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ASPERGER'S SYNDROME AND METAMEMORY: HOW WELL CAN ONE CHILD PREDICT HIS KNOWLEDGE OF THE WORLD AROUND HIM?

By

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We investigated whether a child with Asperger's Syndrome would demonstrate deficits in awareness of cognitive processing similar to those demonstrated for awareness of social interactions. The cognitive processes examined were memory and metamemory, or knowing about knowing. With regard to procedural metamemory, the child was unable to accurately predict his own memory, particularly which items he would not be able to recall. Declarative metamemory also was impaired. Tasks requiring imitation of the researcher or that were largely nonverbal resulted in particularly poor performance. The findings indicate that the child's social deficits related to Asperger's Syndrome extended to the cognitive domain. Overall, a deficit in cognitive awareness was observed.

DEDICATION

This work is dedicated to my loving husband, Casey Bell, for his endless support, guidance, and commitment. Without your strength this would not have been possible. Also, to my parents for their constant encouragement and love, to my grandmother for being my shining light, to my brother for always challenging me to do my best, to my beautiful niece, Lynleigh Burt, for all the joy, and to my number one fan, Manda Smith, for her unwavering support, her constant laughter, and her endless belief in my achievement.

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CHAPTER I

INTRODUCTION

Imagine a child who is standing outside on the playground watching other children as they run by. You might ask yourself, what is wrong with the child and why is he not playing with the other children? You might even assume the child is being defiant or odd. Yet, to a child with Asperger's Syndrome, it is the activity of the other children that is odd. The ability to interact and socialize with other individuals is a concept that is hard for a child with Asperger's Syndrome (AS) to comprehend or master. They are unaware of their interactions with others and the impact of their interactions. Their approach to other people often seems inappropriate and peculiar, and they are seen as being insensitive to others (Klin & Volkmar, 1997). According to Portway and Johnson (2005), children with Asperger's Syndrome become vulnerable to the risk of being bullied, ridiculed, and rejected because others may not understand their behavior. Trying to converse with a child diagnosed with Asperger's Syndrome can at times be difficult and frustrating, but being educated about the diagnosis and learning the child's strengths can better equip individuals interacting with these children (Bashe & Kirby, 2005).

The *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR*; APA, 2000) describes Asperger's Syndrome as a severe and constant impairment in social functioning, with repetitive behaviors and activities. Children with Asperger's Syndrome display marked impairment in social interaction without evidencing an awareness of the impairment (APA, 2000). In our study, the question was asked whether the lack of social awareness can be translated to a lack of cognitive awareness. In other words, do children with Asperger's Syndrome demonstrate deficits in awareness of cognitive processing similar to those demonstrated for social interaction? The cognitive processes we investigated were memory and awareness of memory, or metamemory. We discuss the potential link between the deficits observed in Asperger's Syndrome and metamemory. First, however, it is important to understand the nature of the disorder itself.

Asperger's Syndrome

Asperger's Syndrome is one of the five Pervasive Developmental Disorders (Bashe & Kirby, 2005). Hans Asperger first identified Asperger's Syndrome in the early 1940's. In 1944, Asperger conducted a study with 4 children whose ages ranged from 6 to 11 years. The group of children displayed difficulties in social integration, but showed no deficit in cognitive or verbal ability (Klin & Volkmar, 1997). Features of Asperger's Syndrome are similar to those of Autism, but they are two distinct disorders. The two disorders do share a common characteristic in that social integration is impaired for both. However, impairment of social integration tends to be more prominent in Asperger's Syndrome and, as such, is the key criterion of the disorder (APA, 2000). Conversely, children with Autism tend to be more impaired in verbal communication and intelligence compared to children with Asperger's Syndrome. Tsatsanis (2004) found that individuals with Asperger's Syndrome are generally of normal intelligence, while those with Autism tend to be of lower intelligence, although there are cases of superior intellect associated with Autism. Several defining features are associated with Asperger's Syndrome, including impairment in nonverbal communication, idiosyncrasies in verbal communication patterns, and conduct problems (Klin & Volkmar, 1997). The age of onset in Asperger's Syndrome is around three years and is predominantly found in males (Bashe & Kirby, 2005; Klin & Volkmar, 1997; Portway & Johnson, 2005; Tsatsanis, 2004).

Children with Asperger's Syndrome have been found to have no developmental difficulty in acquiring grammar, despite impairment in social communication (Tsatsanis, 2004). In fact, they display noticeable verbosity and have shown excellent memory ability when dealing with verbal information (Tsatsanis). However, social impairment can interact with memory performance. Bowler, Gardiner, and Berthollier (2004) hypothesized that children and adults with Asperger's Syndrome would perform better on tests of recall when a form of contextual support (e.g., whether the material was presented in a male or female voice) was given during testing than when support was not given. Bowler et al. conducted a study with 32 participants diagnosed with Asperger's Syndrome, with ages ranging from 12 to 46 years old, who were compared to 32 control participants. The participants were asked to study a list of words under two different conditions. For the active condition, participants were asked to perform four tasks relevant to each word. The tasks were to produce a word associated to the word presented, to create a longer word, to think of a word that rhymed with the one presented, or to produce an action associated with the word presented. In the passive condition, the word was presented in one of four different ways, either at the top or bottom of a computer screen or in a male or female voice. During the testing session, the participant reported if they had seen or heard the word before. If the word was reported as having been seen or heard, one group was offered support from an experimenter in selecting which of the four tasks or styles of presentations were associated with the word on the screen. The second group was offered no support and relied on free recall to report the presentation mode. Bowler et al. found that there was no significant difference between the groups in overall recall. However, the group with Asperger's Syndrome performed more poorly on source identification when they were not provided with experimenter support. For instance, participants with Asperger's Syndrome performed better on tasks of source identification when they were prompted to think about the source of presentation. Bowler et al. concluded that individuals with Asperger's Syndrome might be able to encode the information, but have difficulty using appropriate cues to support retrieval of the information. As such, children with Asperger's Syndrome perform better at tasks when they are given precise instructions on what is expected of them to complete a task (Bowler et al., 2004; Lawson, 2003). Precise instructions also help to alleviate inaccurate results in the classroom, social settings, and other areas (Portway and Johnson, 2005).

Memory and Cognitive Awareness

Despite social impairment, children with Asperger's Syndrome have the ability to perceive, store, and retrieve information in memory (Tsatsanis, 2004). What is not known is whether the documented lack of awareness is specific to social situations or if it is more universal. Perhaps the lack of social awareness extends to a cognitive domain. Brain regions that have been implicated in deficits in social awareness in children with Asperger's Syndrome have also been implicated in deficits in cognitive awareness. According to Coleman (2005), children with Asperger's Syndrome have some impairment in the frontal lobe of the brain, particularly in the anterior regions of the frontal lobe. The frontal lobe is divided into three sections with each section controlling a different aspect of perception. The anterior region is responsible for "processing and directing the development of socially appropriate behavior," (Coleman, 2005). There is also indication of some impairment in the temporal lobe of the brain, particularly in the hippocampal region (Salmond, Ashburner, Connelly, Friston, Gadian, & Vargha-Khadem, 2005). The temporal lobe is responsible for functions such as language, memory, speech, object perception, and recognition. Salmond et al. conducted their study with children diagnosed with Asperger's Syndrome and High Functioning Autism, aged 8 to 18 years, to determine whether there was impairment in episodic memory versus semantic memory, and to see if this impairment could be related to temporal lobe abnormalities as compared to a control group. After completing a series of tasks designed to test memory and attention, the children were submitted to an MRI to evaluate brain abnormalities. The results from the neuropsychological testing revealed that children in the Asperger's Syndrome and High Functioning Autism group performed significantly lower than controls with episodic memory tasks. Results of the MRI reveal that children with Asperger's Syndrome and High Functioning Autism have increased grey matter in the hippocampus regions and fusiform gyrus regions of the temporal lobe, which may lead to impairments in memory, memory judgment, recognition, and so forth. Salmond et al. provided another explanation for the deficit of episodic memory. The researchers suggested that the social component related to episodic memory could be the cause of this deficit. Episodic memory includes emotions tied to a specific memory, and memory of a specific time, place, event, or person. Therefore, episodic memory tends to rely more on innate social aspects than semantic memory.

The brain regions associated with social impairment in children with Asperger's Syndrome have also been implicated in patients with metamemory deficits. Shimamura and Squire (as cited in Metcalfe & Shimamura, 1994) conducted a study with patient diagnosed with Korsakoff's syndrome and other patients with amnesia. Korsakoff's syndrome is marked by a deficiency in vitamin B resulting in an impairment of the thalamus region of the brain located within the temporal lobe. The thalamus region is partly responsible for arousal states. For the study, Korsakoff's patients were presented with general knowledge questions and asked to provide answers to the questions. If the answers were un-recallable, the patients were asked to provide judgments on whether they would be able to recognize the answer from a list of alternatives. The researchers found that patients with Korsakoff's syndrome displayed impairment in their accuracy of judgments about whether they could recall the answers to the questions. As such, patients with Korsakoff's syndrome were unaware of what he or she did or did not know. The regions of the brain, such as the frontal and temporal regions, appear to not only influence the way aspects of the environment are perceived, stored, and retrieved, but also social and cognitive awareness. The similarities in impairment as a result of brain regions and social impairment led to the question of whether impairment in social awareness in children with Asperger's Syndrome is associated with impairment in cognitive awareness. Our study looks at how well a child with Asperger's Syndrome can perform memory tasks, but also how aware he is of his memory ability. Not only do we want to know what information he knows, but also whether he is aware that he knows the information.

Metamemory

Awareness of memory ability is central to the concept of metamemory. Defined as knowing about knowing, metamemory was first investigated in children by Flavell and Wellman (1977). Although the concept of metamemory has been in literature since the early 1900's, Flavell provided the term "metamemory." Flavell and Wellman were also the first to make a connection between social awareness and cognitive awareness by categorizing metamemory as a type of social cognition. Researchers first focused on the development of metamemory. For instance, early studies asked children of different ages to predict how many items on a list they would be able to recall at a later time (e.g., Butterfield, Nelson, & Peck, 1988; Wellman, 1977). Wellman conducted a study to assess development of metamemory across young childhood. Children enrolled in kindergarten through third grade, were asked to name pictures. If the child could not name the picture, they were asked if they could recognize the item pictured at a later time and also whether they had ever seen the item before. The results showed that third graders were more likely to accurately predict that they would be able to recognize the item at a later time if it had been previously seen. Conversely, kindergartners were less likely to accurately judge whether they would be able to recognize the item at a later time. Wellman concluded that there appears to be a striking increase with age in a child’s accuracy and ability in predicting which items they would be able to recall at a later time. In other words, older children are better able to evaluate their memory than younger children.

Studies of metamemory in children led to the development of a taxonomy that distinguishes between procedural and declarative metamemory (Flavell & Wellman, 1977; Schneider & Lockl, 2002). Procedural metamemory refers to knowing about the state of ones memory processes, such as how well you have learned some information and whether information will be available for later recall. The relevant literature on the development of procedural metamemory will be discussed after a review of the literature regarding declarative metamemory.

Declarative metamemory examines knowledge about one’s own memory globally rather than specific to a single process. Knowing you are better at remembering visual rather than auditory information is an example of declarative metamemory. As such, declarative metamemory is not specific to a particular memory process. Declarative metamemory is evaluated in terms of accuracy, or the correct response to the specific scenario or task. It is examined within three variable categories: person, task, and strategy. Person variables include knowledge about the memory ability of particular individuals. For instance, a four-year-old might be asked which person would be most likely to remember a long list: a two-, four -, or six-year-old. Task variables include knowledge about how aspects of a memory task (e.g., rehearsal for 5 minutes or 15 minutes) or materials (e.g., items on a list are categorically related or not) impact memory ability. For example, a child might be asked whether a list of seven or a list of 12 words would be easier to remember. Strategy variables include knowledge of what factors can help to enhance memory and recall. For example, a child may know that writing a note to remind him to bring his baseball cards to show-and-tell would improve his memory for doing so. For the purpose of our study we focused on person and task variables, as well as the combination of the two.

Yussen and Bird (1979) conducted a study to evaluate children's declarative metacognitive ability. The researchers wanted to see how well children understood that certain cognitive attributes can aid in making cognitive tasks easier or harder and whether this understanding developed over the course of early childhood. The study consisted of 36 children divided into two age groups: 4- and 6-year-olds. First, Yussen and Bird examined the level of understanding in the children regarding the impact of four variables (e.g., length, noise, time, and age) on memory. For example, whether a 6-year-old who is presented with a picture depicting a child learning a list of words knows that a list with three words (e.g., length variable) is easier to remember than a list of nine words. The children in the study were presented with two pairs of pictures in which a young girl is engaged in a memory task. For instance, in one picture a young girl is attempting to remember three pictures, whereas in another picture the young girl is attempting to remember ten pictures. After presentation of the pictures, each child was asked, "Which girl has the harder job of (doing the task)?" and to give a reason for their choice. Yussen and Bird found that 6-year-olds were significantly better at accurately judging the pictures than the 4-year-olds. The researchers concluded that children's ability to understand the impact of certain variables on memory increases with age.

Evaluation of Metamemory

In the study, several tests were developed to evaluate the child's declarative metamemory (as discussed in Methods). Most studies have found that development of accuracy for declarative metamemory is maximized at around the age of 10 to 11 years old (e.g., Flavell and Wellman, 1977; Schneider, 1999; Schneider & Lockl, 2002). Accuracy findings in the literature for children without Asperger's Syndrome were compared to those of the case study. Because the child was 11 years old, any decrements in accuracy as compared to non-Asperger's Syndrome children could be attributed to developmental delays in declarative metamemory.

In contrast to declarative metamemory, procedural metamemory measures knowing about the current state of ones memory processes, such as how well you have learned some information and whether information will be available for later recall. For example, during study of a list of words, you might be asked to make predictions about your future memory for items on the list. A framework for examining procedural metamemory was provided by Nelson and Narens (1990). The framework organizes metamemory predictions around the three processes of memory: encoding, storage, and retrieval. For instance, predictions made at encoding include *Judgments of Learning* (JOLs), whereas predictions made at retrieval include *Feeling of Knowing* judgments (FOKs). One role of procedural metamemory is to monitor memory processes and direct strategies to impact the process outcome. For instance, if an individual studying for an exam senses metamorially that the information has not been learned well enough to pass the exam, then a strategy would be employed, such as to study longer. Typically, predictions about procedural metamemory are made using a probability scale of 0 to 100, although historically many studies used likert type scales (e.g., Hart, 1965; Koriat, Lichtenstein, & Fishchoff, 1980; Lockl & Schneider, 2002). Procedural metamemory is evaluated in terms of sensitivity and accuracy. Sensitivity refers to the magnitude of the predictions in response to characteristics of the materials. For instance, prediction magnitude for memory of concrete versus abstract words on a list can be compared. Accuracy refers to the correlation of predicted to actual memory outcome. If a high prediction is given for a word and that word is remembered, metamemory accuracy for that item is high. In the current study, two types of procedural metamemory were tested: JOL and FOK judgments.

JOLs are made at encoding and are predictions about memory for newly learned information. When testing for JOL accuracy, the participant typically is presented with two pieces of new information that they must learn to link together. For instance, participants might be asked to learn to link two unrelated words (e.g., frog – table). After each pair of items is studied, the first item in the pair is presented and the participant is asked to predict whether he or she will be able to remember the second item in the pair on a subsequent memory test. JOL predictions are made right after studying the pairs on an item-by-item basis. After JOLs have been collected on all items, the first item in the pair is presented again, and the task is to recall the second item. The typical finding is that people are relatively good at making accurate JOLs (e.g., Nelson & Dunlosky, 1991; King, Zechmeister, & Shaughnessy, 1980; Koriat & Bjork, 2005).

Koriat and Shitzer-Reichert (2002) examined procedural metamemory in children by testing whether JOL accuracy increased with practice. Thirty-two second graders and 32 fourth graders with the mean age ranging from seven to nine years studied word pairs. They then made JOL predictions about memory for the second item in the pair, given the first item. After each word was presented, their memory for the second item was tested. Testing sessions were repeated for a total of three sessions. Koriat and Shitzer-Reichert found that JOL predictions increased over the four trials for both age groups, indicating that practice helps to facilitate accuracy of JOL predictions. Although the second graders' predictions continued to increase with the four trials, the fourth graders' JOL predictions were more accurate. In the current study, procedural metamemory was examined at encoding using JOLs, but metamemory ability at retrieval also was examined by using FOKs.

FOKs are predictions about future recognition of currently unrecalled information. The experimental paradigm for examining FOKs was pioneered by Hart (1965), and is known as the recall-judge-recognize (RJR) procedure. FOKs can be made on either newly learned information or prior knowledge, and are made after a recall attempt. The general procedure for FOKs is such that participants answer questions about either newly learned information (e.g., word pairs) or previous knowledge (e.g., general knowledge questions). Then, for items for which participants are unable to provide a correct answer, participants make FOKs about how well they will be able to recognize the answer from among several alternatives. Finally, a recognition test is given for each item. Sometimes participants provide FOKs for all items, not just the unrecalled items, in order to avoid providing feedback about their recall performance prior to collecting predictions. The typical finding is that people are fairly accurate in predicting memory for information that is not recallable at the time of prediction (e.g., Cultice, Somerville, & Wellman, 1983; Hart, 1965; Nelson, Leonesio, Landwehr, & Narens, 1986; Wellman, 1977).

Brown and Lawton (1977) assessed FOK accuracy in educable retarded children by presenting 100 pictures of from children's books, television, pop, and news magazines in order to assess FOK accuracy in children. The children were asked to name each picture. For each picture in which the name could not be recalled, the children were presented with the pictures and asked to make FOKs about whether they would be able to recall the name of picture when presented with a list of alternatives. The study showed that older children (e.g., 11 to 14 year olds) produce more accurate FOK judgments than were younger children (e.g., 7 to 11 year olds). The few studies of procedural metamemory in children have found that accuracy increases across age, with development completed at early adolescence (e.g., Brown & Lawton, but see Butterfield, Nelson, & Peck, 1988; Lockl & Schneider, 2002).

Purpose of the Study

The current study was designed to measure both procedural and declarative metamemory for an 11-year-old boy who has been diagnosed with Asperger's Syndrome. As such, a series of tasks was designed to test both types in a fun and entertaining way. It is important to test both types of metamemory, because it may be the case that a child with Asperger's Syndrome will demonstrate ability in one type of metamemory over the other. Procedural metamemory requires the individual to monitor his or her own cognitive ability and does not require knowledge of another individual's cognitive ability. Because procedural metamemory does not have a strong social component it is predicted that this type of metamemory may not be impaired. Declarative metamemory, however, does require an understanding of another individual's cognitive ability. As such, impairment in declarative metamemory might be observed, paralleling that observed in social interaction with Asperger's Syndrome. A deficit in both procedural and declarative metamemory could be observed if the underlying mechanism for cognitive and social awareness is the same. Conversely, no deficits in either type of metamemory might be observed if there is no link between cognitive and social awareness.

Also, because of the known deficits with interpreting social situations, the tasks were varied in terms of the degree to which they were imitative and/or non verbal in nature. We did not want to unduly handicap the child with tasks that did not draw on his strengths, and in addition, we wanted to determine whether imitation components in some way affected metamemory. Imitative tasks involved the child interacting with the experimenter and interpreting body movement from another person in order to learn the information. Thus, perhaps a lack of cognitive awareness would occur for the imitative, but not the nonimitative tasks.

CHAPTER II

METHOD

Participant and Design

The present study was a single case study with an 11-year-old boy who had been clinically diagnosed with Asperger's Syndrome at the age of 10, by a licensed neuropsychologist. At diagnosis the parents reported a history of normal education. Although the child was tutored in reading and other subjects, no special education was needed. At time of diagnosis and testing the child was in the sixth grade and his school performance was average, with grades ranging from A's to C's. The parents reported a history of difficulty with the child completing homework assignments, particularly if the child felt the assignment was too difficult. In those cases, he was reluctant to try. The parents also reported difficulty in social interactions in school. The child frequently had altercations with other children his age, primarily on the school bus. No problems in the actual school setting were reported. The altercations became disruptive and at the time of testing, the child's parents met weekly with school officials to discuss the situation. The parents reported the altercations were due to a lack of knowledge regarding the social deficits related to their child's disorder on the part of school officials, teachers, and fellow students. The parents reported problems with social interaction at home as well. The child had difficulty with nonverbal communication. His conversations were one sided and egocentric, and he did not maintain personal space. The parents reported that the child often became inattentive during conversations, and that they had difficulty keeping the child on topic when it was not interesting to him.

The Wechsler Intelligence Scale for Children – IV (WISC-IV; Wechsler, 2003), used to measure intelligence in children ages six to sixteen years old, was administered to the child by the neuropsychologist. On the WISC – IV the child performed at an average level on the performance domain and lower than average on the verbal domain. During the WISC – IV, he was interested more in his accomplishments, including how well he performed, than whether he received verbal or social praise. On the Wechsler Individual Achievement Test – II (WIAT-II; Wechsler, 2002), used to measure achievement level in children ages four to nineteen years old, the child's overall achievement aptitude was average. The child was also administered the Comprehensive Assessment of Spoken Language and two areas were impaired for this child: interpretation of language, which includes understanding literal meanings of phrases (e.g., It looks like a tornado has come through this room) and pragmatic language, which includes how a person communicates in social situations (e.g., saying hello). The child had performance difficulty with both areas and was reluctant to participate. The child was also administered the Vineland Adaptive Behavioral Scale (VABS; Sparrow, Balla, & Cicchetti, 1984), which measures personal and social skills from birth to adult. In the areas of communication and daily living skills, coping skills, and socialization, the child performed poorly. His performance in these areas was indicative of his diagnosis of Asperger's Syndrome due to their social-interaction components.

Materials

Incentives

In exchange for participating, we provided the child rewards for his effort. Rewards included stickers, playing cards, drawing pencils, and culminated in a grand prize of a sleeping bag. The rewards were given for his participation and not for providing correct answers.

Procedural Metamemory

Procedural metamemory refers to knowing about the state of ones own memory processes, such as how well you have learned some information and whether that information will be available for later recall. Predictions are made using judgments of learning (JOLs) and feelings of knowing (FOKs). The probability scale on which both types of predictions typically are made ranges from 0 to 100, but for the purpose of our study, judgments for each task were made with a pictorial scale. Procedural and declarative metamemory ability both were measured by a unique set of tasks (see Table 1). The score sheets used for each task, indicating the specific items for every task, are located in Appendix A.

Judgment Scale

Table 1

Task Key: Tasks divided into Judgment Type, Imitative, and Verbal

Task	Judgment Type (JOL,FOK)	Imitative/Nonimitative (I, NI)	Verbal/Nonverbal (V, NV)
Sign Language Game (SLG)	JOL	I	NV
Color Body Movement (CBM)	JOL	I	NV
The Matching Game (TMG)	JOL	NI	V
The Mr. Cucumber Task (MCT)	JOL	NI	V
Musical Instruments Game (MIG)	FOK	I	V
The Movement Task (TMT)	FOK	I	NV
The Game Show Technique (GST)	FOK	NI	V
Bobbins and Woozles (BW)	FOK	NI	V

Tasks are categorized in terms of whether they require the child to imitate the researcher (i.e., imitative, nonimitative) and whether they have a verbal component. Verbal and nonverbal tasks were categorized based on either the item cue or response. For example, the TMG task is categorized as verbal based on response because the child was required to verbally recall the target word. However, the MIG task was imitative and categorized as verbal based on the cue nonsense word which the child would verbalize.

Two pictorial rating scales were developed to assess JOL and FOK judgments. The scales included the Thermometer Scale and the Caterpillar Scale. Both scales were presented as laminated cards for the child to hold. For the Thermometer Scale, the child was asked to make confidence judgments based on the hot/cold game technique. For example, when the child indicated his level of confidence as high or hot (e.g., certainty he will be able to recall the information) he pointed to the thermometers indicating degrees above 50. The Caterpillar Scale ranged from one body circle, indicating the lowest confidence level, to ten body circles, indicating the highest confidence level. For example, if the child indicated his level of confidence as high he would choose the caterpillar with body circles above five. Each pictorial judgment scale was pre-tested with the child to see to which he preferred. During training on the Caterpillar Scale, the child became fixated on the colors, bodies, and legs of the caterpillars and was unable to direct his attention to the purpose of the scale. It was clear that it would not be possible to use the Caterpillar Scale. The child did not demonstrate the same problems with the Thermometer Scale (see Appendix B). He understood the use of the scale and enjoyed using the thermometers. The Thermometer Scale was used throughout the study.

Judgments of Learning (JOLs)

JOLs by definition are predictions about how well one has learned to associate new information. JOLs are made at encoding during a study phase in which new associations are learned, and reflect one's prediction of future recall of the newly associated information (Koriat & Shitzer-Reichert, 2002). As such, each of the tasks developed for measuring JOLs involved associating two pieces of information that were not associated prior to the study.

Sign Language Game (SLG). A sign language game was developed using 15 sign language techniques (see Appendix A). The task was to learn to associate a picture of an object with its sign. For example, a W shape made with three fingers tapping the chin indicates water. There were 15 pictures to represent the 15 signs, and each picture was printed on 4x6-laminated cards.

Color Body Movement (CBM). The CBM task required the child to link each of 15 colors with a particular body movement (see Appendix B). For example, every time the color red was presented, the child learned that he should bend over and touch his knees with his hands. Each color represented a different body movement. Each color was printed on 4x6-laminated cards and the researcher demonstrated the associated body movement.

The Matching Game (TMG). The TMG was developed using 25 cue-target word pairs taken from the Test of Memory and Learning (TOMAL) and new word pairs created specifically for this task (see Appendix C). The word pairs were not semantically associated (e.g., tall and book). Each word was typed on a 5x6-laminated card with the cue word printed in red and the target word in blue. The task was to learn to associate each cue and target in order to be able to match the target to the cue when presented with it at a later time.

Mr. Cucumber Task (MCT). The child was shown a picture displaying Mr. Cucumber (Case, 1985). Mr. Cucumber has two eyes, a nose, two ears, a mouth, hair extensions, arms, and legs. A different shape, such as a square, circle, star, or diamond, was placed on a specific body part of Mr. Cucumber (see Appendix D). The task was to remember which shape was associated with which specific body part. For example, the shape of a square was placed on Mr. Cucumber's leg. Each card contained a different shape placed on Mr. Cucumber. There were 9 5x6-laminated cards displaying Mr. Cucumber and the different color shape and body part.

Feeling of Knowing Judgments (FOKs)

FOK predictions can be made based on newly learned information as well as previously learned information, and are made after a recall attempt on unrecalled items. The predictions assessed the child's confidence about future recognition of the information.

Musical Instruments Game (MIG). The MIG was developed using 16 signs for different common musical instruments (see Appendix E). The task was to learn to associate a nonsense word with a particular musical instrument pantomime. For example, the nonsense word *mumph* indicated the child should place his fingers on the table and create the movement associated with playing the piano. There were 16 nonsense words associated with 16 musical instruments. The 16 nonsense words were printed on 4x6-laminated cards.

The Game Show Technique (GST). Twenty-five general knowledge questions were selected from the child's current textbooks and quizzes (see Appendix F). The questions were chosen based on the child's grade level, reading level and chronological age, and varied in the level of difficulty. The general knowledge questions were printed on 4x6 cards that were pasted on a piece of cardboard with a column for math questions, a column for science questions, and a column for geography questions. The child was allowed to select the card he wanted to answer.

The Movement Task (TMT). The movement task relied on previous knowledge of the color-body movement associations from the CBM task (see Appendix G).The child was asked to recall the body movements he learned during the CBM task, when presented with the color cards. Once FOKs were collected, the child was then asked to choose the correct body movement from between two movements demonstrated by the researcher. Each color was printed on 4x6-laminated cards.

Bobbins and Woozles (BW). The two Bobbins and Woozles illustrated storybooks introduced two types of imaginary animals, one called Bobbins and the other Woozles (see Appendix H). The stories contained information about the individual features, eating habits, and behaviors of the characters. The child was given the choice to learn about Bobbins or to learn about Woozles, and he chose Bobbins. A set of 30 questions were developed to assess the child's knowledge of the newly learned information from the Bobbins story. The task was to learn information related to the story's characters (e.g., what the Bobbins eat).

Declarative Metamemory

Declarative metamemory is not specific to a particular memory process; rather it tests metamemory for another individual's cognitive ability. The type of memory tasks can involve person, task and strategy variables. A task frequently used to evaluate declarative metamemory for person variables involves judging the ability of people of different ages to perform memory tasks. The current study focuses on metamemory for person and task variables, as well as the combination of the two.

Task variable. Task variable components of declarative metamemory were tested using a grocery-shopping task. A large plastic set of 48 typical grocery items, sold for child's play, were used for the task.

Person variable. The Human Pictorial Scale (HPS) was developed to evaluate declarative metamemory for person variables. The HPS consists of a set of 5 5x6 color pictures of individuals ranging in age from an infant, to a toddler, to a cohort child, to a young adult, to an older adult. Each picture was matched in race with the child, also with the cohort child matching in age.

Procedure

The parent(s) were asked to bring the child to the Psychology Clinic located in Magruder Hall on the Mississippi State University campus for testing sessions. Informed consent was obtained from the child's parent, and an assent form was discussed with and signed by the child before proceeding with testing. During the initial visit, the researcher focused on establishing rapport with the child in order to increase cooperation and to facilitate the testing process. During the initial visit, the child also was oriented on the different judgment scales to determine the one he liked best. After rapport was established and the Thermometer Scale was selected, the child and author proceeded to the first task. Upon completion of the first testing session, subsequent testing sessions were scheduled for the upcoming weekends. The actual testing tasks occurred over the course of five visits, each lasting one to two hours. For each subsequent session, the child reported to the psychology clinic as he did for the initial session. Before proceeding to the testing room, the child always was allowed to play with the toys in the waiting room and we discussed the happenings of his day and weekend. Also prior to each session, the father was consulted about any questions or concerns he had from the previous testing sessions. We would then proceed to the experiment room to begin the tasks. During the testing sessions, the order of the tasks presented was predetermined, but flexible. Specific procedures for each task are provided in detail below.

Procedural Metamemory

JOLs. The child was presented with new information in each of the four JOL tasks, including the SLG, CBM, TMG, and the MCT task. Immediately after each item was presented the child was asked to predict whether he would be able to remember the information later using the Thermometer Scale, chosen during the initial testing session. Each JOL was collected on an item-by-item basis. Immediately after JOLs were collected on all items, the first part of each item was presented again, and the task was to demonstrate knowledge for the second part. For instance, for the SLG task, the picture for the sign was presented on a card and the child was asked to make the sign. The procedure was the same for each JOL task, regardless of the specific materials.

FOKs. The general procedure for FOKs is different from JOLs in several ways. For FOKs for previously learned information, the GST and TMT tasks, the general knowledge questions or color cards were presented and the child was asked to answer the question or to provide the appropriate body movement. Items were presented to the child one at a time during the recall phase and he was asked to provide an answer for each item. Once all items had been administered, the child was asked to make FOKs on how well he would be able to recognize the answer to each item from among several alternatives. FOKs were made using the Thermometer Scale. Immediately after the prediction phase, we moved to the recognition phase. During the recognition phase, each item was presented again along with several alternatives. The task was to choose the answer to each item.

The procedure for FOKs for newly learned information, represented by the MIG and BW tasks, was the same with one exception. Prior to the recall phase, there was a learning phase in which the nonsense words or the story were presented in order for the child to learn the information to be tested. Otherwise, the procedure for the FOKs of newly learned information was the same as for previously learned information.

Declarative Metamemory

Task variable. For the grocery-shopping task, the child was read a “shopping” list of 20 items. The child was asked to report how many items on the list that he would remember to buy at the “store” without the list. The child was then sent to the store, which consisted of the 48 plastic grocery items on a table, and was asked to retrieve as many of the 20 list items as he could.

Person variable. After completing each of the procedural metamemory tasks, the child was asked to use the HPS to evaluate how well others would be able to perform the each task. For each of the procedural metamemory tasks described, first the child was asked to choose which individuals would be able complete the tasks. Then, from among pictures he chose, he was asked to rank the pictures in order of ability from best to worst. The HPS was presented for each of the JOL and FOK tasks, as well as the grocery-shopping task.

CHAPTER III

RESULTS

Case Conceptualization

Session One

The first session was held on a Saturday afternoon in the psychology clinic in Magruder Hall on the Mississippi State University campus (all visits were held at the same location). The child presented to the first session carrying his backpack, and appeared cheerful and eager to participate in the tasks assigned for the day. There seemed to be no difficulty establishing rapport. The child and his father were asked to enter the waiting room where there were toys and games available. The child immediately noticed and began to play with the bowling pins and ball. While the child played, I obtained informed consent from the father and arranged future dates and times for testing. I then explained to the child the purpose of the assent form, which was to get his approval to participate in the study and to explain to him his rights as a participant. After explanation, he signed without hesitation. After speaking briefly with the father, I began interacting with the child. He expressed his eagerness to teach me how to bowl, so I played with him for a short time.

The parents had been asked to send the child's backpack from school so that I could obtain information from the child's textbooks for a future task. I asked him to show me some of the books in his backpack. The child immediately responded and was eager to talk about what he had been studying in school. He selected his reading books and his math, science, and geography textbooks. The two reading books were about a popular skateboarder and the game of baseball. The child informed me that he was interested in both skateboarding and baseball, and that his favorite subjects in school were math and science. He freely responded to questions regarding his likes and dislikes. He offered details about his favorite sports, movies, and games. The child reported a strong liking for video games, especially ones involving popular animated characters. His account confirmed reports from the child's parents that he spends much of his free time playing video games. He also reported a strong liking for movies and television. He gave me a detailed description of some of his favorite movies and television programs. He was able to report specific plot lines from beginning to end. He named all of the characters in his favorite movies or television programs without hesitation. After getting oriented with the surroundings, as well as to each other, I decided to begin the first task.

The child was taken into the experiment room and asked to sit at the small table set up for the study. The child was perceptive about the room; he commented on the windows and the chairs. We began with an orientation to the three scales: a) the Thermometer Scale, b) the Caterpillar Scale, and c) the Human Pictorial Scale. The first two scales were described and their use was explained. The child was allowed to pick which scale he preferred, and he chose the Thermometer Scale. This scale was used for the duration of the experiment. The Human Pictorial Scale was also demonstrated and set aside for future use. We then proceeded to the Mr. Cucumber Task.

Mr. Cucumber Task (MCT). During MCT the child was presented with the Mr. Cucumber card and was told that the purpose of the task was to remember which shape was associated with which specific body part. The child was presented with the practice MCT card and immediately commented on the look and shape of Mr. Cucumber. He commented that he looked like an actual cucumber, but didn't understand the hair that was on top of his head. After mastering the practice card we proceeded to the learning phase of the task. During the learning phase the child was presented with Mr. Cucumber cards and asked to learn where each specific shape was located on each card. We proceeded through the learning phase and the child appeared to pay careful attention to detail. For instance, he commented on a difference in Mr. Cucumber's hair from one card to another. During the judgment phase of the MCT, the child began to engage in friendly joking by moving objects in the room (i.e., chair across table). He tried his best to convince me that the chair had moved on its own. I decided to entertain his idea and engage in the friendly joking. It was April Fools' Day, a fact about which the child was aware. The child was responsive and became cheerful, laughing. At one point, he tried to convince me a spider had dropped from the ceiling into my hair. After a brief break, I redirected him to the task. The child proceeded through the judgment phase making his predictions quickly and without question. During the recall phase of the task, the child was attentive and engaging. However, his responses for items were often delayed, even though he correctly recalled all but one item. Upon completion of the MCT task, we entered the HPS phase. The child was presented with five pictures ranging from older adult, to young adult, to cohort child, to toddler, and to infant. The child was asked to first choose which of the five people would be able to complete the MCT task; he chose all five pictures. Next, the child was asked to rank the pictures in order from who would perform the best on the MCT task to who would perform the worst on the MCT task. He ranked the older adult as best and the infant as worst. Asked why the older adult would perform the best, he stated, "he would have done it already" and why the infant the worst, he stated, "because babies aren't ready for advanced levels."

Before the session began, the child had been informed that there were prizes he would receive for completing each task. The goal was to provide a motivating factor for the child to focus on each task, as well as to reward him for his participation. After the session was finished, the child and I entered into the clinic hallway where the child was able to retrieve his prize for the day. Immediately after opening the box, the child began to play with the new toys.

Session Two

The second session was held on a Monday afternoon after the child's school day. The child presented to the second session appearing fatigued, but eager to participate in the tasks assigned for the day. The child was forthcoming and discussed various video games he had played at home after school. He was knowledgeable about one game and gave details about the names for each character, as well as their special powers and abilities, including game strategy techniques. After a short discussion, I began the session. I began the session with a brief review of the Thermometer Scale and the Human Pictorial Scale. He remembered the purpose and use of each scale, and no further training on the scales was necessary. We began the first task.

The Matching Game (TMG). During TMG, the child was presented with the cue-target word pairs and was told that the task was to learn to associate each cue and target word in order to match the target word to the cue word when presented with it at a later time. Next, the child was presented with the practice TMG word pairs. After mastering the practice cards, we proceeded to the learning phase. During the learning phase, the child was presented with each cue-target word pair and directed to learn the target word that was associated with each cue word. Throughout the learning phase, the child appeared fatigued and disinterested in the task, often times yawning and placing his head on the table. His demeanor did not appear as cheerful and eager as in the previous session and, as the task continued, he began to ask about its remaining length. At this time, I encouraged the child to try his best and reminded him of the prize that awaited him after completion of the task. After a brief break, the learning phase was continued. During the judgment phase of the TMG, the child began to move the chair that was placed across the table. Once begun, he became fixated on moving the chair and became inattentive toward the judgment phase of the task. After redirection, the child continued with the task. During the recall phase, the child appeared to have difficulty recalling the appropriate response for the word pair items. His facial expressions tended to be negative and he appeared bored. His responses were sporadic, and at times he created responses that were not associated with TMG word pairs. There was a noticeable delay in responses for each item, and recall was poor for this task. During the HPS phase, the child was asked to first choose which of the five people would be able to complete the TMG task. He chose four of the five pictures; for this task he did not choose the infant. Next, the child was asked to rank the pictures in order from who would perform the best on the TMG task to who would perform the worst. He ranked the older adult as the best and the toddler as the worst. As to why the older adult would perform the best, he stated, "he would have done it already" and why the toddler the worst, he stated, "he hasn't gotten good at it."

After TMG was complete, I attempted to proceed to the next task, the MIG. However, the child expressed reluctance to continue. He complained of fatigue and hunger; therefore, I felt it was in the best interest of the child to postpone MIG to a later session. We proceeded into the clinic hallway where the child was able to retrieve his prize for the testing session. His reaction was one of excitement and intrigue. He immediately began to explore his new prize.

Session Three

The third session was held on a Saturday afternoon and the child appeared cheerful and eager to participate in the tasks assigned for the day. The child was not as forthcoming with information as he had been previously, but he began discussing various video games he had played over the weekend. After a brief discussion, I began the first task after a brief review of the two scales.

Color Body Movement (CBM). The child was told that the purpose of the task was to link each of 15 colors with a particular body movement. To demonstrate, he was presented with the practice CBM color card and I demonstrated the body movement associated with that color. Immediately, the child began to voice his disinterest in the task. He was reluctant to imitate me and asked that the game be changed so that only I engaged in the body movement. Once it was explained to the child that for the purpose of the CBM task he must engage in the corresponding body movements, we moved on to the learning phase. Both the learning and the recall phase of the task required the child to stand at the table rather than sit. Throughout the learning phase the child would place himself across the table, stand on the bracing of the table, and/or kneel down on the ground, often appearing bored or disinterested. The behaviors continued throughout all three phases of the task: learning, judgment, and recall. The behaviors became disruptive because he was inattentive to the task material. After several instances of redirection, the learning phase was completed.

During the judgment phase of the CBM task, the child began selecting the 100 judgment on the Thermometer Scale for every item. For validity purposes, the researcher reiterated the purpose, use, and importance of the scale. The child indicated that he understood and that the judgments of 100 reflected his true confidence level. During the recall phase, the child had difficulty recalling the appropriate body movement for the corresponding color card. His facial expressions tended to be negative and he appeared disinterested. His responses varied and as with the TMG, at times he would create responses that were not associated with the CBM color cards. He did not correctly demonstrate any of the correct body movements for this task. Upon completion of the CBM task, we entered the HPS phase. He chose all five pictures as persons able to do the task. He ranked the young adult as the best and the infant as the worst. During this task he ranked the older adult before the infant, indicating the older adult would perform poorly on this task. As to why the young adult would perform the best, he stated, "he has done it before" and why the infant the worst, he stated "the baby doesn't know exercise." After a short intermission, we proceeded to the next task, Bobbins and Woozles.

Bobbins and Woozles (BW). The child was told the purpose of the BW task was to learn information related to the story's characters in order to recall the information at a later time. The Bobbins stimulus book was read to the child; he was allowed to follow along with the story. Immediately, the child became engaged in the story; his demeanor completely changed from that for the CBM. During the learning phase of the task, I read the book out loud to the child. He was attentive at all times and actively participated by helping to turn each page. During the reading, he commented on the pictures and actions. For both the subsequent recall and recognition phases, the child appeared to have no difficulty providing the appropriate responses; in fact, at times he would answer the question before I had a chance to finish reading the card. For the judgment phase, the child was confident in his recognition of the items by indicating a 100 on the Thermometer Scale for each item, and correspondingly, his recall was quite good for this task. Upon completion of the BW task, we entered the HPS phase. The child chose all five people as capable of completing the BW task. He ranked the older adult as the best and the infant as the worst. As to why the older adult would perform the best, he stated, "he has done it before" and why the infant the worst, he stated "because he is a baby." Upon completion of the task, the child indicated that BW was his favorite task because he enjoyed learning about new characters.

Because the child completed two tasks for the session, he was rewarded with two prizes. The child was excited to play with his new toys, even allowing the researcher to share in the fun.

Session Four

The fourth session was held on a Sunday afternoon, and the child appeared cheerful and eager to participate in the tasks assigned for the day. I asked him about his week at school and how his time had been spent since the last session. He indicated that he didn't have much to talk about, so we proceeded to the experiment room.

The Movement Task (TMT). The child was taken into the experiment room and asked to sit at the table in order to begin The Movement Task. For the TMT task, the child was asked to recall each of the body movement that he had learned during the CBM task completed during the previous week, given each of the 15 color cues. The child immediately began to voice his disinterest in the task. Once again, he was reluctant to imitate me, and indicated that he could not remember the body movements from the prior session. After some prompting and encouragement, the child reluctantly agreed to proceed with the task. Because the movements were previously learned during the CBM task there was no learning phase in this task. Instead we proceeded straight to the recall phase. Both the recall and recognition phases required the child to stand at the table rather than sit. Throughout the recall and recognition phases, the child would once again place himself across the table, stand on the bracing of the table, and/or kneel down on the ground, often appearing bored or disinterested. The behaviors continued throughout each phase of TMT, and often became disruptive to the task. Several instances of redirection were required. As with the CBM task, during the judgment phase of TMT, the child provided judgments of 100, predicting perfect recognition for each item. During the recognition phase, the child appeared to have difficulty recognizing the appropriate body movement for the corresponding color card. His facial expressions tended to be negative and he appeared disinterested. His responses varied and as for the CBM task, at times he would demonstrate body movements that were not part of the task. Recognition was poor for this task.

Upon completion of the TMT task, we entered the HPS phase. He chose all five people as able to complete the task. He ranked the young adult as the best and the infant as the worst. During this task he ranked the older adult before the infant, indicating the older adult would perform poorly on this task. As to why the young adult would perform the best, he stated, “he has done it before” and why the infant the worst, he stated “because he is a baby.”After a short intermission, we proceeded to the next task, the GST.

The Game Show Technique (GST). The child was told the purpose of the GST was to answer questions about information from his school textbooks. The child was oriented to the game board for GST. The game board contained all of the questions associated with the task and appeared in three columns corresponding with two of the child’s stated favorite subjects in school, math and science, and geography. Upon noticing the column labeled geography, the child immediately indicated that he did not perform well in geography and did not want to answer questions from that section. After reassurance that he could choose which question he would like to answer, the child agreed to proceed through the recall phase of the task. During the recall phase of the task, the child began to systematically pick each question card. He began with the math section and chose every other card from the math column. Upon reaching the bottom he began back at the top of the math column and proceeded down in the same pattern. After each question was chosen from the math column he began the same systematic pattern down the science and geography columns of the game board. During the recall phase, he became fatigued and disinterested, but was encouraged to proceed, and he did so. During the recognition phase of GST, once again the child strategically picked which cards he would answer first, except this time he eliminated the cards by row, choosing the entire top row, then the second row, etcetera, regardless of category. Once again, he expressed fatigue and wanted the task to be finished. Later the child indicated that this was his least favorite game because of the geography section of the game board. Upon completion of the GST task, we entered the HPS phase. The child chose all five people as able to complete the task. He ranked the older adult as the best and the infant as the worst. As to why the older adult would perform the best, he stated, "he knows all of it" and why the infant the worst, he stated "he is just a baby."

After the session was finished the child and I entered into the clinic hallway where he received his prize, with which he immediately began to play. He seemed pleased with his reward.

Session Five

The fifth session was held on a Saturday afternoon. The child presented to the fifth session appearing cheerful, lively, and eager to participate in the tasks assigned for the day. The child was forthcoming and eager to discuss a video game he had played at home after school. He again went into extensive detail concerning the video game, including character names, powers, and game strategy tips. We then began the session.

The Musical Instruments Game (MIG). After entering the experiment room and sitting at the table, the child was presented with the practice MIG nonsense word card and told that the purpose of the task was to learn to associate a nonsense word with its particular musical instrument, as pantomimed by the researcher. The child appeared to understand what the task called for, but was reluctant to proceed because, as he stated, "I don't like having to do that." Before proceeding to the learning phase, I asked the child what his concerns were for the task. He explained that he was not able to perform well at tasks that required him to match particular sounds with particular words. He was reassured that this was not the purpose of the task and was once again told the purpose of the MIG. Nevertheless, the child proposed changing the recognition phase of the task so that I was required to show him one instrument instead of two, and allow him to indicate whether it was the correct instrument. I explained the importance of his involvement in the task, at which point the child agreed to move ahead with the MIG in its original format.

Throughout the learning phase the child was engaged and attentive. His demeanor appeared cheerful and eager, but as the task continued he began to ask about its remaining length. I encouraged the child to try his best and reminded him of the grand prize that awaited him after completion of the task. During the recall phase, his responses were sporadic and the child often created instrument movements that were not associated with the MIG nonsense words. During the recognition phase, the child appeared to have difficulty recognizing the appropriate responses for the nonsense word. His facial expressions tended be negative; for instance, he often yawned and looked away during the task. His recognition of the correct musical instrument was poor. Upon completion of the MIG task, we conducted the HPS phase. He chose all five people as able to complete the task. He ranked the older adult as the best and the infant as the worst. As to why the older adult would perform the best, he stated, “he has done it before” and why the infant the worst, he stated “he is a little baby.” After a short intermission, we proceeded to the next task, The Sign Language Game.

Sign Language Game (SLG). For the SLG task the child was asked to learn to associate a picture of an object with its corresponding sign. The child appeared reluctant, but interested in the task. The child promptly expressed his limitations on one particular task item that required him to snap his fingers. He indicated to the researcher that he was unable to snap and wanted to change how the sign was presented. After encouragement to try to snap his fingers, the child refused to proceed until the item was changed, and an alteration was made to this sign. Despite his reluctance to begin the SLG, the child proceeded to the learning phase. During the judgment phase of the SLG task, the child indicated that he was confident in his ability to recall the appropriate sign associated with each word. During the recall phase, he appeared to have no problem recalling the correct item response for most of the task items; recall was good for this task. Upon completion of the SLG task, we entered the HPS phase. He chose four out of the five pictures; the infant was not chosen. He ranked the older adult as the best and the toddler as the worst. As to why the older adult would perform the best, he stated, "he has done it before" and why the toddler the worst, he stated "he hasn't got good at it."

Session End

The last session ended with the child and I entering the clinic hallway so the child could receive his grand prize for completing all of the tasks to which he was assigned during the study.

Characteristics Consistent with Asperger's Syndrome

Nonverbal behavior. Children with Asperger's Syndrome are known to have impairments in nonverbal communication, including eccentric nonverbal behaviors. Consistent with the disorder, the child exhibited unconventional nonverbal behavior. Before giving a response to a particular item, often the child would fixate his eyes on a particular location in the experiment room; his eyes appeared glazed and his mouth was slightly open as if he was going to respond. After some delay, and often only with prompting from the researcher, the child would eventually give a response. It was difficult to judge whether the child was thinking about the appropriate answer, or was being inattentive or noncompliant. Also, when the researcher was presenting the testing information, the child would often make high-pitched noises with his mouth. He did not appear to be aware he was doing this behavior. As the sessions progressed, the behavior became more and more frequent. In addition, the child frequently grabbed his crotch area during testing sessions. When asked by the researcher, he denied needing to use the restroom. Finally, there were instances when the child would slump down in his chair as if he was bored and inattentive. However, when I asked if he felt fatigued or needed a break, he would often respond that he was fine and wanted to proceed with the task. All of these behaviors persisted throughout the testing sessions, and were socially inappropriate for the child's developmental age and the situation. The behaviors appeared to be unique to the testing setting; the parents did not indicate that the high-pitched noises and crotch grabbing were observed at home.

Not only were the child's nonverbal behavior idiosyncratic, but the child was unable to interpret the nonverbal cues given by the researcher in an attempt to indicate dissatisfaction with his disruptive behavior. A simple discouraging look was not sufficient; verbal commands were a must. Also, while initiating conversation with the researcher, the child had difficulty comprehending personal space. While communicating, if standing, he would gradually move closer to the researcher in order to finish the conversation.

Social behavior. Children with Asperger's Syndrome are known to have impairments in social behavior as well, and this child was no exception. The child was unable to monitor appropriate times to verbally communicate topics of interest, and often abruptly interrupted the experiment to discuss a favorite animated character, movie, or television show. Even with prompting to return to the task at hand, the child would often continue with the conversation. During the initial testing sessions, the child responded well to redirection, however, as the testing sessions progressed the child became less compliant when redirected during a task.

Defiant behavior. The child also exhibited the defiance common in children with Asperger's Syndrome. The inappropriate behaviors previously discussed, including lying across the table, moving the chair, grabbing of his crotch, and off-topic interruption of testing sessions did not dissipate after one instance. Rather, they remained consistent throughout the duration of the testing session despite correction from the researcher, including a particular discussion about keeping his hands on the table. The child required consistent prompting by the researcher and, although he would eventually comply, repeated redirection was necessary.

Procedural Metamemory

In order to conduct the analyses, tasks were coded in term of Judgment Type (JOL, FOK), Task, Imitation (Imitative, Nonimitative), and Verbal (Verbal, Nonverbal). We conducted several univariate analyses of variance (ANOVA) to assess the impact of each variable on probability of recall, probability of recognition, and metamemory judgments. Scores for each task are listed in Appendix C. For all analyses, a criterion of $p < .05$ was required to achieve significance.

Judgments of Learning (JOLs)

Recall. The relevant means for probability of recall, or the percentage of correctly recalled items, for the JOL and FOK tasks are reported in Table 2. The overall probability of recall was low (*M* = 0.48, *SEM* = 0.04) across all judgment types and tasks. A one-way ANOVA was conducted on probability of recall with Judgment Type as a factor. There was no significant difference in recall between the JOL (*M* = 0.44, *SEM* = 0.06) and FOK (*M* = 0.51, *SEM* = 0.05*)* judgment types, $F(1,149) = 0.80$, $p = 0.37$.

Separate one-way ANOVAs were conducted to examine the effect of Task on probability of recall within each judgment type (there were not enough degrees of

Table 2

Probability of Recall and Probability of Recognition

Task Name	Task Code		JOL		FOK	
			Recall			
			M	*SD*	*M*	*SD*
SLG	I	NV	0.80	0.41		
CBM	I	NV	0.00	0.00		
TMG	NI	V	0.32	0.48		
MCT	NI	V	0.89	0.33		
			0.44			
MIG	I	V			0.25	0.45
TMT	I	NV			0.00	0.00
GST	NI	V			0.48	0.51
BW	NI	V			0.93	0.25
					0.51	
			Recognition			
			M	*SD*	*M*	*SD*
MIG	I	V			0.31	0.48
TMT	I	NV			0.47	0.52
GST	NI	V			0.76	0.44
BW	NI	V			1.00	0.00
					0.64	

freedom to include both Judgment Type and Task in the same ANOVA). There was a significant difference among the JOL tasks, $F(3, 63) = 16.09$, $p < 0.01$. Post hoc tests using a Least Significant Difference (LSD) adjustment showed that probability of recall for CBM (*M* = 0.00*, SEM* = 0.10) was significantly lower than any of the other tasks (see Table 3), followed by TMG (*M* = 0.32, *SEM* = 0.08), which was significantly higher than the CBM task, and significantly lower than the other two tasks. Probability of recall for the SLG (*M* = 0.80, *SEM* = 0.10) and the MCT (*M* = 0.89, *SEM* = 0.13) was significantly higher than the other two tasks, but they were not significantly different from each other.

Table 3

Pairwise Comparisons of Probability of Recall

Comparisons		JOL			
		Mean Diff.	*SEM*		
CBM	SLG	-0.80**	0.14		
CBM	TMG	-0.32*	0.13		
CBM	MCT	-0.89**	0.16		
TMG	SLG	-0.48**	0.13		
TMG	MCT	-0.57**	0.15		
SLG	MCT	-0.09	0.16		
				Mean Diff.	*SEM*
BW	MIG			0.68**	0.11
BW	GST			0.45**	0.10
BW	TMT			0.93**	0.12
GST	MIG			0.23	0.12
GST	TMT			0.48**	0.12
MIG	TMT			-0.68**	0.11

*Note.** indicates $p < 0.05$. ** indicates $p < 0.01$

Metamemory sensitivity. The relevant means for the metamemory sensitivity, or the magnitude of the metamemory rating, for the JOL and FOK tasks are reported in

Table 4. Overall, metamemory ratings were moderately high (*M* =76.60, *SEM* = 2.80) across all judgment types and tasks. A one-way ANOVA conducted on metamemory sensitivity with Judgment Type as a factor showed that, although JOL (*M* = 71.80, *SEM* = 4.24) judgments were somewhat lower than FOKs (*M* = 81.40, *SEM* = 3.67), there was no significant difference in metamemory sensitivity between the two types, $F(1,149) = 2.94$, $p = 0.09$.

Separate one-way ANOVAs were conducted to examine the effect of Task on metamemory sensitivity within each of the Judgment Types (there were not enough

Table 4

Metamemory Sensitivity

Task Name	Task Code		JOL		FOK	
			M	*SD*	*M*	*SD*
SLG[a]	I	NV	96.67	12.91		
CBM[a]	I	NV	76.67	20.93		
TMG[a]	NI	V	44.00	39.90		
MCT[a]	NI	V	99.44	1.67		
			71.80			
MIG[b]	I	V			73.75	26.05
TMT[b]	I	NV			33.33	38.85
GST[b]	NI	V			92.80	17.21
BW[b]	NI	V			100.00	0.00
					81.40	

degrees of freedom to include both Judgment Type and Task in the same ANOVA). There was a significant difference among the JOL tasks, $F(3, 63) = 15.35$, $p < 0.01$. Predictions were lowest for the TMG task (*M* = 44.00, *SEM* = 5.58) and post hoc tests using a LSD adjustment showed that metamemory sensitivity for TMG was significantly lower than the other tasks (see Table 5). Predictions for the CBM task were relatively high (*M* = 76.67, *SEM* = 7.20); conversely, the CBM had the lowest probability of recall. Metamemory sensitivity for SLG and MCT was equally high (*M* = 96.67, *SEM* = 7.20; *M* = 99.44, *SEM* = 9.30 respectively), and the CBM, SLG, and MCT tasks did not significantly different from each other.

Table 5

Pairwise Comparisons of Metamemory Sensitivity

Comparisons		JOL		FOK	
		Mean Diff.	*SEM*		
TMG	SLG	-52.67**	9.11		
TMG	CBM	-32.67**	9.11		
TMG	MCT	-55.44**	10.84		
CBM	SLG	-20.00	10.19		
CBM	MCT	-22.78	11.76		
SLG	MCT	-2.78	11.76		
				Mean Diff.	*SEM*
TMT	MIG			-40.42**	7.78
TMT	GST			-59.47**	7.07
TMT	BW			-66.67**	6.84
MIG	GST			40.42**	7.78
MIG	BW			-26.25**	6.70
GST	BW			-7.20	5.86

Note. ** indicates $p < 0.01$

Metamemory predictions seemed to be sensitive to items that were recalled (the MCT and SLG), but for tasks for which recall was poor, predictions did not monitor recall. Relatively high predictions were given for CBM, the task for which recall was worst. In contrast, the lowest predictions were given for the TMG task, for which 32% of the items were recalled.

A two sample *t-test* was conducted to examine metamemory sensitivity for recalled versus unrecalled items for the JOL judgment type (see Table 6). There was a significant difference between ratings for the recalled (*M* = 88.15, *SEM* = 28.96) and ratings for the unrecalled (*M* = 55, *SEM* = 36.95) items, $t(56) = 3.76$, $p < 0.05$. The distribution of ratings relative to recall varied. For recalled items, relatively high ratings were provided; the variance was 838.75. Conversely, for items that were not recalled, variability among ratings was high, ranging from high (e.g., 100) to low (e.g., 0) ratings, and the variance was nearly double that for recalled items, 1365.00.

Table 6

Metamemory Sensitivity for Recalled vs. Unrecalled and Recognized vs. Unrecognized Items

	JOL		FOK	
	M	*SD*	*M*	*SD*
Recalled	88.15	28.96	97.05	10.25
Unrecalled	55.00	36.95	65.00	38.59
Recognized			88.36	27.76
Unrecognized			64.40	36.06

Metamemory accuracy. The relevant Goodman-Kruskall gamma correlations for the correlation between metamemory predictions and recall for the JOL tasks are reported in Table 7. A gamma could not be calculated for the CBM tasks. For the CBM recall was imperfect; none of the items were recalled in this task. Because of the limited number of tasks, statistical comparisons cannot be made, but observationally several patterns of results stand out.

Table 7

Metamemory Accuracy

Task Name	Task Code		JOL	FOK
			Gamma	
SLG	I	NV	1.00	
CBM	I	NV	-[a]	
TMG	NI	V	0.41	
MCT	NI	V	1.00	
MIG	I	V		0.50
TMT	I	NV		-0.11
GST	NI	V		0.19
BW	NI	V		-[b]

Note. [a]Gamma cannot be calculated for the CBM task because one of the items is a constant. [b]Gamma cannot be calculated for the B&W task because one of the items is a constant.

Metamemory accuracy for two of the JOL tasks was perfect; a gamma correlation of +1.0 was obtained for both the SLG and the MCT, and it should be noted that for both of these tasks, the child only utilized two thermometer ratings (50 and 100 for SLG; 95 and 100 for MCT). The gamma for the TMG task was 0.41. The gamma was relatively low because although his predictions were frequently high when he could recall the item, when he could not, his predictions varied from 0 to 100.

Feeling of Knowing Judgments (FOKs)

Recall. A one-way ANOVA was conducted to examine the effect of Task on probability of recall within each judgment type. There was a significant difference among the FOK tasks, $F(3, 85) = 25.55$, $p < 0.01$. Post hoc tests using a LSD adjustment for multiple comparisons revealed that probability of recall for BW (*M* = 0.93, *SEM* = 0.07) was significantly higher than the other tasks; probability of recall was almost double that of the other tasks (see Table 2). Probability of recall for GST (*M* = 0.48, *SEM* = 0.74) was significantly lower than BW, but significantly higher than MIG (*M* = 0.25, *SEM* = 0.09) and TMT (*M* = 0.00, *SEM* = 0.10). Probability of recall for MIG and TMT were low and not significantly different from each other.

Recognition. The relevant means for the probability of recognition for the FOK tasks are reported in Table 2. The overall probability of recognition was higher than that for recall (*M* = 0.64, *SEM* = 0.04 and *M* = 0.48, *SEM* = 0.04, respectively) across the FOK judgment type and tasks. Recognition was measured only for the FOK tasks; none of the subsequent analyses included the Judgment Type factor.

A one-way ANOVA was conducted to examine the effect of Task on probability of recognition within the FOK judgment type. There was a significant difference among the FOK tasks, $F(3, 85) = 13.98$, $p < 0.01$. Post hoc tests using a LSD adjustment for multiple comparisons revealed that probability of recognition for both BW (*M* = 1.00, *SEM* = 0.07) and GST (*M* = 0.76, *SEM* = 0.08) were significantly higher than the other two tasks (see Table 8), and also were significantly different from each other; GST was significantly lower than BW. GST was significantly higher than MIG (*M* = 0.31, *SEM* =

0.10) and TMT (*M* = 0.47, *SEM* = 0.10). Probability of recognition for MIG and TMT were low and not significantly different from each other. Overall, probability of recognition followed the same pattern as probability of recall with regard to the FOK tasks. For unrecalled items, recognition accuracy was low (*M* =.45, *SEM* = 39.53).

Table 8

Pairwise Comparisons of Recognition

Comparisons		FOK	
		Mean Diff.	*SEM*
BW	MIG	0.69**	0.12
BW	GST	0.24*	0.10
BW	TMT	0.53**	0.12
GST	MIG	0.15**	0.12
GST	TMT	0.29*	0.12
MIG	TMT	0.15	0.14

Note. * indicates $p < 0.05$. ** indicates $p < 0.01$

Metamemory sensitivity. A one-way ANOVA conducted on metamemory sensitivity with Task as a factor showed that there was a significant difference among the FOK tasks, $F(3, 85) = 35.02$, $p < 0.01$. Post hoc tests using a LSD adjustment for multiple comparisons revealed that metamemory sensitivity for TMT (*M* = 33.33, *SEM* = 5.59) was significantly lower than the other tasks (see Table 5).

Although metamemory sensitivity for MIG (*M* = 73.75, *SEM* = 5.41) was significantly higher than TMT, it was significantly lower than both GST (*M* = 92.80, *SEM* = 4.33) and BW (*M* = 100.00, *SEM* = 3.95). Metamemory predictions for GST and BW were highest and not significantly different from each other.

Probability of recognition for GST and BW was higher than the other two tasks (*M* = 0.76, *SEM* = 0.08; *M* = 1.00, *SEM* = 0.07, respectively). As such, metamemory predictions were consistent with recognition outcome for the two tasks for which recognition was good, the GST and BW tasks. Relatively low predictions were given for TMT (*M* = 0.47, *SEM* = 0.10), the FOK task for which recognition was worst. In contrast, relatively high predictions were given for the MIG task (*M* = 0.31, *SEM* = 0.10), for which only 31% of the items were recognized.

A two sample *t-test* was conducted to examine the relationship between recognized and unrecognized items for the FOK judgment type. There was a significant difference between FOK predictions for the recognized items as compared to ratings for the unrecognized items $t(84) = 3.32$, $p < 0.05$. Ratings were relatively high for the recognized items (*M* = 88.36, *SEM* = 27.76) and the variance was 770.60; for items in which the child was confident that he would recognize the correct response, he gave ratings that were consistent with his recognition of the item. For items which he was unable to recognize, he gave both high (above 50) and low (below 50) ratings and the variance was nearly double, 1489.02. To determine sensitivity of FOKs in the absence of recall, a two sample t-test was conducted to examine the difference in sensitivity for recognition of unrecalled items only. FOK predictions did not vary for recognized (*M* = 68.57, *SEM* = 39.30) and unrecognized (*M* = 61.43, *SEM* = 38.24) items. When recall failed, there was no difference in prediction magnitude with regard to subsequent recognition accuracy.

Metamemory accuracy. The relevant Goodman-Kruskall gamma correlations for the correlation between metamemory predictions and recall and recognition for the FOK tasks are reported in Table 7. A gamma could not be calculated for the BW task because recall was perfect. Metamemory accuracy was generally worse for FOK tasks than for JOL tasks. Low gamma correlations indicated that discriminability between recognized and unrecognized items was at chance for both the TMT (G = -0.11) and GST (G = 0.19) tasks, both tasks for which recognition accuracy was low. Low correlations seem to be due to inaccuracy at predicting unrecognized items; high predictions were frequently associated with items that were not recognized. Predictions of 100 were frequently given for those items that were recognized. However, discriminability was nonexistent for unrecognized items. This same pattern of giving indiscriminately high predictions for unrecognized items led to a relatively low gamma correlation for the MIG task (G = .50). Although the gamma was higher than the other FOK tasks, it was about the same as the lowest JOL task, the TMG task (G =.41).

Imitation

Recall. To examine whether the differences in probability of recall for the tasks were due to differences in the imitative nature of the tasks, a one-way ANOVA was conducted on probability of recall with Imitation as a factor. Probability of recall was significantly higher for Nonimitative (M = 0.63, SEM = 0.05) than for Imitative (M = 0.27, SEM = 0.06) tasks, $F(1, 149) = 22.14$, $p < 0.01$. In other words, recall was impaired when the child had to imitate the researcher in order to learn the task relative to when he did not.

Recognition. To examine whether the differences in probability of recognition for the tasks were due to differences in the imitative nature of the tasks, a one-way ANOVA was conducted on probability of recognition with Imitation as a factor. Consistent with recall, probability of recognition was significantly higher for Nonimitative ($M = 0.89$, $SEM = 0.05$) than for Imitative ($M = 0.39$, $SEM = 0.07$) tasks, $F(1, 85) = 33.28$, $p < 0.01$.

Metamemory sensitivity. To examine whether metamemory sensitivity was influenced by differences in the imitative nature of the tasks, a one-way ANOVA was conducted on metamemory sensitivity with Imitation as a factor. Metamemory predictions were significantly higher for Nonimitative ($M = 82.19$, $SEM = 3.57$) than for Imitative ($M = 70.16$, $SEM = 4.32$) tasks, $F(1, 149) = 4.60$, $p = 0.03$. Metamemory predictions were lower when the task was imitative, a finding that was consistent with those regarding recall and recognition.

Metamemory accuracy. Metamemory accuracy was higher for nonimitative than imitative tasks ($G = 0.53$ and $G = 0.46$, respectively).

Verbal

Recall. The degree to which the verbal nature of the tasks impacted probability of recall was evaluated using a one-way ANOVA. The main effect of Verbal was significant, $F(1, 149) = 12.55$, $p < 0.01$). Probability of recall was significantly higher for tasks with a verbal component (*M* = 0.57, *SEM* = 0.05) than those without one (*M* = 0.27, *SEM* = 0.07). Recall was lower when the task contained a nonverbal component.

Recognition. The degree to which the verbal nature of the tasks impacted probability of recognition was evaluated using a one-way ANOVA. The main effect of Verbal was significant, $F(1, 85) = 5.39$, $p = 0.02$. Consistent with recall, probability of recognition was significantly higher for tasks with a verbal component (*M* = 0.76, *SEM* = 0.05) than those without one (*M* = 0.47, *SEM* = 0.12). Recognition was lower when the task contained a nonverbal component.

Metamemory sensitivity. The degree to which the verbal nature of the tasks impacted metamemory sensitivity was evaluated using a one-way ANOVA. The main effect of Verbal was nearly significant, $F(1, 149) = 3.98$, $p = 0.05$. Metamemory predictions were higher for tasks with a verbal component (*M* = 80.91, *SEM* = 3.30) than those without one (*M* = 68.89, *SEM* = 5.04), and the difference nearly achieved significance.

Metamemory accuracy. Metamemory accuracy was the same for verbal and nonverbal tasks ($G = 0.45$ and $G = 0.46$, respectively).

Declarative Metamemory

Task Variable

The Grocery Store Task. The child gave an item prediction of five out of 20 items that he would be able to recall during this task. The child's confidence in his memory ability was low; he actually recalled 15 out of the 20 items listed. When asked which of the people depicted in the HPS would be able to complete the task, the child chose all five. He ordered the Scale with the older adult ranked as having the ability to remember all 20 items, followed by the adult who was also ranked as having the ability to recall all 20 items, followed by the cohort child who was ranked as having the ability to recall 19 items, followed by the toddler who was ranked as having the ability to recall five items. The infant was ranked last and as having the ability to recall 0 items. The child ranked himself as having the ability consistent with the toddler by predicting he would only recall five out of the 20 items. However, as evidenced by the HPS ordering, he ranked other young children of his age as having a greater memory capacity than himself by predicting they would recall 19 out of the 20 items.

Person Variable

Procedural tasks. The relevant means for the HPS for the JOL and FOK tasks are reported in Table 9. The child was first asked to choose the individuals who could complete each of the tasks. On all of the tasks except the TMG, the child identified every person as able to complete the task. Most often, the child accurately ordered the pictures with the older adult ranked as having the most ability to complete the task, followed by the adult, followed by cohort child, followed by the toddler. The infant frequently was ranked as having the least ability to complete the task (see Table 9).

However, there were two exceptions to this pattern. For both the TMT and CBM task, the child ranked the older adult second to last before the infant as having poor ability to perform both tasks.

Table 9

Human Pictorial Scale

Rank Order	JOL	FOK	I	NI	V	NV
Rank #1 [a]	4.75	4.75	4.50	5.00	5.00	4.30
Rank #2	3.75	3.75	3.50	4.00	4.00	3.30
Rank #3	2.75	2.75	2.50	3.00	3.00	2.30
Rank #4	2.75	2.75	3.50	2.00	2.00	4.00
Rank #5 [b]	1.00	1.00	1.00	1.00	1.00	1.00

Note. [a] Denotes the Human Pictorial Scale card that would perform the best. [b] Denotes the Human Pictorial Scale Card that would perform the worst.

Imitation and verbal factors. After dividing the tasks into imitation and verbal categories, a different pattern of results with regard to the ranking portion of the HPS was obtained. For tasks requiring imitation, the cohort child was ranked below every other person in the group except the infant. For nonverbal tasks, again the infant was last, but the toddler was ranked after the young adult. Again, the only person ranked below the cohort child was the infant.

CHAPTER IV

DISCUSSION

Case Conceptualization

The child always approached the testing sessions with a positive attitude, cheerful demeanor, and an eagerness to learn. Children with Asperger's Syndrome display noticeable verbosity (Tsatsanis, 2004), and the child in the study was no exception. He used a mature vocabulary and his conversations were descriptive and detailed, especially when discussing a topic of interest. He was playful and engaged during the tasks, and his smile and enthusiasm were particularly present during tasks he enjoyed. Usually these tasks were ones on which he performed well. However, when the task was one with which he was uncomfortable, he often became disinterested, inattentive, and expressed concern about the remaining length of task. He often became frustrated and did not hesitate to express his dislike for the task and/or his shortcomings related to the task requirements. He particularly exhibited these behaviors during tasks that required imitating the researcher in some way, as well as tasks that were largely nonverbal. For instance, he required the most redirection for the CBM task, which was both imitative and nonverbal. The child would often become fixated on objects inside the room (i.e., moving chair across table with his feet), which contributed to his inattention. Also, the child would often try to bargain with the researcher to change the task to something he would rather do. However, when he was redirected back to the task he was always compliant. His behavior was reflected in his performance; recall performance was always low for imitative and/or nonverbal tasks as compared to the nonimitative and verbal tasks.

Consistent with his diagnosis, the child exhibited unconventional nonverbal behavior. Often his eyes appeared glazed and his mouth was slightly open as if he was going to respond to a task item, but did not answer. The child also made high-pitched noises with his mouth during the tasks, but he did not appear to be aware of this behavior. When the child was disinterested, bored, and/or uncomfortable with a task, he accurately depicted these feelings with his body language (i.e., slumped over in chair, head placed on table). His deficit in social awareness was most evident in the child's inability to interpret the nonverbal cues given by the researcher to indicate her dissatisfaction with his disruptive behavior. A simple discouraging look was not sufficient; verbal commands were always required. Also, while initiating conversation, the child had difficulty comprehending personal space. While communicating, if standing, he would gradually move closer to the researcher in order to finish the conversation. Despite the fact that he was generally well-spoken, the child also was not always appropriate in terms of verbal behavior. He was unable to appropriately monitor times to communicate topics of interest to the researcher, and often interrupted testing to discuss one of these topics. Even after prompting to hold the conversation until the end of the task, he appeared fixated on the topic because he repeatedly returned to it in subsequent conversations.

Several conclusions can be drawn from the case conceptualization. If the task is one for which he feels comfortable and on which he does well, the child was engaged and lighthearted. He took direction with ease and had a playful spirit about him. However, on tasks for which he was less comfortable, he became frustrated, disengaged, disruptive, and tried to create ways to manipulate the situation to his advantage. It appeared that tasks requiring gross body movement or nonverbal responses, and imitation of the researcher, caused the child the most discomfort. It is not clear whether he is uncomfortable because of the imitative, physical nature of the task, or if he is aware that he will not do as well on such tasks. It could be the case that he did not do well because he did not like the task. Teasing apart these two possibilities given the tasks used in the present case study is difficult. However, neither the neuropsychologist nor the parents reported any motor difficulties. Regardless of the underlying reason, if a task wasn't going right for him, he loses interest. Even when he was finally redirected and agreed to participate, his demeanor was completely different from the tasks for which he felt comfortable. He was not responsive to reciprocal communication. He became preoccupied with how he could get out of the situation and back to something that he liked. He attempted to bargain to change the task into something with which he was more comfortable. His noncompliance was especially problematic given the potential for perseveration with Asperger's Syndrome (APA, 2000); his discomfort with the task tended to linger, even when he agreed to continue. His tendency to perseverate was not the only characteristic of Asperger's Syndrome evidenced during the study. Related to perseveration is repetitive behavior. The child frequently became fixated on particular objects in the room. He frequently moved the chair with his feet, and during the MIG task, he became fixated on trying to find words that rhymed with each nonsense word. In addition, he became fixated on subject matters that did not pertain to the specific task. He exhibited the sometimes selfish and defiant behaviors associated with Asperger's Syndrome (Klin & Volkmar, 1997); he didn't hesitate to bargain to try to get out of or change tasks. Despite repeated instruction, he continued to exhibit inappropriate behaviors during the sessions.

The child exhibited the impairment in social awareness that is typical of children with Asperger's Syndrome. Several of his behaviors were indicative of this impairment: unconventional nonverbal behavior, inability to monitor personal space during conversation, and a one-sided social approach to conversations. Social impairment was most evident in his inability to monitor nonverbal cues from the researcher. The impairment in social awareness was clear, as was impairment in cognitive awareness as evidenced by the findings regarding metamemory.

Procedural Metamemory

The procedural metamemory tasks were designed to examine cognitive awareness during a cognitive process, such as retrieval. As such, predictions for future recall and recognition were collected. Probability of recall did not vary between JOLs and FOKs, overall. Recall was somewhat better for FOKs, but not significantly so. Recall did vary significantly among the tasks, however. The highest probability of recall was for the BW task, which the child identified as his favorite, followed by the MCT task, which had relatively few items. The tasks for which recall was the lowest were the two imitative tasks: the TMT and the CBM tasks. No items were correctly recalled for either of these tasks. With the exception of the SLG task, for which recall was 80%, recall for all of the other tasks was below 50%. For the FOK tasks, recognition was better than recall for all four tasks, but was still less than chance for half of them. Recognition was perfect for the BW task, followed by the GST task at 76% recognition. Similar to Bowler et al. (2004), it appeared that memory was better when additional contextual support was provided (i.e., the presence of the response on recognition versus recall tests). However, when recall failed, recognition of unrecalled items was poor. Apparently, any benefit from the additional contextual support provided by recognition was not enough to aid the child in recognizing unrecalled items.

Metamemory sensitivity did not vary between the JOL and FOK predictions, overall. Predictions were somewhat higher for the FOK judgments, but not significantly so. Predictions tended to be high: for all but two tasks, they were over 70%. The highest metamemory prediction was for the BW and MCT tasks, which also had the highest probability of recall, and additionally, recognition was perfect for the BW task. The two tasks for which predictions were the lowest, TMT and TMG, also had low probability of recall. For the two tasks for which recall was zero (CBM, TMT), predictions also were low. Metamemory predictions for recognition of unrecalled items were the same regardless of recognition outcome. In the absence of recall, predictions did not discriminate recognition performance.

Metamemory accuracy was higher for the JOL tasks than the FOK tasks. For two of the JOL tasks, MCT and SLG, the correlation between memory and metamemory was perfect. For the FOKs, predictions about recognition were not accurate. Recognition was relatively poor for the FOK tasks, with the exception of BW, and predictions did not accurately reflect this outcome. The gammas close to zero demonstrated that the child could not discriminate with regard to recognition performance.

Compared to the few studies on children without Asperger's Syndrome, the child performed at a lower developmental level than one would expect for his age (Brown & Lawton, 1977; Koriat & Shitzer-Reichert, 2002; Lockl & Schneider, 2002). For example, Wellman (1977) found that metamemory accuracy as measured by FOKs was low for kindergartners, followed by first graders, and highest for third graders ($G = 0.19$, $G = 0.35$, and $G = 0.60$, respectively). The child is currently in the sixth grade, and with a mean gamma of 0.26 for FOKs, his level of performance in the current study was below that of the first and third graders in the Wellman study.

Procedural metamemory tasks were not only categorized in terms of the type of judgment, but also in terms of whether they were predictions of successful retrieval, and whether they were imitative and/or verbal in nature. Metamemory predictions given for recalled/recognized items were significantly higher than those given for unrecalled/unrecognized items. An examination of the variance in predictions of successful versus unsuccessful memory performance demonstrated that, for recalled/recognized items, metamemory predictions were consistently high and did not vary, as evidenced by low variance among the ratings. The findings for predictions for unsuccessful memory performance were quite different. For unrecalled/unrecognized items, metamemory predictions varied greatly, and the variance among the metamemory ratings was much larger than that of metamemory predictions for subsequently recalled/recognized items. Examination of predictions in the absence of recall demonstrated that there was no significant difference among the ratings given for recognized versus unrecognized items that had not previously been recalled.

In terms of the imitative versus nonimitative nature of the task, probability of recall was significantly higher for nonimitative than for imitative tasks. Recall was impaired when the child had to imitate the researcher in order to learn the task relative to when he did not. The same pattern of results was obtained for probability of recognition. Recall and recognition performance was reflected in the metamemory judgments; ratings were significantly higher for nonimitative than for imitative tasks.

Both probability of recall and recognition were significantly higher for verbal than for nonverbal tasks. Regardless of whether predictions were for recall or recognition, the metamemory findings are consistent with the memory findings; predictions were significantly higher for tasks with a verbal component than those without one. There was one notable exception. The SLG task was both imitative and nonverbal, and yet recall was high and metamemory accuracy was perfect for this task. However, the SLG task was unique in other ways. Any impairment that might have been evidenced due to the imitative, nonverbal nature of the task could have been overridden by the child's ability to inform his answers using prior semantic knowledge. There was a high degree of overlap between the sign to be retrieved and the meaning of the sign. For example, the sign for food is to mimic the action of putting food in your mouth using your hand. As such, memory for the sign was not completely dependent on ability to imitate the researcher and perhaps the reason for differences in the pattern of results for this task.

The hypothesis that impairments in declarative, but not procedural, metamemory would be obtained was not supported. At first pass, both types of metamemory seem not to be impaired in the child. However, the typical divisions of metamemory suggested in the literature proved not to be the dimensions that were important for understanding the kinds of deficits in cognitive awareness that were exhibited by the case child. Three important dimensions emerged from the findings. First, metamemory ability differed depending on whether the child was predicting items that were later recalled/recognized or for which retrieval failed. Second, metamemory ability varied depending on whether a task required imitation. Third, metamemory ability varied based on the verbal versus nonverbal nature of the task.

The first relevant dimension to emerge regarding the child's metamemory ability was whether the child was making predictions about subsequently recalled/recognized versus unrecalled/unrecognized items. Items that were recalled/recognized were associated with high metamemory predictions. It could be the case that for these items, the child actually retrieved the target item at the time of prediction. If so, for tasks for which his recall/recognition was high, his ratings could have been accurate because he was actually recalling those items at the time of prediction. Therefore, his accuracy might be more an indicator of retrieval of the item, rather than cognitive awareness. Perhaps a better indicator would be to examine predictions for items he was later unable to recall/recognize. For unrecalled/unrecognized items, predictions did not discriminate memory performance. The ratings varied greatly, and unsystematically. For example, for the CBM task, nearly half of the ratings were 100, but no items were subsequently recalled. Compared to the few studies in the metamemory literature examining predictions in terms of recall outcome, this finding is not typical. Koriat and Goldsmith (1996) demonstrated that college-aged people are able to accurately predict which items they will and will not recall. In other words people generally are able to indicate both what they will know and what they will not know. Eakin (2005) found that metamemory magnitude varied systematically with recall outcome: higher predictions were given for recalled versus unrecalled items, and that the variability in predictions were not greater for unrecalled items.

Based on predictions about recalled items, it appeared that the child was able to discriminate recalled items, but not unrecalled items. However, both because of the increased variability in prediction magnitude for unrecalled items and the fact that the same predictions were given (e.g., ratings of 100) for both recalled and unrecalled items, it must be concluded that the child's cognitive awareness is impaired. Even when the child knew the answer and seemed to be cognitively aware that he would know it, it is uncertain whether his metamemory ability was intact or that he actually retrieved the answer while making the prediction. The findings for unrecalled/unrecognized items suggest that the latter is the case. When he did not recall the item, which presumably indicated he didn't recall it when he made the prediction either, his predictions were indiscriminate with regard to memory outcome; he could not accurately identify which items he would or would not recognize.

One way to test whether accurate predictions for recalled items are due to recall of the item at prediction or due to an intact metamemory ability is to examine predictions about recognition for unrecalled items. For those items, it is empirically clear that the item is not retrieved at the time of prediction, and metamemory ability for predicting recognition in the absence of recall can be measured. In absence of retrieval of the answer at the time of prediction, evidence of impairment of cognitive awareness emerged. Metamemory ratings did not differ with regard to subsequent recognition and metamemory accuracy at predicting recognition of unrecalled items was low. The child's ability to predict recalled items appeared to be due to retrieval of the items at prediction, rather than intact metamemory ability for recalled, but not unrecalled, items. Therefore, the conclusion is that the child does demonstrate a deficit in cognitive awareness as evidenced by an inability to discriminate between what he will and will not remember.

The second relevant dimension to emerge regarding the child's metamemory ability was whether the task was imitative or nonimitative. For the imitative tasks the child was unable to recall the correct response. With the exception of the SLG task, lowest recall and recognition scores were obtained for tasks requiring the child to imitate the researcher in order to learn the task information. The two tasks for which *no* item was recalled were both imitative tasks. All of the imitative tasks required the child to interpret and mimic body movement, and perhaps the child particularly disliked the physicality of the tasks. However, his parents did not report any problems with motor skills. In addition, typically children in his age range perform the same on the TOMAL for motor working memory and verbal working memory. Children without Asperger's Syndrome in his age range perform at 36% to 40% accuracy with motor working memory domain and 39% to 43% accuracy in the verbal working memory domain. A search did not reveal any literature suggesting that motor skills are impaired in children with Asperger's Syndrome. That the motor tasks were relatively simple, and no motor impairment would be expected given previous literature or was reported by the parents suggests that the imitative nature of the tasks led to his memory and metamemory impairment for those tasks.

The motor components of the imitative tasks were not complex (e.g., the child was required to touch his knees, put his hand on his head, and touch his toes) suggesting that it was the imitative nature of the task rather than the motor component that proved problematic for the child. That the child performed more poorly on the imitative tasks is surprising considering that the imitative tasks arguably should have been the easiest to complete. These tasks should have been easier than, for instance, learning to link together two unrelated words. However, the imitative tasks were the most difficult as evidenced by poor memory performance. His performance on other tasks indicates that his ability to learn and retrieve new information is not impaired; he performed quite well on nonimitative tasks such as the BW and MCT. Presumably, the deficits in social awareness inherent in Asperger's Syndrome contributed to his difficulty with the imitative nature of these tasks.

With regard to metamemory sensitivity, predictions were significantly higher for nonimitative than for imitative tasks. Although significant, the magnitude of the difference was small compared to the difference in recall between the imitative tasks. The child gave a mean prediction of 70 for the imitative and 82 for nonimitative tasks, yet recall was only 26% for the imitative tasks, as opposed to 63% for the nonimitative tasks. Also, metamemory was more accurate for nonimitative than for imitative tasks, the mean gammas were 0.53 and 0.46, respectively. Apparently, performance on imitative tasks suffered due to the child's impairment in social awareness. Similarly, particular deficits in cognitive awareness were found for imitative tasks; discriminability was lower for imitative as compared to nonimitative tasks.

The third relevant dimension examined regarding the child's metamemory ability was whether the task was verbal or nonverbal. Previous research has found that children with Asperger's Syndrome have excellent memory ability for verbal information (Klin & Volkmar, 1997), and such was the case in the present study. Memory performance for verbal tasks was higher than for nonverbal, unless that task was also imitative. For the MIG task, which was imitative and verbal, memory performance was low; indicating that the imitative nature of the tasks was more influential on memory performance than the nonverbal component. When the task was nonverbal, overall recall/recognition was lower. As we saw for imitative tasks, the child was unable to recall the appropriate response for tasks in which he relied on the interpretation of body movement/language in order to learn the information. If the child was unable to verbally communicate with the researcher, and was required to mimic and interpret the movement of the researcher, his ability to retrieve the information was impaired. The one exception was the SLG task. The child may have performed better on this task because the sign was not completely dependent on the ability to imitate the researcher. Prior semantic knowledge could have helped in remembering the sign due to a high degree of overlap between the sign and the meaning of the sign.

Metamemory predictions were significantly higher for verbal than for nonverbal tasks. Although significant, the magnitude of the difference was small compared to the difference in recall between the nonverbal tasks. The child gave a mean prediction of 69 for the nonverbal and 81 for verbal tasks, yet recall was only 27% for the nonverbal tasks, as opposed to 57% for the verbal tasks. Also, metamemory was more accurate for verbal than for nonverbal tasks, the mean gammas were 0.53 and 0.45, respectively. His cognitive awareness was impaired for nonverbal relative to verbal tasks. As found for imitative tasks, tasks that relied on social awareness suffer due to his impairment in this area. Additionally, deficits in cognitive awareness were particularly evident for tasks that contained a nonverbal component.

Declarative Metamemory

Declarative metamemory was examined by having the child evaluate, not his own current memory state, but rather metamemory for another individual's cognitive ability. Declarative metamemory was evaluated for both a person and task variable. For all but one task, the child indicated that every individual on the HPS had the ability to complete the task. Even tasks with which the child struggled, he indicated that the toddler and the infant would be able to complete the task. He appeared to be unaware of the limitations for the younger people in the set to perform tasks such as the GST task, which dealt with general knowledge questions dealing with math and science. In addition, and perhaps to be expected, he was unaware that older persons might have difficulty with some memory tasks, such as the TMG task. By selecting every person for almost every task, the child demonstrated impairment in declarative metamemory.

Although he inaccurately selected every person for every task except one, most of the time the child accurately ordered the pictures on the HPS with the older adult ranked as having the most ability to complete each task, followed by the young adult, the cohort child, the toddler, and the infant. This pattern of ranking was obtained regardless of whether the task involved JOL or FOK judgments. One exception in the ranking was for the two tasks requiring gross body movement, CBM and TMT, for which he ranked the older adult as being second to worst before the infant. For the CBM task, when asked why the infant would perform the worst the child made a reference to the infant not knowing how to exercise. Perhaps his discomfort in these two tasks stems from a dislike of exercise. Also, the child may have been demonstrating an understanding that an older adult could have difficulty with the physicality of the movements, but considering the elementary movements required for these tasks, this is perhaps not the case.

A different pattern emerged when the tasks were divided into imitative and verbal categories. The ranking of older adult, young adult, cohort child, toddler, and infant was given for nonimitative and verbal tasks. However, for tasks requiring imitation, the cohort child was ranked below every other person in the group except the infant. For nonverbal tasks, again the infant was last, but the toddler was ranked after the young adult, followed by the cohort child and the infant. Again, the only person ranked below the cohort child was the infant. Because the imitative and nonverbal tasks required body movement, the child ranked the infant last because the infant could not physically do the movements. Ranking the cohort child below everyone else may indicate that the child was aware that he would not perform well on these tasks and extended his own limitations to other children his age. He did not demonstrate awareness that others his age might have the ability to perform well on tasks with which he had difficulty. His impairment in social awareness led to an egocentric style of rating the cohort child, indicating that he related the cohort child to himself. As such, he was unable to extend abilities to the cohort child that he did not evidence himself.

For the task variable, the child was asked to judge his memory ability by predicting how many items he would remember to buy at a grocery store, without a written list. The child was strikingly underconfident; he predicted only five items, but was able to remember 15. His underconfidence was even more glaring when compared with the predominantly high predictions for the procedural metamemory tasks. His ranking of the HPS revealed his perception of his status with regard to the task. He again ranked the older adult as most able and the infant as least able, but said that the cohort child would remember 19 items. The person whom he ranked as able to remember five items, the number of items he predicted for himself, was the toddler.

Contrary to his egocentric use of the cohort child in previous tasks, it appears that he was attributing abilities to the cohort child that he did not predict for himself. However, it is important to note that the grocery shopping task was the only task for which the child received immediate feedback concerning his performance prior to making the HPS predictions. Although the child predicted he would remember only five items, he knew that he had actually retrieved 15 items from the grocery store. For this reason, his ranking of the cohort child as able to recall 19 items may have been influenced by his own performance.

Limitations

To our knowledge, the present study was the first case of its kind. No other studies investigating the relationship between Asperger's Syndrome and metamemory have been found, despite an extensive search. Therefore, the tasks and procedures developed for this study were exploratory. Also, because this is a case study with one participant, generalization should be done with caution if at all. The findings related to this particular child may not be found in the majority of children with Asperger's Syndrome. Future research is required on multiple children with the disorder before any general conclusions can be drawn. Generalization is also limited due to the low number of tasks in the current study; the study only contained nine tasks. Even if the number of tasks had been appropriate, the total number of items limited some analyses and may not have appropriately or comprehensively tapped into the underlying abilities of the child. Most often, the number of items was limited by the tasks materials. For example, the number of items in the CBM task was limited by the number of colors a child of 11 would be able to identify. One goal for future studies would be to ensure that the tasks were developed so that the number of items for each task could increase. However, one disadvantage with having more items is clear from examining tasks like TMG and GST. For both of these tasks, 25 items were used, and the child became fatigued and frustrated.

Although some of the most interesting findings regarded the deficit in cognitive awareness were obtained by examining tasks according to their imitative and nonverbal characteristics, the tasks were not orthogonal with regard to these variables. The study was designed to examine task that were imitative, but the nonverbal dimension was identified post hoc. As such, the two variables were correlated unsystematically. For instance, the MIG task was both imitative and verbal. The lack of distinction between the variables could make it difficult to understand the unique contribution of each factor.

Future research should avoid varying tasks across both dimensions at the same time and use an equal number of tasks of each type. The findings also must be taken with care because of other confounds within the tasks. First, all of the imitative tasks also required gross body movement. Perhaps the child has a particular dislike of gross motor movement, or was embarrassed to have to imitate the researcher in such a demonstrative manner. It is not clear whether the child performed worse on the imitative tasks because of a cognitive deficit related to the physical nature of the imitative tasks or if he performed worse simply because he did not like the task. One task of future studies should be to ask the child what he is thinking and feeling during these tasks in order to determine exactly what it is that he does not like about them. Second, the two tasks in which he performed the best involved cartoon characters (MCT and BW); it is uncertain whether he did better on these two tasks because he liked them or because they were not imitative and verbal. The goal of a future study would be to design tasks that contain an imitation component, yet do not require gross body movement. In addition, tasks should be used that vary not only in terms of imitation and verbal components, but also in whether they have an entertaining content. Finally, the imitation dimension should be explored further by varying whether imitation is required of the researcher or of a cartoon character, for instance. Examples of children with autism regaining speech ability by imitating cartoon characters rather than humans suggest that impairment may not be seen for tasks requiring imitation of a cartoon character versus a person (Bosseler & Massaro, 2003). Finally, the findings have to be interpreted in the context of the disruptive nature of testing a child with Asperger's Syndrome. Experimental considerations such as timing between learning and recall, equating time to study for each item, and providing an uninterrupted learning session were violated in the present experiment because of interruptions to redirect and deal with the child's behavioral idiosyncrasies. It is not clear how this concern could be addressed in future studies.

Conclusions

The most prominent feature of Asperger's Syndrome is impairment of social integration (APA, 2000). The child in the case study certainly exhibited impairment in social awareness related to several behaviors common among children with Asperger's Syndrome: unconventional nonverbal behavior, inability to monitor personal space during conversation, one-sided social approach to conversations, and an inability to monitor nonverbal cues from others. The social deficits related to Asperger's Syndrome appear to extend to the cognitive domain, at least for the case child. Impairment in cognitive awareness was evident in the child's inability to accurately predict his own memory, particularly in the absence of successful retrieval. Apparently, he could accurately predict what he would remember, but only if he could retrieve the answer while making the prediction. Not only could he not discriminate unrecalled items, but also could not identify which previously unrecalled items would be recognized. As such, when retrieval failed, his metamemory ability also failed. Deficits in social awareness negatively impacted his performance on tasks requiring him to mimic the researcher. Tasks that have a nonverbal nature also result in poor memory and metamemory performance. He can correctly order performance of others on a task, but inaccurately suggests that toddlers and infants can perform tasks for which he had difficulty. Apparently, not only does the child have well-documented deficits in social awareness associated with Asperger's Syndrome, but also has a corresponding deficit in cognitive awareness.

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APPENDIX A

TASK EXAMPLES

Score Sheet: JOL ~ The Sign Language Game

<u>Picture</u> *Assigned Order*	<u>JOL RATINGS</u> *Based on Scale*	COMMENTS
P-1 *Mom*		
P-2 *Water*		
P-3 *House*		
P-4 *Food*		
P-5 *Airplane*		
P-6 *Bear*		
P-7 *Car*		
P-8 *Dad*		
P-9 *Dog*		
P-10 *Doughnut*		
P-11 *Angel*		
P-12 *Animal*		
P-13 *Clap*		
P-14 *Love*		
P-15 *Flag*		

<u>Picture</u> *Random Order*	<u>Recall</u> *1/Correct* *~0/Incorrect*	COMMENTS

Human Pictorial Scale Images

Score Sheet: JOL ~ Color Body Movement

COLOR *Assigned Order*	JOL RATINGS *Based on Scale*	COMMENTS
C-1 *red*		
C-2 *yellow*		
C-3 *dark green*		
C-4 *light pink*		
C-5 *turquoise*		
C-6 *white*		
C-7 *brown*		
C-8 *maroon*		
C-9 *purple*		
C-10 *grey*		
C-11 *hot pink*		
C-12 *lime green*		
C-13 *teal*		
C-14 *black*		
C-15 *orange*		

COLOR *Random Order*	Recall *1/Correct* *~0/Incorrect*	COMMENTS

Human Pictorial Scale Images

Score Sheet: JOL ~ The Matching Game

Cue Word *Assigned Order*	JOL RATINGS *Based on Scale*	COMMENTS
W-1 Tall/ *Book*		
W-2 Girl/ *Flag*		
W-3 Ball/ *Key*		
W-4 Hat/ *Straw*		
W-5 Doll/ *Pencil*		
W-6 Truck/ *Knife*		
W-7 Sun/ *Nose*		
W-8 Phone/ *Snow*		
W-9 Brain/ *Flower*		
W-10 Paper/ *Lamp*		
W-11 Candy/ *Swing*		
W-12 Kite/ *Shoe*		
W-13 Chair/ *Tree*		
W-14 Horse/ *Bridge*		
W-15 Desk/ *Car*		

Cue Word *Random Order*	Recall *1/Correct* *~0/Incorrect*	COMMENTS

Human Pictorial Scale Images

Score Sheet
JOL ~ Mr. Cucumber Task

<u>Shape on Mr. C</u> *Assigned Order*	<u>JOL RATINGS</u> *Based on Scale*	COMMENTS
S-1 *Rectangle*		
S-2 *Crescent*		
S-3 *Square*		
S-4 *Star*		
S-5 *Diamond*		
S-6 *Hexagon*		
S-7 *Flower*		
S-8 *Circle*		
S-9 *Heart*		

<u>Shape</u> *Random Order*	<u>Recall</u> *1/Correct* *~0/Incorrect*	COMMENTS

Human Pictorial Scale Images

Score Sheet
FOK ~ The Musical Instruments Game

<u>Cue Word</u> *Assigned Order*	<u>Recall</u> *1/Correct* *~0/Incorrect*	COMMENTS
I-1 Gleep/ *Violin*		
I-2 Zoot/ *Drums*		
I-3 Dingle/ *Triangle*		
I-4 Mumph/ *Piano*		
I-5 Flink/ *Cello*		
I-6 Sooze/ *Cymbals*		
I-7 Blurp/ *Flute*		
I-8 Sneel/ *Clarinet*		
I-9 Nardy/ *Guitar*		
I-10 Junder/ *Trumpet*		
I-11 Zeedle/ *Bells*		
I-12 Larp/ *Maracas*		
I-13 Yook/ *Harmonica*		
I-14 Zump/ *Harp*		
I-15 Gip/ *Tambourine*		
I-16 Frund/ *Trombone*		

<u>Cue Word</u> Random Order	<u>FOK RATINGS</u> *Based on Scale*	COMMENTS

Cue Word *Random Order*	Recognition *1/Correct* *~0/Incorrect*	COMMENTS

Human Pictorial Scale Images

Score Sheet
FOK ~ The Game Show Technique

<u>Question</u> *Random Order*	<u>Recall</u> *1/Correct* *~0/Incorrect*	COMMENTS

<u>Questions</u> *Random Order*	<u>FOK RATINGS</u> *Based on Scale*	COMMENTS

Questions Random Order	Recognition *1/Correct* *~0/Incorrect*	COMMENTS

		[redacted]
		[redacted]

Human Pictorial Scale Images

Score Sheet

FOK ~ The Movement Task

<u>COLOR</u> *Assigned Order*	<u>Recall</u> *1/Correct* *~0/Incorrect*	COMMENTS
C-1 *red*		
C-2 *yellow*		
C-3 *dark green*		
C-4 *light pink*		
C-5 *orange*		
C-6 *white*		
C-7 *brown*		
C-8 *black*		
C-9 *purple*		
C-10 *grey*		
C-11 *hot pink*		
C-12 *lime green*		
C-13 *teal*		
C-14 *maroon*		
C-15 *gold*		

<u>COLOR</u> *Random Order*	<u>FOK RATINGS</u> *Based on Scale*	COMMENTS

<u>COLOR</u> *Random Order*	<u>Recognition</u> *1/Correct* *~0/Incorrect*	COMMENTS

Human Pictorial Scale Images

Score Sheet
FOK – Bobbins

<u>QUESTION</u> *Assigned Order*	<u>RECALL</u> *1/Correct* *~0/Incorrect*	COMMENTS
1B. What color are Bobbins?		
2B. Where do Bobbins like to live?		
3B. How do Bobbins make their homes?		[redacted]
4B. How do Bobbins move from place to place?		
5B. What do the Bobbin tails look like?		
6B. How can Bobbins fly?		[redacted]
7B. How do Bobbins get their food?		
8B. What was happening when Basil awoke from his sleep?		
9B. Who did Basil decide to visit?		[redacted]
10B. How long would it take Basil to get to (this place he wanted to go OR to Hilda's house)?		
11B. Where did Basil hide to hunt for his breakfast?		
12B. What did Basil eat for breakfast?		[redacted]
13B. What did Basil decide to get as a present for his cousin?		

14B. What did Basil find in the middle of the road to play with?		
15B. How did Basil get across the river?		[redacted]
16B. What did Basil find on the other side of the river?		
17B. How did Basil get across the long forest of trees?		
18B. What did Basil hear singing?		[redacted]
19B. What did Basil do when he heard the music?		
20B. What did Basil help back into the tree that had fallen out?		
21B. What did Basil drink when he was thirsty?		[redacted]
22B. What came up to Basil as he was drinking?		
23B. Where did Basil go to avoid the storm (lightening, thunder, rain)?		
24B. What did Basil find in a whole in the middle of the road?		[redacted]
25B. What did Basil use to get the (object or rock) out of the whole?		
26B. What did Basil do when he got to the cliff?		

27B. What was snuck up behind Basil on his journey?		
28B. What did Basil do to get away (from the cat)?		
29B. How did Basil get over the wall that was in the road?		
30B. What did Basil and his cousin have for diner?		

<u>QUESTION</u> *Assigned Order*	<u>FOK RATING</u> *Based on Scale*	COMMENTS
1B		
2B		
3B		
4B		
5B		
6B		
7B.		
8B		
9B		
10B		
11B		
12B		
13B		
14B		
15B		
16B		
17B		
18B		
19B		
20B		
21B		
22B		
23B		
24B		
25B		
26B		

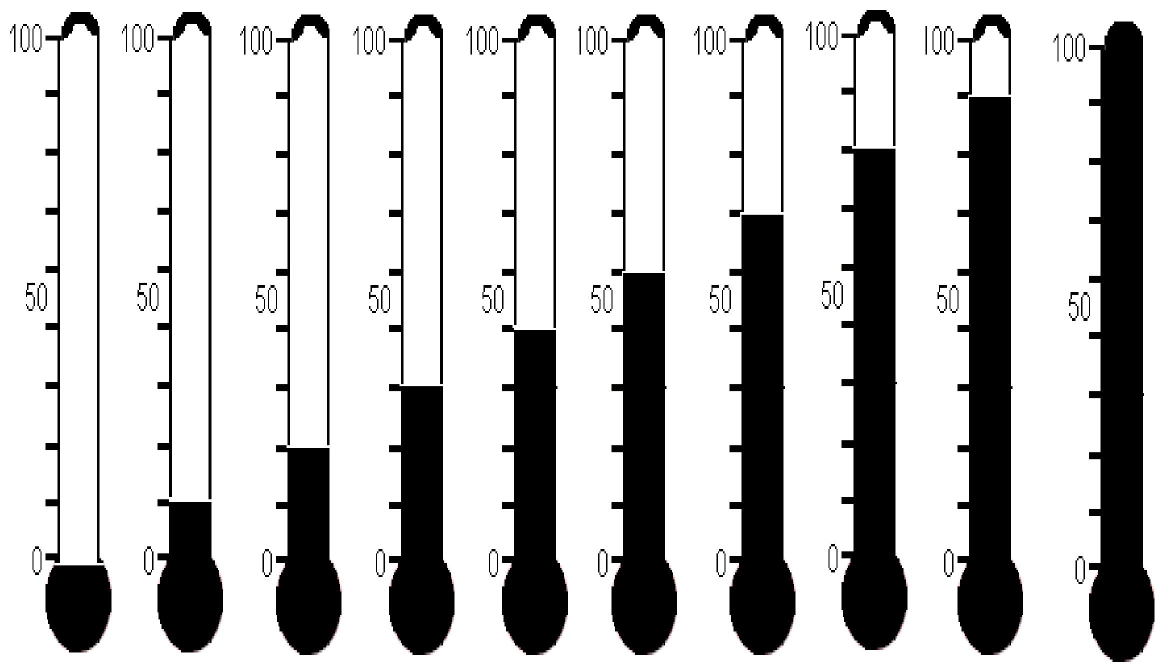
27B		
28B		
29B		
30B		

QUESTIONS *Random Order*	RECOGNITION *1/Correct* *~0/Incorrect*	*COMMENTS*

Human Pictorial Scale Images

APPENDIX B

THERMOMETER SCALE


100
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APPENDIX C

TASK DATA

TASK	ITEM	ITEMCODE	RECALL	RATING	RECOG	HPS
JOL-SLG	P-1	87	0	100		5
	P-2	88	0	50		4
	P-3	89	1	100		3
	P-4	90	1	100		2
	P-5	91	1	100		1
	P-6	92	1	100		
	P-7	93	1	100		
	P-8	94	1	100		
	P-9	95	0	100		
	P-10	96	1	100		
	P-11	97	1	100		
	P-12	98	1	100		
	P-13	99	1	100		
	P-14	100	1	100		
	P-15	101	1	100		
JOL-CBM	C-1	102	0	50		4
	C-2	103	0	70		3
	C-3	104	0	70		2
	C-4	105	0	100		5
	C-5	106	0	60		1
	C-6	107	0	50		
	C-7	108	0	100		
	C-8	109	0	100		
	C-9	110	0	60		
	C-10	111	0	50		
	C-11	112	0	100		
	C-12	113	0	70		
	C-13	114	0	70		
	C-14	115	0	100		
	C-15	116	0	100		

TASK	ITEM	ITEMCODE	RECALL	RATING	RECOG	HPS
JOL-TMG	W-1	117	0	90		5
	W-2	118	1	100		4
	W-3	119	0	90		3
	W-4	120	1	100		2
	W-5	121	0	50		
	W-6	122	1	90		
	W-7	123	1	50		
	W-8	124	1	30		
	W-9	125	0	30		
	W-10	126	0	50		
	W-11	127	0	30		
	W-12	128	0	100		
	W-13	129	1	0		
	W-14	130	0	100		
	W-15	131	0	30		
	W-16	132	0	0		
	W-17	133	0	0		
	W-18	134	0	10		
	W-19	135	0	0		
	W-20	136	1	10		
	W-21	137	0	30		
	W-22	138	0	10		
	W-23	139	1	100		
	W-24	140	0	0		
	W-25	141	0	0		
JOL-MCT	S-1	142	1	100		5
	S-2	143	1	100		4
	S-3	144	0	95		3
	S-4	145	1	100		2
	S-5	146	1	100		1
	S-6	147	1	100		
	S-7	148	1	100		
	S-8	149	1	100		
	S-9	150	1	100		
FOK-MIG	I-1	1	0	90	1	5
	I-2	2	0	100	0	4
	I-3	3	1	100	1	3
	I-4	4	0	80	0	2
	I-5	5	0	100	0	1
	I-6	6	0	90	0	
	I-7	7	0	70	0	

TASK	ITEM	ITEMCODE	RECALL	RATING	RECOG	HPS
	I-8	8	1	50	1	
	I-9	9	0	100	1	
	I-10	10	1	80	0	
	I-11	11	0	90	1	
	I-12	12	0	70	0	
	I-13	13	0	40	0	
	I-14	14	1	60	0	
	I-15	15	0	50	0	
	I-16	16	0	10	0	
FOK-GST	GM-100	17	1	100	1	5
	GM-200	18	1	100	1	4
	GM-300	19	1	100	1	3
	GM-400	20	0	100	0	2
	GM-500	21	1	80	0	1
	GM- 600	22	1	100	1	
	GM-700	23	1	100	0	
	GM-800	24	1	100	1	
	GM-900	25	1	100	1	
	GM-1000	26	1	100	1	
	GM-1100	27	1	100	1	
	GM-1200	28	1	100	1	
	GM-1300	29	1	100	1	
	GM-1400	30	0	100	1	
	GS-100	31	0	30	1	
	GS-200	32	0	90	1	
	GS-300	33	0	90	0	
	GS-400	34	0	80	1	
	GS-500	35	0	100	1	
	GS-1000	36	0	100	1	
	GG-200	37	0	50	1	
	GG-400	38	0	100	1	
	GG-600	39	0	100	0	
	GG-800	40	0	100	0	
	GG-1000	41	0	100	1	
FOK-TMT	C-1	42	0	100	1	4
	C-2	43	0	10	1	3
	C-3	44	0	50	0	2
	C-4	45	0	70	1	5
	C-5	46	0	90	0	1
	C-6	47	0	0	1	

TASK	ITEM	ITEMCODE	RECALL	RATING	RECOG	HPS
	C-7	48	0	20	0	
	C-8	49	0	0	0	
	C-9	50	0	30	1	
	C-10	51	0	30	0	
	C-11	52	0	0	0	
	C-12	53	0	0	1	
	C-13	54	0	0	0	
	C-14	55	0	0	1	
	C-15	56	0	100	0	
FOK-B&W	1B	57	1	100	1	5
	2B	58	1	100	1	4
	3B	59	1	100	1	3
	4B	60	1	100	1	2
	5B	61	1	100	1	1
	6B	62	1	100	1	
	7B	63	1	100	1	
	8B	64	1	100	1	
	9B	65	1	100	1	
	10B	66	1	100	1	
	11B	67	1	100	1	
	12B	68	1	100	1	
	13B	69	1	100	1	
	14B	70	1	100	1	
	15B	71	1	100	1	
	16B	72	0	100	1	
	17B	73	0	100	1	
	18B	74	1	100	1	
	19B	75	1	100	1	
	20B	76	1	100	1	
	21B	77	1	100	1	
	22B	78	1	100	1	
	23B	79	1	100	1	
	24B	80	1	100	1	
	25B	81	1	100	1	
	26B	82	1	100	1	
	27B	83	1	100	1	
	28B	84	1	100	1	
	29B	85	1	100	1	
	30B	86	1	100	1	

APPENDIX D

IRB APPROVAL LETTER

Mississippi State UNIVERSITY

February 15, 2007

Jacqueline Bell
500 Mallory Lane Apt. 25M
Starkville, MS 39759

RE: IRB Study #07-022: Asperger's Syndrome and Metamemory: How well can one child predict his knowledge of the world around him?

Dear Ms. Bell:

The above referenced project was reviewed and approved via expedited review for a period of 2/15/2007 through 1/15/2008 in accordance with 45 CFR 46.110 #7. Please note the expiration date for approval of this project is 1/15/2008. If additional time is needed to complete the project, you will need to submit a Continuing Review Request form 30 days prior to the date of expiration. Any modifications made to this project must be submitted for approval prior to implementation. Forms for both Continuing Review and Modifications are located on our website at http://www.msstate.edu/dept/compliance.

Any failure to adhere to the approved protocol could result in suspension or termination of your project. Please note that the IRB reserves the right, at anytime, to observe you and any associated researchers as they conduct the project and audit research records associated with this project.

Please refer to your docket number (#07-022) when contacting our office regarding this project.

We wish you the very best of luck in your research and look forward to working with you again. If you have questions or concerns, please contact me at cwilliams@research.msstate.edu or by phone at 662-325-5220.

Sincerely,

Christine Williams
IRB Administrator

cc: Deborah Eakin
Kristine Jacquin

Office for Regulatory Compliance
P. O. Box 6223 • 8A Morgan Street • Mailstop 9563 • Mississippi State, MS 39762 • (662) 325-3294 • FAX (662) 325-8776

APPENDIX E

CONSENT FORM

Research Consent Form
Asperger's Syndrome and Metamemory
Mississippi State University
Department of Psychology
Mississippi State, MS 39762
Participant Copy

Jacqueline Bell, B.A.	Deborah K. Eakin, Ph.D.
Graduate Student	Assistant Professor
227 Magruder Hall	214 Magruder Hall

You are being asked to allow your child to act as a volunteer in a research study. The purpose of this form is to tell you about the study your child will be participating in and to inform you about your child's rights as a research volunteer. You will be given a copy of this consent form to keep and you do not waive any legal rights by signing this consent form.

Thank you for allowing your child to participate in this study. Our work could not be done without your help.

Purpose of Study:

One aspect of Asperger's Syndrome (AS) is difficulty relating to others and a lack of awareness of why other people act the way they do in a social setting. Despite having some problems with social interactions, children with AS are bright, verbal, and have an excellent memory. Our study looks at whether children with AS are aware of their memory capability, a topic known as metamemory. What we want to know is whether children with AS who lack social awareness also lack an awareness of their own mental abilities as they relate to memory.

Procedure of the Study:

If you decide to allow your child to participate in this study, he/she will be predicting his/her memory ability for a variety of tasks. We want our study to be fun for your child. Therefore, the tasks have been designed to be fun and interactive. Each task is designed differently, but with the same goal of making predictions about future memory performance. Sometimes your child will be presented with new information to learn and be asked to make predictions on how well he will be able to recall or recognize the information at a later time. For instance, in one task he/she will learn to act out a particular body movement (e.g., put his/her hands on her head) when presented with a particular color-card (e.g., red card). Then he/she will be presented with the color card and asked to predict whether he/she will be able to remember the body movement that goes with that color. Then he/she will be presented with the card again and asked to act out the associated movement. At other times, your child will be asked to predict his/her memory for information he has already learned. For example, with the game-show task, your child will be asked general knowledge questions appropriate for his/her age group. After providing an answer to the question, he/she will predict whether he/she will be able to recognize the answer later. Finally, he/she will be presented with the question and a list of possible answers and be asked to choose the correct answer. Other tasks will be to learn to associate a picture (e.g., a bike) with the sign-language sign for that image, learning to link two unrelated words together (e.g., frog – table), and, by listening to a story about Bobbles and Woozles, learn what they eat and look like. For each task, he/she will make predictions about his/her future memory for the information. In order to make the predictions, we will provide a scale (e.g., a thermometer) that he/she has had practice using. Finally, we will also provide pictures of people of different ages (e.g., toddler, older adult) and ask your child to predict whether each of those people could do the task he/she just completed. For each task, your child will be given clear instructions to make sure he knows what he is supposed to do and will have an opportunity to practice the tasks. He/She will be free to stop any task at any time. Incentives, such as stickers and small toys will be provided, but these will be given regardless of performance on any task.

Discomfort and Risks:

There are no major physical discomforts involved in this study. Risks are minimal and do not exceed those of any normal classroom activity. We have designed the study to be flexible in terms of what we do each session. Therefore, if your child is not enjoying a particular task, we will change to a different one. Please tell us if your child is having trouble with any tasks or if your child needs additional rest and we will be happy to accommodate him/her in any way possible. If your child feels any discomfort, please tell us immediately.

Benefits:

This study will provide valuable information regarding Asperger's Syndrome and Metamemory. Your child is not likely to benefit personally in any way from joining this study, but thanks to the willingness of people like you and your child, we will continue to learn about this disorder and the cognitive system, as well as how to improve quality of life.

Confidentiality:

All of your child's responses will be kept strictly confidential. Only members of this research project will be allowed access to any information. Your child's performance eon the tasks will be numerically scored and stored in a computer with no identifying information. Any identifying information, such as this consent form, will be stored in a separate location from the actual test scores. No identification of your child's individual answers to questions will be given to anyone. We want you to be completely assured that your child's information will be held completely confidential.

Study Site:

All of the sessions will be held at the clinic offices of Magruder Hall at the Mississippi State University campus. We anticipate a series of 4 to 5 sessions, each lasting about 1-½ hours.

Compensation:

There is no direct compensation for this study. You and your child are participating on a voluntary basis. However, we will provide small incentives for your child, including stickers, small books, and prizes. We would also like to provide you with a Wal-Mart gift card in the amount of $100 as a token of thanks for your time and effort in bringing your child to the sessions.

Contact Information:

If there are problems that arise during your child's participation, please feel free to contact Jacqueline Bell (601-527-7620) or Dr. Deborah Eakin (662-325-7949) at Mississippi State to discuss the problems. If you have any questions about the research procedures described above, please feel free to talk with the researcher or contact Dr. Deborah Eakin. Further, if you have any questions about your child's rights as a research volunteer, please feel free to contact the MSU Regulatory Compliance Office at 662-325-5220.

Participant Consent:

I have read (and have been told) the information above. The researchers have answered my questions to my satisfaction and they have given me a copy of this form. I consent to have my child participate in this research study.

Participant's Name: _________________________ Date: _______________________

Guardian/Representative's Signature: ___________________________ Date: _______

Investigator's Signature: ________________________ Date:___________________

APPENDIX F

ASSENT FORM

Research Assent Form
Asperger's Syndrome and Metamemory
Mississippi State University
Department of Psychology
Mississippi State, MS 39762
Participant Copy

Jacqueline Bell, B.A.
Graduate Student
227 Magruder Hall

Deborah K. Eakin, Ph.D.
Assistant Professor
214 Magruder Hall

Your parent knows we are going to ask you to participate in this project. We want to know about kids' experiences with memory. It will take 5 to 8 hours across 4 to 5 sessions of your time to complete the tasks. Your name will not be written anywhere on the tasks. No one will know these answers came from you personally.

If you don't want to participate, you can stop at any time. There will be no bad feelings if you don't want to do this. You can ask questions if you do not understand any part of the study.

Do you understand? Yes No Is this OK? Yes No

Name (Please print):____

Signature: ____

Date: ____________________________

Investigator's Signature: _________________________________Date:_______________