astington, J. W. & Pelletier, J. (2005). Theory of mind, language, and learning in the early years: Developmental origins of school readiness. In B. D. Homer and C. S. Tamis LeMonda (Eds.), *The development of social cognition and communication.* (pp. 205-230). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Autism and Developmental Disabilities Monitoring Network Surveillance Year 2008 Principal Investigators. (2012). Prevalence of autism spectrum disorders-Autism and Developmental Disabilities Monitoring Network *MMWR Surveillance Summary* (Vol. 61, pp. 1-19). United States, 2008: Centers for Disease Control and Prevention.

Autism Speaks Inc. (2013). *Autism speaks*. Retrieved from http://www.autismspeaks.org/index.php.

Aylward, G. P. (1992). Review of the Differential Ability Scales. In J. J. Kramer & J. C. Conoley (Eds.), *The eleventh mental measurements yearbook* (pp. 281–282). Lincoln: The Buros Institute of Mental Measurements of the University of Nebraska—Lincoln. Braden, J.

Baird, J. A. & Moses, L. J. (2001). Young Children's Understanding That Identical Actions May Be Motivated by Different Intentions. *Journal of Cognition and Development, 2*(4), 413-448.

Baldwin, D. A. (2000). Interpersonal understanding fuels knowledge acquisition. *Current Directions in Psychological Science, 9*(2), 40-45.

Baldwin, D. A., & Baird, J. A. (1999). Action analysis: A gateway to intentional inference. In P. Rochat (Ed.), *Early social cognition* (pp. 215-240). Hillsdale, NJ: Lawrence Erlbaum Associates.

Baron-Cohen, S. (1989a). Are autistic children behaviourists? An examination of their mental-physical and appearance-reality distinctions. *Journal of Autism and Developmental Disorders, 19*(4), 579-600.

Baron-Cohen, S. (1989b). The autistic child's theory of mind: a case of specific developmental delay. *Journal of Child Psychology and Psychiatry, 30*, 285-298.

Baron–Cohen, S. (1993). From attention-goal psychology to belief–desire psychology: The development of a theory of mind and its dysfunction. In S. Baron-Cohen, H. Tager–Flusberg, & D. Cohen (Eds.) *Understanding other minds: Perspectives from autism* (pp. 59–82). Oxford University Press.

Baron-Cohen, S. (1992). Out of sight or out of mind: another look at deception in autism. *Journal of Child Psychology and Psychiatry, 33*(7), 1141-1155.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind.* Cambridge: MIT Press.

Baron-Cohen, S. (2001). Theory of mind and autism: A review. *International Review of Mental Retardation, 23*, 169–184.

Baron-Cohen, S., & Goodhart, F. (1994). The "seeing leads to knowing" deficit in autism: the Pratt and Bryant probe. *British Journal of Developmental Psychology, 12*, 397-402.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have theory of mind? *Cognition, 21*, 37 – 46.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1986). Mechanical, behavioural and intentional understanding of picture stories in autistic children. *British Journal of Developmental Psychology, 4*, 113-125.

Baron-Cohen, S., Ring, H., Moriarty, J., Shmitz, P., Costa, D., & Ell, P. (1994). Recognition of mental state terms: a clinical study of autism, and a functional neuroimaging study of normal adults. *British Journal of Psychiatry, 165*, 640-649.

Baron-Cohen, S., Tager-Flusberg, H., & Cohen, D. (1994). *Understanding other minds: Perspectives from autism*. London: Oxford University.

Baron-Cohen, S., Ring, H.A., Bullmore, E.T., Wheelwright, S., Ashwin, C., Williams, S.C. (2000). The amygdala theory of autism. *Neuroscience Biobehavioral Review, 24*(3), 355–364.

Bennetto, L., Pennington, B. F., & Rogers, S. J. (1996). Intact and impaired memory functions in autism. *Child development, 67*(4), 1816-1835.

Bigham, S. (2010). Impaired Competence for Pretense in Children with Autism: Exploring Potential Cognitive Predictors. *Journal of autism and developmental disorders, 40*(1), 30-38.

Bowler, D. M. (1992). ``Theory of mind'' in Asperger's syndrome. *Journal of Child Psychology and Psychiatry, 33*, 877-893.

Brandone, A. C., & Wellman, H. M. (2009). You can't always get what you want: Infants understand failed goal-directed actions. *Psychological Science*, *20*(1), 85-91.

Callahan, K., Shukla-Mehta, S., Magee, S., & Wie, M. (2010). ABA Versus TEACCH: The Case for Defining and Validating Comprehensive Treatment Models in Autism. *Journal of Autism and Developmental Disorders, 40*(1), 74-88.

Carpenter, M., Akhtar, N. & Tomasello, M. (1998a) Fourteen- through 18-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior and Development*, *21*(2), 315–30.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63*(4), 1–143.

Carpenter, M., Pennington, B. F., & Rogers, S. J. (2001). Understanding of others' intentions in children with autism. *Journal of Autism and Developmental Disorders, 31*(6), 589 –599.

Carter, A.S., Davis, N.O., Klin, A., et al. (2005). Social development in autism. In: Volkmar, F.R., Paul, R., Klin, A., et al., editors. (3rd Eds). *Handbook of autism and pervasive developmental disorders*. Vol. 1.pp. 312-340. Hoboken (NJ): Wiley.

Charman, T., & Baird, G. (2002). Practitioner review: Diagnosis of autism spectrum disorder in 2- and 3- year-old children. *Journal of Child Psychology and Psychiatry, 43*(3), 289–305.

Chevallier, C., Kohls, G., Troiani, V., Brodkin, E.S., & Schultz, R.T. (2012). The social motivation theory of autism. *Trends in Cognitive. Science*, *16*, 231–239.

Colombi, C., Liebal, K., Tomasello, M., Young, G., Warneken, F., & Rogers, S. J. (2009). Examining correlates of cooperation in autism Imitation, joint attention, and understanding intentions. *Autism, 13*(2), 143-163.

Couture, S. M., Penn, D. L., Losh, M., Adolphs, R., Hurley, R., and Piven, J. (2009). Comparison of social cognitive functioning in schizophrenia and high functioning autism: more convergence than divergence. *Psychological Medicine 40*(4), 569–579.

d'Arc, B. F., & Mottron, L. (2012). Social Cognition in Autism. In: Anderson, V., & Beauchamp, M. H. (Eds.). *Developmental Social Neuroscience and Childhood Brain Insult: Theory and Practice*. pp. 299-322. Guilford Press.

Dawson, G., & Burner, K., (2011). Behavioral interventions in children and adolescents with autism spectrum disorder: a review of recent findings. *Current Opinion in Pediatrics 23*, 616-620.

Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J., Donaldson, A., & Varley, J. (2010). Randomized, controlled trial of an intervention for toddlers with autism: The Early Start Denver Model. *Pediatrics, 125*, e17−e23.

Eisenmajer, R., & Prior, M. (1991). Cognitive linguistic correlates of ``theory of mind'' ability in autistic children. *British Journal of Developmental Psychology, 9*, 351-364.

Elliott, C. D. (1990b). *Differential ability scales (DAS).* San Antonio, TX: The Psychological Corporation.

Elliott, C. D. (2007). *Differential Ability Scales, 2nd edition: Introductory and technical handbook*. San Antonio, TX: The Psychological Corporation.

Estes, D., Wellman, H. M., & Woolley, J. D. (1989). Children's understanding of mental phenomena. In H. Reese (Ed.), *Advances in child development and behavior*. New York: Academic Press.

Fabricius, W. V., & Khalil, S. L. (2003). False beliefs or false positives? limits on children's understanding of mental representation. *Journal of Cognition and Development, 4(3),* 239-262.

Feinfield, K. A., Lee, P. P., Flavell, E. R., Green, F. L., & Flavell, J. H. (1999).Young children's understanding of intention. *Cognitive Development, 14*(3), 463-486.

Ferster, C. B., & DeMyer, M. K. (1961). The development of performances in autistic children in an automatically controlled environment. *Journal of Chronic Diseases, 13,* 312–345.

Flavell, J. H., Green, E. R., & Flavell, E. R. (1986). Development of knowledge about the appearance-reality distinction. *Monographs of the Society for Research in Child Development, 51* (1, Serial No. 212).

Flavell, J. H. (2004). Theory-of-mind development: Retrospect and prospect. *Merrill-Palmer Quarterly, 50*(3), 274–290.

Fombonne, E., Siddons, F., Achard, S., & Frith, U. (1994). Adaptive behavior and theory of mind in autism. *European Child and Adolescent Psychiatry, 3*, 176-186.

Frith, U. (1989). *Autism: Explaining the enigma.* Oxford, UK: Blackwell Publishing.

Frye, D., & Ziv, M. (2005). Teaching and learning as intentional activities. In B. D. Homer & C. Tamis- Lemonda (Eds.), *The development of social cognition and communication* (pp. 231 – 258). Mahwah, NJ: Lawrence Erlbaum.

Gaito, J. (1980). Measurement scales and statistics: Resurgence of an old misconception. *Psychological Bulletin, 87*, 564–567.

Guttman, L. (1944). A basis for scaling qualitative data. *American Sociological Review, 9*, 139-150.

Green, B. F. (1956). A method of scalogram analysis using summary statistics. *Psychmetrika*, *21*, 79-88.

Hall, D., Chung, J., & Navidi, G. (2010, May). *Comparative Analysis of IMFAR Sample Sizes in Support of the National Database for Autism Research*. Poster presented at Proceedings of the 9th Annual International Meeting for Autism Research, Philadelphia, PA.

Hamilton, A. F. D. C., Brindley, R. M., & Frith, U. (2007). Imitation and action understanding in autistic spectrum disorders: How valid is the hypothesis of a deficit in the mirror neuron system?. *Neuropsychologia*, *45*(8), 1859-1868.

Hamilton, A. F. D. C., Brindley, R., & Frith, U. (2009). Visual perspective taking impairment in children with autistic spectrum disorder. *Cognition*, *113*(1), 37-44.

Happé, F. (1993). Communicative competence and theory of mind in autism: A test of Relevance Theory. *Cognition, 48*(2), 101-119.

Happé, F. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Development Disorders, 24*(2), 129-154.

Happé, F. (1995). The role of age and verbal ability in theory of mind task performance of subjects with autism. *Child Development, 66*(3), 843–855.

Happé, F., & Frith, U. (2006). The weak coherence account: Detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 36*(1), 5–25.

Happé, F., & Ronald, A. (2009). The ‘fractionable autism triad’: A review of evidence from behavioural, genetic, cognitive and neural research. *Neuropsychology Review, 18*(4), 287–304.

Harms, M. B., Martin, A., & Wallace, G. L. (2010). Facial emotion recognition in autism spectrum disorders: A review of behavioral and neuroimaging studies. *Neuropsychology review*, *20*(3), 290-322.

Harter, S., & Whitesell, N. R. (1989). Developmental changes in children’s understanding of single, multiple, and blended emotion concepts. In C. Saarni & P. L. Harris (Eds.), *Children’s understanding of emotion* (pp. 81 – 116). Cambridge, England: Cambridge University Press.

Hobson, R. P. (1986a). The autistic child's appraisal of expressions of emotion. *Journal of Child Psychology and Psychiatry, 27*, 321-342.

Hobson, R. P. (2002). *The cradle of thought: Exploring origins of thinking*. London: Macmillan.

Hobson, R. P., Ouston, J., & Lee, A. (1988). Emotion recognition in autism: coordinating faces and voices. *Psychological Medicine, 18*, 911–923.

Hobson, R. P., Ouston, J., & Lee, A. (1989). Naming emotion in faces and voices: abilities and disabilities in autism and mental retardation. British Journal of *Developmental Psychology, 7*, 237–250.

Hofer, T., & Aschersleben, G. (2007). *''Theory of Mind'' Skala für 3- bis 5-jährige Kinder [German theory of mind scale for 3- to 5-year-old children]* (3rd ed.). Munich, Germany: Max Planck Institute for Human Cognitive and Brain Sciences.

Hogrefe, G-J., Wimmer, H., & Perner, J. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. *Child Development, 57*(3), 567-582.

Hornbeck, V. S. (2001). Understanding of intention and imitation in young children with autism, children with other developmental disabilities and children with typical development. *Dissertation Abstracts International: Section B: The Sciences and Engineering, 62* (3-B), 1579.

Howlin, P. (2005). Outcomes in autism spectrum disorders. In F. R. Volkmar, R. Paul, A. Klin, & D. Cohen (Eds.), *Handbook of autism and pervasive developmental disorders, vol. 1: Diagnosis, development, neurobiology, and behavior* (3rd ed., pp. 201– 220). Hoboken, NJ: Wiley.

Huang, C., Heyes, C., & Charman, T. (2002). Infants' behavioral reenactment of ''failed attempts'': Exploring the roles of emulation learning, stimulus enhancement, and understanding of intentions. *Developmental Psychology, 38*(5), 840–855.

Huang, C., Heyes, C., & Charman, T. (2006). Preschoolers' behavioural reenactment of 'failed attempts': The roles of intention-reading, emulation and mimicry. *Cognitive Development, 21*(1), 36–45.

Hughes, C., Russell, J., & Robbins, T. (1994). Evidence for executive dysfunction in autism. *Neuropsychologia, 32*(4), 477-492.

Jarrold, C. (2003). A Review of Research into Pretend Play in Autism. *Autism, 7*(4), 379–390.

Jones, E. J. H., Webb, S. J., Estes, A., & Dawson, G. (2013). Rule Learning in Autism: The Role of Reward Type and Social Context. *Developmental Neuropsychology, 38*(1), 58-77.

Joseph, R. M., & Tager-Flusberg, H. (1999). Preschool children's understanding of the desire and knowledge constraints on intended action. *British Journal of Developmental Psychology, 17*(2), 221-243.

Kaland, N., Callesen, K., Møller-Nielsen, A., Mortensen, E. L., & Smith, L. (2008). Performance of children and adolescents with Asperger syndrome or high-functioning autism on advanced theory of mind tasks. *Journal of autism and developmental disorders*, *38*(6), 1112-1123.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217-250.

Kristen, S., Thoermer, C., Hofer, T., Aschersleben, G., & Sodian, B. (2006). Skalierung von "Theory of Mind"-Aufgaben [Validation of the "Theory of Mind" scale]. *Zeitschrift fur Entwicklungspsychologie und Padagogische Psychologie*, *38,* 186 –195.

Kruger, A. C., & Tomasello, M. (1996). Cultural learning and learning culture. In D. R. Olson & N. Torrance (Eds.), *The handbook of education and human development* (pp. 369–387). Oxford, UK: Blackwell.

Lagattuta, K. H. (2005). When You Shouldn't Do What You Want to Do: Young Children's Understanding of Desires, Rules, and Emotions. *Child Development, 76*(3), 713-733.

Landa, R. J., & Goldberg, M. C. (2005). Language, social, and executive functions in high functioning autism: A continuum of performance. *Journal of autism and developmental disorders*, *35*(5), 557-573.

Lee, A., Hobson, P. R., & Chiat, S. (1994). I, you, me, and autism: An experimental study. *Journal of Autism and Developmental Disorders, 24*(2), 155–176.

Leslie, A. M. (1987). Pretense and representation: The origins of "theory of mind." *Psychological Review, 94*(4), 412-426.

Leslie, A. M., & Frith, U. (1988). Autistic children's understanding of seeing, knowing, and believing. *British Journal of Developmental Psychology, 6*(4), 315-324.

Lind, S. E., & Bowler, D. M. (2010). Impaired performance on see-know tasks amongst children with autism: evidence of specific difficulties with theory of mind or domain-general task factors?. *Journal of autism and developmental disorders*, *40*(4), 479-484.

Lombardo, M. V., & Baron-Cohen, S. (2010). Unraveling the paradox of the autistic self. *WIREs Cognitive Science*, *1*, 393-403.

Lopez, B. R., Lincoln, A. J., Ozonoff, S., & Lai, Z. (2005). Examining the relationship between executive functions and restricted, repetitive symptoms of autistic disorder. *Journal of Autism and Developmental Disorders*, *35*(4), 445-460.

Lord, C., & Jones, R. M. (2012). Annual Research Review: Re-thinking the classification of autism spectrum disorders. *Journal of Child Psychology and Psychiatry 53*(5), 490–509.

Lord, C., & Somer, L. B. (2010). Autism Spectrum Disorders: Diagnosis, Prevalence, and Services for Children and Families. *Social Policy Report, Society for Research in Child Development 24*(2), 1-27.

Lovaas, O. I., & Simmons, J. Q. (1969). Manipulation of self-destruction in three retarded children. *Journal of Applied Behaviour Analysis*, *2*(3), 143–157.

Loveland, K., Tunali-Kotoski, B., Chen Y., Ortegon J., Pearson, D., Brelsford, K., & Gibbs, M. (1997). Emotion recognition in autism: verbal and nonverbal information. *Development and Psychopathology, 9*, 579–593.

Low, J., Goddard, E., & Melser, J. (2009). Generativity and imagination in autism spectrum disorder: Evidence from individual differences in children's impossible entity drawings. *British Journal of Developmental Psychology, 20*, 425–444.

Lunney, G. H. (1970). Using analysis of variance with a dichotomous dependent variable: An empirical study. *Journal of Educational Measurement*, *7*, 263–269.

Luyster, R., & Lord, C. (2009). Word learning in children with autism spectrum disorders. *Developmental psychology*, *45*(6), 1774.

Macdonald, H., Rutter, M., Howlin, P., Rios, P., LeCouteur, A., Evered, C., & Fostein, S. (1989). Recognition and expression of emotional cues by autistic and normal adults. *Journal of Child Psychology and Psychiatry*, *30*, 865–878.

Malle, B. F. (1999). How people explain behavior: A new theoretical framework. *Personality and Social Psychology Review, 3*(1), 23–48.

Matson J. L., & LoVullo S. V. (2008). A review of behavioral treatments for self-injurious behaviors of persons with autism spectrum disorders. *Behavior Modification, 32*(1), 61-76.

Matson, J. L., & Wilkins, J. (2008). Nosology and diagnosis of Asperger's syndrome. *Research in Autism Spectrum Disorders, 2*(2), 288-300.

Machalicek, W., O'Reilly, M. F., Beretvas, S., Sigafoos, J., Lancioni, G., Sorrells, et al. (2008). A review of school - based instructional interventions for students with autism spectrum disorders. *Research in Autism Spectrum Disorders*, *2*, 395-416.

McDuffie, A. S., Yoder, P. J., & Stone, W. L. (2006). Labels increase attention to novel objects in children with autism and comprehension-matched children with typical development. *Autism, 10*(3), 288-301.

Meijer R.R., & Sijtsma K. (2001) Methodology review: evaluating person fit. *Applied Psychological Measurement, 25*(2), 107-135.

Mesibov, G. B., & Shea, V. (2010). The TEACCH Program in the era of evidence-based practice. *Journal of Autism and Developmental Disorders, 40*(5), 570-579.

Mesibov, G. B., Shea, V., & Schopler, E. (2004). *The TEACCH approach to autism spectrum disorder*. New York: Springer Publishers

Miller, S. A. (2000). Children's understanding of preexisting differences in knowledge and belief. *Developmental Review, 20*(2), 227-282.

Moore, C., & Dunham, P. (1996). *The role of joint attention in development*. Lawrence Erlbaum Assoc.

Moses, L. J. (1993). Young children's understanding of belief constraints on intention. *Cognitive Development, 8*(1), 1-25.

Moses, L. J. (2001). Some thoughts on ascribing complex intentional concepts to young children. In B. F. Malle, L. J. Moses, & D. A. Baldwin (Eds.), *Intentions and intentionality: Foundations of social cognition* (pp. 69-83). Cambridge, MA: MIT Press.

Mundy, P., Sigman, M., & Kasari, C. (1993). The theory of mind and joint attention in autism. In S. Baron–Cohen, H. Tager–Flusberg, & D. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 181–203). Oxford: Oxford University Press.

Mundy, P., Sullivan, L., & Mastergeorge, A.M. (2009). A parallel and distributed-processing model of joint attention, social cognition and autism. *Autism Research: Official Journal of the International Society for Autism Research, 2*, 2–21.

Mundy, P., Sigman, M., Ungerer, J., & Sherman, T. (1986). Defining the social deficits of autism: The contribution of non-verbal communication measures. *Journal of Child Psychology and Psychiatry*, *27*(5), 657–669.

National Research Council. (2001). *Educating Children with Autism*. Washington, DC: National Academy Press.

Olineck, K.M., & Poulin-Dubois, D. (2005). Infants' ability to distinguish between intentional and accidental actions and its relation to internal state language. *Infancy, 8*(1), 91–100.

Olson, D. R., & Bruner, J. S. (1996). Folk psychology and folk pedagogy. In D. R. Olson &N. Torrance (Eds.), *The handbook of education and human development* (pp. 9-27). Oxford, UK: Blackwell.

Osterling, J., & Dawson, G. (1994). Early recognition of children with autism: A study of first birthday home videotapes. *Journal of Autism and Developmental Disorders*, *24*(3), 247–256.

Ozonoff, S., Pennington, B., & Rogers, S. (1991). Executive function deficits in high-functioning autistic children: relationship to theory of mind. *Journal of Child Psychology and Psychiatry, 32*, 1081-1106.

Pellicano, E. (2010). Individual differences in executive function and central coherence predict developmental changes in theory of mind in autism. *Developmental Psychology*, *46*, 530–544.

Perner, J. (1991). *Understanding the representational mind*. Bradford Books: MIT Press.

Perner, J., Leekam, S. R., & Wimmer, H. (1987). Three-year-olds' difficulty with false belief: The case for a conceptual deficit. *British Journal of Developmental Psychology*, *5*(2), 125-137.

Perner, J., Frith, U., Leslie, A. M., & Leekam, S. R. (1989). Exploration of the autistic child's theory of mind: Knowledge, belief, and communication. *Child Development*, *60*(3), 689-700.

Peterson, C. C., & Wellman, H. M. (2009). From fancy to reason: Scaling deaf children's theory of mind and pretence. *British Journal of Developmental Psychology*, *27*(2), 297–310.

Peterson, C. C., Wellman, H. M., & Liu, D. (2005). Steps in theory-of-mind development for children with deafness or autism. *Child development, 76*(2), 502-517.

Peterson, C. C., Wellman, H. M., & Slaughter, V. (2012). The Mind Behind the Message: Advancing Theory-of-Mind Scales for Typically Developing Children, and Those With Deafness, Autism, or Asperger Syndrome. *Child Development, 83*(2), 469–485.

Pexman, P. M., Rostad, K. R., McMorris, C. A., Climie, E. A., Stowkowy, J., & Glenwright, M. R. (2011). Processing of ironic language in children with high functioning autism spectrum disorder. *Journal of autism and developmental disorders*, *41*(8), 1097-1112.

Phillips, W., Baron-Cohen, S., & Rutter, M. (1998). Understanding intention in normal development and in autism. *British Journal of Developmental Psychology, 16*(3), 337–348.

Pratt, C., & Bryant, P. (1990). Young children understand that looking leads to knowing (so long as they are looking into a single barrel). *Child Development, 61*(4), 973-983.

Prior, M. R., Dahlstrom, B., & Squires, T. L. (1990). Autistic children's knowledge of thinking and feeling states in other people. *Journal of Child Psychology and Psychiatry*, *31*, 587-602.

Rao, P. A., Beidel, D. C., & Murray, M. J. (2008). Social skills interventions for children with Asperger's syndrome or high-functioning autism: A review and recommendations. *Journal of autism and developmental disorders*, *38*(2), 353-361.

Rasch, G. (1960). *Probabilistic models for some intelligence and attainment tests*. Chicago: University of Chicago Press.

Rakoczy, H., Warneken, F., & Tomasello, M. (2007). "This way!", "no! that way!" -3-year olds know that two people can have mutually incompatible desires. *Cognitive Development*, *22*(1), 47-68.

Reinehr, R. C. (1992). Review of the Differential Ability Scales. In J. J. Kramer & J. C. Conoley (Eds.), *The eleventh mental measurements yearbook* (pp. 282–283). Lincoln: The Buros Institute of Mental Measurements of the University of Nebraska—Lincoln.

Repacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month olds. *Developmental Psychology, 33*(1), 12–21.

Repacholi, B., & Slaughter, V. (Eds.). (2003). *Individual differences in theory of mind: Implications for typical and atypical development*. New York, NY, US: Psychology Press.

Robinson, E. J., Rowley, M. G., Beck, S. R., Carroll, D. J., & Apperly, I. A. (2006). Children's sensitivity to their own relative ignorance: Handling of possibilities under epistemic and physical uncertainty. *Child Development, 77*(6), 1642-1655.

Rogers, S., Hall, T., Osaki, D., Reaven, J., & Herbison, J. (2001). The Denver model: A comprehensive, integrated educational approach to young children with autism and their families. In J. Handleman & S. Harris (Eds.), *Preschool education programs for children with autism*. Austin: Pro-Ed.

Rogers, S. J., Hayden, D., Hepburn, S., Charlifue-Smith, R., Hall, T., & Hayes, A. (2006). Teaching young nonverbal children with autism useful speech: A pilot study of the Denver Model and PROMPT interventions. *Journal of Autism and Developmental Disorders, 36*(8), 1007–1024.

Russell J. (Ed). (1997). *Autism as an executive disorder*. Oxford: Oxford University Press.

Russell, J., & Hill, E. L. (2001). Action-monitoring and intention reporting in children with autism. *Journal of Child Psychology and Psychiatry, 42*(3), 317–328.

Russell, J., Hill, E., & Franco, F. (2001). The role of belief veracity in understanding intentions-in-action: preschool children's performance on the transparent intentions task. *Cognitive Development, 16*(3), 775–792.

Saarni, C. (1999). *The development of emotional competence*. New York: Guliford.

Sancho, K., Sidener, T. A., Reeve, S. A., & Sidener, D. W. (2010). Two variations of video modeling interventions for teaching play skills to children with autism. *Education and Treatment of Children, 33 (3),* 421–442.

Schaefer, G. B., & Mendelsohn, N. J. (2008). Clinical genetics evaluation in identifying the etiology of autism spectrum disorders. *Genetics in Medicine, 10*(4), 301–305.

Schopler, E. (1997). Implementation of TEACCH philosophy. In: Cohen DJ, Volkmar FR (eds) *Handbook of autism and pervasive developmental disorders,* 2nd edn. Wiley, New York, pp. 767–798.

Schopler, E.,& Reichler, R. J. (1971). Parents as cotherapists in the treatment of psychotic children. *Journal of Autism and Childhood Schizophrenia, 1,* 87–102.

Schult, C. A. (2002). Children's understanding of the distinction between intentions and desires. *Child Development, 73*(6), 1727 – 1747.

Searle, J. (1984). *Minds, brains, and science*. Cambridge: Harvard University Press.

Shultz, T. R., & Wells, D. (1985). Judging the intentionality of action-outcomes. *Developmental Psychology, 21*(1), 83-89.

Shultz, T. R., Wells, D., & Sarda, M. (1980). Development of the ability to distinguish intended actions from mistakes, reflexes, and passive movements. *British Journal of Social and Clinical Psychology, 19*(4), 301-310.

Scott, F., & Baron-Cohen, S. (1996). Imagining real and unreal objects: an investigation of imagination in autism. *Journal of Cognitive Neuroscience, 8*, 400-411.

Sanders, J. L. (2009). Qualitative or Quantitative Differences Between Asperger's Disorder and Autism? Historical Considerations. *Journal of Autism Developmental Disorders, 39*(11), 1560–1567.

Smetana, J. G., Campione-Barr, N., & Yell, N. (2003). Children's moral and affective judgments regarding provocation and retaliation. *Merrill-Palmer Quarterly*, *49*(2), 209-236.

Sobel, D. M. (2004). Children's developing knowledge of the relationship between mental awareness and pretense. *Child Development*, *75*(3), 704-729.

Sodian, B., & Frith, U. (1992). Deception and sabotage in autistic, retarded, and normal children. *Journal of Child Psychology and Psychiatry*, *33,* 591-606.

Stuss, D. T., & Knight, R. T. (2002). *Principles of frontal lobe function*. Oxford: Oxford University Press.

Tomasello, M., Kruger, A. C., & Ratner, H. H. (1993). Cultural Learning. *Behavioral and Brain Sciences, 16,* 495–552.

Wainryb, C., Shaw, L. A., Laupa, M., & Smith, K. R. (2001). Children’s, adolescents’, and young adults’ thinking about different types of disagreements. *Developmental Psychology, 37*, 373–386.

Wang, Z. (2010). Mindful Learning: Children’s Developing Theory of Mind and Their Understanding of the Concept of Learning. *Publicly accessible Penn Dissertations*, 157.

Weeks, S. J., & Hobson, R. P. (1987). The salience of facial expression for autistic children. *Journal of Child Psychology and Psychiatry, 28*, 137-152.

Wellman, H. M. (1991). *From desires to beliefs: Acquisition of a theory of mind*. Cambridge, MA, US: Basil Blackwell.

Wellman, H. M. (1988). *First steps in the child's theorizing about the mind*. New York, NY, US: Cambridge University Press.

Wellman, H. M., & Bartsch, K. (1988). Young children's reasoning and beliefs. *Cognition, 30*(3), 239-277.

Wellman, H., & Estes, D. (1986). Early understanding of mental entities: a reexamination of childhood realism. *Child Development*, *57*(4), 910- 923.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development, 72*(3), 655-684.

Wellman, H. M., & Lagattuta, K. H. (2004). Theory of mind for learning and teaching: The nature and role of explanation. *Cognitive Development. Special Issue: The Development of Children's Teaching*, *19*(4), 479-497.

Wellman, H. M., & Liu, D. (2004). Scaling of theory-of-mind tasks. *Child Development, 75*(2), 523-541.

Williams, D., & Happé, F. (2010). Representing intentions in self and other: studies of autism and typical development *Developmental Science 13*(2), 307–319.

Wooley, J. D., & Wellman, H.M . (1993). Origin and Truth: Young Children's Understanding of Imaginary Mental Representations. *Child Development, 64*(1), 1-17.

Woodburn, E. M. (2008). *The social aspects of learning: The role of theory of mind, children’s understanding of teaching and social-behavioral competence in school readiness.* Unpublished doctoral dissertation, University of Pennsylvania.

World Health Organization. (1993). *The International Classification of Diseases and Disorders-10 (ICD-10) Classification of Mental and Behavioral Disorders: Diagnostic Criteria for Research.* Geneva: World Health Organization

Wright, B. D., & Masters, G. N. (1982). *Rating scale analysis.* Chicago, IL: MESA Press.

Wright, B. D., & Stone, M. H. (1979). *Best Test Design*. Chicago, IL: MESA Press.

Vallotton, C. D. (2008). Signs of emotion: What can preverbal children “say” about internal states? *Infant Mental Health Journal*, *29*(3), 234–258.

Volkmar, F. R., Lord, C., Bailey, A., Schultz, R. T., & Klin, A. (2004). Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry, 45*(1), 135–170.

Yates, D. (2012). Neurogenetics: unravelling the genetics of autism. *Nature Reviews Neuroscience*,*13*(6), 359.

Yirmiya, N., Solomonica-Levi, D., & Shulman, C. (1996). The ability to manipulate behavior and to understand manipulation of beliefs: A comparison of individuals with autism, mental retardation, and normal development. *Developmental Psychology, 32*(1), 62-69.

Yirmiya, N., Erel, O., Shaked, M., & Solomonica-Levi, D. (1998). Meta-analyses comparing theory of mind abilities of individuals with autism, individuals with mental retardation and typically developing individuals. *Psychological Bulletin, 124,* 283–307.

Zalla, T., Labruyere, N., Clement, A., & Georgieff, N. (2010) Predicting ensuing actions in children and adolescents with autism spectrum disorders. *Experimental Brain Research, 201*(4), 809–819.

Ziv, M., & Frye, D. (2004). Children’s understanding of teaching: The role of knowledge and belief. *Cognitive Development, 19*(4), 457–477.

Ziv, M., Solomon, A., & Frye, D. (2008). Young children's recognition of the intentionality of teaching. *Child Development*, *79*(5), 1237-1256.