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Asperger Syndrome and Blogging: Theory of Mind and the Extreme Male Brain Theory in Self-Identified Women with Asperger Syndrome

Master Thesis

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ABSTRACT

Autism Spectrum Disorder (ASD) is marked by varying levels of impairment in social, cognitive, and communicative functioning. Two prominent theories accepted as possible causes of autistic functioning were explored in this paper. The first experiment tested the purported Theory of Mind (ToM) deficiency thought to be responsible for the lack of social and communication skills. The theory that autistic individuals are deficient in ToM came about through failure at ToM tasks. However, these types of tasks rely on skills that may be independent from ToM. ToM indicators were compared in blogs written by self-identified women with Asperger Syndrome and women who did not identify as such. Only font formatting was found to be marginally significant ($p = .041$), with typically developed (TD) women using it as a textual tool more often. The second portion of this study examined the Extreme Male Brain (EMB) theory. The EMB theory suggests that increased fetal testosterone causes a hyper-masculinized, autistic brain. Using noted differences between men and women's language patterns, language in blogs authored by self-identified women with Asperger Syndrome was compared to blogs authored by women who did not identify as such. Previous studies have found that women use significantly more function words, first person pronouns, cognitive words, and fewer articles than men. A decrease in the number of social words has also been found to occur with an increase in testosterone. In both the principal investigation and the replication study, no significant differences were found between the blogs by self-identified women with Asperger Syndrome and those authored by the TD women. In fact, the women with Asperger Syndrome showed a trend of a more female writing style compared to the TD women, further indicating that the EMB theory may not be accurate.

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Table of Contents

ASPERGER SYNDROME AND BLOGGING

List of Tables

ASPERGER SYNDROME AND BLOGGING

Disclaimer: The author of this paper used the identity-first wording (e.g., autistic person, ASD individual) rather than the person-first wording (e.g., person with autism, person with ASD), as the former was believed to be the preferred wording of autistic individuals (Autistic Self Advocacy Network (ASAN), 2014). This was consciously done and with the utmost respect. The identity-first wording was not intended to be derogatory.

Autism Spectrum Disorder (ASD) is applied to individuals experiencing a variety of social, cognitive, communicative, and possibly neural behavioral abnormalities. These abnormalities differ along a continuum which range from mild to severe (National Institutes of Health (NIH), 2012). The cause of ASD is not known, but it is widely believed to have a genetic component (Centers for Disease Control and Prevention (CDC), 2014). Frequently, signs of ASD appear in early childhood, before the age of three. Common social impairments throughout the autism spectrum can include inability or difficulty maintaining eye contact, an apparent unawareness of another's feelings, and a preference to be alone. Common communication impairments can include difficulty starting or sustaining a conversation, talking in a monotone or singsong voice, and stereotyped and repetitive use of words or phrases (echolalia); in the most severe cases, language may be lacking altogether. In addition there may be repetitive, stereotyped behaviors, the most common of which across the spectrum are self-stimulating behaviors, commonly referred to as "stimming." Examples of "stimming" can be repeatedly turning a light off and on, repeatedly spinning the wheels of a toy truck, or flapping one's hands (CDC, 2014).

With the change of the DSM-V in May 2013, separate diagnoses that once made up the autistic spectrum (i.e., Autism Disorder, Childhood Disintegrative Disorder (CDD), Asperger's Syndrome, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS)) have

been done away with. Today, ASD is used as an umbrella diagnosis, combining all of the previously separate diagnoses into one that more accurately reflects the continuum of symptoms and severity. However, the separate classifications may still be used as a kind of shorthand by the public, researchers, and medical professionals as a way of indicating severity. People who were diagnosed with Autistic Disorder were considered to be the most severely affected. Behaviors such as repetitive gestures (e.g., hand-flapping, body rocking), self-harming activities (e.g., head banging), and lack of verbal ability were typical of the Autistic Disorder diagnosis. The CDD diagnosis shared much of the same criteria as Autistic Disorder, with the exception that the child appeared to develop typically until around two years old, at which point the child would begin to display behavior more characteristic of a child diagnosed with Autistic Disorder. At the other end of the spectrum are the people considered to be "high functioning." High functioning autistics (HFAs) often exhibit symptoms that were very similar to the criteria for Asperger Syndrome, and whether these are separate disorders is not clear. However, people who were diagnosed either with HFA or Asperger Syndrome exhibit far less impairment than those diagnosed with Autistic Disorder or CDD. Language and intellectual abilities remain relatively intact, but people with HFA or Asperger Syndrome will often admit to difficulty with social interactions and may exhibit unusual behaviors or interests (e.g., repetitive self-soothing behaviors, obsessive collecting, and focused attention to minor detail). Finally, the diagnosis of PDD-NOS, often called "atypical autism," was given for those who met some, but not all of the criteria for the other disorders within the spectrum. As with Asperger Syndrome, people diagnosed with PDD-NOS tend to exhibit fewer and milder symptoms than people with Autism Disorder, with milder symptoms occurring mostly in social and communication functioning (CDC, 2014; NIH, 2012).

ASPERGER SYNDROME AND BLOGGING

Many researchers believe that the noted differences between ASD and typically developed (TD) individuals are due to differences in neurocognitive processing. Researchers have found that the ability to read facial expressions is impaired for HFA individuals (Kennedy & Adolphs, 2012). However, many ASD diagnosed individuals can read basic emotions (i.e., anger, fear, disgust and happiness). The ability to read more basic expressions may be due to a learned ability to analyze parts of a face. ASD diagnosed children tend to analyze faces using cognitive faculties more often than emotional ones, as TD children would (Grossman, Klin, Carter, & Volkmar, 2000). TD people also read a face in its entirety, with most of the understood facial expression coming from the eyes. Typically, the reading of the eyes is intrinsically linked to one's own affective state. People with ASD, however, seem to analyze parts of a face with a tendency to focus on the mouth. There also seems to be less of an affective reaction when reading facial expressions, and more reliance on a cognitive interpretation (Tanaka et al., 2012). For people with ASD, it is likely that the reading of facial expressions is learned differently, requiring more of a cognitive effort than would be necessary for TD people. The difficulty in reading others is a likely contributing factor in the noted social difficulties with ASD.

Communication impairments are also likely to affect sociability. Even for those not as severely affected, such as those with Asperger Syndrome, ASD can still create difficulty in communication. When speaking to one another, most people rely on paralinguistic cues (e.g., intonation, pitch, prosody, etc.) to help express an underlying emotional nuance. Without these cues, interpretation of an ironic or sarcastic statement could be taken literally. For example, if a person were to overhear the phrase "that's great" without context, using paralinguistics he or she would be able to immediately understand the speaker's intention and the emotional meaning behind the statement. Without paralinguistics, there could be a number of ways the statement

could be interpreted. It could be taken as a literal, sincere expression, as resigned

disappointment, or even as a sarcastic comment. By using paralinguistics, people can

successfully parse the underlying emotional meaning of a statement. Pragmatics can also aid in

effective communication, because, like paralinguistics, it gives one the ability to communicate

socially and non-literally. When pragmatics is used, understood meanings change according to

an inherent social context. Language use will also change to appropriately suit a context, as when

individuals adjust their language depending on to whom they are speaking. It would be socially

appropriate to describe an event in greater detail to someone who was not present for the event

than to someone who was. Pragmatics is also used to understand a speaker's intended meaning

because it allows for non-literal interpretation based on a context. For example, if a child was

washing his hands and his mother told him to "Wash off the soap," pragmatics would allow the

child to understand that the mother is requesting that he wash the soap off of his hands, rather

than to wash off the bar of soap. Difficulty in understanding paralinguistics and pragmatics can

be problematic for those with ASD (Baron-Cohen, 1988; Gibson, Adams, Lockton, & Green,

2013).

It is currently estimated that one in 68 children will be diagnosed with ASD, with boys

five times more likely to receive a diagnosis (CDC, 2014). The higher proportion of diagnosed

males has led some researchers to believe that there are protective factors surrounding women

which limit the impairments associated with ASD (Robinson, Lichtenstein, Anckarsäter, Happé,

& Ronald, 2013). However, because many studies focus on males, the understanding of ASD

manifestations may be biased. Conclusions drawn from research using males are often

generalized to both genders, leading to the assumption that boys and girls are similarly affected.

However, it remains unclear whether ASD disproportionately affects males or if males are more

likely to receive the diagnosis because of more apparent symptoms (Dworzynski, Ronald, Bolton, & Happé, 2012). Sensitivity to female diagnoses or symptoms may be lacking.

One reason for this difference could be differences in socialization. Socialization conforms a person to a culture's gender norm, potentially influencing how indications of ASD are expressed. Because girls and boys are often socialized differently, girls may have discovered adaptive strategies that conceal more atypical behavior, while exhibiting previously unknown symptoms specific to females (Cheslack-Postava & Jordan-Young, 2012). Studies that have looked into sex differences between ASD diagnosed males and ASD diagnosed females have found differences in information processing, display of symptoms, and reported social functioning (Beacher et al., 2012; Mandy et al., 2012). One study using both ASD diagnosed males and females concluded that, while mentalizing and facial recognition were equally impaired, ASD women performed as well as TD controls in experiments testing attention to detail and executive functioning dexterity (the ability to switch between tasks efficiently), indicating that while there are similarities between the sexes within autistic functioning, differences remain as well (Lai et al., 2012).

From refrigerator mothers in the 1950s to the current vaccine-induced autism, many popular theories regarding autism have been based on the piecing together of opportune facts to form unsound conclusions. For nearly 20 years, from the 1950s to the 1970s, it was popularly believed that autism was *caused* by poor parenting. Kanner (1943) had observed that parents of autistic children—notably mothers, as they were the primary caregivers at that time—tended to be cold and distant toward their children. This observation led to some researchers, including the noted child psychologist Bruno Bettelheim, to speciously reason that the cold parent-child relationship must be the cause of the unusual behaviors exhibited by autistic children

ASPERGER SYNDROME AND BLOGGING

(Bettelheim, 1956). Mothers of autistic children became popularly known as *refrigerator*

mothers. Scientists and parents of autistic children vocalized their indignation, which led to

better research and the eventual rejection of the refrigerator parent theory in favor of more valid

causes.

Unfortunately, specious reasoning and misinformation continue to impede ASD research

today. Over the past 15 years, it has been a popular notion that vaccines are responsible for the

noted increase in rates of ASD. Despite overwhelming evidence to the contrary, many parents

fear that thimerosal—a mercury based preservative found in vaccines—is responsible for causing

ASD (CDC, 2014; DeStefano, Price, & Weintraub, 2013; Price et al., 2010). This belief comes

from anecdotes about children who, shortly after receiving childhood immunizations, began to

develop symptoms of ASD. Much like the *refrigerator mother* theory, the vaccine-induced ASD

theory suffers from erroneous logic. Many parents connect the timing of the vaccine to the

display of autistic symptoms, leading to the widespread belief that vaccines caused their child's

ASD. However, this connection seems to be coincidental. Children begin to show signs of ASD

in early childhood, often before the age of three. The presentation of autistic symptoms happens

to align with the age that children typically receive childhood vaccinations (CDC, 2014). The

autism-vaccine theory is also fueled by the fact that ASD diagnoses have been increasing over

the past few decades, as vaccination has become more widespread.

However, the increase in ASD diagnoses can be attributed to other factors. In general,

there is increased familiarity with ASD compared to previous decades. ASD research has gained

prominence in the public eye leading to increased awareness of symptoms. This increased

awareness of diagnostic criteria allows doctors and other public workers, such as teachers and

social workers, to better recognize ASD. Criteria for a diagnosis have also been broadened over

the years to incorporate those who are not as severely affected, likely leading to an overall increase in diagnoses. We now understand ASD to be made up of a spectrum of symptoms with large variations in levels of impairment. Finally, improved technology has allowed for better accuracy when reporting rates of ASD across the United States (CDC, 2014).

The current research aims to examine and address predictions of two prominent theories of ASD. The first theory this research attempts to examine is the Theory of Mind (ToM) deficit proposed to exist in ASD (Baron-Cohen, Leslie, & Frith, 1985). The second is the proposed Extreme Male Brain (EMB) theory (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003; Baron-Cohen and Wheelwright, 2004).

Theory of Mind (ToM)

ToM was first proposed by Premack and Woodruff (1978) through their use of experiments with chimpanzees. In their experiment, a chimpanzee was shown a series of videos in which an actor was struggling with a problem. The animal was then to choose a photographic representation of a solution for the situation shown in the video. For example, one video showed an actor locked in a cage. In order for the chimpanzee to appropriately demonstrate both an understanding of the actor's mental state (desire to get out of the cage) and the appropriate response to that state, it would have to choose a photograph of a key from a series of photographs presented to her. Premack and Woodruff (1978) believed that by consistently choosing an appropriate solution to the problem, the chimpanzee demonstrated an understanding of both the actor's state of mind (i.e., desire to get out of the cage) and a desired solution (i.e., using the key to open the cage).

ASPERGER SYNDROME AND BLOGGING

This experiment was believed to demonstrate a basic mental ability that allows the chimpanzee to understand another's perspective, thereby gaining an understanding of the other's mental state. It was apparent that the chimpanzee understood that the goal of the actor was being frustrated. It was also apparent that the solution was a learned response to previous training or observation. A chimpanzee in the wild would not understand what a key was, having no previous experience with one. The problem with this experiment is that it did not irrefutably demonstrate that the chimpanzee had an *understanding* of the mental state of the actor. In order to have a true ToM, chimpanzees would have to be able to grasp representations of mental states and be able to attribute such a state to a separate being. Premack and colleagues argued that performing a learned behavior (i.e., choosing the key) cued from a perceived intended goal (i.e., escaping the cage) is conclusive evidence that the chimpanzee has the ability to attribute and understand the mental states of others, but others disagreed, arguing that the tasks could have been solved using logic rather than ToM (Heyes, 1998; Kummer, Dasser, & Hoyningen-Huene, 1990).

Fortunately, most humans can express subjective mental states and the understanding of other people's mental states through language. Therefore there can be little doubt that we possess at least the capacity for ToM. And the ability to express these inner mental states opens broader channels for the exploration of ToM in human psychology. It has been well understood that children with ASD have social and communicative impairments. What is not clearly understood was why these impairments occurred. In 1985, a proposed ToM deficiency was applied to autism through the research experiment of Baron-Cohen, Leslie, and Frith. Because ToM gives one the ability to infer the full range of mental states (beliefs, desires, intentions, imaginations, emotions, etc.) of others, it seemed possible that the autistic child lacked a ToM (Baron-Cohen, Leslie, & Frith, 1985). ToM is what gives one the understanding that another person has feelings and

thoughts other than his or her own. In this way, ToM can be understood to be a key component to sociability and may also underlie typical human ability to judge speaker intent through paralanguage and pragmatics when it is not explicit in the words alone. Thus a ToM deficit seemed a plausible explanation for the behavior of autistic children.

Most of the support for the claim that faulty ToM is an underlying cause of some of the social and communicative deficits in autism comes from false-belief tasks. One of the most popular false belief tasks is the Sally Anne task. First used in autism research by Baron-Cohen, Leslie, and Frith (1985), the Sally Anne task is used to determine whether one has mastered first-order false belief. In the task, two characters, one named Sally and the other named Anne, are placed in view of the child. Sally places a ball in her basket while Anne watches. Sally then leaves the scene. Anne takes the ball out of Sally's basket and places it in a box nearby. Sally then comes back into the scene. The child is asked where Sally will look for her ball. According to this task, answering that Sally will look in her basket demonstrates a basic understanding of ToM. It is reasoned that, in order to come to this conclusion, the child would have to take the perspective of Sally. Children before the age of four and most autistic children "solve" the Sally Anne task by attributing what they themselves know to the characters, not by taking Sally's perspective.

However, false belief tasks, such as the Sally Anne task, may require conceptual understanding and cognitive skills that may not be relevant to ToM. First, in order to pass the Sally Anne task a child must be able to follow the sequence of two separate characters. This requires that appropriate attention is given to both characters. If the child does not have the attention span to follow the narrative, then s/he will fail to grasp a true picture of ToM not because of a ToM deficit per se, but because s/he could not follow the story. Secondly, the child

must also fully appreciate that Sally was not present, and therefore was not able to see the ball

being moved. If it is not made explicit that Sally was not able to see what Anne did, then the

child may think that Sally was able to witness Anne moving the ball (Bloom & German, 2000).

A third problem with this task is that it relies on an understanding of syntax and vocabulary.

Conditional words like *should* are not concrete and may therefore be difficult for some children

to understand. It has been demonstrated that language ability is a contributing factor in the ability

to pass false belief tasks. Children with ASDs often need a higher verbal mental age (VMA) than

TD children in order to successfully pass (Happe, 1995; McGregor & Bennett, 2008; Sparrevohn

& Howie, 1995) indicating that what the task may actually be capturing are language skills.

Performance on false belief tasks has also been shown to improve for TD children who

have siblings (Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki, & Berridge, 1996), suggesting

that a false belief is learned through social interactions with others. However, ASD children with

siblings do not show this improvement (O'Brien, Slaughter, & Peterson, 2011). A false-belief

understanding requires that the child appropriately read another person in order to determine if

someone believes something that is not true. If the child has never attended to other people in

this way, it could hinder their false-belief understanding. Trouble interpreting social situations

and emotional cues are common problems for people throughout the spectrum. This may be due

to difficulties in understanding non-verbal cues such as facial expression and paralinguistic

information, such as pitch, intonation, and volume. False belief understanding is likely to rely

heavily on interpreting social cues, rather than the understanding that another person has a

mental state separate from one's own.

Furthermore, success at this task may not accurately reflect ToM. Some HFAs can

successfully pass the false belief task, while admitting to lack the ability to understand other

people's thoughts. The ability to pass this task may actually reflect an ability to use logical reasoning and other non-social skills (Peterson, Wellman, & Liu, 2005).

Sensitivity may also be an issue with the false belief task. Few studies have been conducted longitudinally in order to capture possible developmental changes of ToM with autistic children. Studies that have done so based development on pass/fail false belief tasks. This led to the conclusion that children with autism fail to develop ToM (Holroyd & Baron-Cohen, 1993; Ozonoff & McEvoy, 1994). However, in a longitudinal study Steele, Joseph, and Tager-Flusberg (2003) found that 70% of children with ASD developed more advanced ToM capabilities. Unlike previous pass/fail scoring, the children in this study were assessed on an overall cumulative score based on competence at progressively more advanced ToM tasks. By changing the tasks from pass/fail to a cumulative score, researchers were able to increase sensitivity, thereby capturing changes in development that previous studies did not. Increased sensitivity helped capture a truer picture of the progression of ToM, while refuting the idea that ASD children entirely lack a ToM.

Baron-Cohen, Leslie, and Frith (1986) have also attempted to assess ToM based on wordless cartoon interpretations. They compared narratives of TD children, children with Down's Syndrome, and HFA children instructed to read a series of wordless cartoons. The cartoons were divided into three categories: mechanical, behavioral, and intentional. Mechanical cartoons depicted scenes of causal interactions, such as a man kicking a rock down a hill or an egg falling off of a table. Mental state attribution was not necessary to understand the cartoon. Behavioral cartoons also needed no mental state inferences to describe the actions taking place in the cartoon. Such cartoons depicted people performing routine tasks. For example, one showed a boy getting dressed and another showed a man planting a garden. Intentional cartoons, on the

other hand, depicted scenes where mental state inferences were necessary to correctly interpret the cartoon. For example, one cartoon depicted a girl who put her teddy bear down to turn and smell a flower. While her back was turned, a boy took the bear and left the scene. When the girl turned back to retrieve her teddy bear, she was surprised that it was no longer there. In order to correctly interpret this cartoon, one would need to appreciate that the girl was unaware of the boy's action and her reaction (surprise) was to be expected considering her ignorance. When the narratives were compared across groups, the HFA children narrated the mechanical cartoons more accurately than the TD children and children with Down's Syndrome, using appropriate causal links and descriptive language. In the behavioral cartoon condition, the HFA children narrated the behavioral cartoons similarly to the TD children, with the children with Down's Syndrome group performing significantly more poorly. However, in the narration of the intentional cartoon, HFA children differed significantly from both the TD children and the children with Down's Syndrome, such that they used significantly less mental state interpretation. HFA children seemed to focus more on describing the scenes rather than applying beliefs and intentions to the characters. Baron-Cohen, Leslie and Frith (1986) used the results of this study to support their previous postulation that an autistic child lacks a ToM. The inability to explicitly demonstrate mental state representation (i.e., by stating a character's mental states) was interpreted as a lack of the capacity to do so. By this logic, it is assumed that explicit ToM demonstration is the only way to capture another's mental state understanding. Comparing TD children with children who have obvious social difficulties is not an ideal way to conclude whether or not one has a ToM. The only safe assumption that can be made from such research is that HFA children do not convey information in the same way that TD and children with Down's Syndrome do. It is possible that children with ASD employ ToM differently from TD children.

Children with ASD may understand that a person is able to see for himself or herself, making any inferences the child may have redundant and unnecessary. Children with ASD often do things "efficiently" rather than socially (Marsh, Pearson, Ropar, & Hamilton, 2013). There could also be difficulty in understanding how to appropriately answer what the researcher was asking. A TD child would likely understand that a literal shot-for-shot translation of what is occurring in the cartoon is not what the researcher wanted to hear. A child with ASD, however, may not understand what the researcher was asking when he said "Can you tell a story?" referring to the cartoon.

While it may be true that language allows ToM to be demonstrated more clearly, it is crucial not to misinterpret the lack of a "correct" response to a contrived experiment as a lack of ToM. Normally, language allows one to express an inner implicit understanding to another with relative clarity. The ability to communicate effectively alone demonstrates a presence of ToM. Often, people use conversation to reveal what they are thinking or discover the thoughts of another. The back-and-forth common in conversation requires a certain level of ToM because it allows one to judge when it is appropriate to speak and what is appropriate to say in response. However, because ASD can cause difficulty in pragmatic understanding (e.g., knowing when to speak or what to take literally), social interactions may be atypical. This would make explicit demonstration of ToM difficult. This atypical reaction can generate the idea that the autistic individual lacks the ability to understand that other people have thoughts and feelings separate from their own. However, it may be that autistic individuals are attending to things other than social cues, causing them to seem like they are incapable of considering the perspective of others. For this reason, a sole reliance on explicit demonstrations of ToM may not be appropriate.

ASPERGER SYNDROME AND BLOGGING

In the past decade, implicit ToM demonstrations have been receiving more credence. Until recently, it was generally believed that children do not understand false-beliefs until four years of age (Perner, Leekam, & Wimmer, 1987; Wimmer & Perner, 1983). Findings from recently conducted studies contradict this long held belief. False-belief tasks traditionally have attempted to elicit responses, which may confound cognitive abilities (e.g., attention and instruction understanding). This would help to explain why false-belief understanding usually seems to emerge only after the age of four. He, Bolz, and Baillargeon (2011) addressed this possible confound by eliminating elicited responses (i.e., directly answering a question) in favor of spontaneous responses (i.e., observing a behavioral response). A false-belief play similar to the Sally-Anne task was acted out for children between 29 months and 35 months old. Children viewed three different scenarios. In the knowledge condition, the agent was present when the toy was moved to another container. In the ignorance condition, the toy was hidden while the agent was absent from the scene (behind the closed curtain). And in the false-belief condition, the toy was hidden in one of two containers in the agent's presence and then moved to the other container in her absence (while behind the curtain). He et al. (2011) noted where the child looked (i.e., the container to the left or right) and the amount of time the child viewed the container. For the knowledge condition, most children looked to the container with the toy inside, indicating an understanding that the agent would look in that container. In the ignorance condition, the children looked at both containers nearly equally, indicating an understanding that the agent did not know where to look. In the false-belief condition, however, children looked at the container that the agent was expected to choose significantly longer. This indicated that despite the likelihood that the child would have answered the false-belief question incorrectly, he or she seemed to understand that others hold false beliefs. Furthermore, this ToM understanding held

across cultures, indicating that an implicit understanding is inherent, rather than learned. Barrett et al. (2013) conducted a similar spontaneous-response false-belief experiment in three non-Western countries (i.e., Fiji, China, and Ecuador). In this experiment, a person put on a play where the agent was looking for a pair of scissors. The agent put the scissors down and left the room. While out of the room, another person moved the scissors to a different, hidden location (e.g., a drawer). When the agent came back, most children looked to where the agent had last left the scissors, indicating an understanding that that is where the agent believed the scissors to be. This adds to growing evidence that false-belief understanding occurs earlier than initially believed and may be a phenomenon inherent to humans despite upbringing and culture. It seems that young children understand false-beliefs but may have difficulty expressing their understanding depending on the task.

Pragmatics, which allows for non-literal, figurative language understanding, has also been implicated in the study of ToM. Because words and phrases can hold different meanings according to a context, the use of pragmatics becomes vital to the understanding of non-literal language. Non-literal language requires flexible language understanding. The interpretations of those words and phrases can be largely dependent on understanding the speaker's intention. For example, "The line was a mile long" is normally understood to be a hyperbole. Most people understand hyperbole to be the speaker's way of exaggerating for effect. However, someone with pragmatic deficiency may take the sentence literally, believing that the line was actually a mile long. Metaphor requires even greater language skill than hyperbole because it requires greater cognitive flexibility. Metaphors are used to draw comparisons between two disconnected things that may share a commonality. For example, "Time is a thief" is understood to mean that time moves quickly without our realizing. Figuratively, we understand that time and a thief share

common characteristics. The writer of the metaphor intends for us to understand that both a thief

and time move quickly, without notice. Thieves also steal valuables, so the writer's implication

is that time steals life away and we do not notice until it is too late. Because understanding of

figurative language requires an understanding of the speaker's intention, some researchers

believe that it requires ToM (Happé, 1995b). Many studies support the claim that figurative

language understanding is lacking in people on the autism spectrum (Hermann et al., 2013;

MacKay & Shaw, 2004). This lack of understanding is often interpreted as being caused by a

ToM deficiency. Figurative language understanding requires a relatively developed language

understanding in general. The seeming inability to understand figurative language, which is

frequently noted in autism, may be due to difficulties unrelated to ToM. In a study comparing

figurative language understanding between autistic children with language impairment, TD

children with language impairment, and autistic children with no language impairment, only

language impairment seemed to be the influencing factor in the understanding of figurative

language. This was true regardless of success on false belief tasks or autism diagnosis (Norbury,

2005). It seems that when language ability is controlled for, ToM no longer influences figurative

language understanding.

　　　　The idea that a ToM deficiency is responsible for autistic communication and social

impairments is far from solid. It is just as likely that the communication and social difficulties

caused by ASD hinder the appropriate demonstration of ToM. Furthermore, explicit ToM testing

relies on cues that may be outside of ToM. For these reasons, ToM should be examined using

alternative methods.

Extreme Male Brain (EMB) Theory

Another theory regarding autism etiology is the "extreme male brain" (EMB) theory, first posited by Baron-Cohen, Knickmeyer, and Belmonte (2005). According to their Empathizing-Systematizing (E-S) model, people cognitively interpret the world using two independent cognitive systems. One is responsible for empathizing (E) and the other is responsible for systematizing (S). The empathizing division allows one to understand, interpret, and respond to the mental and emotional states of others, and thus operate successfully in the social world. The systematizing division essentially has a complementary role. It allows one to interpret non-agentive behaviors and events using analytical logic. For example, one would use the systematizing cognitive style to read a map or predict a falling object's path. Systematizing requires no emotional or mental state understanding.

To determine how much an individual relies on either of these two cognitive styles, two self-report measures were created. The empathizing quotient (EQ) is determined by a questionnaire that is meant to discern how much one relies on the empathizing system when interacting with others. In the EQ questionnaire, a statement is presented (e.g., I am good at predicting what someone will do; or, I can tell if someone is masking their true emotion) and the participant must indicate his or her level of agreement with the statement (i.e., Strongly Agree, Slightly Agree, Slightly Disagree, or Strongly Disagree). Each response is then given a score and an empathizing quotient is determined (Baron-Cohen & Wheelwright, 2004). The systematizing quotient (SQ) is similar, except that it is meant to assess one's reliance on systematizing cognition. The SQ questionnaire measures how much one uses rule-based logic when encountering non-agentative behaviors. SQ is also determined by a questionnaire where statements are presented (e.g., If I were buying a stereo, I would want to know about its precise

ASPERGER SYNDROME AND BLOGGING

technical features; or, I do not care to know the names of the plants I see) and the participant

must indicate their level of agreement with the statement (Baron-Cohen, Richler, Bisarya,

Gurunathan & Wheelwright, 2003).

Based on these quotients, Baron-Cohen et al. (2005) suggested that the extent to which an

individual relies on the empathizing or systematizing style of cognition differs between the

sexes. Most females who were tested fell into the empathizing brain (E>S) category because they

typically scored higher on the EQ compared to the SQ. This was interpreted to mean that most

females have brains that primarily rely on empathizing over systematizing cognition. The second

type is the systematizing brain (E<S), where one relies primarily on systematizing over

empathizing abilities. Most men fell into this category. This result was interpreted to mean that

men have brains that primarily rely on systematic thinking over empathic thinking. There were

also the two extremes: the Extreme Female (E>>S) and the Extreme Male (E<<S). The Extreme

Female category consisted of participants who scored very high on the EQ and very low on the

SQ. Only 7% of all participants scored in this category and were exclusively female (Goldenfeld,

Baron-Cohen, & Wheelwright, 2005). Alternatively, the Extreme Male category reflected very

high scores on the SQ and very low ones on the EQ. No females, 6.1% of males, and 46.7% of

ASD/HFA participants scored in the E<<S category (Goldenfeld, Baron-Cohen, & Wheelwright,

2005). This type of scoring was understood to reflect the cognition process and assess the "type"

of brain an individual possessed. Baron-Cohen et al. (2005) believed that autistics rely very

highly on systematizing, even more so than most non-autistic males, and have very little

empathic cognitive ability. In essence, the researchers believed that autistics may hold an overly

"masculine" systematizing brain.

ASPERGER SYNDROME AND BLOGGING

Baron-Cohen et al. (2005) argued that differences in brain structure, possibly due to an increased fetal testosterone level, create an overly systematic autistic brain. It is known that men and women have brains that differ physically. In general, women tend to have comparatively more gray matter (Luders, Gaser, Narr, & Toga, 2009) and more neural connections between hemispheres, rather than within hemispheres as men seem to do (Ingalhalikar et al., 2013). Baron-Cohen et al. hypothesized that differences in neural connectivity may relate to differences in demonstrated empathizing and systematizing. It is also known that androgens influence sex traits. Increased testosterone during fetal development may also relate to differences in behavioral characteristics between males and females.

But as Bejerot et al. (2012) discovered in their study on gender traits in ASDs, there appears to be an androgynous quality in people with ASDs. Men with ASD have more feminized faces, voices, and body types compared to their peers, while women with ASD have more masculinized facial features and larger heads. If fetal androgens were responsible for influencing brain development, it is likely they would also be responsible for influencing physical characteristics of sex traits. Another study found that—while both ASD male and females scored higher on the SQ than the EQ, as predicted—when tested on gender role conformity using the Minnesota Multiphasic Personality Inventory (MMPI-2), ASD male and females scored lower on the Gender-Masculine (GM) measure than their control peers (Stauder, Cornet, & Ponds, 2011). If ASD was due to a masculinizing quality of the brain, as proposed, it would likely show up in physical and behavioral characteristics across both genders.

Furthermore, the EMB theory may not be a suitable evaluation of ASD, as supportive research was predominately focused on autistic males. For example, in one supporting study, TD girls were found to perform better than TD boys at recognizing a social faux pas. However, when

ASPERGER SYNDROME AND BLOGGING

researchers compared differences between TD children and children with HFA and Asperger Syndrome, they only looked at the performance of boys. The researchers claimed that leaving out female HFA/Asperger Syndrome children was not likely to alter results because 11-year-old TD girls and boys performed equally well on the task. Therefore, it was assumed that boys and girls with HFA and Asperger's Syndrome would perform similarly (Baron-Cohen, O'Riordan, Jones, Stone & Plaisted, 1999). Based on information from the previously discussed more recent studies, we cannot rule out the possibility that autism may manifest differently in males and females.

Another piece of evidence used in support of the EMB theory is the lower 2D:4D ratio (the length of the second finger divided by the length of the fourth finger) noted in ASD individuals compared to the typical population. It has been demonstrated that fetal testosterone controls for the growth of these two digits and that the ratio is therefore an indicator of fetal testosterone exposure (Galis, ten Broek, van Dongen, & Wijnaendts, 2010; Hönekopp & Watson, 2010). Smaller differences in digit length are more male-typical, while larger differences are more female-typical. In a meta-analysis, 2D:4D ratios were found to be unrelated to SQ and EQ for both sexes in the typical population. The 2D:4D ratio was found to be a significant predictor only for the autistic population (Hönekopp, 2012) suggesting that there is likely another variable influencing differences in scoring. Higher fetal testosterone may increase the risk for autism, but may not be responsible for the noted sex differences in EQ and SQ.

Moreover, the EQ-SQ assessment does not take into account that socialization has an influence on gender roles. In the case of the EQ, empathy may be too large a construct to capture specific sex distinctions, leading to an overly broad and perhaps inaccurate conclusion that men are less empathic than women. In a study where empathy was broken down into component parts

(i.e., cognitive empathy, affective empathy, social skills, and emotional reactivity), the sex difference previously noted only became apparent for emotional reactivity (Muncer & Ling, 2006). By searching for distinctions, an entirely different interpretation for noted sex differences can be presented. In general, it is more socially acceptable for women to display emotion than men. The higher EQ scores for women may reflect that. Rather than measuring cognitive style, the EQ-SQ may actually be measuring societal gender conformity. Gender norms are socially reinforced and gender role behavior would have a strong influence on how people would like to present themselves. Individuals not susceptible to social norms are unlikely to fit the stereotype of that norm. There is evidence that men and women on the autism spectrum seem to be more androgynous than their TD peers (Bejerot et al., 2012). In other words, ASD women may not be as susceptible to female gender norms.

Many of the statements meant to measure systematizing and empathizing are self-serving statements that disregard socialization as a factor for differences in scores, particularly among the non-autistic population. EQ is measured by statements such as "I find it difficult to explain to others things that I understand easily, when they don't understand it first time," "I really enjoy caring for other people," and "In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking." It is already known that autistic people have difficulty "reading" others. Naturally, if one were to have difficulty interacting with people, a primary focus may be given to things rather than people. Asking these types of questions tells us nothing new about autistic cognition and even less about gender.

Autism Spectrum Disorder is marked heterogeneity in phenotype and severity of impairment. One study even suggested that differing levels of fetal testosterone were responsible for the levels of impairment noted within the autism spectrum (Manning et al., 2001). However,

in Hönekopp's (2012) meta-analysis, no such linear relationship was found between 2D:4D ratio, a fetal testosterone indicator, and autistic impairment. This further suggests the EMB theory may be an inaccurate or incomplete ASD theory and that fetal testosterone alone is not a likely candidate for ASD.

Current Research

Two studies were conducted to further examine the ToM and EMB theories. Because of the relatively intact language ability of people with Asperger Syndrome, blogs of people who self-identified as having Asperger Syndrome were selected. These selected blogs were chosen for their diary-like, first-person narratives. This style of blog was believed to be an ideal format for further examination of Baron-Cohen's theories, because they relied on unsolicited, natural language use. This type of naturalistic observation may be better at capturing how ASD affects cognition. In doing so, it is the hope of the researcher to address the proposed theories of ASD in a less contrived way.

Through such blogs, we can capture a glimpse of each blogger's perspective and life. We can also examine typical communication of bloggers, as the blogs are written in a conversational style, with the understanding that others will be reading and possibly commenting on what is written. This is of particular importance because the bloggers cannot rely on paralinguistics to emphasize certain points, as would happen in a face-to-face conversation. Other devices must be used to make clear to the reader how to interpret certain statements. The use of such cues, like font formatting, may illustrate ToM in action because it demonstrates that the blogger understands how certain statements may be misinterpreted by others. The devices are used as clarification. Non-literal language was also examined as an indicator of ToM because, as

explained previously, they require the author to understand that certain words and phrases can hold dual meanings. The appropriate use of figurative language may also help to reveal an intact ToM.

Finally, to examine the EMB theory, frequency of linguistic categories associated with differences between the sexes were explored. Pennbaker (2011) has found that men and women communicate differently through the types of words they use. While content words have always been a popular source of study, Pennebaker has found that function words (words that serve as the "glue" of sentences but hold no meaning, e.g., such as with, have, but), cognitive words (e.g., know, think, ought), first person pronouns (e.g., I, me, mine), social words (e.g., gossip, helpful, love) and articles (e.g., the, an, a) can differentiate between a male or female author. Women tend to use function words, cognitive words, and first person pronouns more frequently, while using articles less frequently when compared to men (Pennebaker, 2011). Their use of each linguistic category was compared between the two groups (i.e., Asperger Syndrome bloggers and TD bloggers).

Experiment 1: ToM and Asperger Syndrome

False belief and elicited-response tasks may not be reliable measures for understanding ToM, therefore, capturing a spontaneous demonstration of ToM becomes necessary. Observing a person in his or her natural world, through day-to-day activities, affords a way of understanding a working ToM. The Internet is one such place where ToM may be captured in operation. The Internet is a public domain where people may express their thoughts relatively unrestricted. Because these thoughts are made public, they are also open for public scrutiny. In such a forum, it becomes important to get meaning across as aptly as possible. In face-to-face interactions, a

person may rely on paralinguistics and body language to communicate a point effectively and may also modify the communication in real time as paralinguistic and body language information is conveyed by the listeners. On the Internet, however, none of this is possible. The non-verbal social cues we use in face-to-face interactions must be translated to text and the text must do its best to reflect intent from the get-go since any feedback from the viewers will be much delayed. Nonverbal textual tools allow the writer to express himself or herself more clearly, just as nonverbal skills would in face-to-face interactions.

Blogs are a source of written text that may hold such nonverbal textual cues. Blogs have become a popular outlet where people can share and express personal views in a public forum. For this study, single author, personal blogs were examined. Such blogs act as a public diary where bloggers write about their day-to-day activities and inner thoughts. But unlike a diary, these blogs are made public. Because the blogs are available for public scrutiny, it should be imperative that the authors understand how their words may be interpreted.

Communication by means of the Internet may be ideal for someone on the spectrum because it can help remove potentially overwhelming cognitive processing that occurs during face-to-face communication. It is likely that the understanding of others' social cues requires more effort for someone on the spectrum compared to a TD individual. Writing can give one time to reflect on what is being said and how it may be interpreted. It can help to remove the added stress of having an instantaneous response to another person's reaction, making it a viable alternative option for exploring the proposed ToM deficit.

One potential ToM indicator that may come up in blogs are emoticons. Emoticons have developed as a form of textual but non-verbal communication. They can allow the writer to more

accurately express a feeling that would otherwise be lost through written text alone (Lo, 2008).

Writing "I ate the whole thing" could be taken as a literal statement, meaning that the whole

thing was eaten. When an emoticon is added, as in "I ate the whole thing ☹," the meaning of the

sentence changes. The sentence now conveys a tone of shame and/or guilt. Alternatively, "I ate

the whole thing ☺" conveys a feeling of pride and/or satisfaction.

Font formatting (i.e., use of italics, bolding, capitalization, and underlining) can also be

used to convey emotional nuance. Such textual cues are analogous to paralinguistics in speech.

They are used to convey emotional information that would otherwise be lost. For example,

capitalizing a word would be similar to raising one's voice. If one were to read the sentence "He

did WHAT?" the reader would have the impression that the writer is conveying surprise or

anger. Italics can also be used similarly. "She went with *him*?" implies disbelief or surprise.

Italics can also be used to signify sarcasm as well, such as in "Yeah, *right*!" Use of these non-

verbal textual cues can demonstrate that the writer understands the impression the reader will

come away with. If a person were to lack ToM, it is likely that the person would not use such

cues in their writing very often. A lack of such cues may indicate that the writer lacks the

perspective of the reader. What is especially nice about emoticons and font formatting from a

coding perspective is that they are readily and objectively identifiable, which is not always the

case with tone of voice and body language.

Because figurative language may be an indicator of ToM as well, its use was compared

between Asperger Syndrome bloggers and TD bloggers. People who write blogs are likely to

believe they are proficient in language, and therefore will be more open to communicating to

others. This increased confidence in language ability may result in more expressive language.

The frequency of figurative language use will be used as another indicator of ToM.

ASPERGER SYNDROME AND BLOGGING

Methods

Materials

Sixty-nine blog sites whose authors identified as having Asperger Syndrome and 65 blog sites whose authors had no mention of Asperger Syndrome were selected from Wordpress.com and Blogspot.com. Asperger blogs from Wordpress.com were found by typing "Asperger's," "Asperger," and "Aspie" into the search bar within the site. The principal investigator then checked within each blog site for specific mention of the author having Asperger Syndrome. Only blogs which explicitly stated that the author had Asperger Syndrome were used for this study's Asperger group. Blog authors from Blogspot.com were found similarly by typing "Asperger's," "Asperger," and "Aspie" into the Google search bar and limiting results to the Blogspot.com domain. These blog sites were also checked for specific mention of the author having Asperger Syndrome. The web addresses of the blog sites were recorded and the number of followers per site was noted.

Blogs were also checked to confirm gender (i.e., specific reference to being female or male). Women were exclusively chosen because there was an overwhelming presence of female bloggers who wrote diary-like, first person narratives; in fact only six of the TD bloggers were males. In order to avoid confounding sex and "diagnosis" the AS population was also limited to female bloggers.

A total of 26 entries were selected from Wordpress.com and Blogspot.com. Fourteen entries were written by women who identified as having Asperger Syndrome. Twelve entries were written by assumed TD women (i.e., had no mention of Asperger Syndrome within their blog site). The number of followers for each blog site was noted and blog sites were divided into

ASPERGER SYNDROME AND BLOGGING

two categories: those with ≤ 99 followers and those with >100 followers. The number of

followers was considered to be relevant because a large following might indicate better than

normal writing ability or sensational content, while a small following could be indicative of

poorer writing. Posts were then further selected for length. Only posts ranging from one to three

pages (around 200-1300 words) were selected. Post length was given consideration in order to

have a sufficient sample to analyze, without being overwhelming to the raters. It was also

considered important to have some homogeneity so categorization would not just be based on

cursory feel for terseness or verbosity.

Medians were calculated for number of blogger followers in both groups (i.e., ≤ 99

followers and >100 followers). In the Blogspot selection for the ASD group, four blogs closest to

the median were selected for ≤ 99 followers and three blogs closest to the median for the >100

followers. In the Wordpress selection for the ASD group, three blogs closest to the median were

selected for ≤ 99 followers and four blogs closest to the median for the >100 followers. In the

Blogspot selection for the TD group, three blogs closest to the median were selected for ≤ 99

followers and three blogs closest to the median for the >100 followers. In the Wordpress

selection for the TD group, three blogs closest to the median were selected for ≤ 99 followers

and three blogs closest to the median for the >100 followers.

A rubric was created to examine ToM within the posts (See Appendix). The rubric

measures potential instances of explicit ToM, potential instances of implicit ToM, and figurative

language use (i.e., puns, sarcasm/irony, idioms, hyperbole, and metaphors) that may be

commonly found in blogs. Explicit forms are statements which assign another person a mental or

emotional state (e.g., "I could see that she thought I had lost my mind."). Implicit forms include

using textual tools to convey hidden meaning (i.e., italicizing, capitalizing, and use of emoticons)

and statements used to clarify something that was otherwise unclear (i.e., an aside used to clarify a statement).

Procedure

The 26 blog posts were selected and redacted by the thesis advisor to eliminate explicit references to diagnosis and any potential identifying information, as requested by the IRB. Thus mentions of Asperger Syndrome, personal information (e.g., proper names, emails, user IDs), and other identifying features (e.g., city names, local store names) were redacted. Redacted posts were then assigned a number. Two raters, the principal researcher and a research associate, both with IRB approval and CITI clearance examined the language in 26 redacted blog posts using a rubric devised for this experiment.

The rubric was devised by the principal investigator, tested, and revised to increase inter-rater reliability. An initial rubric had very poor inter-rater reliability, likely due to the ambiguous criteria for coding. A second rubric (see Appendix) was then devised by the principal investigator and the research associate. The second rubric had more concrete, quantifiable items that led to better agreement.

Raters were given the redacted blogs and asked to rate each blog post using the rubric. Raters were instructed on the definition of ToM and potential examples of ToM from the rubric were explained. The rubric contained both explicit and implicit forms of ToM, as well as commonly used figurative language. Raters then independently made notations on the blogs of any item from the rubric being present within the blog. The raters discussed the validity of the notations and agreement was reached. Any item that was not agreed on was excluded. There were no such instances.

ASPERGER SYNDROME AND BLOGGING

Metaphors and idioms were discussed once again by the two raters and the thesis advisor. All metaphors and idioms that occurred within the blogs were classified as dead metaphor/idiomatic expression or creative/live metaphor. It was thought to be important to distinguish between the two because many metaphors are now considered to be idiomatic or dead, could just be looked up in a "mental dictionary" and do not entail any special creative construction as might be needed for a true metaphor. For example, something like "It is raining cats and dogs" or "I didn't catch your name" is unlikely to be literally interpreted by an adult, but it is also not a novel, metaphoric use of language. On the other hand, a creative metaphor or live metaphor (e.g., time personified as a thief), is a novel use of language that requires a deeper understanding of language. This type of metaphor is more likely to reflect true figurative language understanding. The thesis advisor was included in this portion of the coding, because of her greater experience in psychology of language (e.g., Tartter, 1998) and to allow for a majority agreement in any case where the two original raters had disagreed or been unsure of what constitutes a "true" metaphor versus an idiomatic one.

The thesis advisor then broke the code for the principal investigator, revealing the condition of each blogger. The blogs were then statistically compared for demonstrations of ToM using SPSS.

Results

A total of 12 TD blogs and 14 Asperger Syndrome blogs were analyzed. Because only one emoticon was used across all the blogs, emoticons as a category were removed from further consideration. For each of the remaining categories, the blogs were un-blinded as to population of writer, and the frequency of occurrence in that category in the population was tallied. Shapiro

ASPERGER SYNDROME AND BLOGGING

Wilk tests of normality confirmed that all variables were non-normally distributed (p<.05), with

the exception of Asides (p=.062). Non-parametric Levene's tests verified equality of variance

(homogeneity of variance) for all variables tested (p>.05). The bloggers were then ranked

according to frequency of occurrence on each variable

Mann-Whitney tests were run to compare frequency of ToM indicators with blogger

population (i.e., not having Asperger Syndrome and having Asperger Syndrome). For all but

Hyperbole and Asides, TD bloggers used ToM indicators more frequently in their writing than

AS bloggers. However, no significant ToM differences were found between TD bloggers and AS

bloggers, except in the case of font formatting. Font formatting was found to be used

significantly more by TD bloggers than by AS bloggers ($p = .041$). Non-parametric effect sizes

were calculated for further comparison. Table 1 illustrates the similarities in ToM indicators

between bloggers with AS and TD bloggers.

ASPERGER SYNDROME AND BLOGGING

Table 1. *Mean Frequency of Theory of Mind Indicators as a Function of Group Status*

Theory of Mind Indicator	Typically Developing Controls (n=12)	Asperger's Syndrome (n=14)	Mann-Whitney U Test	Effect Size (*r*)
	Mean (Std. Dev)	**Mean** (Std. Dev)		
Mental State References	**.75** (.62)	**.64** (.93)	ns	-.16
Idioms	**2.50** (3.48)	**1.71** (1.86)	ns	-.06
Hyperbole	**.17** (.39)	**.57** (.94)	ns	-.23
Irony/Sarcasm	**.42** (.67)	**.07** (.27)	ns	-.33
Metaphor	**2.17** (2.52)	**1.79** (2.75)	ns	-.14
Font Formatting	**2.66** (2.77)	**.92** (1.82)	TD > AS, *p* = .041	-.42
Asides	**.67** (.65)	**1.29** (1.07)	ns	-.30

A number of moderate effect sizes suggest that sample size may present an issue. A larger sample may better capture any differences in ToM use. There was a trend toward typically developed women expressing ToM more frequently, but there was no significant difference in usage with the exception of font formatting.

ASPERGER SYNDROME AND BLOGGING

Experiment 2: The EMB Theory and Asperger Syndrome

The second experiment was conducted to investigate the EMB theory. One way to do this is to examine language used by autistic and non-autistic women. Language can represent internal states and reveal an individual's cognition. We often recognize this through the particular use of content words. For example, the frequency of moral and virtue words (e.g., honesty, patience, virtue, and decency) can help trace the cultural importance of morality throughout time (Kesebir & Kesebir, 2012). People can also reveal perceptions through the unconscious use of function words. For example, the frequency of male and female pronoun usage in books can map the shift of the societal status of women in the U.S. (Twenge, Campbell, & Gentile, 2012). More recently, it has been discovered that men and women have subtle differences in the way they communicate verbally. When compared to men, women tend to use function words, cognitive words, and first person pronouns more frequently, while using articles less frequently (Pennebaker, 2011). These changes are subtle and unconscious. For example, Pennebaker points out that even the speeches of Juliet in Shakespeare's *Romeo & Juliet* have hallmarks of being written by a man, despite the flowery, feminine prose often used for the female characters. If the "extreme male brain" theory is correct, then female autistics would likely have a more masculine way of communicating.

To specifically address the idea that increased testosterone is responsible for the masculinization of the brain, social words were examined. In two case studies, Pennebaker, Groom, Loew, and Dabbs (2004) examined the writings of two men who were taking testosterone. One was a female-to-male transgendered individual and the other was a man taking testosterone as a treatment for the loss of upper body strength. At the peak of their testosterone levels, the men used significantly fewer social words than at any other time. When the testosterone levels were at their lowest, the number of social words significantly increased. This

occurred independently of any other language increase expected from testosterone (i.e.,

aggression words, sexual words, or achievement words). Admittedly, this is a case study

involving only two individuals. Nevertheless, if the EMB theory is correct, one might expect to

see fewer social words used by women with an Asperger Syndrome diagnosis, thus more male-

like, than in is seen in women without the diagnosis.

By examining the language of female bloggers, we can capture a natural, unsolicited

form of communication. With social or function word use, we are looking at something that is

largely out of conscious control. Blogs are ideal format to examine language because they

provide an unobtrusive view into a person's thinking. This is especially important as gender

differences in speech have been most apparent in unconstrained language (Newman, Groom,

Handelman, & Pennebaker, 2008).

Two studies using separate samples were conducted to investigate the EMB theory. The

first study processed the language of the 26 blogs from the ToM experiment (Experiment 1). The

second study involved a larger sample of blogs, as a replication with greater n, to check if the

ToM sample was significantly different from the larger sample. It was hypothesized that a "male

brain" would lend itself to a male language pattern within the blogs. A male language pattern

would consist of more articles and fewer function words, first-person pronouns, social words and

cognitive words.

ASPERGER SYNDROME AND BLOGGING

Study 1

Methods.

Materials

The 26 blog entries selected from Wordpress.com and Blogspot.com for Experiment 1 were analyzed. As may be recalled, a total of 14 entries were written by women who identified as having AS and 12 entries were written by assumed TD women (i.e., had no mention of AS within their blog site). For further details on blog selection see Materials for Experiment 1.

The Linguistic Inquiry and Word Count (LIWC) 2007 program was used to analyze text from blogs. LIWC is language analysis software that counts words in psychologically meaningful categories. The output of the program yields a general descriptive category, (i.e., total word count, words per sentence, and percent of words longer than six letters), rates of linguistic dimensions (e.g., pronouns, articles, auxiliary verbs, etc.), 32 word categories meant to capture psychological constructs (e.g., affect, cognition, biological processes), seven personal concern categories (e.g., work, home, leisure activities), three paralinguistic dimensions (assents, fillers, non-fluencies), and 12 punctuation categories (periods, commas, etc). The most recent LIWC2007 dictionary contains nearly 4,500 words and word stems. These words are contained in common usage categories. For example, the word "cried" would fall into five different categories: overall affect, negative emotion, sadness, verbs, and past tense verb.

Procedure

The 26 redacted blogs from Experiment 1 were processed through LIWC 2007. Rates of function words, first person pronouns, articles, social words, and cognitive words were compared

between the TD bloggers and the self-identified AS bloggers. Total word count was also compared to ensure that both the TD and Asperger Syndrome groups were similar with regard to blog length. Results of the LIWC analysis were run through SPSS to obtain measures of central tendency and significance testing in Independent *t*-tests.

Results.

A total of 12 TD blogs and 14 Asperger Syndrome blogs were analyzed. Shapiro-Wilk tests of normality confirmed normal distribution for all variables ($p > .05$), except function word usage by Asperger's bloggers ($p = .016$). Levene's tests confirmed homogeneity of variance ($p > .05$), with the exception of Word Count ($p = .04$).

Independent sample *t*-tests were then run for all variables, none of which reached significance ($p > .05$), indicating no difference in typical female language patterns between the TD bloggers and the Asperger Syndrome bloggers. Parametric effect sizes were calculated. Table 2 illustrates the similarities between Asperger Syndrome language use and TD blogger language use for each of the Female/Male language categories.

Table 2. *Female/Male Language Pattern in Redacted Blogs*

	Condition	**Mean** (Std. Dev.)	Effect Size (*d*)
Word Count	No Asperger's	**565.25** (311.67)	
	Asperger's	**574.71** (156.35)	.04
Function Words	No Asperger's	**60.42** (3.18)	
	Asperger's*	***61.29** (4.41)*	.23
First Person Pronouns	*No Asperger's**	***10.42** (2.81)*	
	Asperger's	**8.29** (3.27)	.70
Articles	No Asperger's	**5.17** (1.47)	
	Asperger's*	***4.86** (1.29)*	.22
Social Words	No Asperger's	**8.17** (2.48)	
	Asperger's*	***9.86** (4.06)*	.50
Cognitive Words	No Asperger's	**18.17** (3.10)	
	Asperger's*	***19.79** (2.67)*	.56

*Italicized group indicates a more female style

Study 2

Methods.

Materials

From the initial pool of 69 blog sites with authors who identified as having Asperger

Syndrome and 65 blog sites with authors who had no mention of Asperger Syndrome from

Wordpress.com and Blogspot.com, 43 sites were selected for this study. The web addresses of

the blog sites were recorded and the number of followers per site was noted. Once the redacted

blogs from Study 1 were decoded, the authors were made known. The blog authors from Study 1

were then removed from selection for the replication study.

As in Study 1, only female bloggers were selected due to the overwhelming majority of

female bloggers. Word count was limited to match the range from Study 1 (200 to 1300 words

per post). A total of 17 blogs written by self-identified women with Asperger Syndrome and 26

blogs written by presumed TD women (i.e., no mention of AS within the blog site) were

selected. These blogs were not redacted for de-identification purposes, since they would only be

examined by a computer program, with its output, aggregated and de-identified data.

LIWC was used once again to determine total word count and rates of function words,

first person pronouns, articles, social words, and cognitive words for the TD bloggers and self-

identified AS bloggers.

Procedure

Blogs were selected by the principal investigator and analyzed using LIWC. Total word,

function word, first person pronoun, social word, article, and cognitive word usage were

compared between female TD bloggers and female Asperger Syndrome bloggers. The results

were analyzed using SPSS as before.

Results.

A total of 26 TD blogs and 17 Asperger Syndrome blogs were analyzed. Shapiro-Wilk

tests of normality confirmed normal distributions ($p > .05$), with the exception of word count (p

$< .05$). Levene's tests confirmed homogeneity of variance of all variables ($p > .05$), except within

ASPERGER SYNDROME AND BLOGGING

Social Words (p = .009). Independent sample *t*-tests were run for each variable. No significant

differences were found between TD and Asperger language use (p >.05). Parametric effect sizes

were calculated for each of the linguistic categories. Table 3 illustrates the similarities found on

each linguistic category between TD and Asperger Syndrome bloggers and their respective effect

sizes.

Table 3. *Female/Male Language Pattern in Replication Blogs*

	Condition*	**Mean** (Std. Dev.)	Effect Size (*d*)
Word Count	No Asperger's	**604.08** (279.18)	
	Asperger's	**720.24** (328.81)	.39
Function Words	No Asperger's	**58.99** (4.01)	
	*Asperger's**	*59.91 (4.00)*	.23
First Person Pronouns	No Asperger's	**6.27** (2.89)	
	*Asperger's**	*7.82 (2.01)*	.60
Articles	No Asperger's	*6.82 (1.86)*	
	*Asperger's**	**6.52** (1.28)	.18
Social Words	*No Asperger's**	*8.73 (3.62)*	
	Asperger's	**7.80** (2.19)	.30
Cognitive Words	No Asperger's	**17.73** (3.01)	
	*Asperger's**	*18.83 (3.23)*	.35

*Italicized group indicates a more female style

Despite not being significant, Study 1 and Study 2 showed a trend toward self-identified

Asperger Syndrome women using a more female writing style when compared to the assumed

TD women as evidenced by the means of each category (e.g., articles, first person pronoun, social words).

Discussion

Two prominent theories of autism posited by Baron-Cohen, Leslie, and Frith (1985) and Baron-Cohen, Knickmeyer, and Belmonte (2005) were tested. Language use within blogs composed by self-identified individuals with Asperger's Syndrome and individuals not so identifying were compared. Blogs were selected to be approximately the same length, equally represented for popularity ($\leq$ 99 followers and >100 followers), and written by women, as women constitute a majority of the blogging population on the two popular blog sites. Language was examined to test whether there is differential awareness of the communicative needs of others, through ToM signified language, and whether there is a differentially gendered pattern of language use.

In Experiment 1, several indicators of ToM were compared between AS bloggers and TD bloggers. Research supports that people on the autistic spectrum have difficulty with ToM. It was hypothesized that if ToM was lacking for the AS bloggers, it would become apparent through decreased use of creative figurative language and fewer remarks on the understanding of another's perspective. No such differences were found in this experiment; however, there were a number of moderate effect sizes. A larger sample may better capture any differences that exist. It is possible that for a select few, ToM is not as severely impaired, or perhaps corrects with maturity. Autism is marked by varying levels of impairment in different aspects of functioning. Perhaps there is a protective factor, either socialized or genetic, that leaves ToM relatively intact in high-functioning women. Or perhaps, higher-functioning women develop learning strategies

that make up for an initial ToM lag. The choice to blog itself may be a demonstration of this.

Blogging is a way of reaching out to others. Successful blogs, ones that are read and enjoyed,

require an understanding of how to communicate in a way that will draw people in. For the

women who self-identified as having Asperger Syndrome, the choice to blog defies the

stereotype of autism.

It must be mentioned, however, that during the coding process, the two raters

encountered a few blogs that were difficult to read through. The writing style of these blogs had

a quality that made them seem clunky and, in one case, alienating to the readers. An example of

this was through the use of strained metaphors. In one case, tasting a favorite dessert was

compared to an exploding symphony. Another blog repeatedly made use of strained warrior

metaphors (e.g., speaking out on the front lines, wearing heavy armor of Truth) and confusingly

attempted to deify concepts by capitalizing them (e.g., Truth). These blogs were found to have

been written by self-identified Asperger Syndrome women. While generally ToM in the

language measures was present, there remained a noticeable, yet unidentified, awkward quality

to the writing in a few cases. It is possible there is a particular trait of autism, outside of ToM

deficiency, that disrupts a fluid communication style. Future research into this topic would be

greatly recommended.

In Experiment 2, the EMB theory of autism was tested. EMB theory hypothesizes that

autistic individuals possess "hyper-masculinized" brains, maybe caused by increased testosterone

exposure in utero. In order to assess this theory, particular language categories associated with

gender were compared between TD female bloggers and female AS bloggers. It was

hypothesized that a masculinized brain would be apparent through the use of a masculine

language pattern. Masculine language would consist of a decreased use of function words, first

person pronouns, social words, and cognitive words, with an increased use of articles. Social words were of particular importance, as Pennebaker (2004) found that social words in particular decreased, as testosterone level increased.

In Study 1 of Experiment 2, the two aforementioned groups of bloggers were compared on male/female language use. No significant differences were found, but there was a trend toward a more female language style for the Asperger women, indicating that the EMB theory may be inaccurate in its portrayal of autistic brain functioning. In fact, social words were found to have been slightly greater in frequency, although not significantly, for the Asperger Syndrome bloggers. If the EMB theory was correct, we would have expected to see the opposite effect. Study 2 was performed as a replication of Study 1 where different bloggers were selected and the sample size was increased. Again, no significant differences were found, but the same trend toward a more female language style held for the Asperger women. In both studies the self-identified Asperger bloggers had increased average rates of function words and cognitive words, with a lower frequency of article use, indicative of a female language style. This is not what one would expect to find if the EMB theory were accurate.

However, it must be repeated that the autistic sample for this study was limited to self-identified, high-functioning women who chose to blog. Interpretations of results must be used with caution. Future studies would be advised to confirm the diagnoses of autistic participants. Another suggestion would be to include males in the study. Due to the minority of male bloggers, no male writing comparisons were analyzed for these experiments. There may be differences in the way male autistics express themselves when compared to TD males. It is believed that in future, more naturalistic and less contrived experiments will help us to better understand ASD cognition and its potential developmental changes.

The experiments conducted help to illustrate potential limitations in how we currently measure and perceive autistic functioning. In Experiment 1, no significant differences were found, indicating that there may not be a great disparity in ToM for high-functioning women on the spectrum. However, there were several moderate effect sizes that may indicate differences in ToM usage if the sample size were increased. By looking at ToM through less contrived means (e.g., elicited response tasks), we are afforded a more nuanced insight into how ToM operates for those with ASD. Studies 1 and 2 of Experiment 2 found no evidence to support the EMB theory. Despite not reaching significance, the trend of self-identified Asperger Syndrome women using a more female writing style is not what would be expected if the EMB theory were true. The accurate interpretations of test results are crucially dependent on the methods used. In using alternate methods of examination, the proposed ToM deficit and the EMB theory have not been found to be a precise representation of autistic functioning.

ASPERGER SYNDROME AND BLOGGING

Appendix

Scoring Rubric

Blog Site _____ Blog #_____

Please indicate on the blog where each item occurs.

Does the entry include…?

1. A pun…………………………….……...…………...…..[   ] Yes [   ] No

    If yes then how many times was this used? _____

2. Irony/Sarcasm…………………….……...…………...…..[   ] Yes [   ] No

    If yes then how many times was this used? _____

3. An idiom……………………………...……...…………...….[   ] Yes [   ] No

    If yes then how many times was this used? _____

4. Hyperbole………………………...……...……..………...[   ] Yes [   ] No

    If yes then how many times was this used? _____

5. Metaphor/Simile/Personification…..…..……...…………...…..[   ] Yes [   ] No

    If yes then how many times was this used? _____

6. Emoticons………………………….……………………...[   ] Yes [   ] No

    If yes then…

    Was it used to express convey a meaning (e.g., a joking statement or softening a seemingly harsh statement?...[   ] Yes [   ] No

        If yes then how many times was this used? _____

7. Font Formatting (i.e., italicizing, bolding, or underlining)……...[   ] Yes [   ] No
    If yes then…

ASPERGER SYNDROME AND BLOGGING

Was it used to convey a meaning? (e.g., a joking statement, an emotion, or sarcasm)…………………………………………………....[   ] Yes [   ] No

If yes then how many times was this used? _____

8. Capitalization of an entire word for emphasis………..……..…..[   ] Yes [   ] No

If yes then how many times was this used? _____

9. Assigning a mental state to another………………………........[   ] Yes [   ] No
If yes then how many times did this occur? _____

Notes: _____

_____

10. Assigning an emotional state to another.......................................[   ] Yes [   ] No
If yes then, how many times did this occur? _____

Notes:_____

_____

11. An aside or statement used to clarify the author's meaning (set off by dashes, parentheses, or some other such punctuation)................................[   ] Yes [   ] No

Notes:_____

_____

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ASPERGER SYNDROME AND BLOGGING

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