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Theory of Mind, Pragmatic Language, and Social Skills in Male Adolescents with Autism Spectrum Disorders

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THEORY OF MIND, PRAGMATIC LANGUAGE, AND SOCIAL SKILLS IN ADOLESCENTS WITH AUTISM SPECTRUM DISORDERS

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ABSTRACT

THEORY OF MIND, PRAGMATIC LANGUAGE, AND SOCIAL SKILLS IN ADOLESCENTS WITH AUTISM SPECTRUM DISORDERS

By

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August 2012

Dissertation supervised by Jeffrey A. Miller, Ph.D.

Autism Spectrum Disorder (ASD) is characterized a core triad of symptoms: impaired social interaction, problems with verbal and nonverbal communication, and unusual, repetitive, or severely limited activities and interests (APA, 2000). Impairments in social development, however, have been considered the most salient and handicapping aspect of ASD and, traditionally, the primary deficit from which the diagnosis results. From a cognitive standpoint, it has been argued that these social impairments in individuals with ASDs arise as a result of deficits in Theory of Mind (ToM) development (Baron-Cohen, 1995). The degree to which impairment in ToM corresponds to real-world social-communicative impairments has received little attention, however. The purpose of this study was to determine whether ToM and pragmatic language skills discriminated

between adolescents with ASD and typically developing, age-matched comparison participants. The study also attempted to explore the relationships between ToM, pragmatic language, and social skills and test the model that pragmatic language mediates the relationship between ToM and social skills. Results indicated that ToM significantly predicted pragmatic language skills and that pragmatic language skills, and not ToM, significantly discriminated between adolescents with ASD ($N = 10$) and typically developing comparison participants ($N = 10$). The mediation model above was not supported by regression analysis; however, the results do provide some insight into the relationships between ToM, pragmatic language, and social skills. Implications of these findings, limitations of the study, and recommendations for future research were discussed.

DEDICATION

This document is dedicated to my mother, Jane, whose constant encouragement to remain true to myself and find my own path led me to a rewarding career in psychology. This document is also dedicated to my wonderful wife, Rica, who provided unwavering support and reassurance throughout this long and challenging process.

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CHAPTER I

INTRODUCTION

Autism Spectrum Disorder (ASD) is characterized by a core triad of symptoms: impaired social interaction; problems with verbal and nonverbal communication; and unusual, repetitive, or severely limited activities and interests (American Psychiatric Association [APA], 2000). Impairments in social development, however, have been considered the most salient and handicapping aspect of ASD and, traditionally, the primary deficit from which the diagnosis results (Rogers, 2000). From a cognitive standpoint, it has been argued that these social impairments in ASD arise as a result of deficits in Theory of Mind (ToM) development (Baron-Cohen, 1995). Theory of Mind refers to the understanding that other persons have thoughts and the ability to make inferences about others' belief, desires, and mental states. It is posited as an indispensable cognitive faculty with regard to everyday social interactions. The degree to which impairment in ToM corresponds to real-world social-communicative impairments has received little attention, however, and further research is needed to clarify this relationship. Further knowledge of this relationship will contribute to understanding of how ToM is understood as a theoretical construct and as a core impairment that defines individuals with ASD.

Significance of the Problem

The purpose of this study was to investigate the degree to which ToM impairments in ASD correspond to real-world social impairments. While this connection appears to carry considerable face validity, relatively few studies have set out to examine the ToM-social impairments relationship (Capps, Kehres, & Sigman, 1998; Fernald,

1987; Travis, Sigman, & Ruskin, 2001). Furthermore, these few studies have not supported a significant relationship between the variables. This research, however, has suffered from a number of methodological drawbacks including sample heterogeneity, reliance on observation-based evaluation of social skills, and conceptualization and assessment of ToM. The present study aimed to (1) address the limitations of previous research by increasing the homogeneity of the sample utilizing an individual assessment-based evaluation of social skills, and using a ToM measure that is developmentally appropriate for the age range featured in the sample, (2) evaluate the usefulness of a laboratory assessment of ToM, and (3) contribute to the discussion of the conceptualization of ToM in ASD.

Theory of Mind

The term Theory of Mind was first used by Premack and Woodruff (1978) to describe a child's ability to ascribe thoughts, feelings, ideas, and intentions to others and use this ability to predict the behavior of others, and has since been extended to the ability to make inferences about others' mental states (Stone, Baron-Cohen, & Knight, 1998). Theory of Mind been has been posited as a component of cognition that is critical for social functioning as well as a naive theory of how behavior can be understood in terms of mental states such as desires, beliefs, and intentions and thus has also been referred to more globally as the ability to empathize and understand other minds (Baron-Cohen, Tager-Flusberg, & Cohen, 2005).

In his book *Mindblindness: An Essay on Autism and Theory of Mind* (1995), Baron-Cohen outlines his original theoretical model of ToM. While competing theories have challenged the validity of the ToM hypothesis and shed new empirical light on its

developmental sequence, Baron-Cohen's initial model continues to serve as perhaps the most comprehensive basis for discussion of ToM as a construct. Initially, the model contained four innate mechanisms that were said to develop in the first four years of a child's life, though Baron-Cohen (2005) has since incorporated two additional components. The first is the Intentionality Detector (ID), which is a perceptual device used to detect goal and desire, which are basic mental states that provide interpretations such as, "He wants to go there" or, "The cat wants the food." The second is the Eye Detection Detector (EDD), which detects eye-like stimuli, detects orientation of eyes, and attributes a perceptual state to the eyes. The third mechanism, the Shared Attention Mechanism (SAM), constructions relationships between the self, an observer, and a third object, thus allowing for shared attention. The fourth mechanism, the Theory of Mind Mechanism (ToMM), represents the full range of mental states such as "knowing," "believing, and, "deceiving" and allows for a comprehensive understanding of how mental states relate to behavior. While these components may themselves provide a broad conceptualization of ToM, Baron-Cohen (2005) revised his theory to include two affective properties—the Emotion Detector (TED), which represents basic emotions and the Empathizing System (TESS), which crucially allows for emotional reaction to others' mental states, such as feeling pain when perceiving that another person is feeling pain.

A wealth of research has demonstrated that children with ASD are impaired in their development of ToM. Seminally, Baron-Cohen, Leslie, and Frith (1985) found that approximately 80% of children with ASD were not able to predict the ideas of others on a ToM test, whereas nearly 100% of comparison participants and children with mental retardation were able to do so. Subsequent studies examining the functioning of ToM

across ASD have similarly revealed deficits in the ability of children with ASD to understand others' minds (Dawson & Fernald, 1987; Hogrefe, Wimmer, & Perner, 1986; Leslie & Frith, 1988; Perner, Frith, Leslie, & Leekam, 1989). Further, this impairment has been documented among adolescents and adults with ASD as well (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).

Connecting ToM with Social Impairments in ASD

That all individuals with ASD suffer from some degree of ToM impairment is mostly agreed upon. However, while a plethora of studies have documented impairments in ToM skills among the ASD population, the notion that their social impairments exist entirely or partly as a result of ToM deficits—a hypothesis that carries considerable face validity—has not been explored extensively. As mentioned, the studies examining this relationship have not found a significant connection between ToM and real-world social impairments that characterize ASD. If ToM theoretically measures the ability to empathize and the ability to empathize underlies social impairments in ASD, why is this result not forthcoming? It has been suggested that more basic social-cognitive processes not accounted for by traditional ToM tasks, such as social-perceptual abilities that involve spontaneous processing and judgment of socially relevant information inherent in facial and bodily gestures, may be responsible for the social impairments in ASD (Joseph & Tager-Flusberg, 2003; Tager-Flusberg, 2001). This notion is consistent with Baron-Cohen's (2005) revision of his theory to include affective components and is supported by brain research examining the amygdala and mirror neuron system, which have been found to be impaired in ASD (Baron-Cohen, Ring, & Bullmore, 2000; Bookheimer,

Wang, Scott, Sigman, & Dapretto, 2008; Hadjikhani, Joseph, Syder, & Tager-Flusberg, 2007). Other methodological barriers have stood in the way as well. For example, ToM tasks, such as the false belief task, propose an explicitly defined problem, such as, "Where will Sally look for the marble?" In real-life social situations, however, such problems are not defined so easily, calling into question the ecological validity of traditional false belief tasks. Further, the false belief task has been shown to demand other cognitive processes outside of ToM, such as executive functioning (Carlson & Moses, 2001; Hughes, 1998).

Another reason for the relatively shallow empirical basis supporting the ToM-social impairment connection has been the tendency to focus on broad, rather than narrow, age ranges. Several potential problems arise from using such a broad age range. One, though all children with ASD pass ToM assessments at a later stage than their typically developing counterparts (Happe, 1995), assessments such as the false belief task are clearly intended for much younger children. Thus, older children diagnosed with ASD, though delayed in their ToM skills, would still be expected to pass such tasks. Two, as children grow and mature, the social skills expected of them naturally change. Reciprocal conversation skills, for example, are not as relevant when understanding the social skills of a 4-year-old as they are for a 14-year-old. This notion would logically call for more specific definitions of "social skills" as well. In sum, understanding the specific relevance of ToM impairment with regard to associated social impairments in older children with ASD demands greater specificity when defining these variables.

Problem Statement

The purpose of this study was to investigate the degree to which ToM impairments in ASD correspond to real-world social impairments that can be assessed in the laboratory. Addressing the above shortcomings of previous research, which include sample heterogeneity, reliance on observation-based evaluation of social skills, and broad conceptualization and assessment of ToM, was paramount to the present study. Tasks should focus as much as possible on ToM skills without relying on language or executive functioning demands. To accomplish this, the present study utilized the Reading the Mind in the Eyes Test—Revised (Baron-Cohen, Wheelwright, Hill et al., 2001). Described as an advanced ToM test, the Reading the Mind in the Eyes task measures the ability to map mental state terms to fragments of facial expressions—the portion of the face around the eyes. At an automatic level, participants must match the set of eyes in each picture to examples of eye region expressions stored in memory to arrive at a judgment concerning which word the eyes most closely match. While there is language in the Reading the Mind in the Eyes Test, the demands are minimal compared to other ToM assessments. Usage of this measure also addresses another aforementioned problem with previous research, namely the failure to include ToM measures that purportedly assess spontaneous social perceptual abilities, which comprise a more affective component of ToM (Baron-Cohen, Tager-Flusberg et al., 2000).

Problems with sample heterogeneity and operationalization of social skills must also be considered when working towards understanding the ToM-social skills relationship. To address the former problem, the present study included males diagnosed with ASD aged 12 to17. The study of ToM in the adolescent population is relatively

scarce compared to that in childhood, and while several studies have examined ToM functioning in adults over the age of 20 (Baron-Cohen, O'Riordan et al., 1999; Baron-Cohen, Wheelwright, Hill et al., 2001) no known study has focused narrowly on middle adolescence. Concerning definition of social skills, previous research has depended primarily on observation checklists that assess a broad range of behaviors. While rating scales are useful for highlighting behaviors specific to a disorder and can provide valuable diagnostic information, the inherent subjectivity of assigning a number to an observation invariably introduces error. Thus, in addition to a social skills checklist, the present study focused on the social dimension of language, which is commonly referred to as pragmatic language. Pragmatic language is essentially language in context, and the study of pragmatics is concerned with how language is used socially to achieve goals, how communication is affected by different environments and contexts, and how different messages are most appropriately conveyed (Phelps-Terasaki & Phelps-Gunn, 1992). With this operational definition in mind, social behavior is inextricably intertwined with pragmatic language, which lends itself relatively well to laboratory-based assessment. Moreover, pragmatic language exists as a deficit universally agreed upon in ASD (Tager-Flusberg, Paul, & Lord, 2005) and has been considered the most stigmatizing aspect of the disorder (Landa, 2000). Specific pragmatic language-related impairments in ASD might include making a relevant comment in response to the topic introduced by the speaker, including extra or unnecessary information in an utterance, and remaining on topic during conversation. At face value, these behaviors would constitute some level of social awkwardness and often imply an overall difficulty with social skills. Subsequently, such social language vulnerabilities can give rise to anxiety,

avoidance of social situations, and self-image challenges (Landa, 2000). Moreover, these difficulties are theoretically attributable to ToM impairment. The present study used a well-validated pragmatic language instrument, the Test of Pragmatic Language, Second Edition (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007), to assess the ability to convey and interpret social language.

In summary, it is hoped that the current investigation will shed further light on the overall conceptualization of ToM in ASD by providing a more fine-tuned investigation of the salient variables.

Research Questions and Hypotheses

This study was conducted to answer the following research questions:

Research Question 1

Do male adolescents with ASD have significantly lower ToM ability compared to typically developing, age-matched male comparison peers?

Hypothesis 1. Male adolescents with ASD will have significantly lower ToM ability compared to typically developing, age-matched male comparison peers.

Research Question 2

Do male adolescents with ASD have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers?

Hypothesis 2. Male adolescents with ASD will have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers.

Research Question 3

Do pragmatic language skills mediate the relationship between ToM and social skills in male adolescents with ASD?

Hypothesis 3. Pragmatic language skills mediate the relationship between ToM and social skills in male adolescents with ASD.

CHAPTER II

LITERATURE REVIEW

Autism Spectrum Disorder

Autism spectrum disorder (ASD) refers to a range of complex neurodevelopment disorders that exist independent of age, ethnicity, and social class. According to data from the Center for Disease Control, it was estimated that in 2009, approximately 1 in every 110 children aged 8 in the United States have a diagnosis of ASD (Rice, 2009). While manifestations of ASD vary markedly across developmental levels, the disorder is characterized by a core triad of symptoms: impaired social interaction, problems with verbal and nonverbal communication, and unusual, repetitive, or severely limited activities and interests (APA, 2000).

A brief overview of these symptoms provides insight into the uniqueness of ASD. Repetitive and stereotypic behaviors, such as flapping, flipping objects, and toe-walking, exist as a hallmark of autistic symptomatology and have been shown to be a consistent symptom of the disorder across studies (Turner, 1999). Recent evidence suggests that this symptom has been shown to be associated with a higher probability of predicting the ASD diagnosis (Mooney, Gray, & Tonge, 2006) and is more prevalent in ASD than in mental retardation (Carcani-Rathwell, Rabe-Hasketh, & Santosh, 2006; Osterling, Dawson, & Munson, 2002). Numerous studies have documented communicative deficits in ASD. Preschoolers with ASD have been found to be significantly impaired in both language expression and comprehension (Charman et al., 1997; Charman, 1998). In a subsequent study, 47 of 134 preschoolers with ASD were reported by parents to produce

no spoken words and 72 were reported to speak only 10 words or less (Charman, Drew, & Baird, 2003).

Though repetitive behaviors and communicative impairments exist as diagnostic hallmarks of ASD, social development has been considered the most salient and handicapping of impairments in autistic disorder and, traditionally, the primary deficit from which the disorder arises (Rogers, 2000). In typically developing children, abilities such as sharing attention with another person, imitating another's actions, understanding emotions, and engaging in pretend play emerge in the first years of life. In ASD, however, a wealth of research has shown that these behaviors are specifically impaired. Numerous studies have documented the global deficits in social functioning in ASD. Harel and colleagues (2001), for example, observed significant impairments in social and daily living skills of nine-year-olds with high- and low-functioning ASD, while Gillham, Carter, Volkmar, and Sparrow (2000) found that the social skills accounted for 48% of the variance in the ASD diagnosis in a sample of 43 four- to thirteen-year-old children. Moreover, a wealth of research has documented specific social impairments in ASDs such as pretend play (Libby, Powell, Messer, & Jordan, 1997; Rutherford & Rogers, 2003), orienting to social stimuli (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998), imitation skills (Dawson, Meltzoff, Osterling, & Rinaldi, 1998) and reciprocal interaction skills (Baron-Cohen, O'Riordan et al., 1999; Capps, Keyres, & Sigman 1998).

The symptoms characterizing social impairments in ASD are thus well documented and agreed upon among researchers and practitioners. Perhaps the most prominent cognitive theory attempting to account for these deficits concerns the development of a Theory of Mind (ToM). This account asserts that symptoms of ASD

can be explained in terms of a core deficit in the ability to understand and represent mental states.

Theory of Mind

The term *Theory of Mind* was first used by Premack and Woodruff (1978) to describe a person's ability to ascribe thoughts, feelings, ideas, and intentions to others and use this ability to predict behavior. More recently, ToM has been referred to as the ability to make inferences about mental states (Stone, Baron-Cohen, & Knight, 1998). Our understanding of others' beliefs is thus considered to be "mentalistic" (Baron-Cohen, Tager-Flusberg, & Cohen, 2000, p. 21)—that is, we conceptualize others' beliefs, desires, and emotions in terms of mental states. Without such a mentalistic framework in place, successful negotiation of everyday human interactions would be quite challenging. Simple examples illustrating the faculty of ToM in everyday life are virtually limitless: in order to make someone happy, you give that person what he or she wants; if you desire an item that another person similarly wants, you may deceive that person into believing that item is unavailable; if you know something that others do not and want to keep it secret, you do not tell them. Mentalistic notions such as wanting, knowing, desiring, and believing are thus embedded deeply in our everyday social world, and human beings are equipped to understand and employ these notions effortlessly and automatically. Consider the employment of ToM when trying to understand the following situation:

> Joe and Tim watched the children in the playground. Without saying a word, Joe nudged Tim and looked across at the little boy playing by himself in the sandpit. Then he looked back at Tim and smiled. Tim nodded, and the two of them started off towards the boy in the sandpit. (Baron-Cohen, 1995)

In this scenario, our ToM of mind allows us to make sense of the boys' intentions even though neither boy spoke. One potential understanding could involve the boys planning to play a prank on the little boy, with Joe's looking at Tim and Tim nodding in response, indicating mutual recognition of each others' intentions. Or, one might surmise that the little boy was a potential playmate for Tim and Joe, with Tim's nodding indicating that he agreed with Joe's idea to go and play with the boy. Either way, our understanding of the situation was made possible by our understanding of mentalistic phenomena. Further, our speculations as to what may have happened next in the story were calculated almost instantly.

It is important to note, however, that in understanding the concept of ToM, one must understand the transparent and private nature of the aforementioned mentalistic themes. Knowing, desiring, and believing are not necessarily preceded by or correlated with specific behavioral cues. As noted in the example above, one behavior alone, such as nodding of the head, cannot suffice in allowing us to understand the intentions of others. We cannot "see" intentions, desires, and knowledge. Without a mentalistic framework in place, then, an individual trying to make sense of the above situation with Tim and Joe would tend to rely on observable behavioral scripts, such as, "children like to play in sandboxes," which would severely limit interpretation of this or any social situation.

Understanding impairment in mindreading is perhaps akin to trying to understand a faculty, such as echo location in bats, which is beyond the realm of the human sensorium. Perceiving an object through echo location is, of course, far different than doing so through the eyes and the ears, so truly understanding what it is like to perceive

like a bat is left to the imagination. Similarly, it is likely impossible for an individual with severe mindreading impairments to imagine what it is like to read minds like typically developing individuals. Consider an account of Temple Grandin, a professor of agricultural science at Colorado State University who has an ASD diagnosis. According to Grandin, learning to socialize involved building up a repository of experiences over the years that could be viewed, in her mind, as videotapes of how people behaved in different situations. Through studying and rehearsing these videotapes, she learned to make correlations between what she saw and how people might act—a process that Grandin herself described as being a logical process. More complex social processes such as those involved in intimacy, however, were completely baffling for Grandin. She has remained celibate and has never dated, believing that such interactions are far too complex to make sense of. The intentions and desires of the other person are beyond her scope of understanding, and Grandin herself has stated that her mind is lacking some sort of subjectivity, the inwardness, that others seem to have (Sacks, 1995).

Temple Grandin's account serves as a concise example of how the inability to read behavior in terms of mental states exists as a reality for individuals with ASD. In a seminal and pivotal study, Baron-Cohen and colleagues (1985) found that approximately 80% of children with ASD were not able to pass tasks that assess ToM, whereas nearly 100% of comparison participants and children with mental retardation were able to do so. Numerous studies have converged on these findings (Dawson & Fernald, 1987; Hogrefe, Wimmer, & Perner, 1986; Leslie & Frith, 1988; Perner, Frith, Leslie, & Leekam, 1989), and ToM impairment is now agreed upon as a universal hallmark of ASD.

Given the definition of ToM and its impairment among ASD, the view that ToM impairment is greatly responsible for the social deficits in ASD appears to carry immediate face validity. Amazingly, however, relatively few studies have attempted to validate this connection, and those that have failed to detect a significant relationship between the two variables, raising questions about the relationship between the ToM construct and social behavior in the real world (Capps et al., 1998; Fombonne, Siddons, Achard, Frith, & Happe, 1994; Joseph & Tager-Flusberg, 2004). Over the past 15 years, neurocognitive research has further specified the nature of ToM and its theoretical contributions to social and communicative skills. Specifically, ToM has been theorized as being characteristic of a broader neurocognitive impairment unique to ASD (Minshew, Goldstein, & Seigel, 1997). Further, while ToM has traditionally been understood chiefly as the ability to represent mental states, social-perceptive abilities such as gleaning information from the eyes are now considered in discussions of ToM (Sabbagh, 2004; Tager-Flusberg, 2001). The present research aims to integrate newer findings in ToM- and autism research in assessing the relationship between ToM and a laboratory measure of social skills. Further methodological improvements over previous studies, such as narrowing the age range in the sample to focus on specific social behaviors, are discussed in detail later in this paper.

Baron-Cohen's Model of Mindreading

So far, terms such as "inwardness" and "mentalistic" have been used synonymously with ToM. From a more empirical perspective, though, what exactly does theory of mind involve? In the following pages, Baron-Cohen's (1995) account of ToM development is reviewed in order to provide a general framework for understanding the

faculty. Subsequent research proposing alternate and additional cognitive perspectives when considering the ToM hypothesis and ASD are reviewed as well. The connection between ToM and social impairments in ASD is then discussed, completing the theoretical foundation for the present study.

Baron-Cohen's conception of ToM exists as perhaps the most comprehensive of its kind in terms of describing a specific, empirically-based developmental sequence. Though current research continues to expand upon and challenge aspects of this model, the initial "four steps" required for mindreading first articulated by Baron-Cohen in his 1995 book *Mindblindness: An Essay on Autism and Theory of Mind* are reviewed here to lay an initial cognitive framework for understanding and discussing ToM. Furthermore, Baron-Cohen has since added new components to the model that expand upon the conceptual nature of "mindreading" to include more affective components, and these additional features will also be discussed.

It is first worth noting the structural framework on which the theory is based. Fodor (1983) was the first to propose a modular account of ToM; that is, it is domain specific, has distinct neural architecture, follows a clear developmental course that is independent of other cognitive skills, and is dissociable from other components of cognition. If ToM is modularly organized, then it follows that one could have a deficit in their mindreading ability while other cognitive skills remained intact. Support for modularity comes from the wealth of research regarding ToM deficits independent of intelligence that are present in individuals with ASD (Baron-Cohen & O'Riourden et al., 1999; Baron-Cohen & Wheelright et al., 2001; Dawson & Fernald, 1987; Hogrefe, Wimmer, & Perner, 1986; Leslie & Frith, 1988; Perner, Frith, Leslie, & Leekam, 1989).

Baron-Cohen's model is considered to be modular in nature and each of its components—the Intentionality Detector, Eye Direction Detector, Shared Attention Mechanism, Theory of Mind Mechanism, Emotion Detector, and Empathizing System are discussed in the following sections.

The Intentionality Detector

The first component is the Intentionality Detector (ID), which interprets motion stimuli in terms of goal oriented behavior. The ID is based on Premack's (1990) notion that humans are predisposed towards goal detection and that infants categorize objects as either self-propelled and intentional or nonself-propelled and lacking intention. For example, if you see an animal moving towards a tree, you would assume that the animal's goal is to get to that tree. Goals and desires are considered to comprise primitive volitional mental states and allow us to discriminate between approach and avoidance among any organism, whether a person, cat, or amoeba. For example, if you see a cat moving, you may deduce that its "goal" is to get to the cheese or that it "wants" to get away from the dog. These inferences are made based only on the basic mental states of desire and goal. For ID to activate, all that is required is that some perceptual event be identified as self-propelling or agent-like. So, while an amoeba might appear as amorphous, its self-propelled motion would render it easily and immediately interpretable in terms of its goals by the ID. Or, when we perceive a baseball flying through the air, the ID could revise its interpretation because the object under scrutiny is not self-propelled and does not have a desire or goal of its own.

The ID is proposed as the primary mechanism required for mindreading in infants and was originally theorized to develop roughly in the first 9 to 14 months of the infants'

life. It can receive input from a wide variety of stimuli through any input modality. Even in the absence of vision (which is later discussed as the most common and important source of input in the model), ID provides succinct goal-desire interpretation through other senses. If you were standing in a dark room and a person touched your shoulder, you would immediately interpret that the hand wanted to approach you. Such would be the case with sole auditory input as well if, in the same dark room, you heard a screech or a crash. You would immediately interpret the sound as a possible agent, such as a person trying to get your attention or an animal calling. Thus, the distinction between agency versus nonagency should be considered a feature of ID functioning since it is theorized that overattribution of agency would serve a survival purpose. For example, a shadow moving toward you would first be perceived as agent-like before the determination of whether or not it was self-propelled could be made since the shadow could pose a threat. Once the shadow was revealed to be that of a leaf blowing overhead, rendering the initial agent classification as a false-positive, ID could revise the interpretation just as in the example with the baseball. In evolutionary terms, it is better to spot a potential agent and interpret its desires and goals than to ignore it.

There is convincing evidence to support the existence of ID functioning in humans. In Heider and Simmel's (1994) experiment, subjects shown a silent film with geometric shapes moving around tended to ascribe agency to the shapes, using a variety of mental state terms such as planned, tried, hesitated, and worried. More recent studies have demonstrated that infants develop understanding of others as animate and goal directed in the first 14 months of life (Phillips & Wellman, 2005; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Children with ASD have been shown some capability of

understanding volitional mental states as well. They often use the word "want" in their spontaneous speech (Tager- Flusberg, 1989) and can distinguish between animate and inanimate objects (Baron-Cohen, 1991). Further, they are able to make the causal connection between a desire and an emotion, such as getting what you want and feeling happy as a result (Baron-Cohen, 1991). Recent evidence, however, suggests that ASD children as young as two as well as neurotypical adults who carry ASD traits do not demonstrate a preference for biological as opposed to non-biological motion (Kaiser, Fermano, & Shriffrar, 2008; Klin, Lin, Gorrindo, Ramsay, & Jones, 2009). Though further research is needed to support these findings, failure to orient towards biological movement constitutes failure to orient towards something or someone that is intentional, which in turn may have cascading effects on social development. This notion will be addressed further in the Discussion section of this paper.

The Eye Detection Detector

As mentioned, the ID receives input from all modalities. However, for a number of reasons which will be discussed shortly, the visual system provides the easiest way to form mentalistic representations. A specialized neurocognitive component within the visual system that Baron Cohen terms the Eye Detection Detector (EDD) allows humans to (a) detect the presence of eyes or eye-like stimuli, (b) compute the orientation of the eyes (i.e., toward the organism or toward something else), and (c) attribute a perceptual state to another organism, such as, "That person sees me." The EDD is thus proposed as the second component of Baron-Cohen's model, developing roughly between 9 and 18 months.

Evidence suggests that the detection of eye gaze has deep evolutionary roots. At its most primitive physiological level, the EDD allows an organism to judge whether or not another set of eyes are oriented toward it, a computation that triggers considerable emotional arousal. Research has consistently demonstrated the significance of eye gaze processing to emotional activity in the brain, suggesting that human neonates are equipped with a specialized mechanism to detect eyelike stimuli (Batki, Baron-Cohen, Wheelright, Connellan, & Ahluwalia, 2000). Evolutionarily, this EDD would serve as an invaluable tool with regard to survival, allowing the organism to identify another organism that is about to attack. Ristau (1991), for example, showed that plovers were keen to whether or not humans were looking at them when the humans approached a plover nest. Similarly, infant maquaques have been shown to possess the ability to follow gaze through eye movements alone (Ferrari, Kohler, Fogassi, & Gallese, 2001).

There is ample research to support the proposed functions of the proposed EDD. With regard to detecting eyes, research has demonstrated that infants look at eyes significantly more than any other part of the face (Hainline, 1978) and that neonates will look significantly longer at a picture depicting an adult face with eyes open than one with eyes closed (Batki et al., 2000). By 12 months, infants have been shown to follow gaze regardless of the communicative situation (Thoermer & Sodian, 2001).

The information obtained from the EDD is important with respect to the ID since it allows individuals to read eye orientation in terms of another person's goals or desires. There is one study that has demonstrated that children do, in fact, infer goals and desires from eye orientation. Phillips, Baron-Cohen, and Rutter (1992) presented typically developing infants ranging from 9- to 18-months-old and children with mental retardation

ranging from 3- to 5-years-old with ambiguous or nonambiguous actions. While most infants in both groups responded to ambiguous actions by instantly (i.e., within 5 seconds) looking at an adult's eyes, only a small portion in each group responded in such a fashion given a nonambiguous action. Thus, when the goal was not immediately certain, infants in both groups looked first to the eyes for understanding of the action.

Research has consistently demonstrated that eye direction detection develops atypically among individuals with ASD. In Phillips and colleagues' (1992) study, while typically developing infants and children with mental retardation responded differentially to ambiguous versus nonambiguous actions, no such difference in orienting was observed in a 3- to 5-year-old ASD group, who made eye contact equally little under both conditions. Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker (1995) found that while typically developing children as well as children with mental retardation demonstrated a preference for an "eye" cue as opposed to an arrow when inferring the mental state of desire, children with ASD did not; a finding, the authors concluded, that was consistent with previous research and reflects a failure of ASDs to appreciate the mentalistic information conveyed by eyes. In a more recent study, Chawarska and Shic (2009) found that compared to an age matched group of typically developing comparison participants, 2- to 4-year-old children with ASD scanned faces atypically, inconsistently attending to key features of faces such as the eyes and mouth.

There is thus considerable evidence to support the notion that orientation towards socially relevant facial cues, such as the eyes, is atypical among younger children with ASD. Does this impairment persist into adulthood? Webster and Potter (2008) recently investigated the developmental nature of eye direction detection in ASD and found that

the skill improved and was as accurate as typically developing comparison participants by adolescence. Similarly, Rutherford and Krysko (2008) found that adults with ASD attended reflexively to an eye direction cue, even when a motion cue was concurrent. These results suggest that poor orientation towards eyes does not persist in ASD past childhood and that adults with ASD find the eyes as compelling an attentional cue as do typically developing individuals. But what of Baron-Cohen and colleagues' (1995) hypothesis that individuals with ASD are blind to the mental significance of the eyes? The above studies investigated a social orienting ability, but does such a reflexive action necessitate understanding of another's mental state? According to Baron-Cohen's model, it does not, as this ability is made possible through other components of the model, which are discussed below.

Turning back to the EDD, in brief, increased physiological arousal due to eye contact is triggered in humans just as it is in animals (Nichols & Champness, 1971), and survival-inclined information, such as whether or not someone else poses a threat or wants to help us, is provided. However, another level of complexity is also present in humans that has not been clearly shown in nonhuman counterparts. That faculty involves a reflective stance following shared attention. For example, after awareness that another organism is staring at the same object he or she is, reflective questions such as, "Why is he/she staring at that?" and "Why is he/she interested in that?" are pondered, reflecting an interest in the other person's interest. The basic survival function of the EDD shared in lower mammals and primates, by contrast, does not require the shared attention between one organism and another. The representations provided by ID and EDD can be described as dyadic in nature; that is, they specify a relation between two things, such as agent and

object (e.g., the girl wants the apple) and agent and self (e.g., the girl sees me). As Baron-Cohen stresses, however, they do not allow one to represent that the self and another agent are both attending to the same object or event in the environment. This information, he argues, is critical for understanding a shared reality and that the self and another agent are thinking about the same thing. As will be discussed later in far greater detail, absence of this information would be phenomologically autistic; while you could see people doing things and attribute agency to them, there would be no way of feeling contact with their mind and simultaneously feeling that they had contact with yours. For this phenomenon to occur, a third neurocognitive mechanism is thought to be required that provided additional representational information. This is the role of the proposed Shared Attention Mechanism (SAM).

The Shared Attention Mechanism (SAM)

The SAM is responsible for constructing relationships between the self, an observer, and a third object. Shared attention towards an object between two individuals is thus made possible through the individual's attention towards an object and the simultaneous awareness of the other observer's attention toward the same object. Because this information is acquired through a visual modality—the monitoring of the other observer's eye orientation—the SAM can be said to have received its information from and is thus dependent on the EDD.

Looking again to evolutionary design, the ability to detect whether another organism spots the same food source or mate as you do would be beneficial in terms of survival. Because SAM is linked to EDD, this more complex function becomes possible. Thus, in higher primates, where grooming, greeting, and social struggles for dominance

are guided considerably by eye contact (Cheney & Seyfarth, 1990) an additional attentional component must also be involved to fully explain the behavior.

Unlike those representations provided by the ID and EDD, the representations SAD makes possible are triadic in nature, allowing for relational processing between self, another agent, and a third object or agent. This processing additionally specifies that the self and agent are attending to the same object. For example, a boy may see a toy car and also see that his friend sees the same car. By comparing his own perceptual state with his friend's, the boy's SAM has created a triadic representation and computed that he and the other boy are seeing the same thing. As mentioned, vision is argued as the most practical modality through which SAM functions. Touch, for example, would become inconvenient since two agents would need to touch the same object and then touch one another's hands at the same time to arrive at shared attention. Functioning would be more limited, however, given that the object would need to be in both agents' reach, whereas the modality of vision allows for a far greater range of perceptual input.

The SAM is theorized to develop in infancy when children typically attain the ability to attend dyadically to objects and events in their environment; that is, they are able to understand that someone else is looking at the same object they are themselves looking at. Behaviorally, this concrete manifestation of SAM functioning has been termed *joint attention* and exists as an indicator of infants' understanding of others as intentional beings whose attention to objects may be shared (Bigelow, MacLean, & Proctor, 2004). Jones and Carr (2004) provided the following example as a demonstration of joint attention:

Sam and his mother were playing in the park when an airplane flew overhead.

> Sam looked up excitedly, then looked back at his mother, and finally pointed to the airplane, as if to say, "Hey, Mom, look at that!" Sam's mother looked at where her son was pointing and responded, "Yes, Sam, it's an airplane!"
>
> Sam directed his mother's attention to the airplane flying overhead. He was not requesting that his mother do anything; he simply wanted to share his experience of the airplane with her, so he engaged his mother in an episode of joint attention (p. 13).

As the authors make clear, shared experience is an important feature in joint attention. And, as Kaplan and Hafner (2006) elucidate, joint attention is not simply the simultaneous looking at an object by two people because it assumes, in addition, a shared intentional relation to the world. For example, if two babies are sitting in a room and one of their toys makes a loud noise, both are likely to look at it immediately. Similarly, the same two babies may be attracted to a blue block in a pile of red ones because the blue one is different. In both situations, a piece of salient information in the environment triggers simultaneous attention by the two babies. What is missing in these situations that distinguishes them from joint attention is the babies' concurrent awareness of each other; while they both may be staring at the same object, they are not aware that the other is staring at it as well.

According to Charman (1997), there are two ways in which infants engage in joint attention. One is when the child responds to another's attempt to direct attention, usually taking the form of a parent or adult shifting attention toward an object coupled with an orienting gesture, such as pointing or gazing, to direct the child's attention toward the object. The other is by the child's directing joint attention in another person as with the

aforementioned airplane example. Of importance here is the fact that the initiation of joint attention requires a declarative function with a social reward. In the airplane example, the reward of Sam's joint attention with his mother was his mother's sharing of the experience. This must be differentiated from the act of requesting, which is similar in behavioral form but different in terms of function. For example, a child may point to a box of candy, alternate gaze, and point to an object just as Sam did with the airplane and his mother. In this new example, however, the reward is entirely nonsocial. The function here is thus imperative, initiating a request or assistance (Jones & Carr, 2004).

From this distinction, it becomes clear that function and not simply gesturing and gazing skills (provided by the EDD) is important when considering joint attention. This is especially relevant in understanding deficits with regard to ASD, and was highlighted in a study by Baron-Cohen (1989). Twenty preschool children with ASD were compared to both typically developing and Downs Syndrome groups in their ability to both interpret and initiate a pointing gesture, and results revealed that the ASD group performed significantly worse on their comprehension of a protodeclarative pointing gesture and ability to produce one, suggesting a severe impairment in the faculty. Deficits in joint attention have also been shown to differentiate between preschool-aged children with ASD and mental retardation (Mundy, Sigman, & Kasari, 1994). Given this research, it becomes clear that individuals with ASD demonstrate atypical development of the SAM, and without this mechanism intact, development of the fourth mechanism is rendered atypical as well.

Theory of Mind Mechanism

All three hypothetical mechanisms discussed thus far—the EDD, SAM, and ID—are necessary for subsequent development of the fourth mindreading mechanism, the Theory of Mind Mechanism (ToMM). While the previous three mechanisms are responsible for perceiving eye detection, interpreting it in terms of simple mental states such as goals and desires, and allowing for relational processing between self and other, the ToMM allows individuals to represent higher order mental states such as imagining, deceiving, guessing, and knowing. Leslie (1992) used the term *M-representations* to describe representations of agent-attitude-propositions such as, "Hubert (agent) thinks (attitude) the ball is behind the tree (proposition)." It is critical to note that while the entire M-representation may be true—that is, Hubert really thought that the ball was behind the tree—the proposition component of it may indeed be false if the ball, in this example, is in fact somewhere other than behind the tree. Baron-Cohen (1995) uses the term *referential opacity* to describe this property of the ToMM that distinguishes between the truth held in the M-representation and the truth in the proposition, allowing for the possibility of misrepresentation. This property is important when understanding the capacity for pretending and recognizing pretending in others, an ability that has been shown to emerge in typically developing children between the ages of 18 and 24 (Leslie, 1987).

During this same time period, children develop the understanding of false beliefs—that is, that others may hold views of the world different than their own. First-order false belief, which involves the ability to understanding that others may hold views of the world different than one's own, begins to emerge between the ages 3 and 4. The

term “false” is used because prior to this age, children assume that others know only the same things that they themselves know, whereas now, they realize others do not know everything that they know and may possess false beliefs about another person's knowledge. “First order” refers to the fact that the faculty involves inferring one person's mental state. Baron-Cohen (1998) uses the example of Little Red Riding Hood to illustrate. When three- and four-year-old children see a picture of Little Red Riding Hood looking at the big bad wolf dressed as her grandmother, they are likely to know that while Little Red Riding Hood thinks it is her grandmother, it is really the wolf in disguise.

The classic measure of first-order false belief is the Sally Anne task. In this task, the individual is read a scenario in which a character, Sally, places an object into a basket, covers it with a cloth, and leaves the room. While Sally is gone, her friend Anne enters the room and moves the object in the basket to a new location, unbeknownst to Sally. When Sally reenters the room, the participant is asked where he or she thinks Sally will look for the object. To arrive at the correct answer, the participant must appreciate Sally’s false belief—that is, that she still believes the object is in the basket and not in the new location. In a seminal and pivotal study, Baren-Cohen and colleagues (1985) found that approximately 80% of children with ASD were not able to pass the Sally Anne task, whereas nearly 100% of typically developing children and children with mental retardation were able to do so. Numerous studies have converged on the finding that children with ASD are impaired on such false belief tasks (Dawson & Fernald, 1987; Hogrefe et al., 1986; Leslie & Frith, 1988; Perner et al., 1989).

Second-order false belief, or belief about belief, is the understanding that others may also represent mental states and also develops at the age of four (Sabbagh, 2004).

Stone, Baron-Cohen, and Knight (1998) present the following illustration of second-order false belief:

> A man and a woman are in a room. The woman puts something somewhere, such as putting a book on a shelf. She then leaves the room. The man hides the book in another location. Unbeknownst to him, the woman is peeking back through a keyhole or a window and sees him moving the book. The subject is asked, "When the woman comes back in, where will the man think that she thinks the book is?" (Stone et al., 1998, p.641)

To solve the problem, the child needs to be able to understand each person's belief regarding the location of the object as well as the man's mistaken belief about the woman's belief state. Perner and Wimmer (1985) provide a clear distinction between first- and second-order false beliefs. First-order beliefs refer to what an individual thinks about real events (e.g., Jim thinks that Johnny is angry) and second-order beliefs involve what an individual thinks about another person's thoughts (e.g., Jim thinks that Johnny thinks he is angry at him). Baron-Cohen (1989) demonstrated that children with ASD who passed first-order false belief tasks were severely impaired on second-order false belief tasks relative to comparison participants.

With understanding of how the ToMM functions and the research demonstrating ToMM impairment among ASD, one might then ask how such impairment manifests behaviorally in children with ASD. As mentioned, being able to pretend and recognizing pretending in others requires representational opacity. Rutherford and Rogers (2003) found that children with ASD scored significantly lower than typically developing comparison participants on their scores on the Test of Pretend Play (Lewis & Boucher,

1997). Libby and colleagues (1997) reported that children with ASD performed significantly worse than typically developing and children with Down Syndrome on pretend play tasks.

As children with ASD grow older, their social impairments become more obvious in their difficulty with conversational interactions and interpersonal understanding, deficits that cross over into the realm of communication. As Sperber and Wilson (1987) stated, “communication exploits the well-known ability of humans to attribute intentions to each other” (p. 699). In a general examination of conversational skills in ASD, Capps and colleagues (1998) found that compared to developmentally delayed comparison participants, children with ASD were less likely to respond to questions, offer relevant contributions, and produce narratives of personal experience. More specific aspects of social discourse among older individuals with ASD have been examined as well. One such aspect is the understanding of a faux pas, or when someone says something without realizing he or she said it. Two mental states are needed to detect a faux pas: the ability to understand that the person saying it should not have said it and that the person hearing it might be hurt. Thus, a cognitive and an empathetic component are required. Baron-Cohen, O’Riordan and colleagues (1999) provides the following example to illustrate faux pas:

> Steve, a scientist, is traveling on a plane with his wife. Suddenly, he is tapped on the shoulder by another scientist. Steve looks up, sees that he knows this man, and says, "Oh hi!" How nice to run into you!" Let me introduce you to my wife, Betsy. Betsy, this is Jeffrey, a good friend of mine from Harvard days." Betsy

says, "Oh hi Jeffrey, pleased to meet you." The other man replies, "Er, my name isn't Jeffrey, it's Mike." (p. 408).

The faux pas in this scenario is the embarrassment and perhaps regretful feeling Steve has when he realizes he has gotten his old friend's name wrong. Such an utterance falls under the category of ToM because it necessitates (a) an understanding that the speaker's and listener's states of knowledge may differ, and (b) an understanding of the emotional impact of the statement on the listener. Compared to age-matched comparison participants, children with ASD aged 7 through 11 have been shown to be significantly impaired on faux pas detection tasks when verbal mental age was accounted for (Baron-Cohen, O'Riordan et al., 1999).

Detection of speech prosody exists as another specific ability required for successful conversation skills that depend on ToM reasoning. Deficiencies in prosody have been found to create an impression of oddness in the case of speakers with ASD and result in poorer ratings of social skills for these individuals among observers (Shriberg et al., 2005). Specifically, these deficiencies include intonation patterns and sensitivity to changes in prosody. If individuals with ASD cannot represent a speaker's intention, modifying the literal meaning of the utterance becomes especially difficult. Without this window into the other person's beliefs and desires—essentially a metaphor for M-representations—communication becomes puzzling for the ASD individual and a rigid interpretation of the person's utterance is adopted by default.

In general, Baron-Cohen's ToMM is responsible for taking SAM's triadic representations and converting them into M-representations. Thus, without SAM, ToMM cannot be triggered. M-representations constitute a qualitative shift in the developing

child's understanding of minds as the child can now ascribe mental states such as "pretending," "knowing," and, "believing." A wealth of research has confirmed that individuals with ASD are impaired in their ToMM functioning as documented by poor performance on false belief and faux-pas tasks. According to Happé (1995), all children with ASD pass ToM assessments at a later stage than their typically developing counterparts. Finally, and to delineate a statement that alludes to the research questions posited in the current study, this impaired ToM among individuals with ASD is theoretically linked to their lack of pretend play skills and later to their poor reciprocal interaction skills.

Baron-Cohen's initial four components may still provide a broad description of the development of ToM. The initial model was cognitive in nature and omitted information about the emotions triggered in the perceptual system by another person's mental states. However, in the past years, Baron-Cohen expanded upon the initial "mindreading" model to include affective components by adding two new components covering emotions and empathy.

The Emotion Detector (TED)

The Emotion Detector (TED) is theorized to develop alongside the IDD and EDD in the first nine months of an infant's life and is chiefly responsible for representing affective states such as, "That person is unhappy with me." Like the ID, the TED is amodal and receives input from information such as touch, facial expressions, and tone of voice. Support for the TED comes from research demonstrating that infants at three months of age are able to represent affective states (Walker, 1982). As infants mature and develop the ability to share attention, the TED, like the EDD, becomes able to build

triadic relationships with the SAM. For example, while a dyadic TED-based relationship might be "That person is angry with me," a triadic one would now be, "I am unhappy because that person is unhappy with me."

The Empathizing System (TESS)

The Empathizing System (TESS) is proffered by Baron-Cohen (2005) as a new feature of the model that is of critical importance. While the ToMM allows the developing child to represent a range of mental states that allows for prediction of others' behavior, the TESS allows for an additional emotional reaction to another's mental state that drives a person to help or avoid the other person. For example, one person might employ their ToMM to understand that another person is in pain by interpreting their facial expressions in terms of the mental state "pain." With the TESS, that person might then feel pain themselves with the affective state "pain" triggered by the other person's experiencing of it, subsequently resulting in a drive to help that other person. Baron-Cohen (2005) uses the term *E-representations* to describe self-affective state propositions such as "I am concerned that you are in pain" or, "I am horrified that you are in pain." Each proposition is characterized by the self's affective state triggered in response to another person's affective state. Evidence for the TESS comes from research demonstrating that typically infants begin to demonstrate emotional response to another's pain at 14 months (Yirmiya, Kasari, Sigman, & Mundy, 1989). This mechanism is then thought to allow for the growth of empathy throughout development. In this same study, Yirmiya and colleagues found that children with ASD were more flat and ambiguous in their affective expressions, suggesting a deficit in the TESS among ASD.

To summarize, Baron-Cohen's theory makes a compelling case for the developmental sequence of ToM based on considerable empirical support. There are, however, other cognitive features of ASDs, such as executive dysfunction and weak central coherence, which have been argued to play a role in the development of ToM in ASD. Further, recent neuroimaging evidence suggesting a more comprehensive, brain-based approach to understanding ToM functioning in ASD may render Baron-Cohen's model as too simplistic in its conception of the impairment. These points will be addressed before further discussion of ToM as it relates to real-world social impairments in ASD.

Executive Function Theory

Executive functions (EF) have been defined as the set of mental operations that enable individuals to disengage from the immediate context in order to guide behavior by reference to mental models or future goals. Specifically, EF encompass the processes of planning, inhibitory control, attentional flexibility, and working memory that are typically associated with the prefrontal cortex (Hughes, 1998). Theoretically, it has been assumed that individuals require some capacity to distance themselves from current stimuli in order to be able to reflect on those stimuli. In other words, one must be able to override the prepotent tendency to reference reality in order to infer the belief of another person (Carlson & Moses, 2001). The association between ToM and EF is also supported by the fact that ToM abilities such as taking perspectives and understanding mentalizing stories (i.e., stories involving misunderstandings or sarcasm) have been shown, like EF abilities, to depend on the frontal cortex (Fletcher et al., 1995; McCabe, Houser, Ryan, Smith, & Trouard, 2001).

The prepotent tendency to reference reality in order to infer belief mentioned above is subsumed under inhibitory control, an EF that has been demonstrated to correlate significantly with theory of mind skills. Several studies have examined this relationship. Hughes (1998) found specific links between EF (i.e., working memory, attentional flexibility, and inhibitory control) and second-order false belief tasks in a sample of fifty three- and four-year-old children, with a particularly strong correlation between inhibitory control and false belief. Carlson and Moses (2001) found that the relationship between inhibitory control and theory of mind remained significant when age, gender, verbal ability, motor sequencing, and family size were partialled out. The authors found more support for the importance of inhibition to ToM in another study where inhibitory control significantly predicted performance on false belief tasks when working memory and IQ were partialled out in a sample of 47 typically developing 3- and 4-year-olds (Carlson, Moses, & Breton (2002). Within the same study, results from multiple regression analysis indicated that inhibition tasks accounted for variance in ToM functioning above and beyond the effects of age, receptive vocabulary, and planning, while planning did not share any unique variance with ToM. These studies have been replicated (Hala, Hug, & Henderson, 2003) and support some degree of connection between inhibition and theory of mind.

Working memory, which has been defined as the complexity of relations that can be processed in parallel, has also been shown to evidence a connection with ToM. In one study of three to five year olds, digits forward and digits backward tasks were entered into a regression equation along with age and vocabulary ability with false belief and false photograph tasks as the dependent variables. While digit span backwards predicted

variance in both false belief and false photograph when age and vocabulary were controlled for, digits forward did not (Davis & Pratt, 1995), suggesting that mental control, and not rote memory, is significant when predicting false belief performance. Gordon and Olson (1998) found strong correlations between false belief and finger tapping tasks, and Hughes (1998) evidenced a significant relationship between working memory and false belief in preschoolers.

According to some researchers, the most plausible explanation for the EF-ToM relationship is that the correlations are due to executive demands in the false belief tasks (Davis & Pratt, 1995). In a false belief task, participants must exert control over the prepotent responses brought upon by observable reality in favor of the protagonist's belief. Furthermore, they must disengage their attention to the old location in the task and focus it on the new one. However, the notion that ToM is secondary to EF is limited by the fact that many clinical groups, such as attention deficit-hyperactivity disorder (ADHD), obsessive compulsive disorder (OCD), and Tourette's Syndrome, present with executive dysfunction and yet do not present with ToM impairments (Yang, Zhou, Yao, Su, & McWhinnie, 2007). Disentangling the developmental relationship between ToM and EF among toddlers given the tasks available thus becomes complicated. The present study, however, does not attempt to answer such specific developmental questions, focusing on older individuals and utilizing measures that do not carry the EF demands of false belief tasks. Further, the hypotheses specifying the EF-ToM relationship in early development do not extend to the matter of interest in the present study; there is no known theoretical account positing that the social impairments observed in older children and adolescents with ASD result primarily from EF impairment. Given the general

interest that the EF-ToM connection has attracted in the cognitive science community, however, the above literature is included here to clarify the cognitive framework underlying the current study.

Central Coherence

Central coherence refers chiefly to the ability to integrate information, or to draw together diverse variables to construct a higher meaning (Frith, 1998). The most concise example of central coherence relates to reading a novel; whereas you might not remember a number of specific details, you immediately recall the gist or overall theme of the story. Central coherence is also apparent in our ability to distinguish between homonyms in everyday speech, such as "meat" and "meet," based on the context of the interaction. Frith (1989) has suggested that this tendency towards global information processing is impaired in ASD and that this impairment may account for many of the non-social deficits in the disorder, such as restricted interests, stereotyped behaviors, preoccupation with parts of objects, and overall lack of generalization. Social deficits may be accounted for as well when viewed through the lens of central coherence, since understanding social interaction would require the integration of a multitude of thoughts and behaviors. In this account, then, individuals with ASD who have impaired central coherence would fail to derive higher meaning through the integration of social variables.

Evidence supporting weak central coherence theory comes from research demonstrating superior local information processing abilities as well as impaired global processing among ASD individuals. ASD individuals have demonstrated superior performance to perceive a whole in terms of, but not as the sum of, its constituent parts on assessments such as the Wechsler Block Design (Wechsler, 1997) and Embedded

Figures Test (EFT; Joliffe & Baron-Cohen, 1997; Prin, Hermelin, & Heavey, 1995). Regarding global processing deficits, ASD individuals have demonstrated impairment on tasks where they are required to choose words to fill gaps in a story as well as determine the correct pronunciation of homographs based on sentence context. (Frith & Snowling, 1983; Happe, 1997).

Central to the aim of this study was connecting such cognitive impairments demonstrated in the laboratory with impairment observed in the real world. With regard to the central coherence account, few studies have set out to explore this connection. Morgan, Mayberry, and Durkin (2003) found no significant relationship between central coherence as measured by the EFT and social skills among children with ASD. Similarly nonsignificant findings were observed in a recent study of high-functioning children with ASD (Burnette et al., 2005). Further longitudinal research is perhaps needed to delineate causal relations. These few preliminary studies, however, suggest that weak central coherence does not sufficiently account for the social abnormalities observed in ASD.

Complex Information Processing—A Neuroanatomical Approach

So far, discussion of ToM has focused primarily on cognition and behavior. However, attributing mental states exists as a highly complex form of reasoning that draws upon a multitude of interconnected subprocesses in the brain including representation of reality, understanding one's beliefs and the beliefs of others, and decoupling beliefs from reality. This complex information processing requires the activity of multiple brain regions for which a requisite level of inter-region interconnectivity is required. According to the underconnectivity theory (Just, Cherkassky, Keller, & Minshew, 2004), such inter-region connectivity is disrupted in

ASD. In brief, the communication between frontal and posterior areas is posited to be lower in ASD than in typically developing individuals. Key to understanding this phenomenon is the notion of bandwidth, or the amount of information that can be transmitted between cortical units in a given time. Everyday human thought, in general, involves a high degree of synchronization between cortical areas that is dependent on bandwidth. Neuroimaging studies suggest that this bandwidth, specifically between frontal and posterior areas, is lower in ASD (Kana, Keller, Cherkassky, Minshew, & Just, 2006; Villabolos, Mizuno, Dahl, Kemmotsu, & Muller, 2005).

Previous functional imaging of ToM has demonstrated that mentalizing depends on activity in a frontal-posterior network (Gallagher et al., 2002; Vogely et al. 2001), suggesting, at face value, that ToM impairment in ASD may indeed result from disruption of this network. A recent neuroimaging study has provided clearer support for this hypothesis. Kana and colleagues found that ToM is processed atypically in ASD, with a lower level of synchronization between frontal and posterior regions when attributing mental states than in age and IQ-matched comparison participants (Kana, Keller, Cherkassky, Minshew, & Just, 2009).

It is important to note with regard to the underconnctivity theory that such insufficient inter-region communication in individuals with ASD extends to tasks beyond ToM. In this sense, cognitive functioning is compromised whenever the processing demands of any task exceed the available bandwidth. Therefore, while individuals with ASD may perform equal to their peers in simple tasks across domains, higher-order tasks that require more complex processing of information, such as ToM, tax the bandwidths of ASD individuals beyond their capabilities. In a seminal study of the neuropsychological

profiles of high-functioning adolescents and adults with ASD, adults with ASD performed similarly to age- and IQ-matched comparison participants in the cognitive domains of attention, memory, sensory perception, oral and written language, and conceptual reasoning. During tasks that required simple information processing, however, the group with ASD performed significantly poorer than the comparison participants in complex tasks in the cognitive domains of memory, language, and conceptual reasoning. The results of this study provided support for the view that ASD does not result from a primary deficit in any one domain, but rather overall inefficiency in higher-order, complex information processing for which interconnectivity between association areas of the cortex is required (Minshew, Goldstein, & Siegel, 1997). Subsequent research has replicated these findings with children as well (Williams, Goldstein, & Minshew, 2006) providing additional support for what is referred to as the complex information processing model of ASD.

While these results do not undervalue ToM as a clear deficit in ASD, they do call into question ToM's primacy with regard to explaining overall constellation of impairments observed in the disorder. Recall that Baron-Cohen's model is modular in nature, stemming from distinct architecture and dissociable from other cognitive abilities. Through the lens of a complex information processing paradigm, ToM impairment would result from a more general underlying neuroanatomical abnormality in ASD. This is not to say that ToM is not a hallmark of ASD. Rather, individuals with ASD present with ToM impairment not because of impairment in a single ToM module, but rather insufficient cortical functional connectivity. Further, it should be noted that the characterization of complex information processing may appear similar to that of Frith's

(1989) notion of central coherence. The former, however, provides a more empirical and wider explanation of higher-order task impairment in ASD, as it includes impairments in sensory, motor, and memory domains in addition to language and visual spatial abilities that can be explained in terms of specific neuroanatomical irregularity as opposed to a nebulous central "coherer" (Minshew & Williams, 2008).

In sum, discussion of complex information processing impairments in ASD and the attribution of ToM impairment to poor inter-region interconnectivity are critical when considering assessment of ToM and interpretation of ToM task performance. This consideration is revisited when discussing ToM task selection for the present study.

Mirror Neurons and Affective Response

While the above account of complex information processing deficits purports to explain myriad cognitive impairments in ASD, another line of research has focused on affective impairment. Recent studies of affective impairment in ASD have focused on the mirror neuron system (MNS), which has been posited as a neural substrate critical in allowing humans to understand the perceptions and intentions of others. The MNS was first discovered by an Italian research group that was performing electrophysiological recording of a monkey and discovered that the same neurons would fire when the monkey was grasping an object and when the monkey observed the experimenter performing the same behavior (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996). Thus, these neurons would in a sense mirror the behavior of another animal or human. A number of neuroimaging studies have indirectly suggested the presence of the MNS in humans as well by showing that some neurons involved in performing an action are indeed selectively activated by seeing a similar action (Cochin, Marthelemy, Roux, & Martineu,

1999**;** Maeda, Kleiner-Fisman, & Pascual-Leone, 2002). Further, the inferior frontal gyrus (IFG), inferior parietal lobule, and superior temporal sulcus have been argued to constitute the MNS and are active during mental representation of one's own actions and another person's (Buccino et. al, 2004).

New evidence suggests that the putative MNS areas may be impaired in ASD. Bookheimer, Wang, Scott, Sigman, and Dapretto (2008) found that children with ASD demonstrated decreased activation in the IFG and amygdala during a face processing task. Hadjikhani and colleagues found similarly reduced activity in the IFG during a face processing task, while a 2007 study evidenced structural abnormalities in the IFG (Hadjikhani, Joseph, Syder, & Tager-Flusberg, 2007). There is thus some consistent evidence supporting IFG impairment among ASD. Regarding the superior temporal sulcus, a structure highly implicated in gaze detection and the perception of biological motion, Pelphrey and colleagues have demonstrated through a series of studies using fMRI that STS functioning is impaired in ASD (Pelphrey & Carter, 2008). Decreased gray matter in the STS has also been documented in the ASD (Boddaert et. al, 2004). Furthermore, in a recent study, actual deficits in biological motion perception have been detected in ASD infants who failed to recognize a display of biological motion but were instead sensitive to presence of non-social aspects of the stimuli which are normally disregarded by typically developing children (Klin et al., 2009).

As just mentioned, another area that has been argued to explain deficits in social functioning among ASD individuals is the amygdala (Baron-Cohen, Ring, Bullmore, Wheelwright, Ashwin, & Williams, 2000), which has reciprocal influence on the other structures that purportedly comprise the MNS. Neuropsychological studies have

demonstrated the core role of the amygdala and MNS in orienting to eyes (Senju & Johnson, 2009; Spezio, Huang, Castelli, & Adolphs, 2007). Using the Reading the Mind in the Eyes task, where participants read mental states based on another's eye expression, Baron-Cohen, Ring and colleagues (1999) found increased activation in the amygdala during the task for a non-clinical group. However, no activation of the amygdala was observed for an ASD group, supporting the position of Baron-Cohen, Ring and colleagues (2000) that the amydgala exists as one of the abnormal neural regions in ASD. Further structural evidence comes from Otsuka and colleagues, who found reduced N-acetyl aspartate concentrations in the amygdala and hippocampal regions of a group of ASD children (Otsuka, Harada, Mori, Hisaoka, & Nishitani, 1999), suggesting the presence of neuronal dysfunction or immature neurons in these regions.

In sum, the aforementioned studies support abnormal development of the fronto-limbic system in ASD. Conceivably, without a sufficient execution/observation matching system, an internal representation of the behavior of others, expressions, and emotions would subsequently be impaired, which in turn would impair the immediate social understanding of others. This would constitute a separate gaze-processing-related impairment in ASD which, while existing as a property of ToM, is differentiated between the first- and second-order false belief tasks that require more complex information processing. Support for this dichotomy has been documented by Sabbagh (2004), who argues, based on neurological evidence, that both components work together to make ToM judgments. Theoretically, it is also argued that the ToM construct encompasses not only social-cognitive reasoning skills tapped by false belief tasks, but also social-perceptual abilities that involve spontaneous processing and judgment of socially relevant

information inherent in facial and bodily gestures as well as voices (Tager-Flusberg, 2001). This distinction also supports Baron-Cohen's (2005) revision of his ToM model to include affective components. Knowledge of this distinction and the functional demands of different ToM measures, such as false belief tests and the Reading the Mind in the Eyes task, is critical when attempting to link ToM performance with real-world social and pragmatic skills.

Linking ToM and Social Impairments in ASD

The focus now shifts to the subject matter of interest: the ability of ToM assessments to predict social skills in the real world, a topic whose understanding demands that several points of discussion are first addressed. ASD exists as a disorder in which social perspective taking is severely impaired and thus serves as an illustrative example of atypical ToM development. Recall that in typically developing children, abilities such as sharing attention with another person, imitating another's actions, understanding emotions, and engaging in pretend play emerge in the first years of life. In individuals with ASD, however, a wealth of research has shown that these social behaviors are specifically impaired (Baron-Cohen, 1989; Dawson, Meltzoff, Osterling, & Rinaldi, 1998; Powell, Messer, & Jordan, 1997). Further, social impairment continues to characterize individuals with ASD well past their early years and into adulthood. In a broad sense, these behaviors have been argued to be due to failure in the development of ToM.

However, while the hypothesis that ToM impairments in individuals with ASD play a causal role in social impairments contains considerable face validity, research specifically examining this relationship has been relatively limited, and those studies that

do exist have not been convincing in deducing a specific relationship between the two variables. For example, Bowler (1992) found that while adolescents with Asperger's Disorder were able to successfully complete second-order ToM tasks, they did not use mental state terms when asked to describe their solutions. Other studies have demonstrated that poor performance on false belief tasks could not explain social impairments in ASD once language ability was partialled out (Capps et al., 1998; Fombonne et al., 1994). In another study, Travis, Sigman, and Ruskin (2001) examined how false belief understanding and perspective taking as well as empathy, concern to distress, and initiating joint attention were related to observed peer-to-peer social interaction in children with ASD. They found that initiating joint attention and empathy, but not false belief test performance, were significantly related to observed social interaction. Joseph and Tager-Flusberg (2004) set out to identify relationships between ToM abilities and social interaction and communication skills in ASD using the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 2002). While ToM impairments were able to explain communicative impairments once language level was partialled out, they could not explain significant variance in social interaction symptoms. Finally, intervention studies have shown that despite improvements in performance on experimental ToM tasks, there is no significant corresponding improvement in social competence (Hadwin, Baron-Cohen, Howlin, & Hill, 1997; Ozonoff & Miller, 1995).

Klin, Schultz, and Cohen (2000) suggest several factors that may underlie the discordance between ToM task performance and real world social competency. First, many ToM tasks, such as the false belief task, are presented verbally. Hence, taking into

consideration the role of language in passing ToM tasks, it is possible that some children are able to compensate for their poor ToM understanding with strong language skills, therefore, and pass the tasks. Second, most ToM tasks propose an explicitly defined problem, such as, "Where will Sally look for the marble?" In real life social situations, however, such problems are not defined so easily. Rather, spontaneous perceptions of a person's characteristics, facial and bodily expressions, and other various elements of the social situation must be integrated and considered in order to define the problem and enact a response. In sum, both factors underscore a problem with ecological validity with regard to classic ToM tasks, such as false belief.

In keeping with the second factor mentioned above, it has also been argued that ToM as a construct encompasses not only social-cognitive reasoning skills tapped by false belief tasks, but also social-perceptual and affective abilities that involve spontaneous processing and judgment of socially relevant information inherent in facial and bodily gestures as well as voices (Tager-Flusberg, 2001). Failure to include such spontaneous social perceptive abilities alongside traditional mental state reasoning skills when assessing ToM stands as another possible explanation as to why attempts to connect ToM with real world impairments have not been fruitful. In terms of Baron-Cohen's model, the majority of the research has accounted for ToM in terms of the cognitive components of his original (1995) model, neglecting the affective components that are now believed to factor into the ToM construct.

A third reason for the relatively shallow empirical basis supporting the ToM—social impairment connection has been the tendency to focus on broad, rather than narrow, age ranges. In the Joseph and Tager-Flusbeg (2004) study, for example, the

sample consisted of 31 children aged 5 to 14. Several potential problems arise from using such a broad age range. One, though all children with ASD pass ToM assessments at a later stage than their typically developing counterparts (Happé, 1995), assessments such as the false belief task are clearly intended for much younger children. Thus, older children diagnosed with ASD, though delayed in their ToM skills, would still be expected to pass such tasks. Two, as children grow and mature, the social skills expected of them naturally change. Reciprocal conversation skills, for example, are not as relevant when understanding a 4-year-old's social skills as they are for a 14-year-old. This notion would logically call for more specific definitions of "social skills" as well. In sum, understanding the specific relevance of ToM impairment with regard to associated social impairments in older children with ASD demands greater specificity when defining these variables.

Assessing ToM in the Present Study

Overcoming the shortcomings of previous research was paramount to the present study. To address the first issue, the verbal nature of classic false belief tasks, the current research utilized the Reading the Mind in the Eyes Test—Revised (Eyes test; Baron-Cohen, Wheelwright, Hill et al., 2001). The Eyes test is a measure of ToM that does not carry heavy language or EF demands. Described as an advanced ToM test, the Eyes test measures the ability to map mental state terms to fragments of facial expressions—the portion of the face around the eyes. At an automatic level, participants must match the set of eyes in each picture to examples of eye region expressions stored in memory to arrive at a judgment concerning which word the eyes most closely match. Usage of this measure also addressed the second aforementioned problem with previous research, namely the

failure to include ToM measures that purportedly assess spontaneous social perceptual and affective abilities, which comprise a more affective component of ToM (Baron-Cohen, Ring et al., 1999). In a validation study, significant correlations between performance on the Eyes test and ASD symptoms were found among high-functioning individuals with ASD, whereas these correlations were inverse in a control group (Baron-Cohen, Wheelwright, Hill et al., 2001). The task thus boasts some degree of discriminant validity.

Defining Social Skills Impairments

The third problem with previous research, as mentioned, concerns sample heterogeneity and dependent variable specificity. The current research included individuals diagnosed with ASDs aged 12 to 17 years. The study of ToM in the adolescent population is relatively scarce compared to that in childhood, and while several studies have examined ToM functioning in adults over the age of 20 (Baron-Cohen, Ring et al., 1999; Baron-Cohen, Wheelwright, Hill et al., 2001) no known study has focused narrowly on adolescents.

Assessment of social skills in the laboratory has focused predominately on rating scales designed to assess a broad range of behaviors. In addition to rating scales, the present study also focused on the social dimension of language, more commonly referred to as pragmatic language. Pragmatic language is, essentially, language in context, and the study of pragmatics is concerned with how language is used socially to achieve goals, how communication is affected by different environments and contexts, and how different messages are most appropriately conveyed (Phelps-Terasaki & Phelps-Gunn, 1992). With this operational definition in mind, social behavior is inextricably

intertwined with pragmatic language, and the study of pragmatics has lent itself well to individual assessment.

The present study used a well-validated pragmatic language instrument, the Test of Pragmatic Language, Second Edition (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007), to assess ability to convey and interpret social language. Pragmatic language impairment exists as a deficit universally agreed upon in individuals with ASD (Landa, 2000; Tager-Flusberg, Paul, & Lord, 2005). Specific pragmatic language-related impairments in ASD might include making an irrelevant comment in response to the topic introduced by the speaker, including extra or unnecessary information in an utterance, and difficulty remaining on topic during conversation. These behaviors would constitute some level of social awkwardness and often result in an overall difficulty with social skills. Moreover, this observation has been shown to hold empirical weight as well. A recent study by Volden and colleagues reported that pragmatic language abilities in children with ASD accounted for significant variance in ADOS Communication and Socialization performance, further underscoring the pragmatic language impairment in individuals with ASD and highlighting the connection between pragmatic language, as measured individually in the laboratory, and social skills observed in the outside world (Volden, Coolican, Garon, White, & Bryson, 2009).

Moving back to theory, why might these specific pragmatic language difficulties result from the social-perceptual impairments assessed by the Eyes test? A task analysis of the Eyes test would include the need for a mental state lexicon (e.g., words such as "alarmed," "ashamed," "reflective") and the ability to match the eyes in each picture to eye-region expressions stored in memory and understood in the context of mental states.

Any difficulty on the Eyes test would presumably be due to a poor understanding of the mental significance of and affective response to the eyes (Baron-Cohen, Ring et al., 1999; Hadjikhani et al., 2007). To recapitulate the broader importance of ToM with regard to social behavior, lack of appreciation for another's mental states conveyed through eyes subsequently makes the conveying and interpretation of social language difficult.

Summary

The purpose of this study was to determine whether ToM and pragmatic language skills discriminate between adolescents with ASD and typically developing, age-matched comparison participants. The study also attempted to explore the relationships between ToM, pragmatic language, and social skills and test the model that pragmatic language mediates the relationship between ToM and social skills. In general, it was hoped that the current investigation will shed further light on the overall conceptualization of ToM in ASD by providing a more fine-tuned investigation of the salient variables.

CHAPTER III

METHOD

Participants

Participants for the group with ASD included 10 adolescent males aged 12 to17 at Wesley Spectrum Services in Wilkinsburg, Pennsylvania who carried a pre-existing ASD diagnosis. These participants were initially referred for evaluation for clinical rather than research purposes and were included in the study based on order of response to evaluation request. Participants for the comparison group were recruited randomly from Hopewell Area School District in Aliquippa, Pennsylvania and matched for age and gender to the participants with ASD. Parents of the participants completed informed consent procedures and participants themselves completed assent procedures for assessment prior to being administered the assessments for the present study.

Exclusionary criteria for the group with ASD included individuals who did not continue to meet criteria for an ASD based on parent scores on the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005). Participants in the comparison group diagnosed with pragmatic language disorders or who met criteria for ASD based on SRS scores of 60 or higher—the clinically significant range—were also excluded from the group. Finally, all participants whose score on the Vocabulary subtest of the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003) fell one standard deviation above or below the mean were excluded from the study given the basic language demands of the Reading the Mind in the Eyes Test, Revised (Baron-Cohen, Wheelwright, Hill et al., 2001) and Test of Pragmatic Language, 2nd Edition

(TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007). This procedure would ensure that all participants evidenced at least average level basic verbal abilities.

Data Collection Procedures

Participants with ASD were recruited through Wesley Spectrum Services, which is located at 211 Penn Avenue, Wilkinsburg, PA 15221. Wesley Spectrum Services is an agency that provides educational and mental health services across Western Pennsylvania. The study targeted adolescent males aged 12 to17 diagnosed with ASD, and while the researcher originally intended to collect 20 participants, data collection was discontinued after obtainment of 10 participants given limited participant availability. Recruitment of the participants who were typically developing was through Hopewell Area School District. The chronological ages of the participants in the group with ASD were matched to those of participants in the comparison group. The following steps were adhered to in the recruitment process:

1. To look for potential participants, the researcher contacted the heads of the schools/agencies mentioned via email (Wesley) or in person (Hopewell), provided them with a brief description of the proposed study, and then asked for permission to conduct the proposed study.
2. Upon receiving a correspondence from the head of the school/agency, the researcher provided him/her with a letter that detailed description of the proposed study.
3. Compliance with the Health Insurance Portability and Accountability Act (HIPAA) was ensured by completing all necessary HIPAA documents. Wesley Spectrum Services contacted parents of adolescents with ASD who received

services at the agency according to agency records and acquired parental permission to participate in the study. Parental permission was obtained through having parents sign a permission form, which was mailed to their residence. Parents who agreed to have their child participate in the present study were asked to sign the parental permission form, put the form back into the envelope, seal it, and then return it to the appropriate school/educational agency, where the researcher picked them up. Individuals with a pre-existing diagnosis of mental retardation according to medical records held at the agency were not contacted. Assent was obtained as well by having the adolescent complete an assent form following obtainment of parent permission.

4. The researcher is employed as a psychologist at Hopewell Area School District and therefore had access to school records for all students. Once permission was granted to collect data at this location, the researcher selected male students from the school's online database matched in chronological age to the comparison group. For example, if the first participant in the group with ASD was 13-years-old, the researcher searched the database for 13-year-olds. Among this group, the researcher selected the first student among those with a last name starting with the letter "a." The process was repeated to match the age of the second participant in the comparison group, and the researcher then selected the first student among those with a last name starting with "b." This process was continued until an age-matched student in the comparison group was found for every participant in the group with ASD. Students with pre-existing diagnoses of ASD or mental

retardation or identified learning disabilities according to school records were not included.

5. Permission and assent procedures were similar to those of the group with ASD. Additionally, the researcher explained to the typically developing students and their parents that they (the typically developing peers) would be serving as the comparison group in this study.

Informed Consent Procedures

The informed consent procedures included the following steps:

1. Each parent of the participant received a parent permission form, which was mailed to their residence. The researcher emphasized that participation was entirely voluntary and that non-participation was absolutely fine and would not have any negative effects on their child's status or services with the school/agency. Parents who agreed to have their child participate in this present study were asked to sign on the parental permission form and return it to the appropriate school/agency so the researcher could pick them up.
2. After the permission forms were returned, the researcher obtained assent from all participants. The researcher arranged to meet with participants from either the school (comparison group) or educational agency (group with ASD) and presented the assent form. The researcher emphasized that participation was entirely voluntary and that their decision would have no effects on their status with the school/agency. All participants whose parents consented to have them participate in the study agreed to sign the assent forms.

Measures

Each assessment was individually administered by a certified school psychologist in a quiet setting within the school in which that participant was enrolled.

The Reading the Mind in the Eyes Test, Revised

The Reading the Mind in the Eyes Test, Revised (Eyes test; Baron-Cohen, Wheelwright, Hill et al., 2001) was used to assess ToM. The Eyes test was designed as "an adult test of social sensitivity" (p. 241) whose general purpose is to gauge how well an individual can put themselves into the mind of another person. It is comprised of 36 items, each of which presents a picture depicting the eye region of the face of an actor or actress. Below each picture are four choices of mental-state words, such as "sad," "happy," and, "afraid," and more complex terms such as, "assertive" or, "bewildered." A glossary of the words was provided in the case that the participant was at any point unsure of a word. Participants were asked to choose which of the four words best describes the mental state term conveyed by the eyes. Normative data is not provided for the Eyes test. Psychometric properties are limited to discriminant validity; in the pilot study, Baron-Cohen, Wheelwright, Hill, and colleagues (2001) found that the test successfully discriminated between adults with and without ASD.

Social Responsiveness Scale (SRS)

The SRS (Constantino & Gruber, 2005) was used to assess social skills in the current study. The SRS is a 65-item questionnaire that assesses various dimensions of social behavior, communication, and repetitive/stereotypic behavior that are symptomatic of ASD and is intended for children and adolescents between the ages of 4 and 18. A Likert scale response format is used to cover a range of symptom sensitivity, with scores

of zero indicating that the behavior is "not true" when describing the individual and scores of four indicating that the statement is "almost always true." Each item falls into one of five subscales: Social Awareness, Social Cognition, Social Communication, Social Motivation, and Autistic Mannerisms. A total raw score is also produced reflecting the sum of the 65 items which is converted to a T-score. Total T-scores of 76 or higher are considered to fall into the severe range and are strongly associated with a clinical diagnosis of Autistic disorder, Asperger's Disorder, or more severe cases of PDD-NOS. Total T-scores of 60 through 75 fall into the moderate range and indicate deficiencies in reciprocal social behavior that are clinically significant and result in mild to moderate interference in everyday social interactions. These scores are typical for children with mild or high functioning ASD. Total T-scores of 59 or less are considered to be within the normal range and usually suggest the absence of ASD.

The SRS was standardized on a sample of over 1,636 children and adolescents aged 4 through 19 that were similar in ethnic background to population figures in the United States. Internal consistency was found to be .97 for all clinical ratings (normative parent and teacher ratings for both males and females). In a clinically-referred group of 62 children and adolescents, interrater reliability was found to be .91 between mother and father, .82 between mother and teacher, and .75 between father and teacher. Concurrent validity was established by comparing the SRS to the Autism Diagnostic Interview—Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), which is widely considered to exist as a gold standard when establishing an ASD diagnosis. A strong association was found between the two instruments, and further, no respondent whose ADI-R score fell above the clinical cutoff had a SRS score below 65 (Constantino et al., 2003). Discriminant

validity is sufficient given that children diagnosed with ASD have been found to have significantly higher scores than children in other diagnostic groups (Constantino, Przybeck, Friesen, & Todd, 2000).

Test of Pragmatic Language, 2nd Edition (TOPL-2)

The Test of Pragmatic Language, 2nd Edition (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007) is a 43-item test that provides a comprehensive assessment of pragmatic language skills by utilizing a series of narratives and story contexts that characterize real-world social interactions. Examinees are required to understand the purposes and objectives of a communicative situation and apply this knowledge when responding to orally-presented vignettes, each of which is accompanied by a picture depicting the situation. The TOPL-2 provides one standard score, the Pragmatic Language Usage Index. Rationale for using the TOPL-2 derives from theory and research denoting pragmatic language impairments as a hallmark of individuals with ASD (Landa, 2005; Tager-Flusberg, Paul, & Lord, 2005; Volden et al., 2009). Further, pragmatic language assessment exists as one of the only direct means of assessing social skills, which is of interest in the present study with regard to ToM.

The TOPL-2 was normed on a sample of 1,136 individuals aged 6 to 18 in 21 states that is considered to represent the nation as a whole in terms of gender, race, ethnicity, family income, parent education, and disability. Internal consistency reliability was calculated at 13 age levels and ranged from .82 to .93; interscorer reliability was found to be .98; and, test-retest reliability exceeded .90 for all age groups, indicating that the TOPL-2 has overall sufficient reliability (Phelps-Terasaki & Phelps-Gunn, 2007). Discriminant validity coefficients were found to exceed .35 at each age (Phelps-Terasaki

& Phelps-Gunn, 2007). Strong criterion-predicted validity is reported as well. Correlations between the TOPL-2 and the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999), Test of Adolescent and Adult Language—Fourth Edition (TOAL-4; Hammill, Brown, Larsen, & Wiederholt, 2007), and Pragmatic Language Skills Inventory (PLSI; Gilliam & Miller, 2005) ranged from .68 to .87 across indexes.

Vocabulary Subtest of the Wechsler Intelligence Scale for Children, 4th Edition and Wechsler Adult Intelligence Scale, 3rd Edition

Assessment of verbal ability was accomplished using either the Wechsler Intelligence Scale for Children, 4th Edition (WISC-IV; Wechsler, 2003) for participants aged 16 and under or the Wechsler Adult Intelligence Scale, 3rd Edition (WAIS-III; Wechsler, 1997) for participants over the age of 16.

The WISC-IV was designed to measure overall cognitive functioning in children aged 6 to 16 and was normed on a sample of 2,200 children that matched census data in terms of ethnicity, geographic area, and parent education (Wechsler, 2003). The Vocabulary subtest of the WISC-IV contains 36 items that consist of two types: picture naming and word definition. For the former, which spans only the first four items and represents the floor of the subtest, the examinee names the pictures displayed in the stimulus book. For the latter, which spans the remainder of the items, the examinee is visually presented with a word that the examiner reads aloud. The examinee then provides oral definitions to the words and is cued for additional information if necessary and as stated in the test booklet. In general, the Vocabulary subtest is designed to measure acquired knowledge and verbal concept formation. It requires approximately 10

minutes to complete. Factor analysis indicates that the WISC-IV Vocabulary subtest loads on the Verbal Comprehension factor of the WISC-IV and its correlation with Full Scale IQ (r = .79) is higher than any other WISC-IV subtest (Sattler & Dumont, 2004). This measure was administered to participants aged 16 and under in the present study.

The WAIS-III was designed to measure overall cognitive functioning in individuals 16 to 89 and was normed on a sample of 2,450 individuals in this age range that matched census data in terms of ethnicity, geographic area, and parent education. The Vocabulary subtest of the WAIS-III looks similar to that of the WISC-IV, but with 33 items and without the initial items accompanied by pictures. Factor analysis indicates that the WAIS-III Vocabulary subtest loads on the Verbal Comprehension factor of the WAIS-III and its correlation with Full Scale IQ (r = .80) is higher than any other WAIS-III subtest (Wechsler, 1997). This measure was used with participants aged 17 in this study.

The Vocabulary subtest was utilized in the present study as a tool to control moderately for basic verbal ability among participants. Because both the Reading the Eyes test and the TOPL-2 contain basic language demands, the possibility that significantly below or above average basic verbal abilities contributed to performance on the other tasks was accounted for. It would have been desirable to match each Vocabulary score in the group with ASD to a score in the comparison group in order to control for variation in TOPL-2 or Eyes test performance due to verbal ability. However, the fact that pairs were already matched for age made finding a comparison participant matched for both age and Vocabulary score difficult for the scope of this study. Thus, in order to control for basic verbal ability, participants in either group who scored one

standard deviation above or below the mean were excluded from the present study to ensure that all participants presented with average level basic verbal ability according to the Vocabulary subtest.

Analysis for Research Questions One and Two

Independent sample *t*-tests were used to test the hypotheses that the group with ASD would perform significantly lower on both the Eyes test and the TOPL-2. Methods to test assumptions for equality of variances and normality were used, and both were satisfied.

Analyses for Research Question Three

A Baron and Kenny (1986) mediation analysis through regression was run to test the hypothesis that pragmatic language skills mediate the relationship between ToM and social skills in male adolescents with ASD. A regression was conducted for each of the following: Eyes test scores predicting SRS scores, Eyes test scores predicting TOPL-2 scores, and Eyes test and TOPL-2 scores predicting SRS scores. Mediation would not be supported in this model if in the third regression the Eyes test was not a significant predictor.

CHAPTER IV

RESULTS

This chapter presents findings of statistical analyses that were conducted to examine this study's three research questions. It is noted that the study originally sought to collect 20 participants from both the group with ASD and comparison group. However, due to participant availability, only 10 were able to be collected in each group. Analyses to address the present study's research questions were still run as originally discussed, and limitations regarding use of multivariate methods with a small sample are acknowledged and discussed further in the Discussion section of this document.

Descriptive Statistics

Twenty individuals participated in this study, 10 (50%) from the comparison group and 10 (50%) from the ASD group. It is noted that two Social Responsiveness Scale (SRS) data values were missing from the ASD group and imputed using an expectation-maximization (EM) method. Descriptive statistics were calculated for age, Eyes test score, TOPL-2 score, SRS score, and Vocabulary score. The range of ages were 14.00 - 17.00 years (M = 15.80, SD = 1.36). The range of Eyes test scores was 11.00 - 31.00 (M = 23.60, SD = 4.87). The range of TOPL-2 scores was 92.00 - 117.00 (M = 106.55, SD = 7.34). The range of SRS scores was 35.00 - 108.00 (M = 61.16, SD = 24.21). The range of Vocabulary scores was 7.00 - 13.00 (M = 11.75, SD = 2.38). The results are presented in Table 1.

Table 1

Means and Standard Deviations of Age, Eyes Test, TOPL-2, SRS, and Vocabulary by Group

	Comparison ($N = 10$)		ASD ($N = 10$)	
Variable	*M*	*SD*	*M*	*SD*
Age	15.80	1.40	15.80	1.40
Eyes Test	24.40	3.13	22.80	6.23
TOPL-2	110.30	4.08	102.80	8.11
SRS	41.10	7.75	81.22	16.83
Vocabulary	11.20	2.10	12.10	2.43

It is noted that as expected, the group with ASD scored significantly higher on the SRS than the comparison group. All individuals in the group with ASD met criteria for ASD based on their SRS score, and no member of the comparison group met criteria. Regarding Vocabulary scores, Levine's Test for Equality of Variances and Kolmogorov Smirnov (KS) tests were run to test for equality of variances and normality, respectively, and met. The result from the *t*-test comparing Vocabulary scores between the group with ASD and comparison group was not significant $t(18) = -0.87$, $p = .399$, and no participant obtained a score that was considered to be a statistical outlier. Thus, participants in the group with ASD and comparison group were not found to differ significantly on their Vocabulary scores. Further, no participants were excluded from the study based on being one standard deviation above or below the mean. Results of the independent sample *t*-test are presented in Table 2.

Table 2

Results of Independent Sample t-Tests on Vocabulary by Group

	ASD		Control				
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
Vocabulary	11.20	2.10	12.10	2.43	-0.87	18	.399

Research Question 1

Do male adolescents with ASD have significantly lower Theory of Mind ability compared to typically developing, age-matched male comparison peers?

To assess the first research question, an independent sample *t*-test was conducted on the Eyes test score by group. Levine's Test for Equality of Variances was not significant, indicating that the assumption of homogeneity of variances was met. Therefore, values corresponding to equality of variances assumed were used. The assumption of normality was assessed using a Kolmogorov Smirnov (KS) test and was met. The result of the *t*-test was not significant $t(18) = 0.73$, $p = .478$. The null hypothesis—that adolescents with ASD will not have significantly lower Theory of Mind ability compared to typically developing, age-matched comparison peers–cannot be rejected. Results of the independent sample *t*-test are presented in Table 3.

Table 3

Results of Independent Sample t-Tests on Eyes Test by Group

	ASD		Comparison				
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
Eyes test	22.80	6.23	24.40	3.13	0.73	18	.478

Research Question 2

Do adolescents with ASD have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers?

To assess the second research question, an independent sample *t*-test was conducted on the TOPL-2 score by group. Levine's Test for Equality of Variances was not significant, indicating that the assumption of homogeneity of variances was met. Therefore, values corresponding to equality of variances assumed were used. The assumption of normality was assessed by a Kolmogorov Smirnov (KS) test and was met. The result of the *t*-test was significant $t(18) = 2.61$, $p = .018$. The comparison group had higher TOPL-2 scores than the group with ASD and thus, the TOPL-2 was found to be more sensitive to detection of group differences than the Eyes test. The null hypothesis–that adolescents with ASD will not have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers–was thus rejected. Results of the independent-sample *t*-test are presented in Table 4.

Table 4

Results of Independent Sample t-Tests on TOPL-2 by Group

	ASD		Comparison				
	M	*SD*	*M*	*SD*	*t*	*df*	*p*
TOPL-2	102.80	8.10	110.30	4.08	2.61	18	.018

Research Question 3

Do pragmatic language skills mediate the relationship between Theory of Mind and social skills in male adolescents with ASD?

To assess the third research question, a Baron and Kenny mediation analysis through regression was conducted for each of the following: Eyes test scores predicting SRS scores, Eyes test scores predicting TOPL-2 scores, and Eyes test and TOPL-2 scores predicting SRS scores. Mediation was supported if in the third regression, Eyes test score was not a significant predictor.

The first regression model, with Eyes test score predicting SRS score, was not statistically significant, $F(1,18) = 3.54$, $p = .076$, $R^2 = 0.16$, indicating that Eyes test scores did not effectively predict SRS scores. The results of the regression are presented in Table 5.

Table 5

Regression with Eyes Test Scores Predicting SRS Scores

Predictor	*B*	*SE*	*β*	*t*	*p*
Eyes test	-2.02	1.07	-.41	-1.88	.076

The second regression model, with Eyes test score predicting TOPL-2 score, was statistically significant, $F(1, 18) = 9.52$, $p = .006$, $R^2 = .35$, indicating that the Eyes test scores effectively predicted TOPL-2 scores. The Eyes test scores accounted for (R^2) 35% of the variance in pragmatic language skills, where $B = 0.89$, $p = .006$, suggesting that for every increase in Eyes test score by one unit, there is an increase in TOPL-2 score by 0.89 units. The results of the regression are presented in Table 6.

Table 6

Regression with Eyes Test Scores Predicting TOPL-2 Scores

Predictor	*B*	*SE*	*β*	*t*	*p*
Eyes test	0.89	0.29	.59	3.09	.006

The third regression model, with Eyes test and TOPL-2 score predicting SRS score, was not statistically significant, $F(2, 17) = 3.20$, $p = .066$, $R^2 = 0.27$, indicating that the Eyes test and TOPL-2 scores did not effectively predict SRS scores. Mediation is not supported since the first and third regressions were not statistically significant. The null hypothesis–that pragmatic language skills do not mediate the relationship between ToM and social skills in male adolescents with ASD – is not rejected. The results of the regression are presented in Table 7.

Table 7

Regression with Eyes Test and TOPL-2 Scores Predicting SRS Scores

Model	*B*	*SE*	*β*	*t*	*p*
Eyes Test	-0.82	1.27	-.17	-0.65	.527
TOPL-2	-1.35	0.84	-.41	-1.60	.129

CHAPTER V

DISCUSSION

This chapter will address findings from the current study in light of the extant literature and recommend future avenues for research. To review, a number of studies have demonstrated that children and adults with ASD are impaired in their development of ToM (Baron-Cohen et al., 1985; Baron-Cohen, O'Riordan et al., 1999; Baron-Cohen, Wheelwright, Hill et al., 2001; Dawson & Fernald, 1987). However, the degree to which impairment in ToM corresponds to real-world social-communicative impairments has received little attention (Capps, Kehres, & Sigman, 1998; Fernald, 1987; Travis, Sigman, & Ruskin 2001). Additionally, these studies have suffered from a number of methodological drawbacks including sample heterogeneity (i.e., including wide age ranges spanning different periods of development) as well as conceptualization and assessment of ToM.

The present study attempted to address shortcomings in previous studies in two ways: one, by including a more homogenous sample (adolescents aged 12 to 17) that has not been studied exclusively in its ToM abilities, and two, by utilizing the Reading the Mind in the Eyes Test—Revised (Eyes test; Baron-Cohen, Wheelwright, Hill et al., 2001) —an advanced ToM test designed to gauge how well an individual can put themselves into the mind of another person—to measure ToM as opposed to traditional measures, such as the false belief task, that carry executive function demands and are not developmentally appropriate for adolescents and adults (Davis & Pratt, 1995). A two-pronged approach, which features a laboratory test of pragmatic language and a social skills checklist, was used to assess social-communicative skills in this study.

The first research question tested the hypothesis that adolescents with ASD would have significantly lower ToM ability compared to typically developing, age-matched male comparison peers. Results indicated that adolescents with ASD did not perform significantly lower in their ToM ability than their age-matched peers. Previous research found that Eyes test performance discriminated between a group of adults with ASD (n = 15, mean age = 29.7 years) and comparison participants (n = 239, mean age = 31.8 years), where adults with ASD obtained a mean score of 21.9 on the Eyes task compared to a mean of 26.2 for general population comparison participants (Baron-Cohen, Wheelwright, Hill et al., 2001). The present study found that adolescents with ASD obtained a mean score of 22.8 compared to a mean of 24.4 for the comparison group, indicating that comparison group still outperformed their ASD counterparts, but not at a level that could be considered statistically significant. However, it is noted that Cohen's effect size value (d = .34) indicated a small to moderate level of practical significance. A potential explanation for the findings of Baron Cohen and colleagues could be that for the comparison group, Eyes test performance improves with age, whereas such improvement is not observed to the same degree in individuals with ASD. Thus, differences in Eyes test performance between individuals with and without ASD may not be as readily observed among adolescents as it is in adults. Given the small sample size used in the present study, however, caution must be applied to any generalizations made from the data.

Research question two tested the hypothesis that adolescents with ASD would have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers. The result of the t-test comparing performance on

the TOPL-2 across ASD and comparison groups was significant $t(18) = 2.61$, $p = .018$, indicating that the comparison group performed significantly better than the group with ASD on this measure of pragmatic language skill. Further, a Cohen's effect size value ($d = .1.23$) suggests a considerably large level of practical significance. This is not surprising given that pragmatic language exists as a deficit universally agreed upon in individuals with ASD and has been considered the most stigmatizing aspect of the disorder (Tager-Flusberg, Paul, & Lord, 2005). Further, pragmatic language tests have been shown to discriminate between individuals with ASD and an age-matched comparison group (Dennis, Lazenby, & Lockyer, 2001; Young, Diehl, Morris, Hyman, & Bennetto, 2005). Thus, findings from the present study are consistent with previous studies with regard to pragmatic language skills and ASD.

The third research question tested the hypothesis that pragmatic language skills mediate the relationship between ToM and social skills in male adolescents with ASD. This model was based on the theoretical notion that lack of appreciation for another's mental states conveyed through eyes subsequently makes the conveying and interpretation of social language difficult, which in turn results in poorer observed social skills. According to the mediation analysis, the above model was not supported given that Eyes test and TOPL-2 scores did not effectively predict SRS scores. Further, Eyes test scores themselves did not predict SRS scores at a significant level. The starting point for Baron and Kenny's (1986) mediation analysis is to establish that there is a significant effect of the independent variable on the dependent variable, and in this case, this effect was not found to be statistically significant. That ToM did not predict social skills in the current study is not consistent with previous research by Baron-Cohen, Wheelwright,

Skinner, Martin, and Clubley (2001), who found an inverse correlation (r = -.53) between Eyes task performance and autistic symptoms as measured by the Autism Spectrum Quotient (ASQ), a questionnaire that assesses autistic symptomatology in adults.

Naturally, one possible explanation for this result is the smaller sample size used for this analysis, which may have prevented a relationship from being detected due to reduced power. Another potential explanation may involve the social skills measures themselves. The ASQ has not yet been validated on a large, normative sample and its potential for screening for ASD in adults with normal intelligence has not been investigated. The social skills instrument utilized in the present study, the SRS, carries several validation studies that indicate strong reliability and validity (Constantino et al., 2003; Constantino, Przybeck, Friesen, & Todd, 2000). Thus, until concurrent validity is established between the ASQ and other well-validated ASD screening instruments such as the SRS and the Autism Diagnostic Interview, Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), further studies utilizing larger sample sizes and validated ASD rating scales are needed to strengthen the argument that Eyes test performance significantly predicts observed social skills in ASD.

A unique contribution of the present study is the finding that ToM did significantly predict pragmatic language skills performance, as Eyes test performance accounted for 35% of the variance in performance on the TOPL-2. This is the first known attempt to empirically link ToM to pragmatic language, and the fact that a significant relationship was found between the two variables is not surprising given the solid theoretical framework underlying their relationship. It is argued that the motivation to communicate with others and acquire language is rooted in the individual's view of

others as intentional beings with whom to share one's own view of the world and learn theirs (Baldwin, 1995; Baron-Cohen, 1995). Without a clear understanding of another individual's mind as holding its own desires, beliefs, and intentions, pragmatic language-dependent skills such as making a relevant comment in response to the topic introduced by the speaker, avoiding including extra or unnecessary information in an utterance, or experiencing difficulty remaining on topic during conversation become more difficult. In this theoretical view, ToM and pragmatic language are linked inextricably; the results of the current study support this theory.

Qualitative observations of performance among the group with ASD on the TOPL-2 provide further insight into their approach to solving pragmatic language-related problems. Four of the 10 participants (compared to 0 in the comparison group) were observed to request additional information when presented with a social scenario on the TOPL-2 in which they were asked to put themselves in the position of a character in a scenario and resolve a social dilemma within that scenario. Rather than respond immediately to the cue, as each of the 10 participants in the comparison group did, these 4 participants in the ASD group on multiple occasions appeared momentarily confused at what action they would take given the scenario. These participants then asked for more information so they could make, as one participant stated, "an informed response." This approach suggests a more strictly logical, rather than intuitive, method to understanding and responding to the social scenario that may imply a certain difficulty in reading mental states. To compensate, these individuals may have relied on specific cues within the scenario or perhaps their own recounting of similar real-life experiences in which they had learned how to respond appropriately. It is noted, however, that not all of the

participants in the group with ASD exhibited this response style, indicating some level of variation in this tendency.

With such a strong relationship between ToM and pragmatic language observed, why then did the two groups not differ significantly in their performance on the Eyes test? Again, this result may have occurred due to small sample size. Also, as mentioned, maturational effects may have contributed to Eyes test performance in the present study. Further discussion of the Eyes test and its limitations is provided below.

Limitations

The purpose of this study was to determine whether ToM and pragmatic language skills discriminate between adolescents with ASD and typically developing, age-matched comparison participants. The study also attempted to explore the relationships between ToM, pragmatic language, and social skills and test the model that pragmatic language mediates the relationship between ToM and social skills. The most prominent limitation of the current study is the limited sample size, which occurred as a result of participant availability. With small samples comes limited generalizability of results along with greater difficulty detecting statistically significant relationships between variables. As mentioned, a multivariate analysis such as mediation is generally not recommended for small sample sizes, though the analysis was still run as originally intended. Thus, the findings of the mediation analysis in particular may not be reliably interpreted in the present study.

A second limitation of the present study relates to varying levels of therapy and social skills training received by participants in the group with ASD. This factor was not controlled for when selecting prospective participants, and it is possible that an

adolescent with ASD who received pragmatic language training through speech therapy and/or outpatient behavioral health services may have had an advantage demonstrating pragmatic language skill competence for the current study. This same notion may also apply to social skills, which may improve depending on the level and duration of services one received prior to participating in the study.

Regarding the failure of the Eyes test to discriminate between participants with ASD and comparison participants, further limitations may lay in the test itself. While the Eyes test purports to measure ability to make an inference about another's mental state using only the eyes, the stimuli presented in the task are static, whereas the eyes one sees and makes inferences about in the real world are dynamic. Thus, eye stimuli in the Eyes test may have potentially been easier to decode and less sensitive to differences in participants with ASD. Also with regard to real world generalizability of the test is the lack of time constraint; real-world judgments of eye movements are made rapidly during a social event, whereas participants are given as much time as they need to complete items on the Eyes test. A further criticism of the instrument exists in the multiple choice format of the test. Coupled with unlimited time, it is possible that participants were able to narrow down their response options, subsequently making informed guesses to items, and thereby increasing their chances of a correct answer by systematically eliminating answer choices.

A final limitation of the current study was its use of only one ability subtest—the Vocabulary subtest of the WISC-IV or WAIS-III—to control for verbal ability. As mentioned, the Vocabulary subtest was chosen given that it correlates higher than any other subtest with Full Scale IQ. Also, because it measures word knowledge, the

Vocabulary subtest was chosen to account for the word knowledge demands of the Eyes test and TOPL-2. The groups did not significantly differ in their Vocabulary scores and no statistically significant outliers were found which ensured that all participants in the study evidenced at least average basic verbal ability. However, it is still possible that some variation in verbal ability between groups contributed to performance on the other measures since the groups were not individually matched on their scores. It is also possible that general thinking and reasoning skills reflected through a Full Scale IQ could have revealed individual cognitive differences that may have contributed to performance on either the Eyes test or TOPL-2. Further research is needed to clarify the relationship between broader thinking and reasoning skills and Eyes test performance.

Recommendations for Future Research

Future research might take into account the aforementioned limitations of the present study. First, a significantly larger sample would increase the generalizability and validity of a similar study in the future. Controlling for aspects of cognition beyond word knowledge would help in eliminating confounding factors as well as allowing for exploration of individual differences on the Eyes task. Also, controlling for external therapies that may improve a participant's pragmatic language and social skills would work to reduce error in the study. Finally, development of a test that features dynamic as opposed to static eyes would better capture the real-world phenomenon of making mental judgments based on eye reading. Including a time component would also work to this end, as real-world mental state judgments, occur at a rapid and automatic level.

Conclusion

The purpose of this study was to determine whether ToM and pragmatic language skills discriminated between adolescents with ASD and typically developing, age-matched comparison participants. The study also attempted to explore the relationships between ToM, pragmatic language, and social skills and test the model that pragmatic language mediates the relationship between ToM and social skills. Results indicated that ToM significantly predicted pragmatic language skills and that pragmatic language skills, and not ToM, significantly discriminated between adolescents with ASD and typically developing comparison participants. The mediation model above was not supported by regression analysis. Though these results provide some insight into the relationships between ToM, pragmatic language, and social skills in ASD, all results must be interpreted keeping in mind the small sample size used in the study. Future research that includes a significantly larger sample size, a broader assessment of cognitive skills, modification of the Eyes test to address concerns regarding ecological validity, and control of factors (e.g., speech and behavior therapies) that may influence performance on pragmatic language and social skills assessments is recommended to clarify the relationship between ToM, pragmatic language skills, and social skills in ASD.

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Appendix

IRB Application

Abstract of the Proposed Research Study Titled
Theory of Mind, Pragmatic Language, and Social Skills in Male Adolescents with Autism Spectrum Disorders

Statement of Research Questions

This study is conducted to answer the following research questions:

1. Do male adolescents with autism spectrum disorders have significantly lower Theory of Mind ability compared to typically developing, age-matched male comparison peers?

   Hypothesis 1: Adolescents with autism spectrum disorders will have significantly lower Theory of Mind ability compared to typically developing, age-matched male comparison peers?

2. Do adolescents with autism spectrum disorders have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers?

   Hypothesis 2: Adolescents with autism spectrum disorders will have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers.

3. Do pragmatic language skills mediate the relationship between Theory of Mind and social skills in male adolescents with autism spectrum disorders?

   Hypothesis 3: Pragmatic language skills mediate the relationship between Theory of Mind and social skills in male adolescents with autism spectrum disorders.

Purpose and Significance of the Study

Autism Spectrum Disorder (ASD) is characterized a core triad of symptoms: impaired social interaction, problems with verbal and nonverbal communication, and unusual, repetitive, or severely limited activities and interests (APA, 2000). Impairments in social development, however, have been considered the most salient and handicapping aspect of ASD and, traditionally, the primary deficit from which the diagnosis results. From a cognitive standpoint, it has been argued that these social impairments in individuals with ASDs arise as a result of deficits in Theory of Mind (ToM) development (Baron-Cohen, 1995). “Theory of Mind” refers to the understanding that other persons have thoughts and the ability to make inferences about others' belief, desires, and mental states (Baron-Cohen, 1995). It is posited as an indispensable cognitive faculty with regard to everyday social interactions. A wealth of research has demonstrated that children with ASDs are impaired in their development of ToM (Baron-Cohen, Leslie, & Frith, 1985; Dawson & Fernald, 1987). Further, this impairment has been documented among adolescents and

adults with ASDs as well (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001).

The degree to which impairment in ToM corresponds to real-world social-communicative impairments has received little attention, however, and further research is needed to clarify this relationship. The purpose of this study is to investigate the degree to which ToM ability in individuals with ASDs corresponds to measurable social-communicative ability. While this connection appears to carry considerable face validity, relatively few studies have set out to examine the relationship (Capps, Kehres, & Sigman, 1998; Fernald, 1987; Travis, Sigman, & Ruskin 2001). Furthermore, these few studies have not supported a significant relationship between the variables. These studies, however, have suffered from a number of methodological drawbacks including sample heterogeneity as well as conceptualization and assessment of ToM. Regarding the sample selection problem, previous research has focused on broad age ranges, often including toddlers as young as 4 years old alongside adolescents. The most significant problem with using such a broad age range is that though all children with ASDs pass ToM assessments at a later stage than their typically developing counterparts (Happe, 1995), assessments such as the false belief task—the most common assessment of ToM—are clearly intended for much younger children. Thus, older children diagnosed with ASDs, though delayed in their ToM skills, would still be expected to pass such tasks.

This problem also highlights the second concern, namely the conceptualization and assessment of ToM. It has been suggested that more basic social-cognitive processes not accounted for by traditional ToM tasks, such as social-perceptual abilities that involve spontaneous processing and judgment of socially relevant information inherent in facial and bodily gestures, may be responsible for the social-communicative impairments in ASD (Joseph & Tager-Flusberg, 2003; Tager-Flusberg, 2001). This notion is supported by brain research examining the amygdala and mirror neuron system, which have been found to be impaired in individuals with ASD (Baron-Cohen et al., 2000; Bookheimer, Wang, Scott, Sigman, & Dapretto, 2008).

To address the problem with sample selection in previous studies, the present study will include adolescents diagnosed with ASD aged 12-17. The rationale for including this age range stems from the fact that study of ToM in the adolescent population is relatively scarce compared to that in childhood, and while several studies have examined ToM functioning in adults over the age of 20 (Baron-Cohen et al., 1999; Baron-Cohen et al., 2001), no known study has focused specifically on adolescence.

To address the second problem, which concerns the conceptualization and assessment of ToM in previous studies, the present study will utilize the Reading the Mind in the Eyes Test—Revised (Baron-Cohen et al., 2001) to measure ToM. Described as an advanced ToM test, the Reading the Mind in the Eyes task measures the ability to map mental state terms to fragments of facial expressions—the portion of the face around the eyes. At an automatic level, participants must match the set of eyes in each picture to examples of eye region expressions stored in memory to arrive at a judgment concerning which word the eyes most closely match. Usage of this measure also purports to capture the

spontaneous social perceptual abilities which comprise a more affective component of ToM (Baron-Cohen et al., 2000).

A two-pronged approach, which features a laboratory test of pragmatic language and a social skills checklist, will be used to assess social-communicative skills in this study. Pragmatic language is essential language in context, and the study of pragmatics is concerned with how language is used socially to achieve goals, how communication is affected by different environments and contexts, and how different messages are most appropriately conveyed (Phelps-Terasaki & Phelps-Gunn, 1992). Pragmatic language exists as a deficit universally agreed upon in individuals with ASDs and has been considered the most stigmatizing aspect of the disorder (Tager-Flusberg, Paul, & Lord, 2005). The present study will use a well-validated pragmatic language instrument, the Test of Pragmatic Language, Second Edition (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007), to assess the ability to convey and interpret social language.

Research Design and Procedures

Participants

A total of 40 male adolescents aged 12-17 will be invited to participate in the study, including 20 adolescents with autism spectrum disorders and 20 typically developing peers. The 20 adolescents with autism spectrum disorders will be serving as the experimental group, while the 20 typically developing peers serve as the comparison group. The rationale for including only males stems from research demonstrating sex differences in performance on the Reading the Mind in the Eyes test, as females have been shown to perform significantly higher than males (Baron-Cohen et al., 2001). Additionally, the parents/guardians of each participant will be asked to complete the Social Responsiveness (SRS; Constantino & Gruber, 2007).

Recruitment Process

Recruitment of the participants with ASDs will be through Wesley Spectrum Services which is located at 211 Penn Avenue, Wilkinsburg, PA 15221. Wesley Spectrum Services is an agency that provides educational and mental health services across Western Pennsylvania. The proposed study will target adolescent males aged 12-17 diagnosed with ASDs, and the researcher will discontinue seeking participants once 20 participants have been obtained. Recruitment of the participants who are typically developing will be through Hopewell Area School District which is located 2354 Brodhead Road, Aliquippa, PA 15001. The chronological ages of the participants in the experimental group will be matched to those of participants in the comparison group. The following steps will be adhered to in the recruitment process:

6. To look for potential participants, the researcher will first contact the heads of the schools/agencies mentioned above via phone calls, providing them with a brief description of the proposed study, and then ask for permission to conduct the proposed study.

7. Upon receiving response from the head of the school/agency, the researcher will send him/her a letter with the detailed description of the proposed study (see attachment # 1).

8. Compliance with the Health Insurance Portability and Accountability Act (HIPAA) will be ensured by completing all necessary HIPAA documents. The agency will contact parents of adolescents with autism spectrum disorders who receive services at the agency according to records held at the agency and acquire parental permission to participate in the study. Parental permission will be obtained through having parents sign a permission form which will be mailed to their residence. If the parents agree to have their child participate in this proposed study, they will be asked to sign the parental permission form, put the form back into the envelope, seal it, and then return it to appropriate school/educational agency, where the researcher will then pick them up. Individuals with a pre-existing diagnosis of mental retardation according to medical records held at the agency will not be contacted. This permission will be obtained through the parents' completion of a permission form (see attachment 3). Assent will be obtained as well by having the adolescent complete an assent form (see attachment 2) following obtainment of permission from his parents.

9. The researcher is employed as a psychologist at Hopewell Area School District and therefore has access to school records for all students. Once permission is granted to collect data at this location, the researcher will select male students from the school's online database matched in age to the experimental group. The researcher will first search the database for an age that corresponds with one of the participants in the experimenter group. For example, if the first participant in the experimental group was 13-years-old, the researcher would search the database for 13-year-olds. Among this group, the researcher will select the first student among those with a last name starting with the letter "a." The process would be repeated to match the age of the second participant in the experimental group, and the researcher would then select the first student among those with a last name starting with "b." This process would continue until an age-matched student in the comparison group was found for every participant in the experimental group. Students with pre-existing diagnoses of ASD or mental retardation or identified learning disabilities according to school records will not be included. Also, only students who have attended Hopewell Area School District since kindergarten and not any other school will be considered for the study.

10. Permission and assent procedures will be similar to those of the experimental group. Additionally, the researcher will explain to the typically developing students and their parents that they (the typically developing peers) will be serving as the comparison group in this study and their performance will be compared to that of the experimental group.

Informed Consent Procedures

The informed consent procedures will include the following steps:

3. Each parent of the participant will receive a parent permission form, which will be mailed to their residence. The researcher will emphasize that participation is entirely voluntary and that non-participation is absolutely fine and will not have any negative effects on their child's status or services with the school/agency. Only those parents who agree to have their child participate in this proposed study need to sign on the parental permission form. They will be asked to put the form back into the envelope, seal it, and then return it to either Hopewell Area School District or Wesley Spectrum Services, where the researcher will then pick them up.

4. After the permission forms are returned, the researcher will then obtain assent from all participants. The researcher will arrange to meet with the student and his parent/guardian at either the school (comparison group) or educational agency (experimental group) and present the assent form. If the participant has difficulty with reading comprehension, the researcher will read the consent form to them and provide explanation as needed. Only those participants who assent to the study will participate, and the researcher will again emphasize that participation is entirely voluntary and that their decision will have no effects on their status with the school/agency.

Measures

All participants in the study will complete three measures: the Reading the Mind in the Eyes Test, Revised (Baron-Cohen et al., 2001), the Test of Pragmatic Language, Second Edition (TOPL-2; Phelps-Terasaki & Phelps-Gunn, 2007), and the Vocabulary subtest of either the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV; Wechsler, 2003), for participants 16 and under, or the Wechsler Adult Intelligence Scale, Third Edition (WAIS-III; Wechsler, 1997), for participants over the age of 16. Additionally, the parent/guardian of each participant will be asked to complete the Social Responsiveness Scale (SRS; Constantino & Gruber, 2007).

The Eyes test is a computer based measure of ToM that requires the participant to examine the eye-region portion of a human face on a computer screen. Below each picture are four choices of mental-state words, such as "sad," "happy," and, "afraid," and more complex terms such as, "assertive" or, "bewildered." A glossary of the words is provided in the case that the participant is at any point unsure of a word. Participants are asked to choose which of the four words best describes the mental state term conveyed by the eyes. The assessment contains 36 items and takes approximately 20-30 minutes to complete.

The Test of Pragmatic Language, 2nd Edition TOPL-2 is a 43-item test that provides a comprehensive assessment of pragmatic language skills by utilizing a series of narratives and story contexts that characterize real world social interactions. Examinees are required to understand the purposes and objectives of a communicative situation and apply this knowledge when responding to orally presented vignettes, each of which is accompanied by a picture depicting the situation. The TOPL-2 requires approximately 30 minutes to complete. The TOPL-2 was normed on a sample of 1,136 individuals aged 6 to 18 in 21 states that is considered to represent the nation as a whole in terms of gender, race,

ethnicity, family income, parent education, and disability. Internal consistency reliability was calculated at 13 age levels and ranged from .82 to .93; interscorer reliability was found to be .98; and, test-retest reliability exceeded .90 for all age groups, indicating that the TOPL-2 has overall sufficient reliability (Phelps-Terasaki & Phelps-Gunn, 2007). Discriminant validity coefficients were found to exceed .35 at each age (Phelps-Terasaki & Phelps-Gunn, 2007).

The Wechsler Intelligence Scale for Children, 4th Edition (WISC-IV) was designed to measure overall cognitive functioning in children aged 6 to 16 and was normed on a sample of 2,200 children that matched census data in terms of ethnicity, geographic area, and parent education. The Vocabulary subtest of the WISC-IV contains 36 items that consist of two types: picture naming and word definition. For the former, which spans only the first four items and represents the floor of the subtest, the examinee names the pictures displayed in the stimulus book. For the latter, which spans the remainder of the items, the examinee is visually presented with a word that the examiner reads aloud. The examinee then provides oral definitions to the words and is cued for additional information if necessary and as stated in the test booklet. In general, the Vocabulary subtest is designed to measure acquired knowledge and verbal concept formation. It requires approximately 10 minutes to complete. Factor analysis indicates that the WISC-IV Vocabulary subtest loads on the Verbal Comprehension factor of the WISC-IV and its correlation with Full Scale IQ (r = .79) is higher than any other WISC-IV subtest (Sattler & Dumont, 2004). This measure will be used with participants aged 12-16 in this study. The Wechsler Intelligence Scale for Adults, 3rd Edition (WAIS-III) was designed to measure overall cognitive functioning in individuals 16 to 89 and was normed on a sample of 2,450 individuals in this age range that matched census data in terms of ethnicity, geographic area, and parent education. The Vocabulary subtest of the WAIS-III looks similar to that of the WISC-IV, but with 33 items and without the initial items accompanied by pictures. Factor analysis indicates that the WAIS-III Vocabulary subtest loads on the Verbal Comprehension factor of the WAIS-III and its correlation with Full Scale IQ (r = .80) is higher than any other WAIS-III (Wechsler, 1997). This measure will be used with participants aged 17 in this study.

The Social Responsiveness Scale (SRS) is a 65-item questionnaire that assesses various dimensions of social behavior, communication, and repetitive/stereotypic behavior that are symptomatic of ASD and is intended for children and adolescents between the ages of 4 and 18. A Likert scale response format is used to cover a range of symptom sensitivity, with scores of 0 indicating that the behavior is "not true" when describing the individual and scores of 4 indicating that the statement is "almost always true." The SRS was standardized on a sample of over 1,636 children and adolescents aged 4 through 19 that were similar in ethnic background to population figures in the United States. Internal consistency was found to be at .97 for all clinical ratings (normative parent and teacher ratings for both males and females). Adequate reliability (Constantino et al., 2003) and validity (Constantino, Przybeck, Friesen, & Todd, 2000) have been reported for the SRS. In a clinically referred group of 62 children and adolescents, interrater reliability was found to be at .91 between mother and father, .82 between mother and teacher, and .75 between father and teacher. Concurrent validity was established by comparing the SRS

against the Autism Diagnostic Interview—Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), which is widely considered to exist as a gold standard when establishing an autism spectrum diagnosis. A strong association was found between the two instruments, and further, no respondent whose ADI-R score fell above the clinical cutoff had an SRS score below 65 (Constantino et al., 2003). Discriminant validity is sufficient given that children diagnosed with ASD have been found to have significantly higher scores than children in other diagnostic groups (Constantino et al., 2000).

Administration Procedures

1. The researcher is a nationally certified school psychologist and will administer the Eyes test and TOPL-2 to all participants in a quiet location at either the school or educational agency.

2. All testing sessions for the experimental group will be scheduled at the convenience of the child/family. Testing sessions for the comparison group will be scheduled when the student has free time to work during the school day.

3. Administration of the TOPL-2 and Vocabulary subtest of the WISC-IV or WAIS will follow the standardized procedures described in the respective test manuals. The Eyes test, which is available publicly online, does not explicitly demand any formal administration method. Brief instructions are written at the top of the webpage on which the test begins, and the examiner will read these instructions aloud to all participants and ensure their understanding before they begin. The examiner will also provide a glossary of the mental state words in print form for each participant and instruct him that he may refer to them at any point during the activity. The examiner will also inform each participant that if he is unsure how to read a word in the glossary, the examiner will read it for them. At no point, however, will the examiner provide additional explanation as to what the words mean.

4. The researcher will give the SRS to the parent/guardian in person before their child is administered the assessments. Brief instructions are written at the top of each SRS form, and the examiner will read these instructions aloud and ensure understanding before the parent/guardian completes the form. If the parent is unable to read or comprehend the questions included on the SRS, the examiner will read the questions orally.

5. Once data are collected, each participant will be given a code and identifying data will be separated from the main data set. Each child's code will be matched to his parent's.

Method of Data Analysis

After data collection, the researcher will analyze and compare the data by using SPSS computer software (multiple regression) to answer the following research questions:

1. Do male adolescents with autism spectrum disorders have significantly lower Theory of Mind ability compared to typically developing, age-matched male comparison peers?

2. Do male adolescents with autism spectrum disorders have significantly lower pragmatic language skills compared to typically developing, age-matched male comparison peers?

3. Do pragmatic language skills mediate the relationship between Theory of Mind and social skills in male adolescents with autism spectrum disorders?

Risks and Benefits

The study contains no risk greater than that encounter in everyday life. Although the participants will not benefit directly from participation in this study, the information they provide will help the researcher gain a better understanding of how ToM develops and may be conceptualized in individuals with ASDs.

Confidentiality

A participant's name will never appear in the research document. His responses will only appear in statistical data summaries. Once data are collected, each participant will be given a code and identifying data will be separated from the main data set. The code and identifying information will be kept in a separate and secure location. The researcher will keep the participant's information secure and confidential. All written materials and consent forms will be stored in a locked file in the researcher's office at Hopewell Area School District, which is located at 2354 Brodhead Road, Aliquippa, PA 15001. No other individuals will have access to the file, and all materials and forms will be kept for 5 years upon the completion of the study.

Voluntary Participation and Right to Withdraw

Participation in the study is completely voluntary and the participant is always free to withdraw at any time for any reason without any penalty. The participant's non-participation will not have any negative effect on his school status, nor will it affect the services he is currently receiving.

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