Working Memory Performance as a Function of the Autistic Scale

by
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fulfillment of the requirements for graduation from the University Honors College

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Acknowledgements

I would like to thank my thesis advisor, Dr. Stephen Schmidt, for guiding and supporting me through this process. He has been an integral part of my thesis and I cannot give him enough gratitude for donating his time and efforts. I would also like to thank my thesis committee for giving me this wonderful opportunity to grow and learn through research. Lastly, I would like to thank all of my friends and family who encouraged me to always do my best.

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Abstract

This study evaluated the relationship between working memory performance and the position on the autistic scale. Participants (n=63) were undergraduates recruited from the MTSU psychology research pool. Most (n=62) were not diagnosed with Autism Spectrum Disorder or Attention Deficit Hyperactivity Disorder. Participants completed a survey, an Austim Spectrum Quotient (ASQ), and two tasks on the computer, the Digit Span task and the Corsi Block task. The participants received five scores – the ASQ score, the digit span forward, the digit span backward, the block span, and the total block span score. The data set was analyzed using descriptive statistics of each of the variables, as well as correlations between the five variables. Two correlation tables were computed, one that used all of the data and the other using the lowest and highest quartile. The results indicated no significant relationship between the ASQ score and the other variables. A possible explanation for the lack of significance could be a simple sampling error in which the participants did not significantly represent the ASD population. Further research is encouraged to determine the relationship between Autism Spectrum Disorder and working memory.

Introduction

Autism Spectrum Disorder (ASD) is a developmental disorder that is characterized by communication deficits, an overdependence on routines, and exhibiting these signs during early childhood (American Psychiatric Association, 2013). ASD is a very common disorder – now affecting 1 in 68 people (Center for Disease Control and Prevention, 2014). Many children who live with ASD have trouble with activities of daily living. This is because ASD affects not only social communication, but executive function as well (Ozonoff,, Pennington, & Rogers, 1991). Some examples of executive functions include "reasoning, problem solving, anticipation, planning, organization, sequencing, resistance to interference, cognitive flexibility, monitoring, and the ability to deal with new situations" (Czermainski, 2015, p. 306). All of these are important to everyday life, but perhaps one of the most important executive functions is working memory.

Reed (2010) defines working memory as "the use of short-term memory as a temporary store for information needed to accomplish a particular task" (p. 74). Basically, working memory allows a person to keep information in the conscious mind while solving a problem or interacting with his/her environmental surroundings. For example, when a person is engaged in a day-to-day conversation, he/she must be keeping the information that is being exchanged in his/her memory, as well as trying to use that information to express his/her ideas. Baddeley proposed a theory of working memory that was composed of three main parts: the central executive, the phonological loop and the visuospatial sketchpad (Baddeley, 2003). The central executive can be seen as the control system, while the last two are concerned with storing and manipulating verbal and visual

information, respectively. The most important quality about working memory is that it has a limited capacity – about 4 +/- 1 items (Cowan, 2000). This estimate of working memory capacity matches with what Domagoj (2011) found in his study on visual working memory, as well. However, it is important to note that the capacity of working memory can vary between individuals. When a person suffers from a disorder that impairs cognitive function, the working memory capacity can suffer as well. Because children with ASD can experience cognitive and executive function deficits (Ozonoff et al., 1991), one must wonder about how this effects the individual's working memory capacity. In Ozonoff et al.'s (1991) study, a group of children with High Functioning Autism scored significantly lower ($p<.0001$) on the executive function tasks than the control group. Several researchers have focused on whether children with ASD have impaired working memory capacities. However, in order to determine this, one must break down the different types of working memory.

There are several different forms of working memory, however the two major types are verbal and visuospatial (as illustrated in Baddeley's working memory model). Verbal working memory involves the storage and manipulation of auditory information in short-term store. Several researchers have studied the correlation between verbal working memory and ASD. In the Bordignon, Endres, Trentini, and Bosa (2015) review of working memory and autism, the correlation between verbal working memory and ASD is not fully understood; the review states that seven of the experiments found no difference in verbal working memory capacity between ASD group and the control group, however seven other experiments found significant impairments in verbal working memory capacity in the ASD group (Bordignon, et al., 2015). This variation could be due

to the different types of tests that were administered, i.e. digit span vs letter-number sequencing task, as well as the fact that some experimenters did not filter out an ADHD diagnosis in the autistic children – i.e., they allowed participants who were diagnosed with both ASD and ADHD in the study. This is important because people with ADHD are known to have an impaired working memory capacity, so this would affect the results. Kercood, Grskovic, Banda, and Begeske (2014) found that impaired verbal working memory capacities in the ASD group were associated with problems in adaptive, restrictive, and repetitive behavior. Thus, there could be some correlation between specific autistic traits and verbal working memory.

A few research experiments in the Bordignon, et al. (2015) review focused on visuospatial memory, where there was more of a consensus on the correlation between ASD and impaired visuospatial working memory. This would make sense, because Jiang (2014) explains that "impairment in spatial working memory may increase the difficulty of representing the locations of people and objects, potentially exacerbating the social and communication deficits experienced by individuals with an autism spectrum disorder (ASD)" (p. 248). Overall, the researchers (McGrath, et al., 2005; Strauss et al., 2006; Steele, et al., 2005; Alderson-Day & McGomigle-Chalmers, 2011; Altgassen et al., 2009; Corbett et al., 2009) found significant impairment, compared to the control groups with no ASD diagnosis, in tests that involved the block span, self-ordered pointing task, twenty question task, the ongoing task, and the spatial span and spatial working memory subtests (Bordignon, et al., 2015). The self-ordered pointing task is a task in which "the individual initiates and executes a sequence of responses, maintains a record of responses, and monitors his/her performance" (Strauss et al., 2006, p. 471). The twenty question task

involves having the participant guess what the researcher is thinking by asking twenty or fewer questions about the picture (Alderson-Day & McGomigle-Chalmers, 2011). The ongoing task is a task in which participants look at a series of symbols and remember their position when it changes (Altgassen et al., 2009). The spatial span is a task in which participants watch a series of blocks light up and then report the order of the blocks, whereas the spatial subtest requires the participant to keep items in working memory while manipulating them (Corbett et al., 2009).

In the research proposed below, the Corsi Block Tapping Task will be used, which will yield a block span score. This task is very similar to the spatial span task and operates in a similar fashion. This task was also used in Joseph, McGrath, and Tager-Flusberg's (2005) study of executive dysfunction, language ability, and autism. They found that participants with ASD performed significantly lower on the block span task than the participants in the control group, especially in the reverse order. However, instead of a manual block span task (where the researcher points to a series of blocks), I will be using an electronic block span task. This will make the scoring of the task easier, because it is automated, and decrease the chance of bias as well. Kessels, et al. (2000) highlight the reliability of the Corsi Block task in assessing the visual memory span – they compared the scores of patients with right hemisphere brain damage with the scores of patients with left hemisphere brain damage and found that the patients with right hemisphere damage performed significantly worse. This demonstrates the validity of the task to assess visual working memory, since the right hemisphere of the brain is responsible for more of the visuospatial tasks.

Because of the variation in the testing, some psychologists still doubt the relation between verbal and visuospatial working memory capacity and ASD. Thus, it is important to further research the relationship in order to determine the cause of some of the symptoms in ASD, as well as potential treatment options. This study will be especially unique in that rather than having two groups (one with ASD and one control), we are looking at where the participants fall on the spectrum of autism – even if they have no prior diagnosis. This will let us measure verbal and visuospatial working memory as a function of autistic traits; on a grey-scale, rather than it being just black or white. It is also different in that we will be looking at the normal population, meaning participants are not required to be previously diagnosed with ASD. This will increase the generalizability of the results.

Thesis Statement

Research has shown that Autism Spectrum Disorder can cause deficits in executive functioning (Czermainski, 2015). One important aspect of executive functioning is working memory, which allows a person to keep information in a short term store while interacting with his/her environment. There are two major types of working memory: verbal and visuospatial. While verbal working memory emphasizes holding and manipulating verbal information, visuospatial working memory focuses on keeping visual and spatial information in the conscious mind, such as where objects or people are in a room and how they are interacting with each other. Given that people with ASD suffer from both cognitive and social deficits, the hypothesis for this experiment is that people who exhibit more autistic traits will score lower on the verbal and visuospatial working memory capacity tests as compared to people who have fewer autistic traits.

Method

Participants

There were 67 participants (20 Male, 47 Female). Participants were recruited from the MTSU Psychology Research Pool. All of the participants were between the ages of 18 and 25. None of the participants had been diagnosed with Autism Spectrum Disorder and only one participant was diagnosed with Attention Deficit Hyperactivity Disorder. The participants received two full credits that applied to their psychology courses. The Institutional Review Board approved this study (see Appendix A).

Materials

The study took place at MTSU in Jones Hall room 307. The participants arrived and began with a quick demographic questionnaire (age, sex, and prior ADHD/ASD diagnoses) then continued to the Autism Spectrum Quotient. This survey took about ten to fifteen minutes to complete and was scored at a later date. After the ASQ, the participants moved on to the computer and began the Digit Span Task. This task was about ten to fifteen minutes long and a score was automatically generated and recorded. Then, while still at the computer, participants began the Corsi Block Tapping Task. This task took only a few minutes and a score was automatically generated and recorded. At this point, the study ended and the participant was dismissed.

Autism Spectrum Quotient (Adult)

The participants self-reported on the Autism Spectrum Quotient developed by the Autism Research Centre at the University of Cambridge. The questionnaire is fifty questions long and requires the participant to "definitely agree," "slightly agree," "slightly disagree," or "definitely disagree" to a variety of statements. Each statement is

related to the participant's current thoughts and behaviors. The answers to these questions can count either as 1 point or 0 points, according to the scoring guide. The raw scores are then added for a total score and interpreted based on where the participant's score lands on the scale; for example, if one participant scores a 9 and another participant scores a 30, we would say that the second participant is higher on the autistic scale and exhibits more autistic traits. After the participants finished the survey, they moved on to the Corsi Block Tapping Task. The surveys were scored at a later date, making sure to mark the survey with the correct participant number to later match to the Corsi Block score. It is important to note that the ASQ is not diagnostic, but it is being used just to measure the extent of autistic traits in the participants (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). This test was chosen because of its simplicity and reliability. Baron-Cohen et al. (2001) report that 80% of adults with Autism Spectrum Disorder scored above the cutoff of 32, whereas only 2% of the adults with no diagnosis of ASD scored above the cutoff. This report displays the reliability of the test.

The Digit Span Task

The participants were administered the test by computer. The test used was the Digit Span task provided by Inquisit Scripts. The test began by the computer reading aloud a series of numbers to the participant. The participants then reported the numbers, in the correct order, by typing them into the computer. The test continued by increasing the digit span by one number every time. At the end of the task, the program reported the score on the screen and I recorded the score directly on the participant's survey. This task was used to evaluate the participant's verbal working memory capacity. The digit span task was chosen because of its high esteem in cognitive psychology for studying verbal

working memory – also, because a majority of the studies in the Bordignon, et al. (2015) review also used this task. The digit span is the most widely used task to evaluate verbal working memory (Monico, Costa, Caltagirone, & Carlesimo, 2013). Furthermore, Jahanshahi, Saleem, Ho, Fuller, and Dirnberger (2008) report that the digit span task is a reliable instrument for assessing VWM and executive function.

Corsi Block Tapping Task

The participants were administered the test by computer. The test used was the Corsi Block Tapping Task provided by Inquisit Scripts. The test began by presenting the participants with several colored blocks (a total of nine). The blocks lit up, one by one, and required the participant to remember the exact order and location of the blocks that lit up. On the first level, the participants had to remember the forward order of two blocks. The levels were ordered by sequence length. The participant had two tries on each sequence length. In order to progress to the next sequence length, the participant must get at least one of the two tries correct. As the levels progress, the participants were required to remember the order of more and more blocks. However, if the participant failed on both tries of a certain sequence length, the test ceased and showed the participant his/her score. The score included both the block span (how many blocks the participant can keep in spatial working memory) and a total score. The total score is the product of the block span and the number of correctly repeated trials. For the purpose of this experiment, the total score was the primary score evaluated because it is the more sensitive and more reliable of the two (Kessels et al., 2000). The scores for this test were used to create a function that evaluates the relation between autistic traits and visuo-spatial memory capacity. This test was chosen because of its simplicity, but also because of its reputation

in psychology research. Berch et al. (1998) describes the task as the single most important nonverbal task in neuropsychological research, in which it is most popularly used for testing visuo-spatial working memory.

Procedure

The participants were informed prior to beginning the study the procedure, per the informed consent. The first task given to the participants was to fill out the the demographics questionnaire on the first page of the Autism Spectrum Quotient. After filling out this information, they continued to the ASQ. After finishing the ASQ, the participants began the Digit Span Task on the computer. The participants wore headphones, so that they could not hear the other computers, and entered the numbers into the computer keyboards. The participants took the digit span task twice – once in the forward direction and once in the backward direction. The two scores were written down directly on the ASQ, in order to prevent mixing up the scores. The participant then continued to the Corsi Block Tapping Task. This task generated two scores, both of which were recorded directly onto the ASQ. After the study ceased, the ASQ was scored and the data were entered into the computer.

Results

Analytical Plan

It is important to know that these results do not include three participants' data. This is because these participants were found to be cheating on the digit span task (writing down the numbers as the computer read them then typing them in from the paper). One of the participants found to be cheating was diagnosed with ADHD, so we

did not have to consider that extra variable in our results. These results would have skewed the data greatly due to the extraordinarily high digit span scores.

Descriptive Statistics were calculated for each of the variables. This included mean, maximum, minimum, and standard deviation. The results are shown in Table 1.

Table 1

Maximum and Minimum Values, Mean, and Standard Deviation of Working Memory Tasks and Autism Spectrum Quotient

Descriptive Statistics (N=63)

Variable	Min	Max	M	SD
Digit Span Forward	4	9	6.95	1.084
Digit Span Backward	4	9	6.27	1.019
Corsi Block Span	3	9	6.05	1.038
Corsi Block Total Score	24	117	55.37	18.607
ASQ Score	6	33	17.08	6.078

Two correlational tests were used to determine the correlation between variables. The first correlation was done with all of the data. There was no significant correlation between any of the variables with the ASQ score. However, there are significant correlations between the digit span forward and the other three variables (digit span backward, corsi block span, and corsi block total score). The results are shown in Table 2 below.

Table 2

Correlations Between All Variables (Working Memory Task Scores and Autism Spectrum Quotient)

Descriptive Statistics (N = 63)

Variables	1	2	3	4
1. Digit Span Forward	-			
2. Digit Span Backward	.464**	-		
3. Corsi Block Span	.360**	.171	-	
4. Corsi Block Total Score	.339**	.146	.957**	-
5. ASQ Score	.003	.095	-.121	-.100

**. Correlation is significant at the 0.01 level (2-tailed).

The data set was then separated into quartiles based on the ASQ score. An independent sample t-test was used to determine if there was a mean difference between the 25th percentile and 75th percentile groups. The results are shown below.

Table 3

Results of t-test for Working Memory Scores based on Percentile of ASQ score

Variable	Group						95% CI for Mean Differences	t	df
	25%			75%					
	M	SD	n	M	SD	n			
Digit Span Forward	6.72	1.018	18	6.83	1.339	18	-.917, .695	-.280	34
Digit Span Backward	6.22	1.166	18	6.39	.850	18	-.858, .52	-.490	34
Corsi Block Span	6.28	1.018	18	5.83	1.150	18	-.291, 1.180	1.228	34
Corsi Block Total Score	59.78	21.092	18	52.78	18.466	18	-6.428, 20.428	1.059	34

The Autism Spectrum Quotient Score was also evaluated in order to determine whether or not it followed a normal distribution curve. This would indicate that the results are overall around the average, but the scores can deviate. The results show that there was normal distribution, however it occurred at the lower end of the scale. Only 1.5% (1 out of 63 participants) of the sample met the definition of autism. The Figure 1 below shows the normal distribution curve. The ASQ Score was also statistically analyzed by using a one-sample t-test to compare the sample mean with the population mean from the Baren-Cohen (2001) study. The results were not significant and are shown in Table 4. Finally, I analyzed the skewness of the data using SPSS and the value is .406, which is not significant.

Figure 1 Normal Distribution Curve for ASQ Scores

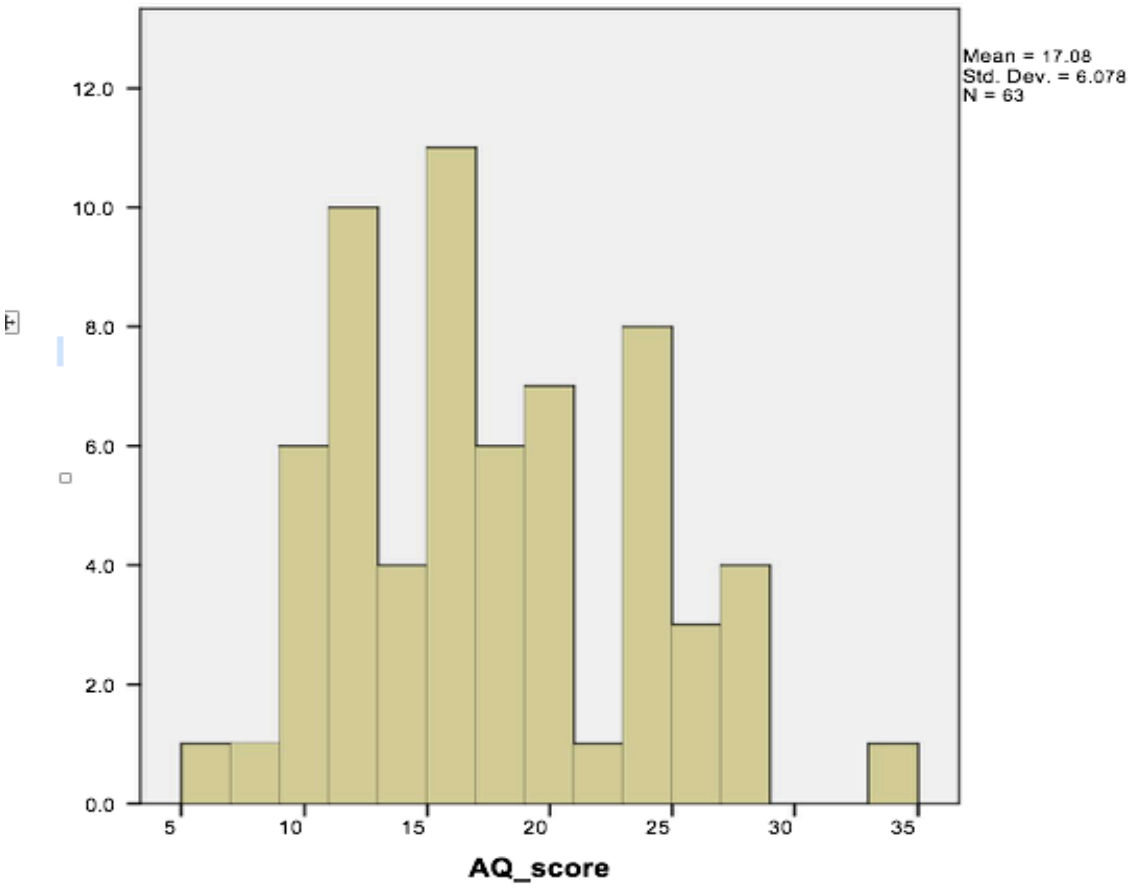

Table 4

One sample t-test for population mean and study mean of ASQ Score

	Population	Study	*t*	*df*
ASQ Score	16.4 (6.3)	17.08 (6.078)	.9402	62

Discussion

This correlational study did not result in any significant correlation between the ASQ score and the other variables (digit span forward, digit span backward, corsi block span, corsi block total score). However, the results did show a slight decline in the corsi block variables as the ASQ score increased (Table 2 and Table 3). This is consistent with my hypothesis, but did not turn out to be statistically significant. The results for the correlation between the digit span forward, digit span backward and the ASQ scores were in the positive direction, however this correlation was miniscule and also not statistically significant (Table 2). This would have been inconsistent with my hypothesis. Thus, I have failed to reject the null hypothesis – that there is no correlation between ASQ score and working memory performance.

It is important to note that the study's results are generally consistent with previous research concerning working memory and research concerning the prevalence of ASD. The means of each of the variables are consistent with what is considered typical, i.e. digit span of 7 (Weschler, 2003). The standard deviation, excluding the corsi block total score, was relatively small for all of the variables (Table 1). The two digit span scores correlated with each other, as did the two corsi block scores (Table 2). The sample

mean for the ASQ score was not significantly different than the population mean indicating that the sample was representative of the normal population without a diagnosis of autism (Table 4). Furthermore, the ASQ scores did show normal distribution, which shows that there was no signifitcant skew in the data (Figure 1). The value of skewness was calculated to be .405, which is not statistically significant (George & Mallery, 2010). The skew demonstrates how symmetrical the probability distribution is around the mean. Because the skew was not significant in the ASQ scores, this means that the distribution is fairly symmetric around the mean. However, because the normal distribution was shifted to the left end, this showed that we had a very normal population, as most (n=62) did not score above the ASQ cutoff of 32. As for the participant who did score above the cutoff, he/she had a digit span forward score of 8, digit span backward score of 7, block span score of 8, and total block span score of 88.

Some of our results also agreed with other research on ASD and working memory. Williams et al. (2005) found there was no significant difference in the ASD group and normal group on their verbal working memory performance. Some other studies have also failed to show significant correlation between ASD and working memory (Russell et al., 1996). However, as many as those who have failed to provide significant results, just as many have found significant correlations. Williams, et al. (2005) found a significant deficit in visual working memory, although no significant difference in verbal working memory, in the ASD group. Goldberg et al. (2005) also found significant differences between the ASD and normal groups in working memory performance. I believe that this inconsistency in results indicates that further and more precise research is needed before any concrete conclusions.

I believe there is a valid reason that this project did not produce significant results – that is the population was not representative of the ASD population. Only one participant went above the ASQ cutoff of 32, which indicates a possible diagnosis of autism. It is hard to tell if we had a larger population of participants diagnosed with ASD that it would change the results. However, we can examine other studies who included a diagnoses as a requirement of the study. Gabig (2008) required a DSM-IV diagnosis of Autism Spectrum Disorder to be considered in the ASD group and matched those with a control (normal population) group. The results showed that the ASD group performed significantly worse than the control group on all working memory tasks given. Furthermore, Benetto et al. (1996) required DSM-III diagnosis of ASD to be included in the ASD group and found a significant deficit in the ASD group in regards to working memory tasks. Thus, it appears that having more restriction on the diagnostic criteria could have impacted the results of my study.

This project requires more research in order to determine, definitively, the relationship between Autism Spectrum Disorder and working memory. In the future, I would like to research using a two group study – one with a normal population and the other diagnosed with ASD. I would still like to include the Autism Spectrum Quotient so that I could examine the scores on the spectrum, however I would like to be certain I would have participants who fit the ASD criteria. Furthermore, this project featured only a single task for the participants. It would be interesting in future projects to introduce a dual task, where the participant has to focus on two tasks at once, to see how ASD participants and normal participants differed in that condition. Garcia-Villamistar and Sala (2002) did both a single task condition and a dual task condition for their study on

working memory and ASD; they found no differences with the single task, but impaired performance by the ASD group in the dual task condition.

If, in the future, those results were to show a relationship, this would have a lot of implications for treatment of ASD symptoms. Jiang (2014) believes that the impairment of visuospatial memory could explain the social communication deficits seen in Autism Spectrum Disorder. Furthermore, the effects of the impaired working memory capacity can cause problems with "behavior regulation, cognitive flexibility, abstract thinking, and focusing and sustaining attention." (Kercood, et. al 2014, p. 1317). This means that this research could provide more understanding about the underlying causes of the symptoms in ASD, including the social and communication deficits. Looking forward, this research could allow more treatment options for children with ASD, especially in the field of occupational therapy. For example, research from Baltruschat (2011) has shown promising treatment in behavioral intervention that improves both the working memory capacity and behavior. In fact, the researchers state that "the effects maintained after reinforcement was discontinued and were generalized to novel stimuli and behaviors (i.e., colors, shapes, and quantities counted)" (Baltruschat, 2011). This could lead to promising treatment options for people with ASD that not only improve cognitive function, but social and behavioral functions as well.

Conclusion

In conclusion, this study found no significant correlation between ASQ scores and working memory performance. There was a slight negative trend between ASQ score and visual working memory, however it was not statistically significant. Further research is

required in order to further examine the relationship between Autism Spectrum Disorder and working memory.

List of Appendices

APPENDIX A

IRB

INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

EXEMPT APPROVAL NOTICE

2/16/2016

Investigator(s): Bethany Marcum & Stephen Schmidt
Department: Psychology
Investigator(s) Email: bpm3j@mtmail.mtsu.edu
Protocol Title: "Working Memory as a Function of Autistic Traits "
Protocol ID: 16-1164

Dear Investigator(s),

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above and this study has been designated to be EXEMPT.. The exemption is pursuant to 45 CFR 46.101(b) **(2) Educational Tests, Surveys, Interviews, or Observations**

The following changes to this protocol must be reported prior to implementation:
Addition of new subject population or exclusion of currently approved demographics Addition/removal of investigators
Addition of new procedures
Other changes that may make this study to be no longer be considered exempt

The following changes do not have to be reported:
Editorial/administrative revisions to the consent of other study documents Changes to the number of subjects from the original proposal

All research materials must be retained by the PI or the faculty advisor (if the PI is a student) for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

NOTE: All necessary forms can be obtained from www.mtsu.edu/irb.

APPENDIX B

Informed Consent

Middle Tennessee State University

Project Title: Working Memory Performance as a Function of Autistic Traits

Purpose of Project: To learn whether or not autistic traits can be correlated with impaired working memory performance

Procedures: The participants will start with the Adult Autism Spectrum Quotient. It is a survey that consists of fifty questions that revolve around the participant's current behavior. The participants will report whether they "definitely disagree", "slightly disagree", "slightly agree", or "definitely agree." After the participant finishes, I will set their scores aside and score them at a later date. It is important to note that the ASQ is not diagnositic of Autism Spectrum Disorder, it is only for research purposes. The participant will continue to the Corsi Block Tapping Task (provided by inquisit scripts) on the computer. The computer will light up a series of blocks and require the participant to report what order the blocks lit up. The task will continue until the participant has two consecutive, incorrect tries. The computer will generate their score and show it on the screen. The participant will move on to the digit span task (provided by inquisit scripts on the computer. The computer will read aloud a series of numbers and require the participant to report the numbers in the correct order by typing them in. This will continue until the participant reaches nine digits. After that, the task will end and the score will show on the screen.

Risks/Benefits: There is no greater risk than what is experienced in everyday life. The only benefit to you is that you can learn about your working memory capacity. The benefit to society is that this study will help people understand more about Autism Spectrum Disorder**.**

Confidentiality: No names will be recorded during the study. Instead, I will mark the results with a unique participant number. The data will be stored on a hard drive and transferred to Dr. Schmidt's computer after the thesis is completed.

Principal Investigator/ Contact Information: Bethany Marcum / bpm3j@mtmail.mtsu.edu

Participating in this project is voluntary, and refusal to participate or withdrawing from participation at any time during the project will involve no penalty or loss of benefits to which you might otherwise be entitled. All efforts, within reason, will be made to keep the personal information in your research record private but total privacy cannot be promised, for example, your information may be shared with the Middle Tennessee State University Institutional Review Board. In the event of questions or difficulties of any kind during or following participation, you may contact the Principal Investigator as indicated above. For additional information about giving consent or your rights as a participant in this study, please feel free to contact the MTSU Office of Compliance at (615) 494-8918.

Consent

I have read the above information and my questions have been answered satisfactorily by project staff. I believe I understand the purpose, benefits, and risks of the study and give my informed and free consent to be a participant.

_____ _____

SIGNATURE DATE

APPENDIX C

The Adult Autism Spectrum Quotient (ASQ)

Ages 16+

SPECIMEN, FOR RESEARCH USE ONLY.

For full details, please see:

S. Baron-Cohen, S. Wheelwright, R. Skinner, J. Martin and E. Clubley, (2001)
The Autism Spectrum Quotient (ASQ) : Evidence from Asperger Syndrome/High Functioning Autism, Males and Females, Scientists and Mathematicians
Journal of Autism and Developmental Disorders 31:5-17

Sex:.....

Age:..... Today's Date.....

Do you have any prior ADHD diagnosis? Yes or No

Do you have any prior Autism Spectrum Disorder? Yes or No

How to fill out the questionnaire

Below are a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree with it by circling your answer.

Please try to answer all questions.

Examples

E1. I am willing to take risks.	definitely agree	slightly agree	slightly disagree	definitely disagree
E2. I like playing board games.	definitely agree	slightly agree	slightly disagree	definitely disagree
E3. I find learning to play musical instruments easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
E4. I am fascinated by other cultures.	definitely agree	slightly agree	slightly disagree	definitely disagree

1. I prefer to do things with others rather than on my own.	definitely agree	slightly agree	slightly disagree	definitely disagree
2. I prefer to do things the same way over and over again.	definitely agree	slightly agree	slightly disagree	definitely disagree
3. If I try to imagine something, I find it very easy to create a picture in my mind.	definitely agree	slightly agree	slightly disagree	definitely disagree
4. I frequently get so strongly absorbed in one thing that I lose sight of other things.	definitely agree	slightly agree	slightly disagree	definitely disagree
5. I often notice small sounds when others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
6. I usually notice car number plates or similar strings of information.	definitely agree	slightly agree	slightly disagree	definitely disagree
7. Other people frequently tell me that what I've said is impolite, even though I think it is polite.	definitely agree	slightly agree	slightly disagree	definitely disagree
8. When I'm reading a story, I can easily imagine what the characters might look like.	definitely agree	slightly agree	slightly disagree	definitely disagree
9. I am fascinated by dates.	definitely agree	slightly agree	slightly disagree	definitely disagree
10. In a social group, I can easily keep track of several different people's conversations.	definitely agree	slightly agree	slightly disagree	definitely disagree

11. I find social situations easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
12. I tend to notice details that others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
13. I would rather go to a library than a party.	definitely agree	slightly agree	slightly disagree	definitely disagree
14. I find making up stories easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
15. I find myself drawn more strongly to people than to things.	definitely agree	slightly agree	slightly disagree	definitely disagree
16. I tend to have very strong interests which I get upset about if I can't pursue.	definitely agree	slightly agree	slightly disagree	definitely disagree
17. I enjoy social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree
18. When I talk, it isn't always easy for others to get a word in edgeways.	definitely agree	slightly agree	slightly disagree	definitely disagree
19. I am fascinated by numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree

20. When I'm reading a story, I find it difficult to work out the characters' intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
21. I don't particularly enjoy reading fiction.	definitely agree	slightly agree	slightly disagree	definitely disagree
22. I find it hard to make new friends.	definitely agree	slightly agree	slightly disagree	definitely disagree
23. I notice patterns in things all the time.	definitely agree	slightly agree	slightly disagree	definitely disagree
24. I would rather go to the theatre than a museum.	definitely agree	slightly agree	slightly disagree	definitely disagree
25. It does not upset me if my daily routine is disturbed.	definitely agree	slightly agree	slightly disagree	definitely disagree
26. I frequently find that I don't know how to keep a conversation going.	definitely agree	slightly agree	slightly disagree	definitely disagree
27. I find it easy to "read between the lines" when someone is talking to me.	definitely agree	slightly agree	slightly disagree	definitely disagree
28. I usually concentrate more on the whole picture, rather than the small details.	definitely agree	slightly agree	slightly disagree	definitely disagree
29. I am not very good at remembering phone numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree

30. I don't usually notice small changes in a situation, or a person's appearance.	definitely agree	slightly agree	slightly disagree	definitely disagree
31. I know how to tell if someone listening to me is getting bored.	definitely agree	slightly agree	slightly disagree	definitely disagree
32. I find it easy to do more than one thing at once.	definitely agree	slightly agree	slightly disagree	definitely disagree
33. When I talk on the phone, I'm not sure when it's my turn to speak.	definitely agree	slightly agree	slightly disagree	definitely disagree
34. I enjoy doing things spontaneously.	definitely agree	slightly agree	slightly disagree	definitely disagree
35. I am often the last to understand the point of a joke.	definitely agree	slightly agree	slightly disagree	definitely disagree
36. I find it easy to work out what someone is thinking or feeling just by looking at their face.	definitely agree	slightly agree	slightly disagree	definitely disagree
37. If there is an interruption, I can switch back to what I was doing very quickly.	definitely agree	slightly agree	slightly disagree	definitely disagree
38. I am good at social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree
39. People often tell me that I keep going on and on about the same thing.	definitely agree	slightly agree	slightly disagree	definitely disagree

40. When I was young, I used to enjoy playing games involving pretending with other children.	definitely agree	slightly agree	slightly disagree	definitely disagree
41. I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).	definitely agree	slightly agree	slightly disagree	definitely disagree
42. I find it difficult to imagine what it would be like to be someone else.	definitely agree	slightly agree	slightly disagree	definitely disagree
43. I like to plan any activities I participate in carefully.	definitely agree	slightly agree	slightly disagree	definitely disagree
44. I enjoy social occasions.	definitely agree	slightly agree	slightly disagree	definitely disagree
45. I find it difficult to work out people's intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
46. New situations make me anxious.	definitely agree	slightly agree	slightly disagree	definitely disagree
47. I enjoy meeting new people.	definitely agree	slightly agree	slightly disagree	definitely disagree
48. I am a good diplomat.	definitely agree	slightly agree	slightly disagree	definitely disagree

49. I am not very good at remembering people's date of birth.	definitely agree	slightly agree	slightly disagree	definitely disagree
50. I find it very easy to play games with children that involve pretending.	definitely agree	slightly agree	slightly disagree	definitely disagree

Developed by:

The Autism Research Centre

University of Cambridge

✏MRC-SBC/SJW
Feb 1998

APPENDIX D

The Adult Autism Spectrum Quotient (ASQ)

Ages 16+: Scoring Key

For full details, please see:

S. Baron-Cohen, S. Wheelwright, R. Skinner, J. Martin and E. Clubley, (2001)
The Autism Spectrum Quotient (ASQ) : Evidence from Asperger Syndrome/High Functioning Autism, Males and Females, Scientists and Mathematicians
Journal of Autism and Developmental Disorders 31:5-17

Responses that score 1 point are marked. Other responses score 0. For total score, sum all items.

		definitely agree	slightly agree	slightly disagree	definitely disagree
1.	I prefer to do things with others rather than on my own.			1	1
2.	I prefer to do things the same way over and over again.	1	1		
3.	If I try to imagine something, I find it very easy to create a picture in my mind.			1	1
4.	I frequently get so strongly absorbed in one thing that I lose sight of other things.	1	1		
5.	I often notice small sounds when others do not.	1	1		
6.	I usually notice car number plates or similar strings of information.	1	1		
7.	Other people frequently tell me that what I've said is impolite, even though I think it is polite.	1	1		
8.	When I'm reading a story, I can easily imagine what the characters might look like.			1	1
9.	I am fascinated by dates.	1	1		
10.	In a social group, I can easily keep track of several different people's conversations.			1	1

11.	I find social situations easy.			1	1
12.	I tend to notice details that others do not.	1	1		
13.	I would rather go to a library than a party.	1	1		
14.	I find making up stories easy.			1	1
15.	I find myself drawn more strongly to people than to things.			1	1
16.	I tend to have very strong interests which I get upset about if I can't pursue.	1	1		
17.	I enjoy social chit-chat.			1	1
18.	When I talk, it isn't always easy for others to get a word in edgeways.	1	1		
19.	I am fascinated by numbers.	1	1		
20.	When I'm reading a story, I find it difficult to work out the characters' intentions.	1	1		
21.	I don't particularly enjoy reading fiction.	1	1		
22.	I find it hard to make new friends.	1	1		
23.	I notice patterns in things all the time.	1	1		
24.	I would rather go to the theatre than a museum.			1	1

25.	It does not upset me if my daily routine is disturbed.			1	1
26.	I frequently find that I don't know how to keep a conversation going.	1	1		
27.	I find it easy to "read between the lines" when someone is talking to me.			1	1
28.	I usually concentrate more on the whole picture, rather than the small details.			1	1
29.	I am not very good at remembering phone numbers.			1	1
30.	I don't usually notice small changes in a situation, or a person's appearance.			1	1
31.	I know how to tell if someone listening to me is getting bored.			1	1
32.	I find it easy to do more than one thing at once.			1	1
33.	When I talk on the phone, I'm not sure when it's my turn to speak.	1	1		
34.	I enjoy doing things spontaneously.			1	1
35.	I am often the last to understand the point of a joke.	1	1		
36.	I find it easy to work out what someone is thinking or feeling just by looking at their face.			1	1

37.	If there is an interruption, I can switch back to what I was doing very quickly.			1	1
38.	I am good at social chit-chat.			1	1
39.	People often tell me that I keep going on and on about the same thing.	1	1		
40.	When I was young, I used to enjoy playing games involving pretending with other children.			1	1
41.	I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).	1	1		
42.	I find it difficult to imagine what it would be like to be someone else.	1	1		
43.	I like to plan any activities I participate in carefully.	1	1		
44.	I enjoy social occasions.			1	1
45.	I find it difficult to work out people's intentions.	1	1		
46.	New situations make me anxious.	1	1		
47.	I enjoy meeting new people.			1	1
48.	I am a good diplomat.			1	1

49.	I am not very good at remembering people's date of birth.			1	1
50.	I find it very easy to play games with children that involve pretending.			1	1

MRC-SBC/SJW Apr 2007

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