Asperger's Syndrome and Learning Strategies: Are Difficulties Due to a Production Deficit or to a Utilization Deficit?

Miranda Lee Morris

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ASPERGER’S SYNDROME AND LEARNING STRATEGIES: ARE DIFFICULTIES DUE TO A PRODUCTION DEFICIT OR TO A UTILIZATION DEFICIT?

By

Miranda Lee Morris

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ASPERGER’S SYNDROME AND LEARNING STRATEGIES: ARE DIFFICULTIES DUE TO A PRODUCTION DEFICIT OR TO A UTILIZATION DEFICIT?

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This study investigated whether knowledge about memory strategies was impaired in a group of young adults with Asperger’s Syndrome (AS) as compared to a group of young adults without AS. Both groups participated in two tasks, one designed to examine the categorization strategy and one to examine the interactive imagery strategy. Participants with AS showed a production deficit because they were unable to spontaneously produce either strategy to benefit their memory performance. However, the group with AS did not show evidence of a utilization deficit; when they were trained on strategies, they were able to use them effectively both immediately after training and after a delay of one week. The findings provide additional evidence that metamemory deficits observed in AS are similar to those seen in children and older adults, presumably due to the frontal and temporal lobe abnormalities that individuals with AS share with both age groups.
DEDICATION

To my parents for their unwavering love, support, and frequent pep talks. Everything I am or ever will be is because of the two of you. To my brother for always keeping me on my toes and for inspiring me to be a better person. You are a great man and I cannot wait to see what incredible things you still have in store for the world. To my “Second Mother”, D. Without your guidance and endless belief in my abilities, this would have never been possible. My life is so much better with you in it. To my “kids”, Hannah and Fred for reminding me that there is life outside of science and that being loved is the only armor you need to get through life. To The Pretty Committee, Bee, Callie, and Johnson. I am so truly blessed to call you my best friends. Thank you for the memories and for making my life so beautiful. To The Chi-Squares. Thank you for sharing this experience with me. The incredibly long nights in Magruder, gallons of coffee, and constant laughter have made this all worthwhile. To Emma and Josh for making me who I am. I miss you both every single day. Finally, to The Gypsies. Thank you for letting me win this round.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEDICATION</strong></td>
<td>ii</td>
</tr>
<tr>
<td><strong>ACKNOWLEDGEMENTS</strong></td>
<td>iii</td>
</tr>
<tr>
<td><strong>LIST OF TABLES</strong></td>
<td>vi</td>
</tr>
<tr>
<td><strong>CHAPTER</strong></td>
<td></td>
</tr>
<tr>
<td><strong>I. INTRODUCTION</strong></td>
<td>1</td>
</tr>
<tr>
<td>Strategies as Metamemory</td>
<td>2</td>
</tr>
<tr>
<td>Neurological Foundations of Metamemory</td>
<td>6</td>
</tr>
<tr>
<td>Metamemory and Asperger’s Syndrome</td>
<td>9</td>
</tr>
<tr>
<td><strong>II. METHOD</strong></td>
<td>17</td>
</tr>
<tr>
<td>Participants and Design</td>
<td>17</td>
</tr>
<tr>
<td>Materials</td>
<td>19</td>
</tr>
<tr>
<td>Peabody-Picture Vocabulary Test, Fourth Edition (PPVT-4)</td>
<td>19</td>
</tr>
<tr>
<td>Category Task</td>
<td>19</td>
</tr>
<tr>
<td>Associative Learning Task</td>
<td>20</td>
</tr>
<tr>
<td>Training Presentations</td>
<td>21</td>
</tr>
<tr>
<td>Additional Materials</td>
<td>21</td>
</tr>
<tr>
<td>Consent Form</td>
<td>21</td>
</tr>
<tr>
<td>Assent Form</td>
<td>22</td>
</tr>
<tr>
<td>Debriefing Statement</td>
<td>22</td>
</tr>
<tr>
<td>Procedure</td>
<td>22</td>
</tr>
<tr>
<td>Category Task</td>
<td>23</td>
</tr>
<tr>
<td>Session I – Pre-training</td>
<td>23</td>
</tr>
<tr>
<td>Session I – Training</td>
<td>23</td>
</tr>
<tr>
<td>Session I – Post-training</td>
<td>24</td>
</tr>
<tr>
<td>Session II – Delay</td>
<td>24</td>
</tr>
<tr>
<td>Associative Learning Task</td>
<td>25</td>
</tr>
<tr>
<td>Session I – Pre-training</td>
<td>25</td>
</tr>
<tr>
<td>Session I – Training</td>
<td>25</td>
</tr>
<tr>
<td>Session I – Post-training</td>
<td>25</td>
</tr>
</tbody>
</table>

iv
Session II – Delay  .................................................................................................................. 26

III. RESULTS ....................................................................................................................... 27

Category Task ..................................................................................................................... 27
  Pre-training ....................................................................................................................... 27
  Post-training ..................................................................................................................... 30
  Delay ................................................................................................................................. 32

Associative Learning (AL) Task ......................................................................................... 33

IV. DISCUSSION .................................................................................................................... 35

Strategy Production ............................................................................................................ 38
Strategy Utilization ............................................................................................................. 39
Limitations ........................................................................................................................ 42
Conclusions ......................................................................................................................... 43

REFERENCES ....................................................................................................................... 45

APPENDIX

A  CONSENT FORM FOR PAID PARTICIPANTS WITH AS ........................................... 49
B  SESSION 1 (PPVT-4) CONSENT FORM FOR COMPARISON GROUP ........................................... 52
C  SESSION 2 CONSENT FORM FOR COMPARISON GROUP ............................................. 55
D  PARENT CONSENT FORMS ......................................................................................... 58
E  ASSENT FORM ............................................................................................................ 61
F  DEBRIEFING STATEMENT .......................................................................................... 63
G  WORD LISTS FOR CATEGORY TASK .......................................................................... 65
H  CATEGORY TASK TRAINING PRESENTATION .......................................................... 67
I  AL TASK WORD PAIRS .............................................................................................. 73
J  AL TASK TRAINING PRESENTATION .......................................................................... 75
K  IRB APPROVAL ............................................................................................................. 84
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Participant Demographic Information and PPVT-4 Scores</td>
<td>18</td>
</tr>
<tr>
<td>2. Probability of Recall for Category Task</td>
<td>28</td>
</tr>
<tr>
<td>3. Pairwise Comparisons of Probability of Recall for Category Task</td>
<td>29</td>
</tr>
<tr>
<td>4. Probability of Recall for AL Task</td>
<td>33</td>
</tr>
<tr>
<td>5. Pairwise Comparisons of Probability of Recall for AL Task</td>
<td>34</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

Successful memory is often determined by the use of appropriate strategies during learning. A strategy, in the context of the present paper, is a consciously implemented process for achieving a goal, such as successful memory outcome (Dunlosky & Hertzog, 1998). For instance, strategies can be used to facilitate learning lists of single words. Organizing a list of seemingly random words into meaningful categories (e.g., Mandler, 1967) or learning a list of unrelated words by imposing a unique meaning structure based on one’s own knowledge (e.g., Bousfield, 1953; Tulving, 1962) are both strategies that aid memory for lists by capitalizing on the semantic qualities of items. Deese (1959) demonstrated that recall rates were better when the items presented in a list were semantically related to one another. Participants were either given a list of words that were categorically organized (e.g., flower, insect, bee; candy, sweet, sugary) or a list of unrelated words. He found that recall rates were higher for the list of categorized words as compared to the unrelated list.

Deese (1959) demonstrated that memory was better for categorized than for unrelated lists. However, Bousfield (1953) demonstrated that even when words were not organized into categories, participants implemented categorization to the list when it was possible to do so. Participants who were presented with a randomized word list that could be grouped into categories (e.g., animals, professions, and vegetables) demonstrated that they used categorization as a strategy. When reporting their memory for the list items,
participants clustered the items they recalled according to their semantic category (e.g., all of the animals followed by all of the vegetables, etc.), and often listed related items together within the categories. For example, when providing a list of animals, individuals would often list several types of felines followed by several types of canines (e.g., Bousfield, 1953).

This study examined differences in learning strategies used by individuals with Asperger’s Syndrome (AS) as compared to those without AS. As will be discussed later, specific deficits have been found that suggest that adults with AS fail to implement strategies that could improve their memory performance. A critical question is whether this failure occurs at the production level or at the utilization level. Additionally, this study will examine what impact, if any, training on the proper use of learning strategies will have on the recall accuracy for this population. First, however, the findings on learning strategies will be reviewed, followed by a discussion of findings related to individuals who have been diagnosed with AS.

**Strategies as Metamemory**

Memory strategies, such as organizational strategies, can be effective; however, what is necessary is both the knowledge that a strategy is required as well as which strategy to implement. This knowledge about strategies is a type of metamemory. Metamemory is “knowing about knowing” (Flavell & Wellman, 1977), and can be thought of as a kind of awareness of the memory process, including awareness about which strategies affect memory and when to use them. Metamemory can be divided into two different types: procedural and declarative. Procedural metamemory refers to knowing about specific aspects of the memory process. For instance, knowing whether or
not some information will be remembered on a later memory test is an example of procedural metamemory (e.g., Nelson & Narens, 1990). Declarative metamemory includes knowing about factors that impact memory, and can be divided into three categories: person, task, and strategy. A measure of metamemory for the person category is knowing that a toddler will not perform as well on a memory test as an older child (e.g., Yussen & Bird, 1979). Knowing that a short list of words will be easier to remember than a long list of words is an example of the task category. Knowing which strategies are effective and when to use them falls under the strategy category (e.g., knowing to impose categorical organization on a list of words in order to facilitate memory).

Metamemory ability overall appears to be developmental (Flavell, Friedrichs, & Hoyt, 1970; Schneider & Sodian, 1997). For instance, Flavell et al. showed a series of pictures to children ranging in age from nursery school to fourth grade and asked them to predict how many pictures they would be able to recall. The older children’s predictions about the number of pictures they later recalled were more accurate than the predictions of the younger children; younger children tended to be unrealistically confident in their predictions. Even when the children were allowed to study the pictures until they could remember all of them without any errors and were again asked to predict how many they would later recall, the predictions of older children still were more accurate than those of the younger children.

Declarative metamemory for strategy use also appears to be developmental. Young children do not exhibit spontaneous strategy use as compared to older children (Moely, Olson, Hawles, & Flavell, 1969), and are less likely to use organizational strategies (Hasselhorn, 1992). Hasselhorn showed groups of second and fourth graders
categorized sets of pictures; six pictures belonged to each of four categories: furniture, clothing, tools, and fruits. First, the experimenter placed 24 pictures on a table in a specific order and named each item. The children were asked to study the pictures for a test that would be given later. Next, the children were told to arrange the pictures in an order that would make it easier for them to learn the names of the items and an additional study period was allowed. After a short delay, the children verbally reported which pictures they remembered. The fourth grade group showed more clustering than the second grade group; they tended to report the pictures in order of category membership more often than the younger children. Therefore, the older children demonstrated more deliberate and effective use of the strategy of categorization as compared to the younger children.

Moely et al. (1969) also examined spontaneous strategy use in children ranging from kindergarten to fifth grade. Children were shown a set of pictures (the number of pictures varied with age group); the pictures were arranged in a pre-determined order on the table. In the control condition, the children were asked to identify the object in the picture. In the naming condition, the experimenter named a category for the children and identified which items belonged to that category. In the teaching condition, the children identified the items in the pictures and then were told to sort the items into categorical groups. They labeled each category and counted the number of items in each. They were told that they should recall the pictures by remembering the name of the category and then listing all of the members of that category on the test. Regardless of condition, the children were then told to study the pictures and to arrange the pictures in any way that might help them better remember the pictures, while the experimenter left the room. When the experimenter returned two minutes later, the pictures were covered and the
children were asked to recall the pictures. The results from the naming condition demonstrated that the younger children had a production deficit—they did not spontaneously generate an effective strategy—because they did not spontaneously arrange the pictures according to category. Only the children in the fifth grade showed a level of categorization that was significantly greater than chance by arranging the pictures in a meaningful way; they also showed evidence of clustering during recall. However, in the training condition, when the younger children were given extensive instructions about categorization, their memory was similar to that of the older children. In addition, when the younger children were provided hints at recall, they were able to group the pictures in a meaningful way and their memory benefited from this strategy use. Therefore, although they showed a production deficit, when instructed on the use of categorization, the younger children did not show a utilization deficit. They were able to use the strategy such that their memory performance improved relative to when they did not.

Barclay (1981) also demonstrated that groups of kindergartners showed a production but not a utilization deficit. Given a set of pictures to remember, one group of children was asked what they could do to facilitate their memory. If the children did not respond, they were prompted until they verbalized their strategy. A second group of children was not prompted about strategy use. The children who were prompted exhibited higher recall and required less study time than the children who were not prompted. Barclay concluded that being questioned about strategies prompted the children in that group to implement successful strategies. The children in the non-prompted group showed a production deficit typical of their age group because they did not spontaneously produce strategies. However, when prompted to do so, the children were able to use the strategies, demonstrating that they did not have a utilization deficit.
Findings from longitudinal studies suggest that the development of a child’s use of memory strategies is strongly correlated with the child’s knowledge about and experience with their own memory (Schneider & Sodian, 1997). Younger children tend to show a production deficit that gradually fades with time as they build their knowledge base and learn which strategies are most effective for certain tasks. However, young children apparently do not suffer from a utilization deficit. When effective strategies are suggested, even young children are able to use those strategies as effectively as older children, and to the benefit of their memory performance.

This study investigated whether young adults with AS demonstrated a production deficit, a utilization deficit, or both with regard to strategy use relative to young adults without AS. There is evidence that people with AS have deficits in the frontal and temporal regions of the brain, as will be discussed, which contribute to the lack of social awareness characteristic of the disorder. These same regions have been implicated in deficits in metamemory, as will be discussed next. The question asked by the present study was whether the lack of social awareness is extended to a lack of cognitive awareness as evidenced by a failure to either produce or effectively use memory strategies by young adults with AS.

**Neurological Foundations of Metamemory**

The frontal lobes, and to a lesser extent the temporal lobes, have been implicated in higher order cognitive functioning, such as planning, decision-making, and other executive functions (Waltz et al., 1999; Zalla, Phillips & Grafman, 2002). Metamemory is a higher order cognitive process requiring reasoning and decision-making, and therefore these same regions have been implicated in metamemory processing.
Because the frontal regions of the brain do not completely develop until adolescence, the production deficits observed in young children may be due to underdevelopment of these important neural regions of the brain (Craik & Bialystok, 2006). In addition, deficits in strategy production in older adults could be due to loss of cortical mass in the frontal regions (Parkin, Walter, & Hunkin, 1995).

Gershberg and Shimamura (1995) compared the use of organizational strategies between patients with frontal lobe damage and a comparison group consisting of individuals without brain damage by presenting for study lists that could be organized in terms of category. Participants studied lists of 15 words that could be organized into five categories with three words in each category. For each trial, the list was presented and then participants recalled the words on the list in any order for each of five trials. The order of the words recalled was examined to determine whether participants recalled the words in category clusters or instead imposed some other organizational strategy to the list. The patients with frontal lesions used categorization to a lesser degree than those in the comparison group; however, like the participants in the comparison group, they increased their use of both strategies across trials. The findings from Experiment 1 and 2 (Gershberg & Shimamura, 1995) suggest that patients with frontal lobe damage suffer from a production deficit in terms of strategy use, thereby evidencing a failure of declarative metamemory. However, because performance tended to improve with experience, the patients did not show evidence of a utilization deficit.

In their third experiment, Gershberg and Shimamura (1995) manipulated the amount of contextual support provided during encoding, during retrieval, or both in order to determine whether the failure of patients with frontal lobe damage to apply effective organizational strategies was due to a production or a utilization deficit. In some
conditions, instructions were provided about a strategy that would prove useful during learning of a presented list. For instance, at encoding, some participants were given a list of the six different categories to which list items belonged; as each word was presented, they had to identify the category to which the word belonged. At retrieval, one group of participants was provided with the categories and was told that the category names could be used to help recall the words. For the other group, category names were provided at both encoding and retrieval. Patients with frontal lobe damage showed a significant increase in clustering behavior when categories were provided at encoding, at retrieval, and at both. This finding suggests that the patients had a production deficit (they did not spontaneously use organizational strategies), but they did not exhibit a complete utilization deficit. When they were provided with the appropriate strategy, they were able to use the strategy as well as the participants without frontal lobe damage. However, the effectiveness of the strategy in terms of facilitating memory performance never achieved the level shown by the comparison group (but see Gershberg, 1997).

Shimamura and Squire (as cited in Metcalfe & Shimamura, 1996) directly examined the relationship between damage in the temporal lobe and metamemory ability. Patients diagnosed with Korsakoff’s syndrome were compared to patients with amnesia; Korsakoff’s syndrome is marked by damage to the thalamus region of the brain located within the temporal lobe, due to deficiencies in vitamin B1. Korsakoff’s patients were presented with general knowledge questions and asked to provide the answers. 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, a measure of procedural metamemory ability. Patients with Korsakoff’s syndrome provided less accurate predictions about their future memory ability as compared to the patients with
amnesia; they demonstrated impairments in metamemory ability related to their brain damage. This finding was not obtained for the patients with amnesia. Although deficits were obtained in memory for both groups, the patients with amnesia were metacognitively aware of those deficits, unlike those with Korsakoff’s Syndrome.

**Metamemory and Asperger’s Syndrome**

As discussed, strategy use is a type of declarative metamemory that can fail in two distinct ways. A production deficit is observed when people do not spontaneously generate appropriate, effective strategies. Deficits of this type have been shown in young children (Barclay, 1981), but dissipate with age (Hasselhorn, 1992; Moley et al., 1969). A utilization deficit occurs when people generate strategies, or are instructed to do so, but the strategy use does not affect memory as effectively as expected. The purpose of the present study was to determine whether adults with AS show such deficits regarding strategy use.

AS is subsumed within the autism spectrum disorders, but is a distinct disorder. Although individuals with AS share some symptoms with people diagnosed with autism, there are also important differences. Although individuals with autism have difficulty with social situations, individuals diagnosed with AS display marked impairment in social interaction that is more prominent. In fact, this factor is the key criterion of the disorder (*DSM-IV TR*, American Psychiatric Association, 2000). However, although people with AS do show delays in social development, they do not show the developmental delays typical of autism. Individuals with AS often display average to above-average linguistic abilities and intact functioning of cognitive processes, such as memory. Neurologically, the same areas that have been discussed previously as leading
to deficits in metamemory have also been implicated in the deficits in social awareness observed in people with AS. The frontal regions of the brain, specifically the anterior regions, have been attributed to the deficits in social awareness typical to AS (Coleman, 2005). In addition, magnetic resonance imaging (MRI) has been used to demonstrate an association between AS and irregular activation in the temporal lobes of the brain (Salmond et al., 2005). For instance, a group of children with high-functioning autism and a group with AS were given tasks designed to test episodic and semantic memory, such as word list recognition and the Rivermead Behavioral Memory Test. After completing the tasks, the children with AS showed intact semantic memory (i.e., world knowledge that is not tied to specific personal experience) and impaired episodic memory (i.e., memory for specific personal events). Forming new episodic memories is accomplished in the temporal regions of the brain. The MRI data revealed that the AS group had increased grey matter in the temporal lobe, which may have led to the memory impairments obtained.

The deficits in frontal and temporal lobe functioning leading to a lack of social awareness in people with AS may also lead to a lack of cognitive awareness, or impaired metamemory. Smith, Gardiner, and Bowler (2007) tested the ability of adults with AS to produce a strategy to learn lists of semantically related (e.g., COW, PIG, HORSE), phonologically related (e.g., BRIGHT, FIGHT, TIGHT), or unrelated (e.g., TRUMPET, ROOF, TROUT) words. Although memory performance was enhanced for the control group when the words on the lists were semantically or phonologically related as compared to the unrelated list, the participants in the AS group did not show better memory for the two related lists as compared to the unrelated list. The poor performance shown by the individuals with AS for the related lists lends support to the theory of an
organizational deficit (Minshew & Goldstein, 2001) because the adults with AS were unable to capitalize on the relations between words on the related lists. Smith et al. inferred that the poor recall performance for the phonologically related words indicated that the adults with AS failed to fully encode the overall property of the words on the lists and were focusing instead on processing the words as individual items. However, it could be the case that the failure was actually due to a failure of metamemory; participants did not spontaneously produce the categorization strategy that would perhaps have led to better memory for the related lists.

Bowler, Matthews, and Gardiner (1997) investigated whether adults with AS would benefit from a list of words that was already organized such that all of the words belonged to the same category (e.g., animals) as compared to a list of unrelated words. Participants listened to an experimenter verbally recite a list of 12 words that were either related to a single category or unrelated. At the end of the list, participants verbally recalled as many words as they could in any order. Participants without AS demonstrated better memory recall for the list of related words, as compared to the unrelated list. However, the adults with AS did not show any benefit in memory for the related list. Bowler et al. concluded that the adults with AS did not use semantic categorical information about the list items to aid recall to the same degree as the participants in the comparison group. From this study, it is not clear whether a production deficit or a utilization deficit contributed to the poorer memory on the part of the adults with AS. It could be the case that they did not notice the relationship among the words on the related list and therefore did not spontaneously produce a categorization strategy to remember those words. On the other hand, perhaps they did notice the relationship, but the use of
the strategy did not facilitate their memory outcome to the same degree as participants in the comparison group.

In the present study, I examined whether young adults with AS demonstrated a production deficit or a utilization deficit for categorical organization strategies. Young adults with AS and a comparison group of individuals without AS were asked to learn three lists of words. Combining aspects of Smith et al. (2007) and Bowler et al. (1997), participants studied a list of categorized words belonging to one category (e.g., animals; related list), a list of words that could be categorized into one of three categories (categorizable list), and a list of unrelated words (unrelated list). Memory performance for each list type was compared between the two groups. I predicted that if the participants with AS had a production deficit, their recall performance would be similar for the three list types whereas I expected that the comparison group would show a benefit for both the categorized and categorizable lists. On the other hand, if the individuals with AS possess a utilization deficit, I predicted that their recall performance on the categorizable list would improve significantly after training and that this benefit would last after a one week delay. It may be the case that, due to differences in the way semantic information is organized in memory (e.g., Minshew & Goldstein, 2001), adults with AS may not categorize information in the same way as people without AS. People with AS reportedly tend to use simple patterns and rules, rather than focusing on the inherent semantic organization of words on categorized or categorizable lists (Frith, 1989). If so, the methods used by the researcher to categorize the lists may not be meaningful to the esoteric organization of information observed in people diagnosed with AS.
The Category Task used in the present study required participants to group list items together in terms of semantic category. It may be the case that people with AS have a particular difficulty in grouping information according to this strategy. For this reason, the Associative Learning Task in this study was designed to investigate the use of nonorganizational strategies. Rather than requiring associations among single items on a list, associative learning requires associating a cue-target word pair such that presentation of the cue on a memory test prompts recall of the target. Production deficits have been obtained with older adults in an associative learning task. Dunlosky and Hertzog (1998) provided a group of younger and older adults a strategy for learning a list of cue-target paired associates (e.g., KING-CROWN). Participants were told to use interactive imagery to create a mental image of the two words interacting in some way. Another group was not provided with any strategy instruction. The older adults who did not receive strategy instruction showed a production deficit; their memory was worse than the older adults who were instructed about an effective strategy. Although significant age differences were found between the two age groups in that the older adults had lower recall overall, they benefited from the instructions to use interactive imagery, relative to the older adults who received no imagery instruction. This finding that the group who received no instruction showed poorer memory is evidence of a production deficit on the part of the older adults; they did not spontaneously use interactive imagery as a strategy to learn the word pairs. However, they did not show a utilization deficit; when instructed to use interactive imagery, they were able to do so effectively, albeit not to the same degree as the younger adults.

In the Associative Learning Task used in the present study, individuals with AS and a comparison group of young adults without AS were asked to study two lists of
related (e.g., KING-CROWN) cue-target word pairs. First, the participants in both groups were shown the list of cue-target word pairs and asked to learn to associate the cue and target with the goal of remembering the target, given the cue, on a later memory test. Then, participants were taught how to use interactive imagery to relate the cue to the target and were then given a new list of related cue-target word pairs with the instruction to use the interactive imagery strategy to associate the pairs. I predicted that if the participants with AS had a production deficit, their recall accuracy would be worse for the list that they learned before being taught the strategy relative to the recall accuracy of the comparison participants.

In addition to examining potential production deficits, the present study examined whether young adults with AS also show a utilization deficit by providing training on effective strategy use for the two tasks. It may be the case that, when instructed, participants with AS can use strategies as effectively as individuals without AS. One prior study examined training in adults with AS. In addition to examining memory for three types of lists (semantically related, phonologically related, and unrelated), Smith et al. (2007) also implemented training. After being shown all three list types, participants received training to create a mental image of the words to aid recall. Training for the phonologically related list instructed participants not to create an image of the words (because some were abstract nouns), but rather to think about the sound of the rhyme among words during recall. Next, new lists of each type were shown and participants verbally recalled the words at the end of each list. The level of recall shown by individuals with AS for the unrelated list was not significantly different from that of the related lists. Even after training, the participants with AS only showed a slight improvement in recall for the related list but no improvement for the unrelated list.
Overall, participants with AS showed significant recall deficits for both types of related lists and were unable to increase recall to the level shown by controls even after training on strategy use. Additionally, unlike those in the comparison group, participants with AS were unable to increase levels of recall for the unrelated list after training. Therefore, the individuals with AS seemed to exhibit a utilization deficit; they were unable to effectively use the strategies on which they were trained.

One potential criticism of studies examining strategy use in adults with AS is that many of the procedures require participants to learn the lists by listening to the researcher recite the lists aloud (e.g., Bowler et al., 1997) or to recall lists by reporting words verbally (e.g., Smith et al., 2007). Given that the key characteristic of AS is a lack of social awareness, it may be the case that performance was poor for people with AS due to the socially interactive nature of the procedure used in prior research. For this reason, the tasks used in the present study as well as the training procedures were presented on a computer. In this manner, social interaction with the researcher was minimized, and performance on tasks did not rely on successful social interactions.

In order to provide training about strategy use, presentations on how to use specific memory strategies were created for the two tasks in the present study. Each training presentation provided an explanation about the appropriate strategy to use for each task and provided step-by-step instructions about how to implement the particular strategy. For instance, for the Category Task, the presentation instructed the participants to use three steps to remember a list of words: (a) notice any categorical relationships between list items, (b) mentally group words that are related into categories, and (c) recall the category name during the recall phase and then recall members of the category. Next, the categorizable list that was shown to the participants in the pre-training phase and the
three steps were demonstrated by highlighting the words on the list in such a way that the words were visually grouped into categories. After the training presentation was viewed, new lists were presented, and participants were given the opportunity to use the strategies shown in the training presentation. A utilization deficit would be obtained if, despite using these strategies, memory performance did not improve.
CHAPTER II

METHOD

Participants and Design

Five young adults who met the criteria for the disorder according to the *DSM-IV-TR* (APA, 2000) as diagnosed by a clinical psychologist participated in the study. However, I only included data from three participants because one participant did not return for the second session and one was unable to stay engaged in the task. The mean age of the group with AS was 16 years (*SD* = 2.6). Three additional young adults were selected to participate because they met the PPVT-4 score inclusion criteria (see next). The mean age of the participants in the comparison group was 20 years (*SD* = 1.0).

Participants with AS were recruited with flyers and local newspaper advertisements and were paid $10 dollars per hour for approximately two hours for the first session and one hour for the second session. The young adults in the comparison group were recruited via SONA from a pool of psychology students at Mississippi State University and were given credit for participation either as part of their introductory psychology course requirement or as extra credit. Prior to participation, participants aged 18 years or older were asked to provide informed consent; participants under 18 years provided assent and their parent or guardian provided consent. All subjects were tested individually. Comparison participants participated in a screening phase during which they were given the PPVT-4 (Dunn & Dunn, 2007) test of verbal IQ in order to match them to the participants with
Demographic information and PPVT-4 scores for all participants in both AS and Comparison groups are reported in Table 1.

**Table 1**

*Participant Demographic Information and PPVT-4 Scores*

<table>
<thead>
<tr>
<th>Participant Pair</th>
<th>Age</th>
<th>Gender</th>
<th>Std. Score</th>
<th>Percentile</th>
<th>Age</th>
<th>Gender</th>
<th>Std. Score</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>M</td>
<td>121</td>
<td>93</td>
<td>21</td>
<td>M</td>
<td>121</td>
<td>93</td>
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<tr>
<td>2</td>
<td>13</td>
<td>M</td>
<td>136</td>
<td>99</td>
<td>22</td>
<td>M</td>
<td>138</td>
<td>99</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>F</td>
<td>109</td>
<td>73</td>
<td>19</td>
<td>F</td>
<td>109</td>
<td>73</td>
</tr>
</tbody>
</table>

Participants whose score matched that of one of the participants with AS were invited to participate in the rest of the study. Those who expressed interest provided an email address and the experimenter contacted them with details about the next session; participants were given a code to sign up through the Sona system. Participants in the comparison group signed a new consent form prior to the beginning of the second and third sessions. Each participant from the group with AS and from the comparison group participated in the same tasks.

Participants in each group were asked to complete two separate tasks: the Category Task and the Associative Learning Task. The Category Task used a 3 (List Type: categorically related list, categorizable list, unrelated list) x 3 (Training Session: pre-training, post-training, delay) factorial design. The Associative Learning Task is a 3 (Training Session: pre-training, post-training, delay) single factor design.
Materials

Peabody-Picture Vocabulary Test, Fourth Edition (PPVT-4)

The PPVT-4 (Dunn & Dunn, 2007) is a measure of receptive (hearing) vocabulary for Standard American English and is suitable for child and adult populations. This test provides a quick and reliable measure of verbal intelligence. The PPVT-4 is untimed and administered individually. Participants are shown a page of four full-color pictures and asked to select the picture that best illustrates the meaning of the word that is spoken by the experimenter. The entire test consists of 228 items that are grouped into 19 sets of 12 items each. The sets are arranged by age group and become increasingly difficult so that the experimenter can administer only those sets which are appropriate for the participant’s vocabulary level. The age norms used for the PPVT-4 are based on a representative sample of United States citizens of 3,540 people aged 2 years 6 months through 90 years of age and older. To score the instrument, the experimenter converts the participants’ raw score to a standardized score using the tables provided in the PPVT-4 manual.

Category Task

Three lists were created for each of the two phases of the category task: (a) an unrelated list, (b) a categorically related list, and (c) a categorizable list. Each of the lists consisted of twelve concrete nouns approximately matched for frequency of use, cue set size, and concreteness rating. Briefly, cue set size refers to the number of words that are semantically related to a cue and concreteness rating refers to how tangible the concept represented by the word is. Each of the 12 items on the unrelated list belonged to a different category than any other list item. The items on the categorically related list were
members of the same category (i.e., animals). The categorizable list consisted of four items from each of three categories which were randomly ordered within the list (i.e., four animals, four drinks). The order in which the three lists were presented was counterbalanced across subjects. For Session II, three new lists were created following the same criteria that was used for the original lists. A post-experimental questionnaire was created in which participants were asked to explain any strategy they used while learning the lists of words. In addition, participants were asked to indicate whether they noticed any difference among the three lists, and if so, what this difference was. However, the participants in both groups reported very little information on the questionnaires and when answers to the questions were provided, no insight was provided into the behavior of the participants; therefore these data are not reported.

**Associative Learning Task**

Three lists of 30 concrete cue-target noun pairs were created for the Associative Learning Task. Each cue was semantically related to the associated target (e.g., KING-CROWN). For each list, the pairs were presented in random order. Cues and targets were chosen from the University of South Florida Free Association Norms (Nelson, McEvoy, & Schreiber, 1990, which consists of a pool of over 5,000 normed stimulus words. Nelson et al. created the norms by using a discrete association task in which each cue word was presented to participants one at a time; participants were instructed to write the first target word that came to mind. The results provide a measurement of *associative strength*, which is the probability of responding with a particular target, given a particular cue. Each cue-target pair used in this task had an associative strength of less than .20 so the retrieval of the target was based on memory rather than associative strength. Each cue
was only related to its associated target; no cue was related to any other cue on the list, nor was any target related to any other target on the list. A special program, Listchecker Pro 1.2 (Eakin, 2010) was used to ensure these relationships, or lack thereof. Other characteristics of words that have been shown to impact memory, such as printed word frequency, semantic set size, concreteness and connectivity were held constant across cues and targets. A post-experiment questionnaire was created that instructed participants to explain any strategy that they used while learning the cue-target pairs. However, similar to the Category Task, the information reported by the participants did not offer any insight into their behavior; therefore, these data were not reported.

**Training Presentations**

Short training presentations were created using Microsoft PowerPoint for each of the two tasks. The presentations consisted of explanations and demonstrations of how to use task-appropriate learning strategies suitable for the individual task. The content of the training presentations are described within the procedure of each task.

**Additional Materials**

**Consent Form.** There were three different consent forms used in the present study. Each consent form described the purpose of the study, procedure, discomforts or risks, benefits, information regarding confidentiality, and how the participant would be compensated. The participants with AS who were paid for their participation received a different consent form (see Appendix A) than the participants who were recruited through SONA because of the different method of compensation. The participants in the comparison group that were recruited through SONA were given a consent form for the initial session when they were
given the PPVT-4 (see Appendix B) and another consent form when they returned for subsequent testing (see Appendix C). In the two instances in which the participants were minors, consent form was signed by the parent (see Appendix D).

**Assent Form.** The two participants who were minors were asked to sign an assent form (see Appendix E) describing the same information provided on the consent form that was signed by the parent.

**Debriefing Statement.** After completing the second session, each participant was given a debriefing statement (see Appendix F) explaining the purpose of the study and what I hoped to learn from the project.

**Procedure**

The testing of the participants with AS took place at the Eakin Memory and Metamemory Lab at Magruder Hall at Mississippi State University. Upon entering the lab, participants signed either a consent or assent form, depending upon their age. If the participant was a minor, their parent signed a consent form and the participant signed an assent form. The participant was then seated at one of the testing stations in the lab. Both the category and associative learning tasks were administered during Session I and the order of task presentation was counterbalanced across participants. Between the tasks, participants played Tetris for five minutes. Participants were offered water and breaks between the tasks. After both tasks were completed, the PPVT-4 was administered. Participants were then reminded about Session II—scheduled to take place exactly one week later—and paid for their participation. Participants in the comparison group were given the PPVT-4 during a separate session before participating in the Category and
Associative Learning Tasks. Those who were selected to participate based on their PPVT-4 scores were also tested in the Eakin Memory and Metamemory lab following the same procedure as the participants with AS.

Category Task

Session I – Pre-training. Participants sat at a testing station equipped with a computer and wireless keyboard and mouse. The Category Task consisted of two phases for each list (see Appendix G for lists); the order of list type was counterbalanced differently for each participant. For each list, intentional instructions directed the participant to view the words presented on the screen with the goal of recalling them later. Each word was presented individually on the screen at a rate of five seconds per word. After all 12 words had been presented, a screen was shown that indicated that the participant should begin writing down, in any order, as many words as he or she could recall from the list. This procedure was repeated until all three lists had been studied and recalled. After all three lists had been recalled, participants were given the post-experiment questionnaire to complete.

Session I – Training. Participants were shown a short PowerPoint presentation that demonstrated how to use categorization during encoding (see Appendix H). The presentation instructed the participants to use a three-step process when trying to remember a list of words. Participants were told to (a) notice any categorical relationships that may exist between list items, (b) mentally group words that are related in meaning into categories, and (c) think of the category name during the recall phase as a cue for remembering the members of the
category. A demonstration of the three steps was then shown in the presentation by showing the categorizable list of 12 words that the participant had previously seen in the pre-training phase. All 12 words on the list were presented all at once; the words belonging to each separate category were highlighted in a different color in order to indicate relationships among items on the list. Finally, a practice recall test was given.

**Session I – Post-training.** After the training presentation was shown, participants played Tetris for five minutes. Then three new lists, one of each type, were presented using the same procedure from the pre-training portion of the task. No instruction was given to use the strategy on which they had just trained; participants received the same intentional instructions as during the pre-training phase. After all three lists had been studied and recalled, the participant filled out the post-experiment questionnaire. Finally, the participant was thanked, paid for their time, and the second session was scheduled for one week later.

**Session II – Delay.** Session II followed the same procedure as Session I with some minor exceptions. Participants were asked to sign another consent or assent form and sat at the same testing station used in Session I. A new set of three lists was presented; (a) an unrelated list, (b) a categorically related list, and (c) a categorizable list following the same procedure as in pre-training phase of Session I. After all three lists were recalled, participants were again given the post-experiment questionnaire to complete. After completion of the questionnaire, the participant was thanked, paid for their time, and debriefed.
**Associative Learning Task**

**Session 1 – Pre-training.** Participants were presented with a list of 30 related cue-target word pairs (see Appendix I). Each pair was presented for a period of five seconds each under intentional instructions; participants were told to study the pairs with the goal of remembering the target, given the cue, on a later memory test. After all of the pairs had been presented, each cue was provided, and participants were instructed to write the target word they remember being paired with the cue. After the recall test, participants were given a post-experiment questionnaire asking them to explain any strategies they used to learn to associate the cues and targets. After completion of the questionnaire, participants were given a five minute break during which they played Tetris on the computer.

**Session 1 – Training.** Subjects were shown a short training presentation (see Appendix J) describing how to use the interactive imagery strategy. The instruction was: “One way to remember a pair of words is to create a mental picture of the two words interacting. The more vivid the image, the more likely you will be to remember the target later. For example, for KING-CROWN you might imagine a king wearing a crown.” After providing instructions about interactive imagery, 10 paired associates from the pre-training list were used to demonstrate the technique.

**Session 1 – Post-training.** After watching the training presentation, participants played Tetris for five minutes and then were shown a new list of 30 related cue-target word pairs. Following the study phase, the cues were randomly presented
and participants were instructed to write down the associated target. After the recall phase was completed, a post-experiment questionnaire was given to ask participants to explain what strategies they used in order to associate the cue-target word pairs.

Session II – Delay. Session II followed the same procedure as Session I with some minor exceptions. Participants were asked to sign another consent or assent form and sat at the same testing station used in Session I. A new set of 30 word pairs was presented following the same procedure as in pre-training phase of Session I. After all 30 word pairs were recalled, participants were again given the post-experiment questionnaire to complete. After completion of the questionnaire, the participant was thanked, paid for their time, and debriefed.
CHAPTER III
RESULTS

Due to the small number of participants in each group, I was unable to conduct an ANOVA with Group (AS, Comparison) as a factor. Therefore, the groups were evaluated separately using one-tailed t-tests and the patterns of these results were compared, rather than conducting a significance test across groups. The following results report planned comparison t-tests within each group that were designed to answer our research questions. Not all comparisons that could be conducted were, because some comparisons were not of theoretical interest. Therefore, family-wise error was not violated in the present analyses. The significance criterion was set at $p < .05$ for all comparisons.

Category Task

Pre-training

The relevant means for probability of recall, or the proportion of correctly recalled items, for the Category Task are reported in Table 2. A paired one-tailed t-test was performed to test whether the participants in the group with AS showed the same lack of benefit for categorizable over unrelated word lists reported in the literature (Smith et al., 2007; Bowler et al., 1997). The mean recall for the unrelated list ($M = 0.64$, $SE = 0.09$) and categorizable list ($M = 0.53$, $SE = 0.09$) was statistically equivalent, $t(2) = -1.57$, $p = .13$. As predicted, participants in the group with AS were not able to use the fact that words on the categorizable list could be organized according to category in order
to support memory performance; they did not spontaneously produce the categorization strategy. This finding supports the hypothesis that the young adults with AS have a production deficit with regard to strategy production. In contrast, the participants in the comparison group had better recall for the categorizable ($M = 0.83$, $SE = 0.06$) than the unrelated ($M = 0.69$, $SE = 0.09$) list, $t(2) = -5.375$, $p = .02$, $d = 0.88$. Participants in the comparison group were able to spontaneously produce the categorization strategy and effectively improved their recall relative to the unrelated list.

Table 2

*Probability of Recall for Category Task*

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>List Type</th>
<th>AS Group</th>
<th>Comparison Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Pretraining</td>
<td>Unrelated</td>
<td>0.53</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Related</td>
<td>0.75</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>Categorizable</td>
<td>0.64</td>
<td>0.13</td>
</tr>
<tr>
<td>Posttraining</td>
<td>Unrelated</td>
<td>0.41</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>Related</td>
<td>0.58</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Categorizable</td>
<td>0.75</td>
<td>0.22</td>
</tr>
<tr>
<td>Delay</td>
<td>Unrelated</td>
<td>0.33</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>Related</td>
<td>0.53</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Categorizable</td>
<td>0.81</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Previous research suggests that contextual support particularly contributes to memory success in people with AS. Therefore, I tested whether the contextual support provided by the related list—the list for which the words were presented pre-organized in terms of category—resulted in better memory as compared to the unrelated list. A paired $t$-test was conducted comparing mean recall for the related ($M = 0.75$, $SE = 0.10$) versus
the unrelated ($M = 0.53, SE = 0.09$) list for participants in the AS group. The comparison approached significance, $t(2) = -2.22, p = .08, d = 1.25$; recall was better for the related than for the unrelated list. All mean differences for the reported comparisons are in Table 3. In the comparison group, the mean difference between the two lists was not significant, $t(2) = -1.76, p = .11$; those participants performed equally well for the unrelated ($M = 0.69, SE = 0.09$) and related ($M = 0.78, SE = 0.09$) lists. However, even the participants in the comparison group showed a small improvement in recall between the two lists, $D = 0.09$ ($D$ stands for difference; see Table 3).

Table 3

*Pairwise Comparisons of Probability of Recall for Category Task*

<table>
<thead>
<tr>
<th>Comparisons</th>
<th>Mean Difference</th>
<th>AS Group</th>
<th>Comp. Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretrain Unrelated</td>
<td>Pretrain Categorizable</td>
<td>0.11</td>
<td>0.14</td>
</tr>
<tr>
<td>Pretrain Unrelated</td>
<td>Pretrain Related</td>
<td>0.22</td>
<td>0.09</td>
</tr>
<tr>
<td>Pretrain Related</td>
<td>Pretrain Categorizable</td>
<td>0.11</td>
<td>0.05</td>
</tr>
<tr>
<td>Posttrain Unrelated</td>
<td>Posttrain Categorizable</td>
<td>0.34</td>
<td>0.08</td>
</tr>
<tr>
<td>Pretrain Categorizable</td>
<td>Posttrain Categorizable</td>
<td>0.11</td>
<td>0.00</td>
</tr>
<tr>
<td>Posttrain Related</td>
<td>Posttrain Categorizable</td>
<td>0.17</td>
<td>0.00</td>
</tr>
<tr>
<td>Delay Unrelated</td>
<td>Delay Categorizable</td>
<td>0.48</td>
<td>0.14</td>
</tr>
<tr>
<td>Delay Related</td>
<td>Delay Categorizable</td>
<td>0.28</td>
<td>0.11</td>
</tr>
<tr>
<td>Pretrain Categorizable</td>
<td>Delay Categorizable</td>
<td>0.17</td>
<td>0.06</td>
</tr>
</tbody>
</table>

I also wanted to test whether providing a structure within the list (related list) would lead to a difference in recall compared to a list for which the participant must
impose the organizational structure themselves (categorizable list). For the participants in the comparison group—although it was not significantly so—recall was better when they had to perform the categorization themselves ($M = 0.83, SE = 0.09$) than when it was done for them in the related list ($M = 0.78, SE = 0.09$). This finding is consistent with the literature on the effect of effortful processing on memory (e.g., Posner & Snyder, 1975), as will be discussed. However, for the individuals with AS, the opposite finding was obtained. Memory was significantly better when categorization was imposed for them in the related list ($M = 0.75, SE = 0.10$) than when they had to organize the words themselves in the categorizable list ($M = 0.64, SE = 0.10$), $t(2) = 3.58, p = .04$. This finding provides further evidence that the participants with AS were not spontaneously producing the categorization strategy due to a production deficit.

**Post-training**

The main question asked of the post-training data was whether participants in the AS group were able to use the categorization strategy on a new list after being trained to use the strategy. The first comparison was to test whether the failure of participants with AS to produce the categorization strategy during the pre-training phase would be ameliorated after training. The relevant comparison was of memory for the categorizable to the unrelated lists. After training, the pattern of results differed for the people with AS compared to the results obtained for pre-training. After the training session, their memory was better for the categorizable ($M = 0.75, SE = 0.16$) than for the unrelated ($M = 0.41, SE = 0.15$) list. Although the difference was not significant, $t(2) = -1.51, p = .13, d = 1.55$, this finding demonstrates that the individuals with AS did not have a utilization deficit. When trained on the categorization strategy, the group was able to benefit from the
strategy implementation to the same degree as the comparison group, prior to training. The participants in the comparison group also benefited from the training; performance was better for the categorizable \( (M = 0.83, SE = 0.10) \) than for the unrelated \( (M = 0.75, SE = 0.10) \) list, \( t(2) = -2.5, p < .01 \).

The benefit of training was also tested by comparing memory for the categorizable list in the pre-training condition to memory for the same list post-training. Although not significant, \( t(2) = -0.88, p = .24 \), the group with AS showed improvement on the categorizable list after training \( (M = 0.75, SE = 0.16) \) as compared to during the pre-training session \( (M = .64, SE = 0.09; D = .11) \). The people in the comparison group performed equally well in the pre- and post-training conditions; in the comparison group, memory for the categorizable lists did not differ significantly between pre- and post-training, \( t(2) = 0, p = .5 \) \((M = 0.83, SE = 0.06 \text{ and } M = 0.83, SE = 0.10, \text{ respectively})\). The lack of a difference may be attributable to the fact that the participants in the comparison group had less room for improvement than the participants with AS.

I also tested whether participants in the AS group were able–after training–to benefit from using the categorization strategy themselves (categorizable list) over and above when the category structure was provided for them (related list). Prior to receiving training, the comparison group showed this benefit, but the group with AS did not. However, after training, a different pattern of results was obtained. Participants with AS showed better memory for the categorizable \( (M = 0.75, SE = 0.16) \) than for the related list \( (M = 0.58, SE = 0.24) \); the results of the \( t \)-test approached significance, \( t(2) = -1.96, p = .09 \). After training, the group with AS resembled the comparison group during the pre-training session with regard to the benefit of applying the organization structure themselves, rather than having it applied for them.
Delay

The data from the delay condition was analyzed to examine whether participants were able to spontaneously produce the categorization strategy that they learned during the training presentation after a one week delay. Memory was compared for the group with AS between the unrelated and categorizable lists; the result of the paired $t$-test was significant, $t(2) = -3.17, p = .04$. Even after a delay, the results were strikingly different from the pre-training session. The participants with AS had significantly better memory for the categorizable ($M = 0.81, SE = 0.07$) than for the unrelated ($M = 0.33, SE = 0.12$) list. Apparently, the participants with AS no longer evidenced a production deficit; they spontaneously produced the strategy to the benefit of their memory performance. The performance of the individuals in the comparison group didn’t change across the post-training and delay sessions; they continued to show better memory for the categorizable list ($M = 0.89, SE = 0.07$) than for the unrelated list ($M = 0.75, SE = 0.16$) after a one week delay. The difference was not statistically significant, $t(2) = -1.87, p = .10$.

I tested whether the benefit on recall of self-imposing structure on a list (categorizable list) as compared to a list with inherent structure (related list) would be evident after a one week delay. Again, participants in the AS group continued to show better memory for the categorizable ($M = 0.81, SE = 0.07$) than for the related ($M = 0.53, SE = 0.15$) list. This finding demonstrates that the group with AS benefited from applying the structure themselves in the same way that the comparison group did ($M = 0.89, SE = 0.07$ and $M = 0.78, SE = 0.18$, respectively) even after a delay, $t(2) = -1, p = .21$.

Finally, we compared memory for the categorizable list from the pre-training session to memory for the categorizable list for the delay session. For the participants with AS, results of the $t$-test approached significance, $t(2) = -1.99, p = .09$; memory was
markedly better for the categorizable list after training and a delay ($M = 0.81$, $SE = 0.07$) than for the categorizable list prior to training ($M = 0.64$, $SE = 0.09$); the difference was 0.17. The participants in the comparison group also showed a small improvement in memory between the pre-training and delay sessions ($M = 0.89$, $SE = 0.07$ and $M = 0.83$, $SE = 0.06$, respectively); the comparison difference approached significance, $t(2) = -2$, $p = .09$.

**Associative Learning (AL) Task**

The relevant means for probability of recall for each session of the AL task are reported in Table 4. Prior to training, there was a significant difference in probability of recall between groups, $t(2) = -3.04$, $p = .05$. Probability of recall for the group with AS was 0.56 ($SE = 0.17$), whereas recall for the comparison group was 0.77 ($SE = 0.13$).

<table>
<thead>
<tr>
<th>Test Condition</th>
<th>Recall</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AS Group</td>
<td>Comp. Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td></td>
</tr>
<tr>
<td>Pretraining</td>
<td>0.56</td>
<td>0.24</td>
<td>0.77</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Posttraining</td>
<td>0.82</td>
<td>0.16</td>
<td>0.87</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>Delay</td>
<td>0.73</td>
<td>0.18</td>
<td>0.83</td>
<td>0.20</td>
<td></td>
</tr>
</tbody>
</table>

After training on the interactive imagery strategy, memory improved for the participants with AS ($M = 0.82$, $SE = 0.12$). Although this difference was not statistically significant, $t(2) = -1.25$, $p = .17$, a improvement of 0.26 was observed between the pre-
training and post-training sessions (see Table 5). For the people in the comparison group, the difference was 0.10, and their memory after training was not significantly better than their memory before training, $t(2) = -1.73$, $p = .11$.

Table 5

*Pairwise Comparisons of Probability of Recall for AL Task*

<table>
<thead>
<tr>
<th>Comparisons</th>
<th>Mean Difference</th>
<th>AS Group</th>
<th>Comp. Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-train</td>
<td>Post-train</td>
<td>0.26</td>
<td>0.10</td>
</tr>
<tr>
<td>Pre-train</td>
<td>Delay</td>
<td>0.17</td>
<td>0.06</td>
</tr>
<tr>
<td>Post-train</td>
<td>Delay</td>
<td>0.09</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Apparently, although the participants with AS did not spontaneously apply a successful strategy—and thereby demonstrated a production deficit—they were able to use the strategy as effectively as the comparison group after training. Therefore, they did not show evidence of a utilization deficit after receiving interactive imagery strategy training.
The present experiment consisted of two tasks that were designed to investigate learning strategy use in individuals diagnosed with AS. The primary goal was to determine what impact strategy training would have on the participants’ recall accuracy as compared to a comparison group. Two types of potential deficits were explored: a production deficit and a utilization deficit. A production deficit is the inability to spontaneously produce learning strategies and a utilization deficit is the inability to use strategies effectively. The Category Task was designed to determine whether participants with AS could spontaneously produce the categorization strategy. Prior research indicated that memory of adults with AS did not benefit from a categorizable list as compared to an unrelated list; adults without AS showed a benefit for the categorizable list that adults with AS did not (Bowler et al., 1997; Smith et al., 2007). Consistent with prior research, in the current study, participants with AS did not benefit from the categorizable list as compared to the unrelated list in the way that the comparison group did. Therefore, the participants with AS demonstrated a production deficit because they were unable to spontaneously produce the categorization strategy to improve their memory performance.

Prior findings on AS have also shown that memory is better when contextual support is provided (related list) as compared to when there is no contextual support (unrelated list), particularly for those with AS (Smith et al., 2007). In the present study,
the participants in the AS group did show some benefit in memory when contextual support was provided for them in the related list. In fact, the mean recall accuracy for the group was the highest for the related list type prior to training. Conversely, participants in the comparison group showed the highest rate of recall for the categorizable list. According to previous literature, this may be due to the impact of effortful processing (e.g., Posner & Snyder, 1975). Effortful processing or “conscious strategies” are intentionally initiated processes (for example, imposing categorization on a list of words) that require the individual to devote considerable attention toward learning the material. Effortful processing techniques benefit memory because they require the individual to interact with the material at a deeper level (e.g., Craik & Lockhart, 1972). In the present experiment, because the participants with AS did not produce the categorization strategy, they did not benefit from effortful processing. This finding is consistent with prior research showing that young children (Brown, 1975) and older adults (Hultsch, 1971) either do not use effortful processing or if they do, they use it ineffectively. Smith et al. (2007) concluded that participants with AS in their study focused on words as individual items rather than processing the overall property of the words, or that they used simple patterns and rules rather than focusing on the semantic organization of words (Frith, 1989). Focusing on individual features of words is a shallower, less effortful type of processing and results in worse memory than deeper, more effortful processing (Craik & Lockhart, 1972). This distinction could explain why the participants with AS in our study did not show a memory benefit for the categorizable over the related lists. They did not spontaneously produce the strategy that would benefit memory for the categorizable list.

The participants with AS also did not spontaneously produce the interactive imagery strategy during the pre-training phase of the Associative Learning Task. The
interactive imagery strategy is effective during associative learning when learning requires individuals to associate a cue-target word pair such that presentation of the cue on a memory test prompts recall of the target. The interactive imagery strategy is effective for some of the same reasons that the categorization strategy is. Attempting to form an image to represent the cue and target and to integrate those images into one requires effortful processing. In addition, forming an image to represent the word pair also provides a visual representation in memory that is an alternative route to memory than the verbal representation. The Dual Code theory (e.g., Paivio, 1971) suggests that having multiple representations results in better memory outcome; if memory for one representation fails, an alternative route to memory success is available. In addition, the interactive imagery strategy allows for another cue toward retrieving the cue-target pair. When the cue is presented for retrieval, retrieving the image formed at encoding serves as an additional cue as to what the associated target is because that target is present in the interactive image (Dunlosky & Hertzog, 1998). The Associative Learning Task was included in the present experiment as a way to assess whether young adults with AS could use a non-organizational strategy to the same degree as those without AS. Prior research suggests that they may not be able to because individuals with AS organize semantic information in memory differently than individuals without AS (Minshew & Goldstein, 2001).

The Associative Learning Task was designed to determine whether a production or utilization deficit (or both) would be obtained when using the interactive imagery strategy. In the pre-training condition, the participants with AS showed significantly lower recall than participants in the comparison group. Apparently, the comparison group was implementing a more successful strategy than the group with AS. Similar to the
Category Task, the participants in the AS group showed a production deficit because they were unable to spontaneously produce a strategy to benefit recall in the same way as the participants in the comparison group did.

**Strategy Production**

The finding that the participants with AS did not spontaneously produce the categorization or the interactive imagery strategy demonstrated a production deficit when it comes to spontaneously implementing appropriate strategies. This finding demonstrates a failure of metamemory similar that obtained in young children who also have been shown to be unable to spontaneously produce strategies. For example, Moely et al. (1969) tested the spontaneous production of categorization in groups of children in kindergarten, first grade, third grade, and fifth grade. They found that the children in the three younger groups did not rearrange pictures of objects according to category membership in the same way as the group of fifth grade children. Other studies have found that, although this production deficit is typical in young children, the deficit dissipates with age, with children performing on the same level as adults by around the age of 10 (Hasher & Clifton, 1974; Neimark, Slotnick, & Ulrich, 1971; Schneider & Sodian, 1997). However, the participants in the present study were well above the typical age at which the production of successful strategies is developed. Unlike children without AS, young adults with AS do not appear to have outgrown this inability to spontaneously produce strategies. This failure of metamemory could be linked to the abnormal development in the frontal regions of the brain seen in individuals with AS (Coleman, 2005). Impaired metamemory ability has been linked to those same brain regions (Craik & Bialystok, 2006; Gershberg & Shimamura, 1995; Metcalfe & Shimamura, 1996), and therefore
could be the underlying neurological explanation for the production deficit obtained in this study. Alternatively, it could be the case that the participants with AS were producing the strategy, but their implementation of the strategy did not garner the same benefit to memory as that of the comparison group. If this was the case, a utilization deficit, not a production deficit, would be to blame for the lack of benefit of categorization to memory of the participants with AS. However, the utilization deficit hypothesis was not supported by the findings.

To determine whether a production or utilization deficit explained the lack of benefit to memory of categorizable versus unrelated lists, participants with AS were trained how to group the words on the categorizable list according to semantic category. The result was that, after training, their memory was better for the categorizable than the unrelated list. After training, the participants with AS were able to use the categorization strategy as evidenced by their improved recall in the post-training and delay conditions. This finding provides evidence that, consistent with prior research (e.g., Barclay, 1981), they showed no evidence of a utilization deficit. Training on the categorization strategy also helped memory for the related versus the unrelated list for participants with AS, although the mean probability of recall in this group was still not as high as that in the comparison group.

**Strategy Utilization**

After receiving training, the individuals with AS also showed the same benefit of effortful processing as seen for participants in the comparison group because they were able to recall more words from the list on which they imposed the organizational structure themselves (i.e., categorizable) compared to the list that was already organized
by category (i.e., related). Although a production deficit was observed in the pre-training session, it was overcome by training; after training the participants with AS were able to produce and effectively utilize the strategy without any prompting by the experimenter to do so. After receiving training about the interactive imagery strategy, recall by the participants in the AS group improved over their pre-training recall, showing clear evidence that once they were trained on interactive imagery, they were able to utilize the strategy as well as those in the comparison group. Similar to the Categorization Task, participants with AS showed no evidence of a utilization deficit after training.

Clearly, people with AS showed that they were able to utilize the strategy that they were taught during the training session. However, the question remained whether they would revert to the production deficit observed during the pre-training session when they returned after one week. The answer was no; after a one week delay, the participants with AS spontaneously produced both the categorization and interactive imagery strategies when presented with a new set of unrelated versus categorizable words and a new set of cue-target word pairs. After a delay, the benefit of training was still evident. People with AS remembered categorizable lists better than unrelated lists, remembered related lists better than unrelated lists, and remembered categorizable lists better than related lists. In all ways, after training the participants with AS resembled the comparison group before training. After a delay, participants with AS still showed a benefit to memory over their pre-training scores. They were able to spontaneously produce the interactive imagery strategy without prompting when they were given a new list of cue-target word pairs one week later. Not only did they show a marked improvement after training, but after a one week delay, the participants in the AS group were able to reach similar levels of recall achieved by the comparison group prior to training.
It is interesting to note that the pattern of results obtained for the participants in the AS group on the Associative Learning Task is similar to the pattern of results Dunlosky and Hertzog (1998) obtained for older adults on the same task. Similar to the participants with AS in the present study, older adults showed evidence of a production deficiency on an Associative Learning Task, but no evidence of a utilization deficit; they were able to perform better after being trained how to use the interactive imagery strategy. It is possible that the pattern of results obtained for those with AS is similar to the pattern obtained for older adults because the two groups share abnormalities in frontal and temporal lobe functioning. Previous findings have shown irregular activation in the frontal and temporal regions of the brain in individuals with AS (Coleman, 2005; Salmond et al., 2005). Likewise, similar patterns of irregular activation in the frontal and temporal regions have been found in older adults (Jack et al., 1998; Kemper, 1984; Raz et al., 1997).

In a previous study, participants with AS showed evidence of a utilization deficit due to their inability to benefit from strategy training (Smith et al., 2007). However I did not find any evidence of a utilization deficit for either of the strategies tested in this study. One reason that the training presentations used in the current study may have been more beneficial is that I minimized social interaction during training in two ways. First, I presented the stimuli for both the Categorization Task and the Associative Learning Task using a computer and asked participants to write down their responses when they were asked to recall the lists and word pairs that were presented. Conversely, previous researchers presented the stimuli verbally (e.g., Bowler et al., 1997) and the participants recalled the words verbally while the researcher wrote down their responses (e.g., Smith et al., 2007). For people with AS, severe social deficits is a critical feature of
their diagnosis (APA, 2000; Klin & Volkmar, 1997). Therefore, it may be possible that
the ability to learn how to use strategies to an effective degree was partially obscured in
past research because it required interaction with the researcher. That this study used a
completely computer-based experiment–training also took place on the computer–could
have contributed to the relative success of our strategy training. This idea is supported by
a theory posited by Swettenham (1996), which states that the use of computers to
accomplish tasks provides a consistent and predictable environment for people with AS.
Furthermore, this type of training may be more beneficial than providing verbal
instructions about how strategy use because people with AS also exhibit difficulties
processing long strings of verbal instruction (Attwood, 2006).

**Limitations**

Certainly additional research is necessary to gain a better understanding of the
findings presented. Due to difficulties recruiting participants who had been diagnosed
with AS, there was not sufficient statistical power to establish significance. Perhaps
repeating this study with a larger sample size would result in a clearer pattern of results
for the group with AS. Furthermore, another possible criticism of the present study could
be the lack of perfectly matched participants with AS to participants in the comparison
group using age as well as PPVT-4 scores. Although our initial goal was to match both
on age and PPVT-4 scores, recruitment of comparison participants younger than those
found in the subject pool was not achieved. However, findings in the developmental
literature show that children are able to spontaneously produce and utilize learning
strategies between 10 and 11 years of age (Moely et al., 1969). Therefore, given the age
of the participants with AS included in the present study, I would expect no difference in
the development of metamemory in the comparison group if I had included some younger participants. Although the findings demonstrated that training was maintained after a one week delay, future research should be conducted to evaluate the beneficial impact of strategy training for people diagnosed with AS over a longer period of time. In addition, research should be done to determine whether the strategy training transfers to different materials and learning contexts. Finally, the questionnaires that were designed to gather information about the participants’ subjective experience were not effective. The participants often offered no response to the questions, and the responses that were provided did not provide the information that they were designed to. Perhaps the questionnaire was too open-ended and using a short-answer or multiple-choice would help guide participants toward providing the information desired. However, it could also be that the quality of the responses suffered due to respondent fatigue; the tasks were relatively lengthy and the questionnaire was given after completing each task.

Conclusions

The present study demonstrates that people with AS show deficits in cognitive awareness that are in parallel to their deficits in social awareness. The participants with AS were unable to spontaneously produce effective strategies, evidencing a production deficit. However, this deficit does not appear to be unmaleable. Participants were able to use effective strategies when instructed to; they did not show a utilization deficit. More importantly, the findings show that the production deficit observed prior to training could be ameliorated after training. Even one week later, training on strategies eliminated the production deficit observed prior to training. In addition, because strategy training did not require social interaction, training in the present study succeeded when training in prior
studies did not. Therefore, not only is it possible for adults with AS to learn how to use both organizational and non-organizational to their benefit, the type of computer-based training used in this study may be one key to circumnavigating the problems that some individuals with AS have with everyday memory tasks.
REFERENCES


Eakin, D. K. (2010). ListChecker Pro 1.2: A program designed to facilitate creating word lists using the University of South Florida word association norms. *Behavior Research Methods, 42*, 1012-1021.


APPENDIX A

CONSENT FORM FOR PAID PARTICIPANTS WITH AS
You are being asked to act as a volunteer in a research study. The purpose of this form is to tell you about the study you will be participating in and to inform you about your rights as a research volunteer. Before you participate, you should read this consent form carefully and completely. 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 participation in this study. Our work could not be done without your help.

**Purpose of Study:**
Our research focuses generally on memory, and specifically on memory for words. We are interested in the approaches people take to learn words.

**Procedure of the Study:**
If you decide to participate in this study, you will be learning lists of words or word pairs. You will be presented with lists of words or word pairs to learn and will be asked to remember the words in such a way that you will be able to recall them later. At each stage, you will be given instructions to make sure you know what you are supposed to do throughout the study. All of the information will be presented on the computer. You will sometimes type your responses on the keyboard and sometimes write them on paper.

The study takes place in two sessions – you will return exactly one week after this session. During the second session, you will also be learning lists of words or word pairs. You will generally do the same tasks in the second session, but with different words. You are providing consent for both sessions by signing this consent form.

**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/office activity. Please tell us if you are having trouble with any tasks or if you need additional rest beyond the breaks provided and we will be happy to accommodate you in any way possible. If you feel any discomfort, please tell us immediately.

**Benefits:**
This study will provide valuable information regarding how people process words and word pairs. You are not likely to benefit personally in any way from joining this study, but thanks to the willingness of people like you, we will continue to learn about the cognitive system, as well as how to improve learning.
Confidentiality:
All of your responses will be kept strictly confidential. Only members of this research project will be allowed access to any information. All of the information which you provide us today will be marked with the code number, not your name. Your performance on 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 individual answers to questions will be given to anyone. We want you to be completely assured that your information will be held completely confidential. Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law.

Compensation:
The study will be conducted in two sessions. Session 1 is anticipated to take between 2-3 hours. You will be paid $10.00 for each hour that you participate. Session 2 is anticipated to take between 1-1.5 hours. Again, you will be paid $10.00 for each hour you participate. Half-hour increments will be paid at $5.00. Times will be rounded to the next half-hour. We want you to know, however, that you are free to withdraw from this research at any time. There will be no penalty for doing so. You will be paid for the first session when it is finished and for the second session when it is finished. You will receive compensation equal to the time involved in the study. However, no participant will receive less than $10.00 for the study.

Contact Information:
If there are problems that arise during your participation, please feel free to contact Miranda Morris (662-325-5804) 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 rights as a research volunteer, please feel free to contact the MSU Regulatory Compliance Office at 662-325-3994 or via email at irb@research.msstate.edu. Again, we are grateful for your help and want to make sure that your participation is a pleasant experience.

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.

Participant’s Name: _______________________________ Date: _______________________________

Guardian/Representative’s Signature: __________________________ Date: _______________

Investigator’s Signature: ____________________________ Date:___________________
APPENDIX B

SESSION 1 (PPVT-4) CONSENT FORM FOR COMPARISON GROUP
You are being asked to act as a volunteer in a research study. The purpose of this form is to tell you about the study you will be participating in and to inform you about your rights as a research volunteer. Before you participate, you should read this consent form carefully and completely. 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 participation in this study. Our work could not be done without your help.

**Purpose of Study:**
Our research focuses on verbal intelligence.

**Procedure of the Study:**
If you decide to participate in this study, you will be asked to take a test of verbal intelligence. The researcher will say a word and you will be shown four pictures. Your task will be to indicate which of the four pictures shows the word that the researcher said.

**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/office activity. Please tell us if you are having trouble with any tasks or if you need additional rest beyond the breaks provided and we will be happy to accommodate you in any way possible. If you feel any discomfort, please tell us immediately.

**Benefits:**
This study will provide valuable information regarding how people process words. You are not likely to benefit personally in any way from joining this study, but thanks to the willingness of people like you, we will continue to learn about the cognitive system.

**Confidentiality:**
All of your responses will be kept strictly confidential. Only members of this research project will be allowed access to any information. All of the information which you provide us today will be marked with the code number, not your name. Your performance on 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 individual answers to questions will be given to anyone. We want you to be completely assured that your information will be held completely confidential. Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law.
Compensation:
The study will be conducted in one session. The session is anticipated to take approximately one hour. You will be compensated 1 research credit for each hour that you participate. We want you to know, however, that you are free to withdraw from this research at any time. There will be no penalty for doing so. You will receive compensation equal to the time involved in the study. However, no participant will receive less than .5 credit for the study.

Contact Information:
If there are problems that arise during your participation, please feel free to contact Miranda Morris (662-325-5804) 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 rights as a research volunteer, please feel free to contact the MSU Regulatory Compliance Office at 662-325-3994 or via email at irb@research.msstate.edu. Again, we are grateful for your help and want to make sure that your participation is a pleasant experience.

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.

Participant’s Name: _______________________ Date: ______________________

Guardian/Representative’s Signature: __________________________ Date: ______________
Investigator’s Signature: ____________________________ Date:___________________
APPENDIX C

SESSION 2 CONSENT FORM FOR COMPARISION GROUP
You are being asked to act as a volunteer in a research study. The purpose of this form is to tell you about the study you will be participating in and to inform you about your rights as a research volunteer. Before you participate, you should read this consent form carefully and completely. 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 participation in this study. Our work could not be done without your help.

**Purpose of Study:**
Our research focuses on verbal intelligence.

**Procedure of the Study:**
If you decide to participate in this study, you will be asked to take a test of verbal intelligence. The researcher will say a word and you will be shown four pictures. Your task will be to indicate which of the four pictures shows the word that the researcher said.

**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/office activity. Please tell us if you are having trouble with any tasks or if you need additional rest beyond the breaks provided and we will be happy to accommodate you in any way possible. If you feel any discomfort, please tell us immediately.

**Benefits:**
This study will provide valuable information regarding how people process words. You are not likely to benefit personally in any way from joining this study, but thanks to the willingness of people like you, we will continue to learn about the cognitive system.

**Confidentiality:**
All of your responses will be kept strictly confidential. Only members of this research project will be allowed access to any information. All of the information which you provide us today will be marked with the code number, not your name. Your performance on 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 individual answers to questions will be given to anyone. We want you to be completely assured that your information will be held completely confidential. Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law.

Compensation:
The study will be conducted in one session. The session is anticipated to take approximately one hour. You will be compensated 1 research credit for each hour that you participate. We want you to know, however, that you are free to withdraw from this research at any time. There will be no penalty for doing so. You will receive compensation equal to the time involved in the study. However, no participant will receive less than .5 credit for the study.

Contact Information:
If there are problems that arise during your participation, please feel free to contact Miranda Morris (662-325-5804) 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 rights as a research volunteer, please feel free to contact the MSU Regulatory Compliance Office at 662-325-3994 or via email at irb@research.msstate.edu. Again, we are grateful for your help and want to make sure that your participation is a pleasant experience.

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.

Participant’s Name: ________________________ Date: ______________________

Guardian/Representative’s Signature:______________________ Date: ____________

Investigator’s Signature: _________________________ Date:___________________
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:**
Our research focuses generally on memory, and specifically on memory for words. We are interested in the approaches people take to learn words.

**Procedure of the Study:**
If you decide to allow your child to participate in this study, he/she will be learning lists of words or word pairs. Your child will be presented with lists of words or word pairs to learn and will be asked to remember the words in such a way that he/she will be able to recall them later. At each stage, your child will be given instructions to make sure he/she knows what they are supposed to do throughout the study. All of the information will be presented on the computer. Your child will sometimes type their responses on the keyboard and sometimes write them on paper.

The study takes place in two sessions – your child will return exactly one week after this session. During the second session, he/she will also be learning lists of words or word pairs. He/she will generally do the same tasks in the second session, but with different words. You are providing consent for your child to participate in both sessions by signing this consent form.

**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/office activity. We will be sure to ask your child to tell us if they are having trouble with any tasks or if need additional rest beyond the breaks provided and we will be happy to accommodate you in any way possible. If your child tells you about any discomfort, please tell us immediately.

**Benefits:**
This study will provide valuable information regarding how people process words and word pairs. Neither you nor your child are likely to benefit personally in any way from joining this study, but thanks to the willingness of people like you, we will continue to learn about the cognitive system, as well as how to improve learning.
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 on 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. Please note that these records will be held by a state entity and therefore are subject to disclosure if required by law.

Compensation:
The study will be conducted in two sessions. Session 1 is anticipated to take between 2-3 hours. Your child will be paid $10.00 for each hour that he/she participates. Session 2 is anticipated to take between 1-1.5 hours. Again, your child will be paid $10.00 for each hour he/she participates. Half-hour increments will be paid at $5.00. Times will be rounded to the next half-hour. We want you to know, however, that your child is free to withdraw from this research at any time. There will be no penalty for doing so. Your child will be paid for the first session when it is finished and for the second session when it is finished. Your child will receive compensation equal to the time involved in the study. However, no participant will receive less than $10.00 for the study.

Contact Information:
If there are problems that arise during your participation, please feel free to contact Miranda Morris (662-325-5804) 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 rights as a research volunteer, please feel free to contact the MSU Regulatory Compliance Office at 662-325-3994 or via email at irb@research.msstate.edu. Again, we are grateful for your help and want to make sure that your participation is a pleasant experience.

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 E

ASSENT FORM
Your parent knows that we are going to ask you to participate in this project. We are interested in memory and memory for words and word pairs. If you decide to participate in this study, you will be learning lists of words and word pairs. You will be shown lists of words or word pairs to learn and will be asked to remember the words in such a way that you will be able to recall them later. At each stage, you will be given instructions to make sure you know what you are supposed to do throughout the study. All of the information will be presented on the computer. You will be asked to either type your answers using the keyboard or write the answers on a sheet of paper.

The study takes place in two sessions – you will return exactly one week after this session. The first session will take about 2-3 hours; the second session will take about 1.5 hours. By signing this assent form, you are providing assent for both sessions.

There are no major discomforts to this study – you will be doing the kinds of things you might do in a regular classroom. However, you should tell the researcher right away if you are having trouble with any of the tasks or if you need a break. If you feel any discomfort, we want you to tell us immediately. Also, you are not likely to benefit personally by participating in this study, but your participation will help us understand how to improve learning.

You will be paid $10.00 for each hour that you participate. We want you to know, however, that you are free to withdraw from this research at any time. There will be no penalty for doing so. You will be compensated for the first session when it is finished and for the second session when it is finished. You will receive compensation equal to the time involved in the study. However, you will not receive less than $10.00 for the study.

All of your responses will be kept strictly confidential. Only members of this research project will be allowed access to any information. All of the information that you give us today will be marked with a code number, not your name. Your performance on the tasks will be scored and stored in a computer with no information that could link it to you. Any information with your name on it, such as this assent form, will be stored in a separate location from the actual test scores. No identification of your individual answers to questions will be given to anyone. We want you to be completely confident that your information will be held completely confidential.

Do you understand? Yes No

Is this OK? Yes No

Name (Please print): ________________________________

Signature: __________________________________ Date: __________________________

Investigator’s Signature: __________________________ Date: ______________________

62
APPENDIX F

DEBRIEFING STATEMENT
Debriefing Statement

Thank you again for participating in our study. Please read this statement carefully, and feel free to ask any questions you might have. The study in which you just participated was designed to determine whether people with and without Asperger’s Syndrome use different strategies when they learn lists of words. During session 1 of the study, you were asked to learn different types of lists in three phases. During the pre-training phase, you were asked to learn a word list. The list consisted of semantically related words (e.g., tiger, giraffe, elephant), semantically unrelated words (e.g., table, shoe, wheel), words that were grouped according to category membership (e.g., apple, rose, banana, daisy), or pairs of words (e.g., frog-toad). During the second phase, you watched a presentation that provided training on how to use learning strategies specific to the list. Finally, you were given another list of words to learn during the post-training session. For Session 2, you were given new word lists to learn in order to determine whether you could apply the strategy you learned to a new list of words.

The information we learn from this study will help us in several ways. We can demonstrate that people with Asperger’s Syndrome often have very good memories and determine whether this is because of the way they use memory strategies. In addition, the information might be helpful in instructing teachers who work with young adults with Asperger’s Syndrome. Again, thank you for participating in the study. Our research could not be conducted without your help. If you should have any questions, please do not hesitate to contact:

Miranda L. Morris
Graduate Student
mlm350@msstate.edu
662-325-5804

or

Dr. Deborah K. Eakin
Assistant Professor
deakin@psychology.msstate.edu
662-325-7949
APPENDIX G

WORD LISTS FOR CATEGORY TASK
<table>
<thead>
<tr>
<th>List A</th>
<th>List B</th>
<th>List C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrelated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BADMINTON</td>
<td>PRIZE</td>
<td>COIN</td>
</tr>
<tr>
<td>STARLING</td>
<td>LIME</td>
<td>BENCH</td>
</tr>
<tr>
<td>VIOLET</td>
<td>STARS</td>
<td>SHOES</td>
</tr>
<tr>
<td>TRUMPET</td>
<td>BRICK</td>
<td>CITIZEN</td>
</tr>
<tr>
<td>PLUM</td>
<td>COAL</td>
<td>THICKET</td>
</tr>
<tr>
<td>BEE</td>
<td>LADDER</td>
<td>TUNNEL</td>
</tr>
<tr>
<td>CAULIFLOWER</td>
<td>CREAM</td>
<td>CORD</td>
</tr>
<tr>
<td>SUIT</td>
<td>GOWN</td>
<td>VISITOR</td>
</tr>
<tr>
<td>AMBULANCE</td>
<td>LOCK</td>
<td>CIRCUS</td>
</tr>
<tr>
<td>PISTOL</td>
<td>ACTOR</td>
<td>SCREW</td>
</tr>
<tr>
<td>PIANO</td>
<td>LIEUTENANT</td>
<td>DESSERT</td>
</tr>
<tr>
<td>ROOF</td>
<td>DIRECTIONS</td>
<td>PAUSE</td>
</tr>
<tr>
<td>Related</td>
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<td></td>
</tr>
<tr>
<td>HORSE</td>
<td>FORK</td>
<td>LIBRARY</td>
</tr>
<tr>
<td>COW</td>
<td>SPOON</td>
<td>APARTMENT</td>
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<tr>
<td>SQUIRREL</td>
<td>PLATE</td>
<td>SHACK</td>
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<tr>
<td>DEER</td>
<td>CUP</td>
<td>CASTLE</td>
</tr>
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<td>MOUSE</td>
<td>PITCHER</td>
<td>BANK</td>
</tr>
<tr>
<td>BEAR</td>
<td>KNIFE</td>
<td>CABIM</td>
</tr>
<tr>
<td>GIRAFFE</td>
<td>CHAIR</td>
<td>COTTAGE</td>
</tr>
<tr>
<td>LION</td>
<td>BOWL</td>
<td>BARN</td>
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<td>MONKEY</td>
<td>UTENSIL</td>
<td>FACTORY</td>
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<tr>
<td>PIG</td>
<td>DISH</td>
<td>GYM</td>
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<td>RABBIT</td>
<td>SAUCER</td>
<td>DORM</td>
</tr>
<tr>
<td>RACCOON</td>
<td>GLASS</td>
<td>STADIUM</td>
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<td>Categorizable</td>
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<td></td>
</tr>
<tr>
<td>DOLPHIN</td>
<td>SAPPHIRE</td>
<td>CIRCLE</td>
</tr>
<tr>
<td>WHALE</td>
<td>PEARL</td>
<td>SQUARE</td>
</tr>
<tr>
<td>SQUID</td>
<td>RUBY</td>
<td>TRIANGLE</td>
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<tr>
<td>FISH</td>
<td>EMERALD</td>
<td>RECTANGLE</td>
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<tr>
<td>COTTON</td>
<td>SOCCER</td>
<td>COAT</td>
</tr>
<tr>
<td>SILK</td>
<td>BASEBALL</td>
<td>SWEATER</td>
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<tr>
<td>LINEN</td>
<td>FOOTBALL</td>
<td>PANTS</td>
</tr>
<tr>
<td>POLYESTER</td>
<td>HOKECY</td>
<td>SHIRT</td>
</tr>
<tr>
<td>LEMONADE</td>
<td>PEPPER</td>
<td>OVEN</td>
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<tr>
<td>TEA</td>
<td>CINNAMON</td>
<td>BLENDER</td>
</tr>
<tr>
<td>COFFEE</td>
<td>SALT</td>
<td>TOASTER</td>
</tr>
<tr>
<td>SODA</td>
<td>GARLIC</td>
<td>REFRIGERATOR</td>
</tr>
</tbody>
</table>
APPENDIX H

CATEGORY TASK TRAINING PRESENTATION
Practice Time!!

You just finished learning 3 different lists of 12 words.

Your job was to remember and to report as many of the words as you could remember.

Would you like to learn a trick to make this task easier?

Here is Part 1 of the trick!!

Try to notice any categorical relationships between the words:
For example, let's take another look at one of the lists you just learned.

DOLPHIN
SILK
LEMONADE
TEA
WHALE
COFFEE
LINEN
SODA
FISH
POLYESTER
COTTON
SQUID

Here is one of the lists you just saw.

DOLPHIN
SILK
LEMONADE
TEA
WHALE
COFFEE
LINEN
SODA
FISH
POLYESTER
COTTON
SQUID

Do you notice any of the words that may belong to a similar category?

First, I have noticed that the words that are highlighted in yellow are categorically related.
DOLPHIN  
SILK  
LEMONADE  
TEA  
WHALE  
COFFEE  
LINEN  
SOJA  
FISH  
POLYESTER  
COTTON  
SQUID

Also, when I think about the other words, I notice that the words highlighted in red are also categorically related.

DOLPHIN  
SILK  
LEMONADE  
TEA  
WHALE  
COFFEE  
LINEN  
SOJA  
FISH  
POLYESTER  
COTTON  
SQUID

Now think about the remaining words highlighted in green. These can also be grouped.

DOLPHIN  
SILK  
LEMONADE  
TEA  
WHALE  
COFFEE  
LINEN  
SOJA  
FISH  
POLYESTER  
COTTON  
SQUID

Next, I mentally grouped the related words shown in yellow and I decided to name the first category "Things That Swim".

DOLPHIN  
SILK  
LEMONADE  
TEA  
WHALE  
COFFEE  
LINEN  
SOJA  
FISH  
POLYESTER  
COTTON  
SQUID

Then, I mentally grouped the other words that are shown in red into a second group of categorically related words that I named "Types of Fabric".

DOLPHIN  
SILK  
LEMONADE  
TEA  
WHALE  
COFFEE  
LINEN  
SOJA  
FISH  
POLYESTER  
COTTON  
SQUID

Then, I mentally grouped the remaining words that are shown in green into a third group of categorically related words that I named "Types of Drinks".

Finally, when I try to remember the list later, I will think of the category names, "Things That Swim", "Types of Fabric", and "Types of Drinks" to help jog my memory.
Ready to try the trick?

Remember:

Part 1 – Try to notice if any of the words are categorically related to each other.

Part 2 – Mentally group the words together that you think belong to the same category.

Part 3 – THINK about your category name when you are asked to remember. Write down all of the members of one category before you move on to another category.

You will now see the same list of words you saw in the first part of this game.

After all of the words from the list have been shown to you once, you will be asked to write down as many of the words from the list that you can remember on the paper that has been provided for you.

Each word will be presented one at a time on the computer screen at a fairly rapid rate.

Your task is to study the word when it appears on the screen but this time, remember to use the trick you just learned!

Press ENTER to see the first word when you are ready to start.

COTTON

COFFEE
APPENDIX I

AL TASK WORD PAIRS
<table>
<thead>
<tr>
<th>List A</th>
<th>List B</th>
<th>List C</th>
</tr>
</thead>
<tbody>
<tr>
<td>GATE – LATCH</td>
<td>MILK – DAIRY</td>
<td>STRUCTURE – FRAME</td>
</tr>
<tr>
<td>OBSERVE – NOTICE</td>
<td>CURVE – ANGLE</td>
<td>STATION – CHANNEL</td>
</tr>
<tr>
<td>NAIL – SCREW</td>
<td>TENT – TEEPEE</td>
<td>ARGUMENT – ANGER</td>
</tr>
<tr>
<td>COUSIN – KIN</td>
<td>FRIENDLY – PLEASANT</td>
<td>FASHION – TREND</td>
</tr>
<tr>
<td>FRUIT – JUICE</td>
<td>DESTROY – RUIN</td>
<td>HEARING – SIGHT</td>
</tr>
<tr>
<td>EVIDENCE – CLUE</td>
<td>CONVINCE – URGE</td>
<td>SECURITY – LOCK</td>
</tr>
<tr>
<td>GENUINE – SINCERE</td>
<td>DUST – VACUUM</td>
<td>REGION – SECTION</td>
</tr>
<tr>
<td>SENSE – TASTE</td>
<td>LANE – ALLEY</td>
<td>EXCELLENT – WONDERFUL</td>
</tr>
<tr>
<td>JOIN – UNITE</td>
<td>PETAL – LEAF</td>
<td>EXISTENCE – PRESENCE</td>
</tr>
<tr>
<td>LOAD – CARRY</td>
<td>SCIENCE – CHEMISTRY</td>
<td>CAPE – VAMPIRE</td>
</tr>
<tr>
<td>CLEAR – GLASS</td>
<td>TOBACCO – CIGAR</td>
<td>RELIGION – CROSS</td>
</tr>
<tr>
<td>GROW – SHRINK</td>
<td>ATLAS – GLOBE</td>
<td>BANK – ACCOUNT</td>
</tr>
<tr>
<td>CALL – YELL</td>
<td>TOOL – SCREWDRIVER</td>
<td>ATMOSPHERE – WEATHER</td>
</tr>
<tr>
<td>PEACE – CALM</td>
<td>DICTIONARY – DEFINITION</td>
<td>REPLY – RESPONSE</td>
</tr>
<tr>
<td>MEAL – LUNCH</td>
<td>FAINT – DIZZY</td>
<td>OBVIOUS – PLAIN</td>
</tr>
<tr>
<td>LIE – FIB</td>
<td>ABILITY - SKILL</td>
<td>CONSTRUCTION – SITE</td>
</tr>
<tr>
<td>FEET – LEG</td>
<td>LAUNDRY – BASKET</td>
<td>TRADITION – CULTURE</td>
</tr>
<tr>
<td>HOSPITAL – NURSE</td>
<td>HUMBLE – MODEST</td>
<td>LOWER – BOTTOM</td>
</tr>
<tr>
<td>FUNNY – JOKE</td>
<td>MOMENT – MINUTE</td>
<td>MEMORY – BRAIN</td>
</tr>
<tr>
<td>CHAIR – SOFA</td>
<td>GRAPE – WINE</td>
<td>REGULAR – USUAL</td>
</tr>
<tr>
<td>TOTAL – COMPLETE</td>
<td>DOOR – KNOB</td>
<td>REALITY – DREAM</td>
</tr>
<tr>
<td>FISH – SEA</td>
<td>AIR – OXYGEN</td>
<td>OBJECTIVE – SUBJECTIVE</td>
</tr>
<tr>
<td>NOVICE – EXPERT</td>
<td>VOICE – SING</td>
<td>DIVISION – SEPARATE</td>
</tr>
<tr>
<td>DESCENT – FALL</td>
<td>HEART – BEAT</td>
<td>FIRM – GRIP</td>
</tr>
<tr>
<td>AIM – GOAL</td>
<td>CONSCIOUS – AWAKE</td>
<td>STRAIGHT – NARROW</td>
</tr>
<tr>
<td>ODD – STRANGE</td>
<td>STEP – STAIR</td>
<td>PRIVATE – PERSONAL</td>
</tr>
<tr>
<td>FILM – CAMERA</td>
<td>SEASON – SUMMER</td>
<td>FOLLOW – LEADER</td>
</tr>
<tr>
<td>BOOZE – DRINK</td>
<td>STORY – PLOT</td>
<td>AFTERNOON – EVENING</td>
</tr>
<tr>
<td>URGENT – HURRY</td>
<td>ANSWER - QUESTION</td>
<td>ALLOW – PERMIT</td>
</tr>
<tr>
<td>LUXURY - RICH</td>
<td>MAIL - LETTER</td>
<td>MEASURE – CUP</td>
</tr>
</tbody>
</table>
APPENDIX J

AL TASK TRAINING PRESENTATION
Practice Time!!

You just finished learning a list of 44 pairs of words. Then, you were shown one of the words from the pair and asked to write down that word that you remembered seeing. Would you like to learn a trick to make this task easier?

Press ENTER to continue

Here is Part 1 of the trick!!

In order to help your memory, you should try to form a mental image of the words interacting in some way. For example, let's take another look at one of the word pairs you just learned:

SHOVEL – SNOW

Press ENTER to continue

If I were to try and create a mental image of these two things interacting in some way, I might imagine using a huge SHOVEL to push the SNOW out of my driveway.

Press ENTER to continue

Let's try it with another one of the word pairs you just saw:

LOAD – CARRY

Can you think of a mental image of these two things interacting in some way?

Press ENTER to continue

I might imagine an ant who is struggling to CARRY a heavy LOAD of food.

Press ENTER to continue
Remember that the amount of time that the pair of words is on the screen is limited so you should try to form an image in your mind of the words as quickly as possible.

If you aren’t able to form an image in the allotted time, don’t worry. Some pairs will be easier to form an image of than others.

Press ENTER to continue

It is more important for you to continue to study the word pair for the entire time it’s on the screen, whether you are able to form an image or not.

In other words, we want you to do your best at studying each word by generating an image, even though we realize that you may not be able to do so for every word.

Press ENTER to continue

Ready to try the trick?

Remember:

Part 1 – Read the pair of words to yourself and concentrate on what the words mean.

Part 2 – Try to form a mental image of the words interacting in some way.

Part 3 – THINK about the mental image you formed when you are shown the first word and asked to recall the second.

Press ENTER to continue

You will now see the same list of words you saw in the first part of this game.

After all of the word pairs from the list have been shown to you once, you will be shown the first word from the pair and asked to recall what the second word is.

Press ENTER to continue

Each word will be presented one at a time on the computer screen at a fairly rapid rate.

Your task is to study the word when it appears on the screen but this time, remember to use the trick you just learned!

Press ENTER to continue

Press ENTER to see the first word when you are ready to start
CALL - YELL

MEAL - LUNCH

CALL - YELL

MEAL - LUNCH

PEACE - CALM

Good!
Press ENTER when you are ready to begin recalling the words. Please write down the words on the sheet that you were provided. After you recall each word, press ENTER to see the next word on the list.

NAIL - ?

OBSERVE - ?
APPENDIX K

IRB APPROVAL
September 21, 2009

Miranda Morris
307 1/2 Scales Street, Apt 21
 Starkville, MS 39759

RE: IRB Study #08-182: Asperger’s Syndrome and Learning Strategies: Are Difficulties Due to a Production Deficit, a Utilization Deficit, or Both?
(SGHA System title: improving Memory for Word Lists)

Dear Ms. Morris,

The above referenced project was reviewed and approved via administrative review on 9/21/2009 in accordance with 45 CFR 46.104(b)(1). Continuing review is not necessary for this project. However, any modification to the project must be reviewed and approved by the IRB prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project. The IRB reserves the right, at anytime during the project period, to observe you and the additional researchers on this project.

Please note that the MSU IRB is in the process of seeking accreditation for our human subjects protection program. As a result of these efforts, you will likely notice many changes in the IRB’s policies and procedures in the coming months. These changes will be posted online at http://www.orc.msstate.edu/humn/hshmp.php. The first of these changes is the implementation of an approval stamp for consent forms. The approval stamp will assist in ensuring the IRB approved version of the consent form is used in the actual conduct of research. You must use copies of the stamped consent form for obtaining consent from participants.

Please refer to your IRB number (08-182) when contacting our office regarding this application.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact me at cwilliams@research.msstate.edu or call 662-325-5220.

Sincerely,

Christina Williams
IRB Administrator

cc: Deborah Eckin
Kristine Jacquin

Office of Regulatory Compliance & Safety • Provost Box 927 • Mississippi State, MS 39762

85