Uncovering a Differentiated Theory of Mind in Children with Autism and Asperger Syndrome

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UNCOVERING A DIFFERENTIATED THEORY OF MIND IN CHILDREN WITH AUTISM AND ASPERGER SYNDROME

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ABSTRACT

Dissertation Title: Uncovering a Differentiated Theory of Mind in Children with Autism and Asperger Syndrome

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Metarepresentational Theory of Mind was studied in children with autism and Asperger syndrome. This research challenged the prominent view that Theory of Mind (ToM) is a single, integrated cognitive ability, wherein reasoning about the mental states of self and others are considered to be one and the same. The Functional Multilinear Socialization Model (Lucariello, 2004) proposes that ToM differentiates into separate cognitive abilities based on the target of reasoning. Social ToM is defined as reasoning about others' mental states. Intrapersonal ToM is defined reasoning about one's own mental states. The current work aimed to investigate if ToM abilities in children with autism and Asperger syndrome differentiate into Social and Intrapersonal ToM. A second aim was to determine if ToM differentiation patterns for children with autism and Asperger syndrome were different.

Participants included 39 children with autism and 34 children with Asperger syndrome ages 8-14. Measures included a language measure, an IQ measure, and a battery of ToM tasks. The ToM tasks assessed Social and Intrapersonal ToM related to

distinguishing appearance from reality, representational change, false belief, and perspective-taking across the domains of emotions, beliefs, and perceptions.

Theory of Mind differentiated into Social ToM and Intrapersonal ToM for all participants. Both children with autism and Asperger syndrome obtained lower Social ToM scores than Intrapersonal ToM scores. ToM differentiation patterns for children with autism were distinct from children with Asperger syndrome. The difference between Intrapersonal ToM and Social ToM was greater for children with autism than children with Asperger syndrome.

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CHAPTER 1: INTRODUCTION

Autism is a developmental disorder characterized by impairments in social interaction, poor communication, and restricted and repetitive behaviors (American Psychiatric Association, 2000). Children do not outgrow autism and there is no cure. It is a lifelong disability with a normal life expectancy. In April of 2002, the United States Congress declared autism a national epidemic, as the incidence is increasing at an alarming rate. Only 10 years ago, it was estimated that autism affected one out of 10,000 children. Three years ago, it was estimated that it affected one out of 250 children (Autism Research Institute, 2007). A 2008 Centers for Disease Control report found that 1 in 150 children in America today suffer from autism, making it more prevalent than Down Syndrome, Childhood Diabetes, and Childhood Cancer combined.

Asperger syndrome is a related pervasive developmental disorder that shares the social impairments and restricted and repetitive behaviors characteristic of autism (American Psychiatric Association, 2000). Although prevalence estimates of Asperger syndrome vary enormously, conservative estimates suggest that every two out of 10,000 children are currently affected. Like autism, the numbers have increased steadily in recent years (Fombonne, 2007). The sharp spike in incidence rates has caused an explosion in the amount of research dedicated to these disorders, yet the causes and specific cognitive processes that are affected remain undefined.

In attempts to understand the psychological deficits associated with autism and Asperger syndrome, much attention has been give to the hypothesis that they entail a disturbance in Theory of Mind (ToM). ToM is the understanding of persons as psychological beings. It entails our imputation of mental states to the self and to others to account for behavior. For some time, the predominant view has been that ToM is a single "integrated" cognitive ability, wherein reasoning about the mental states of self and others are considered to be one and the same cognitive skill (Wellman, Cross, & Watson, 2001; German & Leslie, 2000; Leslie & Polizzi, 1998; Scholl & Leslie, 1999, 2001; Ruffman, & Leekam, 1994; Pears & Moses, 2003; Fonagy, Redfern, & Charman, 1997; Hughs & Dunn, 1998).

While the integrated view prevails, recent research with typically developing samples suggests that ToM differentiates into separate cognitive abilities. The Functional Multilinear Socialization (FMS) Model (Lucariello, 2004) proposes a differentiated view defining separate cognitive abilities related to the target of the reasoning. Social ToM is reasoning about *others'* mental states and Intrapersonal ToM is reasoning about one's *own* mental states (Lucariello, 2004). The differentiated view also holds that these separable ToMs may not develop in synchrony ontogenetically. Previous research with typically developing samples supports the FMS Model of ToM. It provides convincing evidence that ToM is a non-integrated cognitive skill that functionally differentiates into Social and Intrapersonal types for kindergarten and 3rd grade children (Lucariello, 2006; Lucariello, Durand, & Yarnell, 2007; Lucariello & Butler, 2008).

An extensive body of work has shown that children with autism and Asperger syndrome perform significantly worse than typically developing children on ToM tasks (Baron-Cohen, 2001). However, this work has been limited in an important way; it has been exclusively conducted under the integrated view of ToM. Results have been based upon measures that generally only tap participant's ability to reason about *other's* mental states. However, investigators have drawn conclusions under the theoretical assumption that ToM is an integrated ability and therefore may have incorrectly generalized children with autism's failure to reason about *other's* mental states to represent impairment in both *other* and *own* ToM. According to the FMS Model (Lucariello, 2004), the inability to pass a task assessing the mental states of others would not necessarily represent an inability in ToM functioning generally or in Intrapersonal ToM.

The purpose of the current study was to test the differentiated account of ToM with children with autism and Asperger syndrome for the first time. In turn, a more specific cognitive profile of these populations was obtained. ToM tasks assessing Social and Intrapersonal ToM (metarepresentational) reasoning related to distinguishing appearance from reality, representational change, false belief, and Level 2 perspective taking across the domains of emotions, beliefs, and perceptions were administered to participants with autism and Asperger syndrome. The Social ToM tasks tapped reasoning about others' mental states. The Intrapersonal ToM tasks tapped reasoning about one's own mental states. A within subject design was employed such that each participant received all tasks. Performance across Social and Intrapersonal tasks was compared.

It was hypothesized that ToM would differentiate. Specifically, it was hypothesized that children with autism and Asperger syndrome would exhibit more severe Social ToM impairments than Intrapersonal ToM impairments, as the differentiated view of ToM rests on a functional analysis. Social Reasoning is critically important in social interactions and Intrapersonal Reasoning is used in learning and reflection. The hypothesis of the current study considered the diagnostic criteria of autism and Asperger syndrome, which include delay in social, but not necessarily intellectual (intrapersonal) forms of reasoning. In addition, it took into account the established weakness that these children show on ToM tasks that measure comprehending and predicting the mental states of others. Accordingly, it was hypothesized that participants may perform lower on Social ToM than Intrapersonal ToM measures.

Moreover, it was hypothesized that this Social ToM deficit would be even more severe in children with autism than children with Asperger syndrome. This hypothesis reflected the fact that the social impairments seen in autism are more severe and frequent than those seen in Asperger syndrome.

CHAPTER 2: LITERATURE REVIEW

AUTISM

Autism, originally described by Kanner in 1943, is among the most severe of all neurodevelopmental disorders. Epidemiological studies indicate a lifetime prevalence of autistic disorder for 1 in 150 individuals (Center for Disease Control, 2008). Recent reports of the rising incidence of autism have generated considerable support for increased research into the causes, manifestations, and treatment. The Child Health Act of 2000 was the first U.S. governmental initiative to specifically address the need for comprehensive research to elucidate the presumably complex causes and nature of the disorder, thereby aiding diagnoses, detection, prevention, prognostic accuracy, and treatment.

Autism is a pervasive disorder associated with substantial deficits in reciprocal social interaction and communication, and the presence of repetitive and stereotyped behaviors and unusual interests. Currently, the following criteria are applied for the diagnosis of autistic disorder, according to the Diagnostic and Statistical Manual (DSM IV-R) of the American Psychiatric Association. These three classic features of autism typically appear in infancy and are, by definition, always present by the age of 3 years.

1. *Social interaction impairment.* There must be a qualitative impairment in reciprocal social interaction, relative to developmental level. There is a lack of personal relationships with others. Behavioral signs include poor use of eye gaze and of gestures.

2. *Communication Deficits.* There must be qualitative impairment in verbal and nonverbal communication, relative to developmental level. Behavioral signs include delay in the acquisition of language, or lack of speech.

3. *Restricted and repetitive behaviors.* There must be a markedly restricted repertoire of activities and interest, appropriate to developmental level. Behavioral signs include repetitive or stereotyped movements, such as hand flapping and interests that are abnormally intense or abnormally narrow.

The following section will describe the core dimensions of autism in more detail in an attempt to provide a thorough understanding of the disorder.

Social Interaction Impairment

Often the social impairments are the first observable and identifiable autistic impairments. Social deficits are present in all individuals with autism spectrum disorders and indicate that problems of social interaction can begin very early. Even before one year, some infants with autism are less likely than control infants to be visually responsive and more likely to show aversion to being touched by another person (Baranek, 1999; Werner et al., 2000). Older infants fail to track people visually, avoid eye contact, exhibit an “empty” gaze, fail to respond to others with emotional expression and positive affect, and show little interest in being held (Adrien et al, 1993; Stone, 1997).

During childhood, a variety of social deficits, such as lack of understanding of social cues and inappropriate social actions, are also evident. There is a certain aloofness, disinterest, and lack of social reciprocity. Children with autism fail to develop relationships with their peers to the extent appropriate to their developmental level. The child may ignore others, fail to engage in cooperative play, or seem overly content to be alone (Volkmar et al., 1997).

Communication Deficits

Disturbed communication- both verbal and non-verbal- is a second aspect of the triad of difficulties in autism. Humans typically "speak" to each other nonverbally by gesture, posture, and facial expression; however, in children with autism, nonverbal communication is atypical or deficient. For example, difficulties exist in understanding social and emotional stimuli, such as the emotional expressions on the faces of other people. Deficits in joint attention interactions are also striking. These interactions involve gestures, such as pointing and eye contact that center the child's and caregiver's attention on an object in order to share an experience. In addition, when youth with autism do use simple instrumental gestures, complex gestures that express feelings may be lacking, even into adolescence (Attwood et al., 1988). The absence of these gestures can be considered a social interaction deficit, as well.

Both comprehension and expression of spoken language are also problematic. The comprehension of language sometimes has been found to be delayed compared with that of children with specific language disorders (Lord & Paul, 1997). About 50 percent of children with autism remain mute or rarely say more than individual words or simple phrases. Babbling and verbalizations may be abnormal in tone, pitch, and rhythm, and these deficits may persist into adolescence and adulthood (Sheinkopf et al., 2000; Tager-Flusberg, 1993). In those who acquire language, development is delayed and often abnormal (Lord & Paul, 1997).

Speech is often excessively literal and echolalias and pronoun reversals are common. In echolalia the person echoes back what another has said. Why echolalia occurs in autism is not yet known. Confusion about the use of pronouns is more common in autism than in other disorders or normal development. A child may refer to others as 'I' or 'me', and to the self as 'he', 'she', 'them', or 'you'.   Pronoun reversal may stem from echolalia (for example, an adult says "You can eat a cookie," and the child then echoes this statement). However, it has been argued that it is likely that there is a more general deficit, perhaps failure to understand that different people have different perspectives or that language requires different forms to refer to different persons (Lord & Paul, 1997; Oshima-Takana & Benaroyam 1989; Tager-Flusberg, 1993).

When speech does occur, the most notable impairment concerns pragmatics, the social use of language (Baron-Cohen, 1988; Klinger & Dawson, 1996). In severe cases, language is mostly simple statements, requests, and commands. In other cases, conversations are characterized by irrelevant details and inappropriate shifts in topic. There may also be an overall failure to develop conversation. Nevertheless, some children do function at a higher level. They may be able to tell stories and may communicate more effectively when given prompts or models of conversation (Loveland & Tunali-Kotoski, 1997). Some are able to read; in fact, they may decode words at above average levels, although comprehension is typically below normal (Lord & Paul, 1997).

Restricted and Repetitive Behaviors

The third major impairment in autism is atypical and often odd behaviors that are described as restricted, repetitive, stereotyped, obsessive, or rigid behaviors and interests. Stereotyped motor behaviors commonly reported by parents include rocking, walking on toes, whirling, and arm or finger flapping (Klinger & Dawson, 1996). Although many of these oddities are seen in typically developing children and select behavioral disorders, they occur in autism more frequently and with greater severity (Bodfish et. al., 2000; Turner, 1999).

Also particularly characteristic of autism are repetitive, obsessive activities and interest. These include unusual preoccupations with aspects of the environment. Children may seem obsessed with a toy, a telephone, or numbers. They may collect objects and seem to place undue value on them. In addition, play behavior may be rigid and lacking in social imitation and imagination. Children with autism often do not pretend when they play, nor use symbols themselves (Baron-Cohen, 1993). They may simply repeat behaviors over and over, such as lining up items. They may also be overly absorbed in hobbies, and they may adopt routines and rituals that must be followed, such as eating and going to bed. Minor changes in the environment, such as rearrangement of furniture or schedules, can cause much upset, a reaction seldom reported in non-autistic groups (Turner, 1999).

General Neural Abnormalities

Research from the past few decades has uncovered multiple neural abnormalities associated with the behavioral symptoms which characterize autism in the amygdala (Baron-Cohen et al, 2000), paracingulate cortex (Flethcer et al., 1995; Gallagher et al., 2000; Vogeley at al., 2001; Brunet et al., 2000; Castelli et al., 2000), and superior temporal sulcus (Casteli et al., 2000). Studies also find reduced gray matter volume in anatomical MRI scans in this population (McAlonan et al., 2004) and abnormal activation in the fusiform gyrus (Cabeza & Nyberg, 2000; Clark et al., 1996; Haxby et al., 1994; Kanwisher, 1999; and Puce et al., 1995; Hubl et al., 2003; Pierce et al., 2001; Schultz et al., 2000) and cerebellum (Gursh, 2004; Ito, 1984; Wolpert, Zoubin, & Flanagan, 2001; see Decety, 1996 for a review). One of the more consistent findings about the autistic brain is that it is larger and heavier than the normal brain. However, this increased size is not evident from birth, but from ages 2-4 (Courchesne et al., 2001). The aforementioned regions are certainly not an exhaustive list of the neural abnormalities in autism. Yet, when one considers these regions, it is clear that autism is a complex neurological disorder. The affected regions span the entire brain from anterior to posterior, cortical to subcortical, and motor to perceptual to cognitive systems, making a unifying link difficult to conceive.

ASPERGER SYNDROME

Asperger syndrome is also a pervasive developmental disorder characterized by deficits in social interaction and unusual or restricted patterns of interest or behavior. However, unlike autism, the DSM-IV-R diagnosis of Asperger syndrome requires *no* clinically significant delay in language acquisition and cognitive development (American Psychiatric Association, 2000).

Social Interaction Impairment

Clinically, the distinction between autism and Asperger syndrome is often made in terms of severity and qualitative expression of the social criteria. In Asperger syndrome there are generally fewer social impairment symptoms than in autism, as well as a distinct presentation (Fitzgerald & Corvin, 2001). While individuals with autism are apt to be withdrawn and may seem disinterested in relating to others, individuals with Asperger's are aware of other people and desire friendship. They are often (involuntarily) socially isolated because their approaches tend to be inappropriate and peculiar. Individuals with Asperger syndrome are unable to execute knowledge about another person's intentions and emotions in a spontaneous and useful manner. The lack of spontaneous adaptation is associated with an over-reliance on formalistic rules of behavior (Klin & Volkmar, 1995; McPartland & Klin, 2006).

Communication Deficits

Although severe deficits in communication would lead to a diagnosis of autism instead of Asperger syndrome, several unique qualitative aspects of communication in Asperger syndrome have been identified. First, speech is often marked by poor prosody. Inflection and intonation typically are not as rigid and monotone as in autism. A restricted range of intonation patterns may result in utterances in which one's tone of voice is inconsistent or unrelated to content and communicative intent. Second, speech may also seem tangential and circumstantial. A third characteristic of communication among individuals with Asperger syndrome is verbosity (McPartland & Klin, 2006). An individual with Asperger syndrome may launch into monologues on their favorite topic with complete disregard of the listener's interest, nonverbal signals, or background information (Kasari & Rotheram-Fuller, 2005).

Restricted and Repetitive Behaviors

Restricted and repetitive behaviors are much less commonly reported in Asperger syndrome than autism. The exception is a preoccupation with an unusual topic about which an individual with Asperger syndrome amasses considerable factual knowledge. Given the deficits in the pragmatics of social interaction, individuals with Asperger syndrome tend to readily share this information, at great length and in considerable detail. The area of special interest may dominate the social interactions and activities of an individual with Asperger syndrome (South, Ozonoff & McMahon, 2005).

Gross and fine motor problems are often seen in association with Asperger syndrome but are not part of the required criteria for diagnosis. Motor milestones may be delayed, but more typically, there are delays in the acquisition of more complex motor skills such as riding a bike, catching a ball, and climbing. Individuals with Asperger syndrome often display an odd gait, poor manipulative skills, and deficits in visual-motor coordination. In autism, however, gross motor skills are often a relative strength (McPartland & Klin, 2006).

General Neural Abnormalities

The neurobiological determinants of Asperger syndrome are poorly understood. One of a very few studies investigated grey matter differences between a group of adults with Asperger's and matched controls. They noted grey matter anomalies in the cerebellum, medial temporal, and frontal lobe structures (Abell et al.,1999). These findings fit broadly with a growing consensus that limbic system and cerebellar abnormalities may be important determinants of autism. McAlonan and colleagues (2002) found that people with Asperger syndrome had significant reductions in grey matter volume of frontostriatal and cerebellar regions. In addition, people with Asperger syndrome had white matter excesses bilaterally around the basal ganglia, whereas they had deficits mainly in left hemisphere. This finding of reduced grey matter in the medial frontal lobe of people with Asperger syndrome is also in agreement with other neuroanatomical studies of autism (Haznedar et al., 1997; Abell et al., 1999).

THEORY OF MIND

The aforementioned sections review the defining features of autism and Asperger syndrome, highlight the behaviors that are quite readily identified by parents, teachers, and others interacting with these individuals and by standardized tests. Recent work has given a more complete and subtle picture of some of the psychological deficits involved. Investigators have asked whether specific cognitive impairments may underlie and account for the wide range of symptoms seen in autism and Asperger syndrome. Specifically, much attention has been given to the hypothesis that autism and Asperger syndrome entail a disturbance in the understanding of persons as psychological beings, also known as Theory of Mind. Admittedly, Theory of Mind deficits are not the only cognitive feature of these disorders. Other impairments include weak central coherence (Frith, 1989), executive dysfunction (Russell, 1997), affective processing (Hobson, 1989), and imitation (Rogers and Pennington, 1991). However, evidence suggests that Theory of Mind seems to be a core and possibly universal abnormality among these populations.

Theory of Mind (ToM) is the understanding of persons as psychological beings. It entails our imputation of mental states to the self and to others to account for behavior. It is one of our most important cognitive abilities, as it is one of the few quintessential abilities that make us human. Understandably, its study has dominated the field of cognitive psychology for more than two decades. A milestone in ToM development is the attainment of metarepresentational reasoning at 4−5 years of age. Metarepresentational reasoning underlies the ability to distinguish mental states from reality. It allows us to simultaneously maintain the contrasting representations of an object as it in reality versus as it appears to be or versus another's conception of it. This reasoning is evident in behaviors such as 1) false belief, or knowing another's erroneous belief with respect to reality, 2) distinguishing appearance from reality, or knowing both an object's/person's appearance and reality when these differ, and 3) representational change, or knowing one's own past false belief with respect to reality. Various tasks are used to measure these behaviors, as outlined below.

Unexpected location tasks are often used to assess false belief. For example, in the "Maxi" story, first used by Wimmer and Perner (1983), a child sees a doll Maxi put a candy bar into a green cabinet. Maxi walks out of the room and while Maxi is no longer in the room, Maxi's mother moves the candy bar from the green cabinet to a white cabinet. Finally, Maxi comes back into the room to find his candy bar. The child is asked where Maxi will look for the candy bar. A child without false belief understanding will respond that Maxi will look in the white cabinet, which is where the candy bar actually is. They make their predictions based on what they know to be true. However, children who do understand Maxi's false belief will correctly predict that Maxi will first look in the green cabinet for his candy bar.

The "Sally-Anne" task is another version of the unexpected location task used to assess false belief and has been well used with children with autism and Asperger syndrome. The experimenter uses two dolls, Sally and Anne. Sally has a basket. Anne has a box. Experimenters show participants a scenario, in which Sally puts a marble in her basket and then leaves the scene. While Sally is away and cannot watch, Anne takes the marble out of Sally's basket and puts it into her box. Sally then returns and the child is asked where they think she will look for her marble.

Unexpected identity tasks are used to measure distinguishing appearance from reality, representational change, and false belief. In unexpected identity tasks, a child is presented with a deceptive object (e.g., a sponge that looks like a rock.) The child initially thinks the object is one thing based on its appearance (e.g., a rock). Then, they are given the opportunity to explore the object (e.g., touch it) and become aware that it is really a sponge, even though it appears to be a rock. To measure distinguishing appearance from reality, the child is asked what the object looks like and what it really is. False belief is assessed by asking the child what a child who hasn't explored the object will think it is. Representational change is assessed by asking the child what they thought the object was before they explored it (e.g., a rock).

An *unexpected contents* task can also be used to measure false belief, distinguishing appearance from reality, and representational change. For example, experimenters ask children what they believe to be the contents of a box that looks as though it holds a candy called Smarties. After the child guesses Smarties, they are shown that the box in fact contains pencils. Representational change is measured by asking the child what they thought the contents of the box were before they opened it. To assess false belief, the experimenter then re-closes the box and asks the child what they think another person, who has not been shown the true contents, will think is inside the box. Distinguishing appearance from reality is measured by asking the child what it looks like is in the box and what is really in the box.

A foundational question about ToM is whether it is a single unitary construct or differentiates into separable abilities. For some time, the predominant view has been that ToM is a single unitary construct. Under this "integrated" view, reasoning about the mental states of self of and others are deemed to be one and the same cognitive ability (Gopnik & Astington, 1988; Gopnik & Wellman, 1994; Wellman, Watson, & Cross, 2001). These integrated accounts include Theory of Mind Mechanism/Selection Processing, Theory-Theory, Sociocultural Based ToM, and Language Based ToM. In contrast, the "differentiated" view suggests that ToM differentiates into separate cognitive abilities related to the target of the reasoning and includes the Simulation account (Gallese & Goldman, 1998; Harris, 1992) and the Functional Multilinear Socialization Model (Lucariello, 2004). These integrated and differentiated accounts are outlined below.

Integrated Theory of Mind Accounts

Theory-of-Mind Mechanism/Selection Processing

Theory of Mind Mechanism/Selection Processing hypothesizes that ToM is a unitary construct with an innate basis (German & Leslie, 2000; Leslie & Polizzi, 1998; Scholl & Leslie, 1999, 2001). According to this hypothesis, ToM originates from a module that spontaneously processes information about attended actions, treats the actions as intentional, and automatically computes the mental states attributable to the actions. The logic of the argument is based on the assumption that the disorder of autism is the result of a biological disorder, rather than the result of some particular experience(s). ToM is specifically and uniquely affected in autism, therefore these theorists attest there must be a biological, brain basis for ToM in the form of a module.

Theory-Theory

Theory-theory proposes that one's ordinary understanding of the mind proceeds by the formation, revision, and replacement of successive theories of the mind. Rather than being determined by some innate maturational schedule, this succession of theories is the result of the operation of more general inferential mechanisms (Gopnick, 1993; Gopnick & Wellman, 1994; Perner, 1991). Like scientists, children understand the world by constructing coherent views of it and change those views in light of new evidence that they obtain. Children play an active role in this process by making predictions, seeking explanations, and considering evidence that is relevant to the mind. Moreover, theories in one domain can influence theories in other domains. The information encoded in theories, unlike that encoded in modules, can be influenced by other types of knowledge.

In other words, there is conceptual change during development. In fact, a consistent developmental progression of ToM understanding across various countries and task manipulations has been shown with meta-analytic data. Wellman and colleagues (2001) argue that developmental changes in ToM understanding are a reflection of genuine conceptual change that occurs during the preschool years. However, the Theory-Theory account does not distinguish between the mental states of self and other during this conceptual change. In fact, ToM development is described by Wellman as "an interrelated body of knowledge, based on core mental-state constructs such as 'beliefs' and 'desires,' that apply to all persons generically, that is, to both self and others" (Wellman et al., 2001, p. 678).

Sociocultural account

The sociocultural account of theory of mind proposes that social contextual variables act as the underlying source of ToM development. These variables include the presence of siblings (Dunn, Brown, Slomkowski, Tesla, & Youngblade, 1991; Jenkins & Astington, 1996; Perner, Ruffman, & Leekam, 1994), social interactions with friends with whom they frequently refer to mental states (Brown, Donelan-McCall, & Dunn, 1996; Hughs & Dunn, 1998), parenting styles (Pears & Moses, 2003; Ruffman, Perner, & Parkin, 1999), secure maternal attachment (Fonagy, Redfern, & Charman, 1997; Meins, Fernyhough, Russell, & Clark-Carter, 1998), and conversational experience (Peterson & Siegal, 1999; Woolfe, Want, & Siegal, 2002).

Language-based account

Without doubt, there is a relation between language and theory of mind. This relationship has been demonstrated in typically developing children (e.g., Milligan, Astington, & Dack, 2007; Astington & Jenkins, 1999; Hughes & Dunn, 1998; Jenkins & Astington, 1996; Ruffman, Slade, Rowlandson, Rumsey, & Garnham, 2003), children with autism (Happe, 1995; Tager-Flusberg & Joseph, 2005), children with specific language impairment (Miller, 2001), and deaf children (de Villiers, 2005; Peterson & Siegal, 1999; Woolfe, Want, & Siegal, 2002). Many researchers argue that language plays a causal role in the development of false-belief understanding (e.g., de Villiers, 2005; Harris, 2005; Nelson, 2005). Data from longitudinal studies (Astington & Jenkins, 1999; J. de Villiers & Pyers, 2002) and training studies (Hale & Tager-Flusberg, 2003; Lohmann & Tomasello, 2003) supports this argument.

However, language is a complex, multifaceted system. Therefore, it is important to determine if all or particular aspects of the linguistic system are involved in theory of mind. For example, semantic ability consists of lexical knowledge/receptive vocabulary (word knowledge). Syntactic ability involves mastering the grammatical structure of a language. Sentential complements are a specific syntactic structure. A sentential complement is a tensed subordinate clause that is embedded under a mental or communication verb to form a complex sentence. For example, in the sentence: Jane thinks *[that] the chocolate is in the cupboard*, the complement is *italicized* (the specific complementizer ‘‘that’’ is optional). This syntactic structure is thought to provide the format needed to represent false beliefs. It allows for a true report of a mistaken representation. The overall complex sentence can be true even though the embedded clause expresses a proposition that is false.

Studies examining the roles of syntax and semantics on theory of mind have produced inconsistent results. Astington and Jenkins (1999) found that syntax but not semantics predicted unique variance in false-belief task scores. In contrast, Ruffman et al. (2003), used different measures and reported the converse finding, that is, semantics but not syntax predicted unique variance in false-belief task scores. Similarly, reports of general language ability and the ability to understand sentential complements conflict. For example, de Villiers & Pyers (2002) found that memory for complements made a unique contribution to false-belief understanding beyond that of more general language measures. Yet, Cheung et al. (2004) found that it did not.

Pragmatic ability, the appropriate use and interpretation of language in discourse exchanges, has also been found to play a role on theory of mind abilities. Correlational studies conducted by Peterson and Siegal (1999, 2000) support the hypothesis that pragmatics are related to ToM performance. In these studies, deaf children who had the opportunity to engage in richer discourse interactions with others were also more skillful in false belief tasks. Appleton and Reddy's (1996) training study employed rich discourse interactions as part of the training, suggesting that rich discourse is in part responsible for ToM improvements. Similarly, Lohmann and Tomasello's (2003) training study supports the effect of pragmatics on ToM abilities. Four training conditions were used. The first involved perspective-shifting discourse about deceptive objects. The second involved the use of mental state terms and associated sentential complement syntax. The third "full" training condition involved both perspective taking discourse about deceptive objects and the use of sentential complement syntax. The fourth "no language" training condition combined exposure to deceptive objects with the use of only a few attention-directing words (e.g., "look"). Significant improvements in false belief performance were found in all conditions, except the "no language" condition. Moreover, the greatest improvements were found in the "full" condition, suggesting perspective-shifting discourse (pragmatics) and experience with sentential complement syntax play important independent roles in ToM development.

In an attempt to make sense of the sometimes conflicting literature, Milligan and colleagues (2007) performed a meta-analysis of 104 studies related to language ability and false belief. Five different aspects of language were examined: general language, semantics, receptive vocabulary, syntax, and memory for complements. Results showed that there is a significant relationship between false belief performance and each of these five types of language ability. Receptive vocabulary accounted for 12% of the variance in false-belief understanding, semantics for 23%, general language for 27%, syntax for 29%, and memory for complements for 44%. Clearly, language and theory of mind abilities are related. Yet, if and how the relationship between these aspects of language differs between self and other reasoning has not been assessed.

Differentiated Theory of Mind Accounts

Simulation

Another account of ToM speculates that children and adults attribute mental states to actions through a simulation process, as opposed to through theoretical constructs, like beliefs and desires (Gallese & Goldman, 1998; Harris, 1992). The simulation account holds that we represent the mental activities and processes of others by mentally simulating them, or generating similar activities and processes in ourselves. For example, children take another person's visual target or emotional stance and feed it into their own perceptual and/or emotional system. In this simulation account, ToM development simply follows age-related improvements in children's simulation abilities.

Simulation is distinct from the aforementioned integrated theories of ToM in that it does differentiate between reasoning about self and other representations. According to the simulation account, a person initially has more accurate and advanced reasoning about their own, compared to other's mental states. They are able to use these more advanced self reasoning skills as a map on which to simulate other's reasoning. In other words, simulation assigns primacy to reasoning about one's own representations. This account can only for uneven ToM development in the direction of better Intrapersonal than Social ToM functioning.

Functional Multilinear Socialization Model

The Functional Multilinear Socialization (FMS) Model also refutes the integrated view in favor of a differentiated view based on a functional analysis of ToM (Lucariello, 2004). Unlike the integrated view of ToM, the FMS Model distinguishes reasoning about one's own and others' mental states as distinct cognitive abilities. This differentiated model poses that theory of mind capabilities differentiate into Social Reasoning (reasoning about ***others'*** mental states) and Intrapersonal Reasoning (reasoning about one's ***own*** mental states). Moreover, the FMS Model defines Social Reasoning and

Intrapersonal Reasoning in relation to the everyday functions they each play. While other researchers have discussed how ToM is a prerequisite for social interaction, they have overlooked its other major functions and uses. The differentiated FMS Model views the Social Reasoning component of ToM as critically important in social interactions; one must be able to understand and predict the mental states of other people to carry out successful social interaction. In addition, the FMS model is able to capture other distinct Intrapersonal uses of ToM, including reflection and learning.

Support for the Functional Multilinear Socialization Model

Typically Developing Population. If we turn again to the behaviors and tasks currently used to measure ToM described earlier, they measure either Social or Intrapersonal ToM. False belief (whether it be assessed in an unexpected location, identity, or contents task) assesses Social ToM, reasoning about someone else's mental states. Distinguishing appearance from reality and representational change (be they assessed in an unexpected identity or contents task) assess Intrapersonal ToM, reasoning about one's own mental states. Researchers working within an integrated theoretical framework would claim that responses across false belief, appearance-reality, and representational change tasks measure the same cognitive ability. Those coming from a nonintegrated view, such as the FMS Model (Lucariello, 2004), would claim these tasks tap two distinct cognitive abilities, Social and Intrapersonal ToM respectively.

Indeed, previous research with typically developing populations supports the differentiated FMS Model (Lucariello, 2004) and elucidates that ToM capabilities do in fact differentiate into Social and Intrapersonal constructs. For example, performance across false belief and appearance-reality tasks is not correlated (Meins, Fernyhough, Wainwright, Gupta, Fradley, & Tuckey, 2002). Similarly, Moore and colleagues (1998) found performance across false belief and representational change (or 'own' belief) not to be correlated. Ruffman and colleague's (1998) results also support a differentiated Theory of Mind model; the majority of their 5 year olds passed an 'other' false belief task, but failed a source task (that assesses a child's understanding of the source of their own representations.) Cutting and Dunn (1999) presented participants with 8 false belief tasks, one of which was designed to be a "recall your own" false belief. This 'own' task was the only task of the eight not correlated with the others.

Moreover, studies designed to specifically test the FMS Model (Lucariello, 2004) have supported differentiated ToM. In 2004, Lucariello found that performance across social and intrapersonal tasks was not correlated in a sample of low-income 5-6 year olds. Specifically, the low-income children were the most successful on the social false belief task. They performed better on the false belief task than the representational change task, on which they performed poorly. Hence, an uneven development across reasoning about own and others' representations was found with greater strength in Social ToM. Lucariello, Durand, and Yarnell (2007) also showed that ToM performance differentiated and was better in the social than intrapersonal condition with low- and middle-SES kindergarten students. Performance in the social condition was strong, with a nearly 67% correct response rate. Moreover, there were no SES or sex differences, suggesting that the finding is generalizable. Also pointing to differentiated ToM was the fact that condition made a unique contribution to ToM performance, beyond the contribution made by language. In addition, Butler and Lucariello (2006) found evidence of uneven development of Social and Intrapersonal ToM in gifted children. Interestingly, gifted children performed significantly better on intrapersonal tasks than social tasks.   The fact that differences on the social and intrapersonal tasks exist and show asymmetric development in either direction certainly provides evidence that ToM is composed of the distinct abilities of social and intrapersonal reasoning.

Admittedly, Wellman, Cross, and Watson's (2001) meta analysis suggests that there are no differences between own and other reasoning tasks. However, this analysis was run only on own and other reasoning within a false belief task paradigm. Many other tasks can be used to measure one's own reasoning such as appearance reality, source, and emotion vignette tasks (Ruffman et. al, 1998; Hughes & Dunn, 1998). Is seems possible that own and other reasoning do not differentiate within the constraints of a false belief task, but do so on other assessments (as supported by the more recent aforementioned studies that were not included in the meta-analysis). In addition, the large majority of studies reviewed were conducted with homogeneous, typically developing, middle income samples. It seems conceivable that a cognitive profile showing an equivalent ability to understand one's own and other mental states may be unique to this group and may reflect synchronous development of two distinct cognitive abilities.

Taken together, the studies cited above provide evidence of a differentiated ToM. The integrated Theory-Theory, Theory-of-Mind Mechanism/Selection Processing, Socialization, and Language Based accounts of ToM cannot account for these data. Moreover, the differentiated Simulation account of ToM cannot account for these data, as it assigns primacy only to self-reasoning. Yet, there is considerable evidence that children (e.g., middle- and low-income) show uneven ToM development in the direction of stronger Social than Intrapersonal ToM.

Neuroscientific Support for FMS Model in Typically Developing Children

Recent neuroscientific data also suggests that ToM may differentiate in typically developing children. Positron emission tomography (PET) data show activation in different regions of brain for self perspective versus third person (other) perspective. Ruby & Decety (2003) conducted a PET study where subjects were asked to respond to a list of health-related questions, taking either their own perspective or the perspective of a 'lay person'. Third-person perspective as compared to self perspective was associated with activation in the medial part of the superior frontal gyrus, left superior temporal sulcus, left temporal pole, and right inferior parietal lobe. Yet, the reverse comparison revealed a specific activation in the postcentral gyrus for the first-person conceptual perspective.

In a second PET study, participants were asked to adopt either their own perspective or a third person perspective of their mothers in response to situations involving social emotions or to neutral situations. The main effect of third-person versus first-person perspective resulted in hemodynamic increase in the medial part of the superior frontal gyrus, left superior temporal sulcus, left temporal pole, posterior cingulate gyrus, and right inferior parietal lobe. However, a cluster in the postcentral gyrus was detected in the reverse comparison (Ruby & Decety, 2004). These two studies support the idea of a differentiated theory of mind in that different areas of the brain are activated when processing self and other perspectives.

However, the recent discovery of mirror neurons in macaque monkeys by Rizzolatti and colleagues has been used to support an integrated ToM. Using single unity electrophysiology, Rizzolatti and colleagues discovered that a portion of neurons in area F5 of the macaque premotor cortex responded not only when the monkey performed an action, but also when the monkey watched the researcher perform a similar action (DiPellegrino et al., 1992). The team named this system the "mirror neuron system", as it seemed that the observed action was "mirrored" or simulated within the monkey's own motor system. More recently, successful attempts have been made to localize a human mirror neuron system (MNS) and investigate its specific properties (Fadiga et. a1.,1995; Buccino et al., 2001; Grezes, 2003; Buccino et al., 2004; Stevens et al., 2000; DiPellegrino and colleagues, 1992).

Of interest to the current study, mirror-like systems in the medial prefrontal cortex (Brodmann's Area 9) may be involved in our ability to infer internal mental states of others. Though not traditionally thought of as part of the MNS, this area responds both when participants are asked to make judgments regarding their own abilities, personality traits, and attitudes (Johnson et al., 2002; Kelley et al., 2002) and when asked to attribute intentions to characters in a comic strip (Brunet et al., 2000) or infer another person's knowledge about a familiar or unfamiliar object (Goel, 1995). Moreover, a study that asked participants to evaluate their own emotional responses to a picture and to infer the mental state of the individual in the picture (Ochsner et al., 2004) found that the medial prefrontal cortex responded during both conditions. Thus, it has been suggested that it is conceivable that the same region of the brain that is involved in representing our own mental states is also involved in inferring mental states of others.

In three fMRI studies (Wicker et al., 2003; Singer et al., 2004; Morrison et al., 2004), empathy for specific emotions activated similar networks of cerebral cortex as the actual experience of that emotion. Both the experience of disgust (while inhaling foul smelling odorants) and the observation of others performing facial expressions of disgust activates the same regions of the insula and the anterior cingulate cortex (Wicker et al., 2003). Additionally, both the experience of a physically painful stimulus and the knowledge that a loved one is experiencing the same painful stimulus activates the anterior insula and rostral anterior cingulate cortex bilaterally (Singer et al., 2004). These areas were also correlated with individual empathy scores, indicating that the more activity produced in these regions, the better the individual's ability to empathize with others. Similarly, another study found that receiving a painful pin-prick and watching a stranger receive the same pin-prick activated dorsal anterior cingulate cortex (Morrison et al., 2004).

Admittedly, the aforementioned MNS evidence suggests that mentalizing about the self and others activates similar areas of the brain. However, it is naive to assume that simply because two abilities use resources from similar brain regions that they are the same cognitive function. For example, it is well known that the hypothalamus is involved in emotion as well as thirst, the amygdala in memory as well as fear, the hippocampus in memory as well as some learning, while the thalamus regulates sleep and wakefulness as well as auditory, somatic, visceral, gustatory and visual systems. It is important to keep in mind that even though some MNS research may suggest that mentalizing about self and other may utilize similar brain regions, that does not necessarily define them as the same cognitive process. Moreover, the aforementioned PET research suggests that thinking about one's own perspective is in fact distinct from thinking about another's perspective.

Autistic Population If ToM does differentiate, we might also expect to see such in autism. However, the immense amount of research regarding theory of mind capabilities in the autistic population has yet to acknowledge, let alone test this possibility. Thus far, research on this population has been conducted primarily under the assumption that reasoning about the self and other are one and the same cognitive ability. Yet, in actuality, the collective studies are primarily based on measures that tap the reasoning of *others*. Findings that suggest poor reasoning about others have been generalized to suggest poor reasoning about self and other. The body of work that establishes ToM deficits with respect to metarepresentational reasoning in children with autism is outlined below, highlighting the almost exclusive focus on reasoning about others mental states.

False Belief. The vast majority of studies investigating ToM in children with autism focus on false belief. Table 1 lists these studies. In the 1980s it was discovered that children with autism fail to understand another person's false beliefs about the world (Baron-Cohen, Leslie, & Frith, 1985). In the initial study, 20 children with autism with a mental age well over four years were tested on the Sally-Anne false belief task. Eighty percent of these children failed to comprehend the character's false belief. In contrast, 86% of Down Syndrome children of a lower mental age succeeded on the task. This paradigm has since been used in numerous studies, with a number of variations. Almost all studies have replicated the finding that a large majority of subjects with autism fail false belief understanding -or- mentalizing about *other's* beliefs. However, none of the tasks directly assess and/or compare the children's reasoning of their own beliefs and beliefs of others.

Table 1

Studies documenting poor performance on false-belief tasks by participants with autism

Baron-Cohen, Leslie, & Frith, 1985	Most autistic subjects fail first order false belief task (Sally-Anne)
Dawson & Fernald, 1987	Autistic subjects are impaired in "conceptual perspective taking" cannot choose gifts appropriate for different people
Harris & Muncer, 1988	Autistic subjects find false desires as difficult as false beliefs
Baron-Cohen, 1989a	Even those autistic subjects who pass first-order false belief tasks fail a second-order false belief task
Baron-Cohen, 1989b	Autistic subjects fail appearance vs. reality task
Oswald & Ollendick, 1989	Autistic subjects not significantly worse than MH controls on picture sequencing or Sally-Ann tasks but worse on a "hide the penny" game
Perner, Frith, Leslie, & Leekam, 1989	Autistic subjects fail "Smarties" test of false belief, cannot infer knowledge from perceptual access, and fail to communicate preferentially information unknown to hearer. Controls were specific-language-impaired children
Nunez & Riviere, 1990	Autistic subjects fail Sally-Ann task

Prior, Dahlstrom, & Squires, 1990	Autistic subjects only significantly different on Sally-Ann task, but not on Smarties, Sally-Ann with real people, or picture sequencing
Reed & Peterson, 1990	Autistic subjects fail both ignorance and false belief questions on Sally-Ann task
Baron-Cohen, 1991	Autistic subjects show specific deficits in understanding only those emotions caused by false beliefs
Eisenmajer & Prior, 1991	Most autistic subjects fail a Sally-Ann task; half of those who fail pass if question includes "look first" wording
Leekam & Perner, 1991	Autistic subjects fail Sally-Ann task but pass "false" photo task
Ozonoff, Pennington, & Rogers, 1991	High-functioning autistic subjects are impaired on Smarties, mental vs. physical, appearance/reality, second order false belief, and mental function of brain tasks. No worse, however, at picture sequencing of intentional stories
Ozonoff, Rogers, & Pennington, 1991	High-functioning autistic, but not Asperger syndrome subjects, show false belief impairments
Roth & Leslie, 1991	Autistic subjects fail to attribute a false belief to a hearer given a deceptive message
Charman & Baron-Cohen, 1992	Autistic subjects fail Sally-Anne task but pass false line drawing task
Leslie & Thaiss, 1992	Autistic subjects fail Sally-Anne task but pass false photo or map task
Sodian &Frith, 1992	Autistic subjects can sabotage but not deceive a competitor and cannot attribute a false belief
Swettenham, 1996	Trained autistic subjects to use strategy of visualizing photos in characters' heads to predict character's behavior, but no autistic subjects could use photo strategy to predict a character's mental states

Deception. Deception is also relevant to understanding other minds, as it involved trying to make someone else believe that something is true when it is actually false. Sodian and colleagues (1992) demonstrated that by the age of 4, normally developing children show an interest in deception and become more adept instigating it. It has been found repeatedly that children with autism show difficulties producing and understanding deception. When these children participate in a game with a goal of not revealing which hand you have hidden a penny, they often make errors such as hiding the penny in one hand, but leaving the other hand open or switching the penny from fist to fist mid-game in front of the other person (Baron-Cohen, 1992; Sodian & Frith, 1992; Yirmiya, Solomonica-Levi & Shulman, 1996). While a lack of deceptive abilities reflects a problem understanding others minds, it is not directly related to one's mental processes about themselves.

Emotion. Children with autism's ability to understand belief-based emotions has been investigated as well. It has been found that children with autism can recognize simple emotions, but have difficulty recognizing belief based emotions (specifically, the emotion of surprise) (Baron-Cohen, Spitz, and Cross, 1993). Typically developing 3-4 year olds understand that emotion can be caused by situations and typically developing 4-6 year olds understand that beliefs can affect emotion (Harris et al 1989). Children with autism also understand situations as causes of emotions and can predict a character's emotion on the basis of the character's *desire* as well as mentally handicapped children. However, children with autism are significantly worse than mentally handicapped and typically developing 5 year olds at predicting a character's emotions on the basis of the character's *beliefs* (Baron-Cohen, 1991).

Yet, it is important to note that these tests only measured this ability using scenarios in which children with autism had to predict the mental state *of a character* as cause of that character's emotion. The currently accepted integrated definition of ToM has caused us to accept that these children have a general inability to understand mental states as a cause, when their ability to determine if their *own* mental states can cause their own emotions has never been tested.

Clearly, an abundance of evidence indicates children with autism's inability to correctly understand other's mental states. However, previous investigators may have incorrectly generalized this inability to represent a *complete* (social and intrapersonal) ToM inability because they have been operating under the integrated ToM assumption. The notion that this inability to understand mental states of others may or may not extend to a child's own mental states has scarcely been acknowledged.

Studies Assessing Children with Autism's Reasoning About Their Own Representations It is important to note the few studies that have assessed children with autism's ability to understand mental states of self and self compared to others and have not found significant differences between the two. Admittedly, Kazak, Collis, and Lewis (1997) asked young people with autism whether they knew or only guessed what was in a box having on some trials seen inside. In a second condition, children were asked if the experimenter knew or only guessed what was in the box. The results showed no superiority in judging own knowledge versus judging other's knowledge. However, as mentioned earlier in regard to the non-autistic population, it certainly seems possible that own and other reasoning do not differentiate within the domain of knowledge/belief, but do so within other domains and/or other tasks that can be used to measure one's own reasoning.

Baron-Cohen's (1989) study also investigated self reasoning. They used an appearance-reality task in which children with autism were shown a misleading object (a stone that looked like an egg). They found that while non-autistic subjects were able to correctly answer an appearance question ("What does it really look like?") and a reality question ("What is it really?"), only a small percentage of children with autism were able to so do. This does provide evidence that children with autism have difficulty understanding their own mental states, but it does not offer insight about this weakness relative to the weakness of understanding others mental states.

Finally, one additional study did directly test the dissociation between self and other reasoning in the autistic population and the results support the *differentiated* FMS Model (Lucariello, 2004). Leekman and Perner (1991) used a simplified version of the Zaitchik (1990) "false photograph" task (which is modeled on the standard false belief task except insofar as it tests children's ability to reason about physical [photographic] misrepresentation) with a group of teenagers with high-functioning autism. One condition tested false belief of others. The second condition tested what they refer to as photographic misrepresentations, but can be considered what we term "intrapersonal", as it tapped the participants own beliefs.

In both conditions, participants were shown a doll (Judy) wearing a red dress. In the false belief condition, a second doll (Susan) sees Judy in the red dress and then leaves the room. Judy's dress is changed from red to green, and subjects are asked "What color does Susan think that Judy's dress is?". In the false photograph condition, a Polaroid photo is taken of Judy in the red dress. While the photo is developing, her dress is again changed from red to green and participants are asked "In the picture, what color is Judy's dress?" This question aims to tap into what the subject themselves believe. Only 25% of participants with autism were correct on the false-belief question, but almost all of those tested passed the false-photograph question (Leekman & Perner, 1991). Similar results were obtained by Leslie and Thais (1992).

Results like this strongly suggest that individuals with autism have a specific inability to reason about the mental states and processes of others. However, they are not generally impaired in their reasoning abilities about self. The fact that the abilities differ across own and other reasoning garners support for the FMS Model (Lucariello, 2004).

Asperger Population. Relatively little research specifically tests the theory of mind abilities of children with Asperger syndrome, let alone their specific Social and Intrapersonal ToM abilities. Often these children are included in ToM studies, but are folded into samples described as children with autism spectrum disorders (e.g., Baron-Cohen et al., 1997; Happé, 1994; Baron-Cohen, O'Riordan et al., 1999; Klin, 2000; Joliffe & Baron-Cohen, 1999; Rutherford, Baron-Cohen, & Wheelwright, 2002). This reflects that many researchers do not think of Asperger syndrome as a distinct disorder, but a variant of autism, and located on the milder end of the autism spectrum (Bennet et al., 2007; Schloper, 1996; Frith, 2004; Macintosh & Dissanayaki, 2004).

Furthermore, there are inconsistencies in those studies that do separately analyze ToM abilities of children with autism and Asperger syndrome. Some suggest deficiencies in ToM abilities are common to both people with autism and Asperger syndrome (Baron-Cohen, Wheelwright, & Jolliffe, 1997; Scott, 1985). Others indicate that these deficits are less characteristic of Asperger syndrome, and suggest that this may be a basis on which the two conditions can be distinguished (Ozonoff et al., 1991; Ziatas, Durkin, & Pratt, 1998). Nonetheless, all of these studies were based on false belief tasks and were therefore unable to illuminate potential differences across Social and Intrapersonal ToM abilities.

It is also important to note that studies indicating differences in ToM abilities across subjects with autism and Asperger syndrome have often been criticized on the grounds that the findings could be attributable to poor subject matching on language abilities. As discussed earlier, there has been strong evidence for a positive correlation between verbal skills and theory of mind abilities (Eisenmajer & Prior, 1991; Ozonoff et al., 1991; Prior et al., 1998). Thus, some argue the apparently better ToM capacity in people with Asperger syndrome may just be a reflection their higher verbal abilities (Ozonoff & McMahon Griffith, 2000; Volkmar & Klin, 2000; Wing, 1998).

Clearly, more research is needed to distinguish the ToM skills of children with Asperger syndrome and autism. The verbal abilities need to be controlled and Social and

Intrapersonal ToM need to be specifically measured to determine if ToM differentiation patterns are different between these two groups of children.

Neuroscientific Support for FMS Model in Children with Autism and Aspergers

It has been argued that many of the behavioral deficits seen in individuals with autism and Asperger syndrome are a result of underlying impairments in neural systems involved in self and other representation abilities, and the Mirror Neuron System is now thought to mediate this ability. And, indeed, abnormal MNS activity has been found in samples with autism (Oberman et al., 2005; Theoret et al., 2005; Dapretto et al., 2006). Often people translate this to mean that children with autism abnormally process self and other representations and, therefore, they are related or one and the same. Yet, this has not been tested. The discovery of the MNS is so recent that its role in the complex ToM mentalizing abilities of the autistic population has not yet been directly examined. However, the way in which children with autism more basically process own vs. other has been explored. The results suggest that individuals with autism process own and other reasoning abnormally, but distinctly, as the FMS Model (Lucariello, 2004) would predict.

The first evidence of MNS impairments in children with autism used recorded mu wave suppression, an index of the integrity of the MNS. Oberman and colleagues (2005) reported an absence of mu wave suppression in a sample of 10 individuals with autism when they watched videos of another person’s actions. While typically-developing individuals showed significant mu wave suppression when they themselves performed a hand movement as well as during an observation of someone else performing that action, participants with autism only showed mu suppression during the self-performed hand movement. There was no significant change in mu power from a baseline condition when the participants with autism were observing. Therefore, the authors suggest that children with autism exhibit dysfunctional mirror neuron systems. Although one cannot directly apply these findings about physical movement to the broader theory of mind cognitive ability, they do suggest that differences exist in the ways individuals with autism perform things related to self and others, aligning with differentiated framework outlined in the FMS Model (Lucariello, 2004).

Theoret and colleagues (2005) had participants watch videos of finger movements that were directed either toward or away from themselves while recording TMS-induced motor evoked potentials (MEPs). In typically developing participants, both scenes resulted in increased MEPs on their index and thumb muscles. However, participants with autism/Asperger syndrome only showed increased MEPs to actions directed toward themselves. The researchers explain these patterns as a function of a mirror neuron deficit to a general self-other representation deficit. But, the fact that the participants with autism/Asperger syndrome TMS-induced MEPs differentiated across self directed and other directed movement conditions, lends support to the possibility that self and other, even if both controlled by the mirror neuron system, may be distinct.

In one of the best known mirror neuron dysfunction studies, Dapretto and colleagues (2006) utilized fMRI and measured the blood oxygen level dependent (BOLD) signal in regions thought to be part of the MNS while participants with and without autism imitated and observed emotional facial expressions. Typically-developing children showed activation in a neural network including the mirror propertied pars triangularis (Brodmann's area 45) when imitating facial expressions, but participants with autism did not. Similarly, when the two groups only observed the facial expressions, different activation patterns emerged; participants with autism showed less activation in the pars triangularis than the typically developing group. The researchers then went on to show that activity in this area was inversely related to autism symptom severity, as indexed by the Autism Diagnostic Observation Schedule (ADOS) and the Autism Diagnostic Interview (ADI).

However, the researchers never directly compared the amount of activation in the pars triangularis when participants with autism were observing and imitating. Imitating involves awareness of both self and other, while observing only requires awareness of others. Although not reported, the authors state that when imitating, individuals with autism "showed no activity in the mirror area in the pars opercularis" (pg 29). However, when reporting the differences found in the observing condition, they only reported that activity in the pars opercularis "was reliably stronger in the typically developing group than in the autistic group" (pg 29). From this, one could imply that the activation between the observing and imitation was in fact different (although not reported, so we cannot infer statistical significance). If this is the case, once again, we have reason to believe that the cognitive processing of self and others may be different.

In conclusion, converging evidence suggests that the MNS activity in children with autism spectrum disorders is different when processing things related to the self compared to others. Thus far, studies have (only) shown that these children are impaired when thinking about others. However, research on the topic is new and studies investigating MNS activity specific to ToM abilities has not yet been conducted. Yet, the evidence that we have thus far suggests that thinking about one's self and others may be cognitively distinct.

THE PRESENT STUDY

The present study was designed to compare the Social and Intrapersonal ToM abilities of children with autism and Asperger syndrome. Previous research specifically designed to test differentiation with typically developing samples supports the differentiated view of ToM (Lucariello, 2004; Lucariello, et al., 2007; Butler & Lucariello, 2006). Studies investigating the ToM abilities of children with autism and Asperger syndrome have nearly exclusively tested only their ability to reason about others and, upon finding delay, have generalized that these children are delayed in both reasoning about others and self. Similarly, neuroscientific data on children with autism that has classically been used to support an integrated view has only found abnormal activity when testing reasoning about others. Therefore, the differentiated view needs to be tested with children with autism and Asperger syndrome to more accurately determine the relative ToM strengths and weaknesses of these populations.

Research Questions and Hypotheses

Using a quasi-experimental within-subjects design, the current proposal addressed the following research questions and hypotheses:

1. *Does Theory of Mind differentiate into Social ToM and Intrapersonal ToM?*

- It is hypothesized that ToM will differentiate into Social ToM and Intrapersonal ToM for all participants. This hypothesis is based on 1) previous research in typically developing populations showing ToM differentiation, 2) studies with these populations reporting (only) impairments in reasoning about others mental states, and 3) neuroscientific data that suggesting that ToM may differentiate.

2. *Do children with autism and Asperger syndrome exhibit more severe deficits in Social ToM than Intrapersonal ToM?*
   - It is hypothesized that both children with autism and Asperger syndrome will exhibit more severe deficits in Social ToM than Intrapersonal ToM. This hypothesis is based on the fact that both disorders are characterized by social interaction impairments, but not necessarily learning impairments and the FMS Model proposes that Social ToM is used in social interactions and Intrapersonal ToM in learning.

3. *If ToM does differentiate, are the differentiation patterns different for children with autism compared to children with Asperger syndrome?*
   a. *Specifically, is Social ToM more severely impaired in children with autism than children with Asperger syndrome?*
      - It is hypothesized that children with autism will show an even more severe deficit in Social ToM than children with Asperger syndrome, as the severity of the social interaction impairments are greater in autism and

the FMS Model proposes that Social ToM is used in social interactions.

b. *Is Intrapersonal ToM more severely impaired in children with autism than children with Asperger syndrome?*

- No clear hypothesis can be generated since no research has been conducted on the Intrapersonal ToM skills of children with autism and/or Asperger syndrome. Moreover, the proposed functional use of Intrapersonal ToM (learning) is not necessarily impaired in either disorder.

CHAPTER 3: METHOD

Participants

Participants included 73 children drawn from 12 schools in the New England area. Thirty-nine of the participants had autism and 34 had Asperger syndrome. All diagnoses were based on the *DSM-IV-R* criteria and made by clinical psychologists and/or psychiatrists. No participants had concurrent *DSM-IV-R* disorder diagnoses. The full sample included 65 males and 8 females (children with autism: 33 males, 6 females; children with Asperger syndrome: 32 males, 2 females.) These numbers reflect the fact that these disorders are much more prevalent in males than females (APA, 2000). The mean chronological age of the full sample was 10.4 years, with a range of 8.04 -13.01 years (children with autism: 10.3; children with Asperger syndrome: 10.4). The mean mental age of the full sample was 10.4, with a range of 8.0-14.9 (children with autism: 10.2, children with Asperger syndrome: 10.6). A prerequisite of a mental age of 8 was set as necessary for participation. (See measures section for a more detailed explanation.)

Procedure

Each participant participated in two individual testing sessions. During the first session, the language and IQ measures were administered along with one of the two ToM story vignette tasks. The condition of the story vignette task administered in the first session was counterbalanced across participants. During the second session, the remaining battery of ToM tasks was administered. All sessions took place in a quiet space outside of the child's classroom and lasted approximately 45 minutes.

Measures

IQ and Mental Age Measure

Literature suggests that mainstream intelligence tests do not accurately measure the cognitive abilities of children with autism because autistic cognition differs from typical human cognition. According to the Association for Psychological Science, a 2007 study by Dawson and colleagues suggested that Raven's Progressive Matrices (RPM), a test of abstract reasoning, may be a better indicator of intelligence for children with autism than the more commonly used Wechsler Intelligence Scale for Children (WISC). Neurotypical children scored similarly on both tests, but the children with autism fared far better on the RPM than on the WISC. Researchers suggest that the WISC relies too heavily on language to be an accurate measure of intelligence for children with autism. Therefore, the Raven's Progressive Matrices (Raven, Raven, & Court, 2003) was used as an IQ and mental age measure for the sample in the current study.

An IQ cutoff of 70 was established due to the cognitive demands necessary to complete the battery of theory of mind tasks proposed. It is important to note that autism is a spectrum disorder and its manifestation varies from individual to individual. Many non-official but widely accepted descriptions of the disorder have emerged: high functioning autism (HFA), low functioning autism (LFA), etc. Although these terms are subjective and there are currently no clinical definitions, most researchers agree that it is appropriate to refer to someone as having HFA if they meet the criteria for autism and have an IQ of 70 or above (Bogdashina, 2006). This widely accepted guideline was applied in the current study and only HFA's were included to afford sufficient cognitive ability to manage the ToM tasks.

Mental age was calculated based on RPM performance, following guidelines presented in the RPM Manuel Research Supplement 3 (Raven, 2000). The mental age cutoff of 8 was established to ensure that ToM weaknesses found were not due to general developmental immaturity. Metarepresentational ToM is usually attained around the mental ages of 4-5 for normally developing children (Astington, Harris, & Olsen, 1988; Flavell, Flavell, & Green, 1983; Gopnick & Astington, 1988; Perner, 1991), but not until at least the mental age of 8-9 for children with autism (Happe, 1995).

Language Measure

It was also necessary to determine the language abilities of each participant, as there is ample evidence that language and ToM abilities are related (see *Language Based Accounts* section). Moreover, it has been argued that differences in ToM abilities between children with autism and Asperger syndrome may just be a reflection of differences in language ability (Ozonoff & McMahon Griffith, 2000; Volkmar & Klin, 2000; Wing, 1998). According to Milligan et al.'s (2007) meta-analysis 1) general language, 2) semantics, 3) receptive vocabulary, 4) syntax, and 5) memory for complements are each related to ToM. The Test of Language Development Intermediate Fourth Edition, TOLD:I-4, (Hammill & Newcomer, 2008) was be given to each participant since it measures general language, semantics, receptive vocabulary, and syntax.

Theory of Mind Measure

The battery of ToM tasks consisted of four metarepresentational reasoning tasks that tapped mental state reasoning across the domains of emotions, beliefs, and perceptions. The four tasks were story vignettes, unexpected contents, unexpected identity, and color filters. See Table 2 for the tasks and metarepresentational behaviors (social and intrapersonal) they assess. See Appendix A for a complete procedural script for all tasks. Each of the four tasks tapped both Social and Intrapersonal ToM reasoning, which represented separate conditions. A within subject design was employed such that each participant received the four tasks in both conditions. Performance across Social and Intrapersonal reasoning tasks could be compared.

Character gender was matched to participant gender. Order of tasks was counterbalanced across participants.

Table 2

Tasks and ToM behaviors by mental state assessed

TASK	SOCIAL	INTRAPERSONAL
Story Vignettes: Character/child feels one emotion but depicts another	**Appearance-reality emotion** "How does Diana/David really feel when ___? Does D/D feel happy or sad or okay?" "How does D/D try to look on her/his face? Does s/he look happy or sad or okay?"	**Appearance-reality emotion** "How do you really feel when ___? Do you feel happy or sad or okay?" "How do you try to look on your face? Do you look happy or sad or okay?"
Unexpected Contents: Nice surprise; INTRAPERSONAL: A closed toothpaste box is opened to reveal M&Ms inside SOCIAL: A band-aid box is opened to reveal crayons inside	**Representational change emotion** "When Sally/Sam first saw the box, before S/S opened it, how did s/he feel about what was inside it? (sad) **Representational change belief** "When S/S first saw the box, before S/S opened it, what did s/he think was inside it?" (band-aids) **False belief** "If another kid hasn't seen inside this box, when this kid first sees the box, before the kid opens it, what will the kid think is inside it?" (band-aids)	**Representational change emotion** "When you first saw the box, before you opened it, how did you feel about what was inside it?" (sad) **Representational change belief** "When you first saw the box, before you opened it, what did you think was inside it?" (toothpaste) **Appearance-reality belief** "What does it look like is in the box? (toothpaste) What is really in the box? (M&Ms)
Unexpected Identity: Deceptive object of a sponge looking like a rock is presented to view. Then, the child touches the object and its true identity is revealed.	**False belief** "If another kid hasn't touched this and hasn't squeezed it, when this kid first sees it, before the kid touches it or squeezes it, what will the kid think it is?" (rock)	**Representational change belief** "When you first saw this, before you touched it or squeezed it, what did you think it was?" (rock) **Appearance-reality belief** "What does this look like?" (rock) "What is this really?" (sponge)
Color Filters: Filter placed over colored object such that only the child sees the color illusion.	**Appearance (for self)** "You are looking at the cake with your eyes right now. Does it look green to you or does it look purple to you?" (green) **Perspective-taking perception** "I'm looking at the cake with my eyes right now. Does it look green to me or does it look purple to me?" (purple)	**Appearance (for self)** "You are looking at the butterfly with your eyes right now. Does it look blue to you or does it look pink to you?" (blue) **Reality perception** "What color is the butterfly really and truly? Is it really and truly blue or is it really and truly pink?" (pink)

Task #1: Story Vignettes

To assess the ability to distinguish apparent from real emotions, story vignettes were administered in which the story character really felt one emotion, but intentionally appeared to feel another, different emotion (as done by Gardner et al., 1988; Gross and Harris, 1988; Harris et al., 1986). In the social condition, the character in the vignette was another child. In the intrapersonal condition, the participant was the character in the vignette.

Children were also given a pretest to assess their understanding of the emotions used in the task (happy, sad, okay). Children had to correctly link each emotion to prototypical situations that elicit that emotion (e.g., birthday would elicit happy; sick would elicit sad; nothing special happening would elicit okay).

Children were also given two memory pretest questions for each story. One probed recall of the situation that caused the real emotion. The second probed recall of the reason for displaying a different emotion. All participants correctly answered all memory questions.

Intrapersonal Story (really feel sad; look happy/okay on face)

1. You go into the dark basement to get a hammer, but you are afraid of the dark. You try to hide how you feel so that you will not be a baby.

Memory Q1: What happens to you when you go to the basement? *(afraid of dark)*

Memory Q2: What will you be if you show how you feel? *(a baby)*

Social Story (really feel sad; look happy/okay on face)

2. David/Diana goes to the dark basement to get a hammer, but he/she is afraid of the dark. David/Diana tries to hide how he/she feel so that he/she will not be a baby.

Memory Q1: What happens to David/Diana when he/she goes to the basement? *(afraid of dark)*

Memory Q2: What will David/Diana be if he/she shows how he/she feels? *(a baby)*

The appearance and reality test questions were asked following the memory questions. See Table 2. Passing the task was defined as correctly answering *both* the appearance and reality test questions.

Task #2: Unexpected contents- nice surprise

Two unexpected content tasks (one in each condition) were used to assess representational change in the domains of emotion and belief. These tasks employ a "trick" scenario where a protagonist (social condition) or the child (intrapersonal condition) is presented with a container typically associated with "non-fun" (undesired) contents (e.g., toothpaste, band-aids). Upon opening the container, the participant learns it actually contains "fun" (desired) contents (e.g., M&M candies, crayons) (e.g., Harris, Johnson, Hutton, Andrews, & Cooke, 1989).

In the *social* condition, a doll character (Mary/Maxi) was introduced as always playing tricks. Then a second doll character (Sally/Sam) was introduced as someone whose favorite thing to do is draw with crayons. Sally/Sam was removed and a band-aid box was introduced. The experimenter had Mary/Maxi remove the band-aid, insert crayons, and place the box on Sally/Sam's table. Sally/Sam then returned to open the box. Test questions assessing representational change (emotion and belief) and false belief were administered. See Table 2. See Appendix A for complete story.

In the *intrapersonal* condition, children experience another trick scenario. The experimenter showed the child a toothpaste box that has M&Ms inside (not toothpaste). The child was then allowed to look inside. Test questions assessing representational change (emotion and belief) and appearance-reality were administered (both appearance and reality test questions had to be correctly answered to receive a passing score). See Table 2 for questions. See Appendix A for complete story.

In both conditions, a pretest question of “What’s inside the box?” was administered after the box had been opened, but prior to administration of test questions, to assess that children realize the actual contents of the box. All children passed the pretest.

Task #3: Unexpected Identity

The rock-sponge deceptive object method (Flavell et al., 1983; Gopnik & Astington, 1988) was used. In the social condition, false belief was assessed. In the intrapersonal condition, representational change and appearance-reality were assessed (for the appearance-reality measure both appearance and reality test questions had to be correctly answered to receive a passing score). All questions were initially asked in an open-ended form. If the child did not provide an answer, the question was re-administered in a forced-choice format between the two possible answer options. See Table 2.

A pretest question of "What is this object really? Is it really a sponge or is it really a rock?" was administered after the child touched the object, but before the test questions were administered, to assess the child's knowledge that the object's actual identity was a sponge. Four children with autism failed this pretest by providing no response or an inappropriate response and were excluded from analyses.

Task #4: Color filters

This task assessed the mental state domain of perceptions (as developed by Flavell, Green, & Flavell, 1986). In each condition, the experimenter showed the child an object (e.g. a purple cake, but the color was not named). The experimenter then placed the object on the experimenter side of a color filter (e.g., green) such that only the child saw the color illusion. In both conditions, children were first asked an "appearance for the self" question. In the social condition, children were asked a perspective-taking question (e.g., what color the object looked like to the experimenter). In the intrapersonal condition, children were asked a reality question (e.g., what color was the object really). In both conditions, both questions had to be answered correctly to receive a passing score. See Table 2 for specific questions used in both conditions.

All participants received a pre-training phase (Flavell, et al., 1986) where the experimenter used a sample object and filter to demonstrate the different colors an object appeared to the experimenter and child when only the child was looking through a filter.

CHAPTER 4: RESULTS

Language and IQ Performance

Language

To determine how children performed on the TOLD-I:4, the mean standard percentile score was computed for the full sample, children with autism, and children with Asperger syndrome. These data are presented in Table 3. An independent samples t-test showed that children with autism performed significantly lower than children with Asperger syndrome, t (71) =-8.502, p<.001. Due to this group difference, language was used as a covariate in many subsequent analyses.

Table 3

Mean percentile scores on language measure

	Participant Type		
	All Children n=73 *M(SD)*	Autistic n=39 *M(SD)*	Asperger n=34 *M(SD)*
Mean Percentile Score	31.82 (28.54)	13.82 (17.26)	53.38 (23.18)

IQ

To determine how children performed on the Raven's Progressive Matrices, the mean standard percentile score was computed for the full sample, children with autism, and children with Asperger syndrome. These data are presented in Table 4. An independent samples t-test showed no significant difference between children with autism and Asperger on this measure.

Table 4

Mean percentile scores on IQ measure

	Participant Type		
	All Children n=73 *M(SD)*	Autistic n=39 *M(SD)*	Asperger n=34 *M(SD)*
Mean Percentile Score	51.66 (15.87)	48.49 (16.13)	55.29 (14.97)

Theory of Mind Performance

Individual Task Performance

Full Sample

To determine how children performed on the individual ToM tasks, the mean proportion of children responding correctly on each task by condition was computed. Table 5 shows performance for all children.

Table 5

Mean proportion of children responding correctly on each task by condition

Task / Test Questions	Condition: Social n=73 *M (SD)*	Condition: Intrapersonal n=73 *M (SD)*
Story Vignettes Task		
Appearance-Reality Emotion	.45 (.50)	.73 (.45)
Unexpected Contents Task		
Representational Change Emotion	.67 (.47)	.89 (.31)
Representational Change Belief	.58 (.50)	.82 (.39)
False Belief	.55 (.50)	
Appearance-Reality Belief		.78 (.42)
Unexpected Identity Task		
False Belief	.37 (.49)	
Representational Change Belief		.85 (.36)
Appearance-Reality Belief		.47 (.50)
Color Filters Perception Task		
Appearance-Reality		.88 (.33)
Perspective Taking	.82 (.39)	

Reliability

Cronbach alpha scores were computed for all tasks by condition. These scores appear in Table 6. Performance on the six tasks in the social condition showed strong reliability (.641) and performance on the seven tasks in the intrapersonal condition showed strong reliability (.698). In order to determine if tasks that tapped the same mental state exhibited strong reliability, tasks were clustered by the mental state they tested. (Note: This could be determined for the mental states of emotion and belief, but not for perception, as there was only one perception task in each condition.) Reliabilities for the mental state of emotion were not high. Reliabilities for the mental state of belief were high, with Social tasks exhibiting a reliability of .723 and Intrapersonal tasks a reliability of .738. Tasks were also clustered to determine if any subset of tasks exhibited a higher reliability than the aforementioned, but no subset of tasks had a higher reliability for both the Social and Intrapersonal conditions than 1) the belief tasks trials or 2) the total task trials.

Table 6

Cronbach alpha scores by condition for tasks (n=73)

	Condition	
Task	Social (# of trials)	Intrapersonal (# of trials)
Total Task Trials	.641 (6)	.698 (7)
Emotion Mental States	.095 (2)	.286 (2)
Belief Task Trials	.723 (3)	.738 (4)

The sample consisted of children with autism (n=39) and children with Asperger syndrome (n=34). Therefore, separate cronbach alpha scores were computed for all tasks by condition for these two participant types. See Table 7 for scores of children with autism. See Table 8 for scores of children with Asperger syndrome. For children with autism, performance on the seven tasks in the intrapersonal condition showed strong reliability (.719), but performance on the six tasks in the social condition showed only moderate reliability (.522). The reliabilities for children with Asperger syndrome were low at .417 for the performance on the seven tasks in the intrapersonal condition and .439 for performance on the six tasks in the social condition.

Table 7

Cronbach alpha scores by condition for tasks for children with autism (n=39)

	Condition	
Task	Social (# of trials)	Intrapersonal (# of trials)
Total Task Trials	.522 (6)	.719 (7)
Emotion Mental States	-.447 (2)	.220 (2)
Belief Task Trials	.674 (3)	.787 (4)

Table 8

Cronbach alpha scores by condition for tasks for children with Asperger (n=34)

	Condition	
Task	Social (# of trials)	Intrapersonal (# of trials)
Total Task Trials	.439 (6)	.417 (7)
Emotion Mental States	.067 (2)	-.100 (2)
Belief Task Trials	.521 (3)	.560 (4)

Group Differences

To determine if success on each individual test question was significantly different for children with autism and Asperger syndrome, a 2 x 13 Repeated Measures ANCOVA was run, with participant type (autism, Asperger) as the between subjects factor, the thirteen items as the within subjects factor, and language as the covariate. See Table 9 for the mean proportion of children with autism and Asperger syndrome that responded correctly on each social and intrapersonal test question.

Significant differences between groups were found on only two test questions. Both test questions were intrapersonal appearance-reality questions. Children with Asperger syndrome were more successful than those with autism on the Intrapersonal Story Vignettes Appearance-Reality Emotion test question, $F(1,72)=5.255$, $p < .05$, and the Intrapersonal Unexpected Identity Appearance-Reality Belief test question, $F(1,72)=6.656$, $p < .05$.

Table 9

Mean proportion of children with autism and Asperger syndrome responding correctly on each test question

Task Test Question	Participant Type Autism n=39 *M (SD)*	 Asperger n=34 *M (SD)*
Social Theory of Mind Test Questions		
Story Vignettes Task		
Appearance-Reality Emotion	.33 (.48)	.59 (.50)
Unexpected Contents Task		
Representational Change Emotion	.44 (.50)	.94 (.24)
Representational Change Belief	.36 (.49)	.82 (.39)
False Belief	.33 (.48)	.79 (.41)
Unexpected Identity Task		
False Belief	.21 (.41)	.56 (.50)
Color Filters Perception Task		
Perspective Taking Perception	.85 (.37)	.79 (.41)
Intrapersonal Theory of Mind Test Questions		
Story Vignettes Task		
Appearance-Reality Emotion	.56 (.50)	.91 (.29)*
Unexpected Contents Task		
Representational Change Emotion	.82 (.39)	.97 (.17)
Representational Change Belief	.74 (.44)	.91 (.29)
Appearance-Reality Belief	.69 (.47)	.88 (.33)
Unexpected Identity Task		
Representational Change Belief	.79 (.41)	.91 (.29)
Appearance-Reality Belief	.41 (.50)	.53 (.51)*
Color Filters Perception Task		
Appearance-Reality Perception	.82 (.39)	.94 (.24)

*$p < .05$

Composite Theory of Mind Performance

As discussed earlier, strong reliabilities were found on the six Social ToM tasks and seven Intrapersonal ToM tasks for the full sample. Therefore, all thirteen tasks were used to compute composite ToM scores for each participant.

Total ToM

The composite 'Total ToM' score was the proportion of correct responses on all 13 tasks, calculated by tallying the number of tasks passed over the total number of tasks received (thirteen). All participants included in analyses received all tasks. See Table 10 for means.

Table 10

Mean composite ToM scores by group

	Participant Group		
Composite Measure	Full Sample n=73 *M (SD)*	Autistic n=39 *M (SD)*	Asperger n=34 *M (SD)*
Total ToM	.68 (.23)	.56 (.23)	.81 (.14)
Social ToM	.57 (.28)	.42 (.25)	.75 (.21)
Intrapersonal ToM	.77 (24)	.69 (.27)	.87 (.15)

Full Sample

The mean Total ToM score for the full sample of participants was .68 (*SD*=.23).

Group Differences

A univariate ANCOVA was run on Composite Total ToM scores by group (autism, Aspgerger) with language as the covarite. No significant difference was found.

Social ToM vs. Intrapersonal ToM

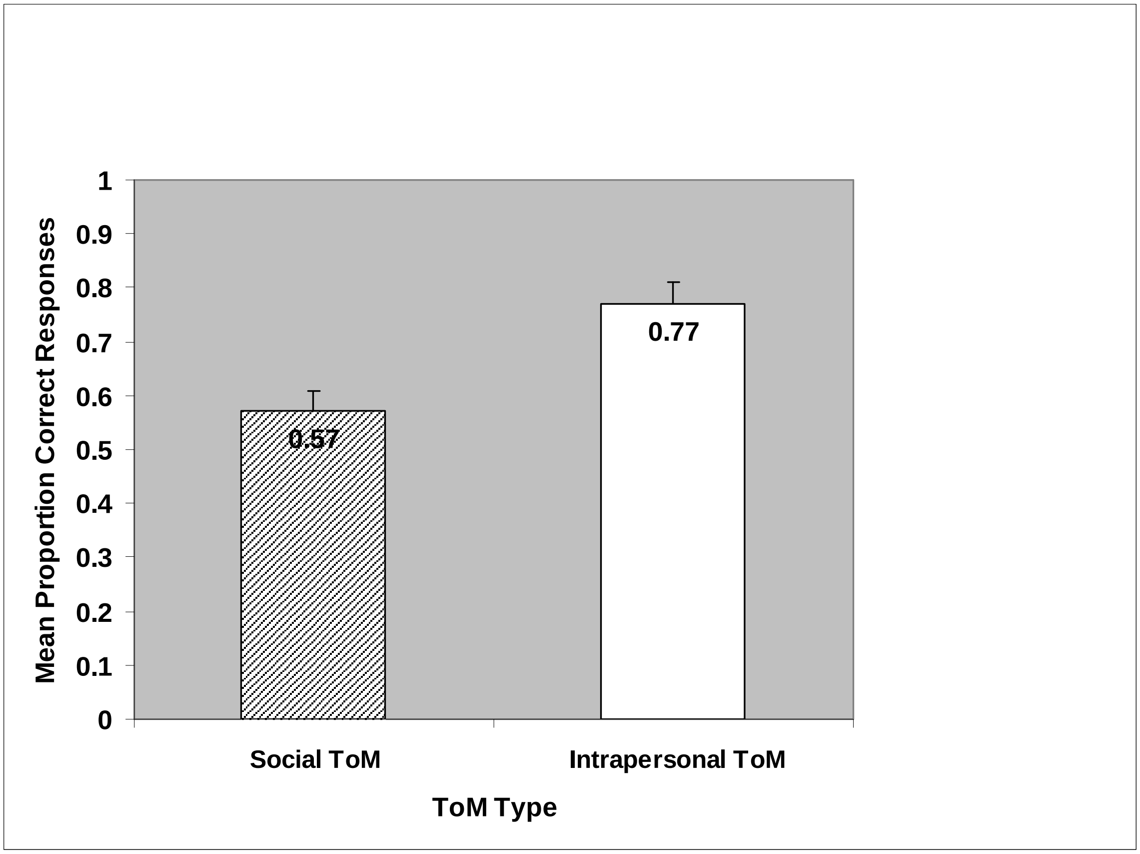
The six social tasks were used to compute a composite 'Social ToM' score for each participant, as the reliability of these six tasks was high (.641) and measured a variety of mental states (emotions, beliefs, and perception). These scores were the proportion of correct responses on the six social tasks, calculated by tallying the number of social tasks passed over the total number of social tasks (six). See Table 10 for means.

Similarly, the seven intrapersonal tasks were used to compute a composite 'Intrapersonal ToM' score, as the reliability of these seven tasks was high (.698) and measured a variety of mental states (emotions, beliefs, and perception). These scores were the proportion of correct responses on the seven intrapersonal tasks, calculated by tallying the number of intrapersonal tasks passed over the total number of intrapersonal task taken (seven). See Table 10 for means.

Full Sample

To determine if the composite Social ToM scores and Intrapersonal ToM scores were significantly different after controlling for language, a Repeated Measures ANCOVA was run with ToM Type (Social ToM, Intrapersonal ToM) as the within subjects factor and language as the covariate. A significant difference was found between the two composite scores, with children having a lower Social ToM score than Intrapersonal ToM score, F (1, 72)=34.634, p<.01. See Figure 1.

Figure 1
Mean Social and Intrapersonal Theory of Mind scores for all children



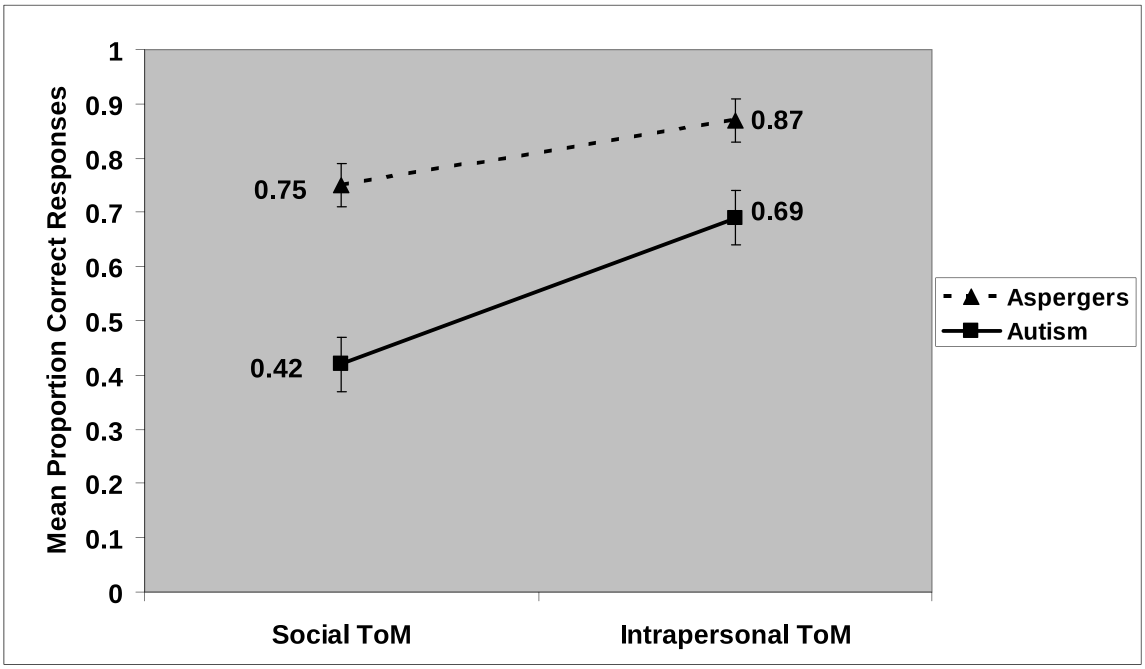
Group Differences

To determine if Social ToM and Intrapersonal ToM scores varied as a function of participant group, a 2 x 2 Repeated Measures ANCOVA was run with ToM type (Social ToM, Intrapersonal ToM) as the within subjects factor, participant group (autism, Asperger) as the between subjects factor, and language as the covariate. Post hoc analyses were conducted to better understand the significant differences.

Consistent with the Repeated Measures ANCOVA run on the full sample discussed earlier, the test revealed a significant main effect of ToM type, with children having higher Intrapersonal ToM scores (M=.77, SD=.24) than Social ToM scores (M=.57, SD=.28), F (1,72) = 10.031, p<.05. No significant main effect of participant type was found, F (1,72) = 1.486, p=.227. However, a significant interaction between participant type and ToM type was found, F (1,72) = 5.934, p<.05. The difference between Social ToM and Intrapersonal ToM scores was greater for children with autism than children with Asperger syndrome (p<.01) Post hoc analyses also revealed a significant difference between Social ToM scores for children with autism and Asperger syndrome, with children with Asperger syndrome having a higher Social ToM scores than children with autism (p<.05). No significant difference was found between the groups Intrapersonal ToM scores. See Figure 2.

Figure 2

Mean proportion correct on Social ToM and Intrapersonal ToM for children with autism and Asperger syndrome.



Contributions of Language and IQ

To determine the relationship between language ability and IQ on ToM performance, Pearson's correlations were run between the Total ToM, Social ToM, Intrapersonal ToM scores and the children's percentile scores on the TOLD-I:4 language measure and percentile scores on the Raven's Progressive Matrices IQ measure. Indeed, both language and IQ were strongly related to Total ToM, Social ToM, and Intrapersonal ToM performance. See Table 11 for correlations.

Table 11

Pearson's correlations for Total ToM scores, language, and IQ

	Language	IQ
Total ToM	.659***	.595***
Total Social ToM	.619***	.539***
Total Intrapersonal ToM	.550***	.517***

***$p < .001$

To investigate the contribution of language and IQ on ToM performance, a series of stepwise linear regressions was conducted. To determine if these regressions should be run on the full sample or separately for children with autism and Asperger syndrome, linear regressions were run with participant type, language percentile score (mean centered), and the interaction of participant type and language percentile score (mean centered) as predictors for Total ToM, Social ToM, and Intrapersonal ToM. Similarly, linear regressions were run with participant type, IQ percentile score (mean centered), and the interaction of participant type and IQ percentile score (mean centered) as predictors for Total ToM, Social ToM, and Intrapersonal ToM.   The interaction terms were not significant in any of these models, suggesting that the relationships between language and IQ on ToMs were not different for children with autism and Asperger syndrome. Therefore, the following stepwise linear regressions were conducted on the full sample.

Total ToM Scores

To determine the contribution of language and IQ to theory of mind abilities, a stepwise linear regression was conducted with Total ToM as the dependent variable. Language percentile score was entered in the first step and IQ percentile score was entered as a second step. Language accounted for 45% of the variance in Total ToM scores, $F(1, 72)=58.49$, $p<.001$. IQ accounted for an additional 11% of the variance in Total ToM scores, $F(1, 72)=16.73$, $p<.001$. See Table 12.

Table 12

Regression of Total ToM on language and IQ

Variable	Change in R^2	B(SE)	β	R^2
Step 1				
Language[a]	.452***	.009 (.001)	.607***	.452
Step 2				
IQ[b]	.106***	.015 (.004)	.332***	.557

Note: Betas are for the finals step in the model.
****p* <.001
[a]TOLD:I-4 Mean Percentiles
[b]Raven Progressive Matrices Mean Percentiles

Social ToM Scores

A stepwise linear regression was conducted for the full sample with Social ToM as the dependent variable. Language percentile score was entered in the first step. IQ percentile score was entered as a second step. Language accounted for 39% of the variance in Social ToM scores, $F(1, 72)=44.40$, $p<.001$. IQ accounted for an additional 5% of the variance in Social ToM scores, $F(1, 72)=6.55$, $p<.05$. See Table 13.

Table 13

Regression of Social ToM on language and IQ

Variable	Change in R^2	B(SE)	β	R^2
Step 1				
Language[a]	.385***	.010(.002)	.574***	.385
Step 2				
IQ[b]	.053*	.013(.005)	.234*	.437

Note: Betas are for the finals step in the model.
****p* <.001
**p*<.05
[a]TOLD:I-4 Mean Percentiles
[b]Raven Progressive Matrices Mean Percentiles

Intrapersonal ToM Scores

Finally, a stepwise linear regression was conducted for the full sample with Intrapersonal ToM as the dependent variable. Language percentile score was entered in the first step. IQ percentile score was entered as a second step. Language accounted for 33% of the variance in Intrapersonal ToM scores, $F(1, 72)=34.56$, $p<.001$. IQ accounted for an additional 12% of the variance in Intrapersonal ToM scores, $F(1, 72)=15.52$, $p<.001$. See Table 14.

Table 14

Regression of Intrapersonal ToM on language and IQ

Variable	Change in R^2	B(SE)	β	R^2
Step 1				
Language[a]	.327***	.008(.001)	.502***	.327
Step 2				
IQ[b]	.122***	.017(.004)	.356***	.449

Note: Betas are for the finals step in the model.
***p <.001
[a]TOLD:I-4 Mean Percentiles
[b]Raven Progressive Matrices Mean Percentiles

CHAPTER 5: DISCUSSION

Three major issues related to ToM abilities in children with autism and Asperger syndrome were addressed. One was the relation between language and ToM ability. The second was whether ToM is a non-integrated cognitive skill that differentiates into Social and Intrapersonal ToMs, as proposed in the Functional Multilinear Socialization Model (Lucariello 2004). The third issue examined was whether ToM abilities were different for children with autism and Asperger syndrome.

Language and Theory of Mind

Language was highly correlated and contributed to ToM performance. In fact, language contributed to performance on Total ToM, Social ToM, and Intrapersonal ToM. These findings are consistent with the large body of literature documenting the relationship between ToM and language in typically developing children (Astington & Jenkins, 1999; Hughes & Dunn, 1998; Jenkins & Astington, 1996; Ruffman, et al., 2003) children with autism (Happe, 1995; Tager-Flusberg & Joseph, 2005), and children with Asperger syndrome (Bennett, 2007; Stein et al., 2004; Klin et al., 2005). In fact, the language measure used in the current study was specifically selected because it measured general language, semantics, syntax, and vocabulary, all of which were found to be related to Theory of Mind performance in Milligan and colleagues (2007) meta-analysis.

The current study contributes to the preexisting literature by suggesting that the relationship between language and ToM may be different based on function. Previous work investigating the relationship between language and ToM has been limited by relying nearly exclusively on performance on false belief tasks as the metarepresentational ToM measure (see Milligan et al., 2007). By investigating ToM as a differentiated cognitive skill, the current study was able to show that language was more strongly related to Social ToM than Intrapersonal ToM. Lucariello, Butler, and Yarnell (2009) also investigated this possibility and found similar results; language accounted for more variance in ToM tasks that were social in nature than those that were object-oriented.

Theory of Mind Differentiation

Findings showed that ToM differentiated. For both groups of children, Intrapersonal ToM functioning was stronger than Social ToM performance. Social ToM performance was not strong, with correct performance at 57%. This makes sense when considering the functional uses of Social and Intrapersonal ToM and the known impairments in autism and Asperger syndrome. The Functional Multilinear Socialization Model (Lucariello, 2004) proposes that Social ToM is primarily used for social interaction and learning about persons (Lucariello, 2006). Children with autism and Asperger syndrome, by definition, have impaired social interactions (DSM-IV-R, 2000). Therefore, it is not surprising that they showed relatively poor Social ToM skills.

On the other hand, Intrapersonal ToM is primarily used for learning (Lucariello, 2004; Lucariello et al., 2006). While it is true that many children with autism exhibit some learning difficulties, learning difficulties do not constitute a diagnostic criterion of autism. In fact, many children with autism do not exhibit learning difficulties. It has been widely reported that seventy-five percent of children with autism have mental retardation (Roeleveld, et al, 1997). However, that estimate was based on clinic populations and did not include the full range of autism spectrum. A more recent study found that only thirty-five percent of children with autism have mental retardation (Baird, et al, 2000). Moreover, individuals with Asperger syndrome *cannot* possess a 'clinically significant' cognitive delay by definition (DSM-IV-R, 2000). Therefore, the fact that the full sample in the current study showed stronger Intrapersonal ToM skills is not surprising, as Intrapersonal ToM is proposed to be used in learning and learning is not necessarily a cognitive weakness for these children.

It is important to note that the finding that ToM differentiates runs counter to the assumption that it is an integrated cognitive ability. The integrated view is told by every mature account of ToM including the modularity view (German & Leslie, 2000, 2001; Leslie & Polizzi, 1998; Leslie & Thaiss, 1992; Scholl & Leslie, 1999, 2000), theory-theory view (Gopnik, 1993, Gopnik & Wellman, 1994; Perner, 1991; Wellman & Cross, 2001), sociocultural (Dunn et al., 1991; Hughes & Dunn, 1998; Perner et al., 1994; Ruffman et al., 1998), and language based accounts (Astington & Jenkins, 1999; Hughes & Dunn, 1998; Jenkins & Astington, 1996; Ruffman et. al., 2003).

The main evidence for the integrated view is the meta-analysis by Wellman and colleagues (2001). However, as noted earlier, this meta-analysis was limited to studies assessing false belief. The current study defined ToM more broadly and measured tasks that tapped emotional, perceptual, *and* belief mental states. Use of this broader definition allowed the differentiation of ToM to be revealed.

The differentiation of ToM into Social and Intrapersonal ToM lends support to the Functional Socialization Model (Lucariello, 2004). The current findings add to a growing body of evidence suggesting that Social and Intrapersonal ToM are in fact distinct cognitive abilities. As discussed earlier, Social and Intrapersonal ToM was found to be differentiated in low- and middle-income 5-6 year olds (Lucariello, 2004; Lucariello et al., 2007). Theory of Mind has also been found to be differentiated in low- and middle-income third-graders (Lucariello et al., 2009).

In all of the aforementioned cases, children exhibited greater strength in Social ToM than Intrapersonal ToM. However, differentiation and asymmetric functioning has been shown in the other direction, as well. Butler and Lucariello (2006) found that gifted children exhibited uneven ToM development. As with the current sample, the gifted children performed better on Intrapersonal ToM tasks than Social ToM tasks. Not only does ToM differentiate into Social and Intrapersonal forms, but asymmetry in the development of the forms can occur in either direction based on which uses are recruited more heavily in development.

The Functional Multilinear Socialization Model is the only ToM theory that can account for asymmetric ToM development in either direction. Harris's (2004) simulation theory does predict uneven development across Social and Intrapersonal ToM. However, according to simulation theory, Intrapersonal ToM is primary and Social ToM secondary or subsequent.

ToM Differentiation by Group

An additional goal of this research was to determine if ToM skills were different for children with autism and Asperger syndrome. While both groups exhibited weaker

Social ToM than Intrapersonal ToM, this asymmetry was greater for children with autism, whose Social ToM function was especially weak (42% correct response rate).

This finding makes sense when considering that Social ToM is proposed to play a role in social interactions and social interactions are more severely impaired in autism than Asperger syndrome. Hence, Social ToM development is vulnerable in children with autism because it is not heavily recruited or exercised. Children with autism tend not to initiate or engage in much social interaction. In contrast, individuals with Asperger syndrome approach others, albeit in an inappropriate or eccentric fashion (Aarons & Gittens, 1993). They often express interest in friendships and in meeting people (Klin, 2006). In the words of the Autism Society of America (2008), “Children with autism are frequently seen as aloof and uninterested in others. This is not the case with Asperger syndrome. Individuals with Asperger syndrome usually want to fit in and have interaction with others; they simply don’t know how to do it.” In addition, differences exist in the number of social impairment symptoms seen between groups. Children with Asperger syndrome exhibit fewer social impairment symptoms than children with autism (Bogdashina, 2006). Finally, children with autism score lower than those with Asperger syndrome on the Vineland Adaptive Behavior Scale, which assesses adaptive behavior in socialization (Szatmari, 2000).

There was no difference in Intrapersonal ToM abilities across the two groups. Intrapersonal ToM is thought to be used in learning (Lucariello, 2004). The fact that learning difficulties are not a diagnostic criterion for either disorder has already been discussed. It is possible that participants in both groups did not have learning difficulties.

Indeed, the IQ measure used in this study indicated that both groups IQ scores fell within the normal range. Moreover, the IQ scores of children with autism and Asperger syndrome were not statistically different, again suggesting that learning potential was the same across groups.

Limitations and Future Research

A few limitations of the present research should be noted. Although the sample included a range of chronological and mental ages, there was not enough variation to be able to determine a developmental trajectory of Intrapersonal and Social ToM. For example, it might be possible that Social ToM improves with age. Research on the relationship between ToM performance and age in these populations is inconsistent. Some have found no relation between the two (Baron-Cohen, et al., 1985; Perner et al, 1981). Yet, others have found that older autistic children are more likely to pass ToM tasks than younger children. For example, in Baron-Cohen's (1992) study, the four autistic participants who passed the false belief tasks were all older than 9.9, and three of the four were older than 15. He concluded that a relatively high age was necessary but not sufficient for subjects with autism to pass the Smarties task. A few studies have assessed the actual *development* of ToM in these populations. Ozonoff & McEvoy (1994) investigated whether ToM abilities changed over a 3-year period and found no improvement. Similarly, another study found ToM skills showed no improvement over a 7-year time period (Holroyd & Baron-Cohen, 1993). In contrast, Serra and colleagues (2002) found that both typically developing children and children with Asperger syndrome showed an increase in ToM scores between the ages of 3-5. However, the increase for the typically developing children was considerably greater, took place over a shorter period of time, and showed a different qualitative pattern of change than seen in the children with autism and Asperger syndrome. Unfortunately, the current study was unable to determine ToM growth patterns due to the limited variation in age of the sample. It will be essential to determine the developmental trajectory now that it has been documented that ToM differentiates. It is possible that the development of Social and Intrapersonal ToM follows different paths for different groups of children. Moreover, developmental differences between Social and Intrapersonal ToM may help clarify current inconsistencies documented in the literature.

A second limitation of the current study is that no information was obtained regarding the amount and type of therapy or intervention participants received prior to participation. To address the consistently documented finding that these children face ToM difficulties, various training programs have been developed in recent years. For example, Howlin, Baron-Cohen, and Hadwin (1999) developed an intervention guide entitled '*Teaching Children with Autism to Mind-Read: A Practical Guide*' that provides information on how to teach ToM skills. A variety of others books and resources are available to help individuals with autism and Asperger syndrome develop ToM understanding (Gray, 2000; McAfee, 2001; Fahety, 2000). It is possible that these resources were utilized more by one group than the other. If this was the case, it is possible that the differences found in ToM skills may have been a result of intervention practices as opposed to the disorders themselves.

The current study suggests that ToM is differentiated, but does not specifically address whether its emergence is domain-general or domain-specific. In order to hypothesize about domain specificity it is important to first consider the contexts in which ToM operates. ToM is used in social contexts; social interactions clearly entail Social ToM and Intrapersonal ToM can be used for social-interactive ends (e.g. when one considers their own false beliefs about others). There are also non-social contexts that require ToM reasoning, such as when it is applied to the physical, object world. Both Social and Intrapersonal ToM operate in these non-social contexts, as well. Social ToM is engaged when children consider another persons reasoning about an object. Intrapersonal ToM is engaged when processing the object world and generating multiple representations of an object.

Therefore, it is important to consider if ToM emerges across these social and non-social contexts (meaning its development is domain-general) or originates in just one context (meaning its development is domain specific). Lucariello, Butler, and Yarnell (2009) specifically explored the question of domain specificity by studying ToM across social and object task contexts. Both Social and Intrapersonal ToM functioning were stronger on social tasks than object tasks, suggesting ToM emergence is domain specific and social contexts are the ground for its emergence. However, it is important to note that these data were collected from a sample of neurotypical third grade students.
It would be interesting to explore ToM domain specificity in children with autism and Asperger syndrome. It seems possible that for these children ToM emergence is domain specific, but that emergence begins within *non-social* contexts. These children exhibit

extreme focus and obsession regarding objects (APA, 2000). Swettenham and colleagues (1998) compared the amount of attention directed towards objects and people in typically developing infants, infants with autism, and infants with developmental disorders. While, infants with autism showed a shorter mean duration of look at people than the other two groups, they showed a longer duration of look at objects. In addition, Baron-Cohen and Wheelwright (1999) found that the obsessions of children with autism and Asperger syndrome occurred more often in the domain of 'folk physics' (defined as an interest in how objects work) and less often in the domain of "folk psychology (an interest in how people work). It would be interesting to see if metarepresentational ToM originates in non-social domains for these children, which would contrast the considerable evidence that it develops in social contexts for typically developing children (Carpendale & Lewis, 2006).

Implications

The finding that ToM differentiates into Social and Intrapersonal ToM has important research and clinical implications. First, the field of psychology needs to reconsider how ToM is defined. This study contributes to a growing body of evidence showing that ToM is not a single integrated cognitive ability, but rather a differentiated set of abilities. The Functional Multilinear Socialization Model (Lucariello, 2004) is the only ToM theory that accounts for this differentiation and variable asymmetric development and should therefore be used as the primary conceptual model moving forward.

The current study also provides a more thorough understanding of autism and Asperger syndrome. There has been much debate as to the relationship between the two. The DSM-IV-R and ICD-10 imply that they are separate disorders although both state that the diagnostic validity of the distinction is uncertain. Others believe that Asperger syndrome is in fact at one end of the autism spectrum, with autism at the other end (Bennet et al., 2007). Yet, some believe that there is no difference between the clinical presentations and that it is not useful to employ the diagnostic labels at all (Scholper, 1996). Literature reviews have highlighted the gaps in research addressing the issue of distinctiveness (or lack thereof) of the diagnoses. These reviews concluded that it is too early to conclude whether the disorders are the same or different (Frith, 2004; Macintosh & Dissanayake, 2004).

The current findings support the idea that Asperger syndrome and autism should be considered separate disorders. Both groups exhibited weaker Social ToM than Intrapersonal ToM. However, the children with autism exhibited a more severe Social ToM impairment than children with Asperger syndrome. This finding suggests that there is something unique about autism: a more severe Social ToM deficit. This new understanding of the autism–Asperger distinction allows us to better understand these children. A better understanding can lead to better specified intervention programs, which can in turn help these children cope with their condition and achieve their full potential.

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Appendix A

Script for Task Administration

Cover Sheet

Child Name: ________________________________

Gender: ________________________________

School: ________________________________

Classroom: ________________________________

Date Tested: ________________________________

Date of Birth: ________________________________

AUTISM

or

ASPERGER SYNDROME

We are going to play some games today. Would you like to play? (Verbal Consent)

<OTHER Pre-test for Story Vignettes>

“This is the face of Diana/David when she is happy, sad and not sad and not happy but just OK.”

“Can you point to Diana/David’s face on her birthday?”

“Can you point to Diana/David’s face when she is sick?”

“Can you point to Diana/David’s face when there’s nothing special happening, nothing bad and nothing good?”

Following this pre-training in the meaning of the 3 verbal expressions-happy, sad, and OK-the drawings are removed.

TASK series-“reality” Q first

Before reading stories, say introductory remarks/preamble:

“Now I’m going to tell you some stories of things that could happen to Diana/David. After the story, I am going to ask you about what happened in the story then, I’m going to ask you about how Diana/David really feels inside and how s/he looks on her/his face. S/he might really feel one way inside but look a different way on her/his face.”

<OWN Pre-test for Story Vignettes>

(Display the three faces first and then label each of them, Start with happy → sad → ok)

"Let's say this is your face when you are happy, sad and not sad and not happy but just OK."

"Can you point to your face on your birthday?"

"Can you point to your face when you are sick?"

"Can you point to your face when there's nothing special happening, nothing bad and nothing good?"

Following this pre-training in the meaning of the 3 verbal expressions-happy, sad, and OK-the drawings are removed.

TASK series-"reality" Q first

Before reading stories, say introductory remarks/preamble:

"Now I'm going to tell you some stories of things that could happen to you. After the story, I am going to ask you about what happened in the story then, I'm going to ask you about how you look on your face and how you really feel inside. You might really feel one way inside but look a different way on your face.

[Vignette 1: Hammer-OTHER] **Diana/David goes to the dark basement to get a hammer, but she/he is afraid of the dark. Diana tries to hide how she feels so that she will not be a baby. I'm going to ask you some questions.**

Memory Q1
What happens to Diana when she goes to the basement? (answer-afraid of the dark)

Memory Q2
What will Diana/David be like if she shows how she feels? (answer- a baby)

If children fail to answer one of both Qs correctly, the story needs to be re-read and the Q(s) not answered correctly should be repeated. Children who answer both correctly are included in analyses.

REALITY: **How does Diana <u>really</u> feel when she goes to the basement? Does she feel sad or happy or okay?** (answer - sad)

APPEARANCE: **How does Diana try to look on her face when she goes to the basement? Does she look sad or happy or okay?** (answer **–** sad or okay)

[Vignette 2: Hammer -OWN**] You go to the dark basement to get a hammer, but you are afraid of the dark. You try to hide how you feel so that you will not be a baby.**

Memory Q1
What happens to you when you go to the basement? (answer-afraid of the dark)

Memory Q2
What will you be like if you show how you feel? (answer- a baby)

If children fail to answer one of both Qs correctly, the story need to be re-read and the Q(s) not answered correctly should be repeated. Children who answer both correctly are included in analyses.

REALITY: **How do you <u>really</u> feel when you go to the basement? Do you feel okay or happy or sad?** (answer - sad)

APPEARANCE: **How do you try to look on your face when you go to the basement? Do you look okay or happy or sad?** (anwser-happy or okay)

Unexpected Identity Task: PRE-TEST

Take a look at this. (Give a few seconds just to look at the object) **Okay now you can pick it up. Squeeze it.**

Pre-test Q1: **What is it?** Presumably, the child answers that it is a sponge.

If they do not respond with the label “sponge” to the initial “What is it?” question, they are asked a second question.

Q2: **What else is it?**

If this fails to elicit the “sponge” response, they are asked a 3rd and final question

Q3: **Is it like anything you have seen or used before?**

If they respond in the affirmative, they are asked the follow-up question

Q4. **Oh, then what is it like?**

Whatever word/phrase the child comes-up with (if not “sponge”), use in questions.

Okay, now put it back on the table (desk).[1]

(Child can hold the object during the pretest.)

[1] The objective is returned to its previous deceptive state after pretest (Gopnik & Astington, 1988, p.29)

Unexpected Identity: APPEARANCE-REALITY (OWN)

APPEARANCE**: What does this look like?** (answer – rock)

If children do not respond, Forced-choice Q: Does it look like a rock or does it look like a sponge (use the words the child comes-up with)?

REALITY**: What is this really?** (answer – sponge)

Forced-choice Q: Is it really a rock or is it really a sponge*?*

Unexpected Identity: REPRESENTATIONAL CHANGE (OWN**)**

REPRESENTATIONAL CHANGE Q (Slowly read) **: When you first saw this, before you touched it or squeezed it, what did you think it was?** (answer **–** rock)
forced-choice Q: <u>Did you think it was a sponge or did you think it was a rock?</u>

Unexpected Identity: FALSE-BELIEF (Other) (Slowly read)

If another kid hasn't touched this and hasn't squeezed it, when this kid first sees it, before the kid touches it or squeezes it, what will the kid think it is? (answer **–** rock)

forced-choice Q:
<u>Will he/she think it's a sponge or will he/she think it's a rock</u>*?*

Unexpected Content Task: Toothpaste- OWN [the 3 questions should be counterbalanced]

Would you rather have M&Ms or toothpaste as snack? (Give some time)
I have something to give you.
Open it up

(One pack of M&Ms in the toothpaste box)

PRETEST Q: **What's inside the box?** Answer (M&Ms)

After pretest, the object returns to its previous deceptive state[2]– **"Give them back to me."** (E put M&Ms back in the box, closes the box and places it on the table between Child and E)

REPRESENTATIONAL CHANGE EMOTION:
When you first saw the box, before you opened it, how did you feel about what was inside it? (Ans: sad, disappointed, not happy...)

Forced Q: <u>Did you feel happy about what was inside it or did you feel sad about what was inside it</u>?

(OWN) REPRESENTATIONAL CHANGE BELIEF:
When you first saw the box, before you opened it, what did you think was inside it? (ans-toothpaste)

If children do not respond, then administer forced-choice Q: <u>Did you think there were M&Ms inside it or did you think there was a toothpaste inside it? (answer-toothpaste)</u>

Unexpected Content Task: APPEARANCE-REALITY

APPEARANCE: **What does it look like is in the box?** (answer-toothpaste)

forced-choice <u>Q: Does it look like there is toothpaste inside or does it look like there are M&Ms inside it?</u>

REALITY: **What's really in the box?** (answer: M&Ms)

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[2] The box is closed after pre-test (Hogrefe et al., 1986; Gopnik & Astington, 1988).

forced-choice Q: Is there really toothpaste inside it or are there really M&Ms inside it?

Unexpected Content Task: Crayon in Bandaid box- OTHER [Should be counterbalanced]

3 Bandaids/ 3 crayons/ One Bandaid box needed for this task
Girl characters for girls. Boy characters for boys.

This is Mary/Maxi and s/he is always playing tricks on the other kids. This is Sally/Sam and her favorite thing to do is drawing with crayons.

Mary/Maxi is going to play a trick on Sally/Sam (while Sally/Sam goes outside). Let's see what Mary does. (Sally/Sam is hiding under the E's table. Mary/Maxi opens the Baindaid box and takes out Bandaid and put three crayons.)

Mary/Maxi put the Bandaid box with the crayons inside it on the table.
Sally/Sam came and saw this Bandaid box on the table.
(Sally/Sam was then brought toward the box and placed beside it and opens the box.)

PRETEST Q: **What's inside the box?** Answer (Crayons)

Experimenter puts the crayons in the Bandaid box, closes it and asks questions.

REPRESENTATIONAL CHANGE EMOTION:
When Sally/Sam first saw the box, before she/he opened it, how did she/he feel about what was inside it? (Ans: sad)

Forced q: Did Sally/Sam feel happy about what was inside it or did Sally/Sam feel sad about what was inside it?

FALSE BELIEF:
If another kid hasn't seen inside this box, when the kid first sees the box, before the kid opens it, what will the kid think is inside it? Answer (Bandaid)

forced-choice Q:
Will the kid think there are crayons inside it or will the kid think there are Bandaids inside it?

REPRESENTATIONAL CHANGE BELIEF:
When Sally/Sam first saw the box, before s/he opened it, what did she/he think was inside it? (Ans: Bandaids)

If children do not respond, then administer forced-choice Q: Did Sally/Sam think there were Bandaids inside it or did Sally/Sam think there was crayons inside it?

Color Filters

Color Pretest-Children are pre-tested for their ability to name or point or given the name, all colors used in the study.

PRETRAINING : Experimenter shows the child a cut-out of a white fish and says "Here's a white fish," places it on the table on Experimenter side of a vertical green filter and says "The fish looks green to you because you're looking through this thing (points to filter). I'm looking at the fish too, but it looks white to me. Now (places fish on the child's side of the filter) and says "The fish looks white to your eyes and green to mine."

General Method –Experimenter shows child the object (but does not name its color), places it on Experimenter's side of the illusion-giving device (so child and NOT experimenter sees illusion), and says "Here's an X."

Pink Butterfly with Blue Filter (Own)

<The following questions should be counterbalanced>

APPEARANCE (Own):

Here's the (first) question. You are looking at the butterfly with your eyes right now. Does it look blue to you or does it look pink to you? (Answer: Blue)

REALITY-PERCEPTION (Own):

Here's the (second) question. What color is the butterfly really and truly? Is it really and truly blue or is it really and truly pink? (Pink)

Purple Cake with Green Filter (Own, Other)

<The following questions should be counterbalanced>

APPEARANCE (Own):

Here's the (first) question. You are looking at the cake with your eyes right now. Does it look green to you or does it look purple to you? (Answer: Green)

PERSPECTIVE-TAKING (Other):

Here's the (second) question. I'm looking at the cake with my eyes right now. Does it look green to me or does it look purple to me?" (Answer: Purple)

< Thanks so much for playing with me. I'm going to play with other children. So don't tell any of the other kids about any of the games that we played, ok? >