Sex Differences in Object and Spatial Memory in College Students

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Abstract

The current study examined sex differences in object and spatial memory in college age students. It is hypothesized that there would be a female advantage in the object memory task and a male advantage in the spatial memory task. The object array task (Levy et al., 2005) was utilized to measure object memory, and the Vandenberg 3D Mental Rotation Task (Vandenberg and Kuse, 1978) was utilized to measure spatial memory. Contrary to previous studies, this study found no evidence supporting a sex difference in either task. There were nearly three times as many females than males who participated in this study, which might have impacted the validity of the statistical analyses.

Sex Difference in Object and Spatial Memory in College Students

Previous research has illustrated that there is a cognitive difference between males and females on performance in object and spatial memory tasks. Much research has shown that males have an enhanced spatial memory ability in comparison to females (Astur, Tropp, Sava, Constable, & Markus, 2004). In contrast, research done on object memory has shown a female advantage (Levy, Astur, Frick, 2005). There are evolutionary and biological theories that attempt to explain these differences in cognitive ability that will be discussed in this paper. The present study examined sex differences in object memory and spatial memory within the same participant pool.

Male Advantage in Spatial Memory

Spatial memory has been defined as the storage and retrieval of information that aids in navigating an environment (Burgess, Brisby, 2018). More specifically, spatial memory is responsible for information about movement and location in the environment. A multitude of studies have shown that there is a male advantage in this type of memory in both humans and rodents (Astur, Tropp, Sava, Constable, & Markus, 2004; LaBuda, Mellgren, & Hale, 2002). This advantage has been found through multiple tasks such as the Virtual Morris Water Task (Astur, Ortiz, & Sutherland, 1998), the 3D Vandenberg Mental Rotation Task (Astur, Tropp, Sava, Constable, & Markus, 2004), the Radial Arm Maze (LaBuda, Mellgren, & Hale, 2002), and many other tasks that examine different types of spatial memory. One of the most commonly tested types of spatial memory is mental rotation. Mental rotation can be defined as the ability for a person to manipulate the orientation of an object in an environment. Mental rotation has demonstrated a reliable male advantage, and can be tested by using the Vandenberg 3D Mental

Rotation Task (Vandenberg, Kuse, 1978). Overall, researchers consistently find a male advantage in spatial memory, especially in mental rotation.

Interestingly, some spatial memory tasks have been used in both human and rodents subjects to investigate the male-advantage in spatial memory. Astur et al. (2004) conducted a study to test if tasks typically used to examine spatial ability in rodents can be used interchangeably withhumans. This study utilized the Virtual Morris Water Task and the Virtual Radial Arm Maze, which are both used to test rodents, along with the Vandenberg 3D Mental Rotation Task, which tests only human participants. Results from the Vandenburg 3D Mental Rotation Task and the Virtual Morris Water Task found a male spatial memory advantage, which is consistent with previous research. However, there was no significant difference between male and female participants spatial ability in the virtual radial arm maze. Even though males traveled faster through the radial arm maze than females, they did not travel more efficiently. Although this study was mainly conducted to test the efficacy of rodent spatial memory tasks on human participants, this study also illustrated the male spatial memory advantage on some tasks.

Another study that also illustrated this male spatial advantage was Moffat et al., (1998). Moffat and colleagues tested the efficiency of spatial route learning between male and female participants through a multitude of different tasks. There were two virtual mazes included in this study to test participants ability to navigate in a novel environment (they were also tested on how quickly they completed each trial). They utilized the Vandenberg 3D Mental Rotation Task to test mental rotation ability. They also utilized the Money Road Map Test of Directional Sense to see whether participants were able to give left-right responses upside-down (also timed). The Guilford-Zimmerman Spatial Orientation Task tested participant’s ability to recognize the way an object has moved in relation to the surrounding environment. Finally participants were given the Advanced Vocabulary Test 1, and the Controlled Oral Word Association Task to test the general intelligence of those participating in the study. Researchers found that males outperformed females on all measures of spatial memory ability. They also found no difference in vocabulary or word association task. This is an important distinction because it implies that spatial memory is not related to intelligence as much as it is related to this specific male advantage.

A commonality of many studies testing the male advantage in spatial memory is the use of the Vandenberg 3D Mental Rotation Task. Previous research has illustrated that males have an advantage when navigating three dimensional spaces, which is why Collins et al., (1997) wanted to test this advantage further with the use of two dimensional stimuli. These researchers utilized both the Vandenberg 3D Mental Rotation Task, along with a select few questions from the PMA Spatial Relations Test (Thurstone, 1958) to test mental rotation ability. Unlike the Vandenberg, the PMA Spatial Relations test involves two dimensional stimuli with both an “easy” and “hard” condition. The “easy” condition included a frame surrounding the stimuli that allowed participants to more easily gauge the amount an object was rotated. The “hard” condition had no rotation cues and it was therefore more difficult to gauge how much an object had been rotated. Researchers found that males outperformed females both measures and across both conditions. Researchers also found that as the tasks got more difficult, there was a bigger disparity between male and female scores. Males and Females started out the study being relatively similar in scores for the “easy” condition of the PMA Spatial Relations test. However, once the tasks got more difficult, the female participants started scoring much lower than the males. This study implies that the male advantage in mental rotation is not dependent on whether objects are two dimensional or three dimensional, and that the male advantage becomes measurable on more difficult spatial tasks.

Along with human research, a plethora of research on spatial memory has been conducted on rodents and other nonhuman subjects. LaBuda et al., (2002) wanted to test whether there would be a difference in performance of an 8-arm radial arm maze between male and female CD-1 mice. The mice were tested across five days, and researchers found that male mice learned the task faster than females, and made fewer errors than the females did. There is also evidence to suggest that the female mice didn't learn the task at all. The male mice had an increase in rewards across testing days, while the female mice did not. The male mice also increased the amount of correct responses they made, while again, the female mice did not. The reason for this specific type of mouse being utilized in this study is due to previous research regarding this particular strain. Most research conducted using this particular strain of mouse does so to test learning and memory (Ammassari-Teule, & DeMarsanich, 1998), there are few studies that have used this strain to test spatial ability. More recent research has found that you are able to teach these mice spatial tasks. However they can only learn in non-stressful situations, where they are rewarded instead of punished. This is important because it shows that even a species with low spatial memory ability replicated this male advantage. This suggests that there is a neurobiological basis to the male advantage in spatial memory.

Female Advantage in Object Memory

Object memory can be defined as memory for an object in the environment. There are different types of object memory that include: object displacement (object moving in an environment), object shift (object moving to a previously unoccupied space), object exchange (objects changing positions) and object substitution (when a new object appears in the environment). Many studies have demonstrated a female advantage in object memory, including the different types of object memory (Levy, Astur, Frick, 2005). This female advantage has been found through a multitude of different tasks such as: the object array task (Levy et al. 2005), Memory (™) (McBurney, Gaulin, Devineni, & Adams, 1997), and the Virtual Reality Spatial Object-Location Test (VRSOLT) (Spiers, Sakamoto, Elliott, & Baumann, 2008). Previous literature illustrates that women outperform men across all measures of object memory.

Eals, and Silverman (1994) utilized an object location task to investigate the female advantage in object memory with uncommon objects. Object location tasks generally use common household objects that most North Americans are familiar with. Researchers in this study wanted to test whether this advantage in object location was confounded due to the familiarity of the objects being utilized for such tests. To test this theory researchers gave participants an object location task that utilized both common and uncommon objects to see if there would be a difference in recognition and therefore overall advantage. Researchers found that even though there was no difference between recollection of the common and uncommon objects, females still outperformed males in object memory. The implications of this study suggest that whether an object is familiar or novel does not influence object location memory, females will have an advantage over males.

Similar findings were replicated by McBurney, Gaulin, Devineni, & Adams, (1997) who utilized the common game, Memory (™) to test this well-known female advantage in object location memory. Memory(™) is a game where players place cards face-down, and attempt to match two of the same card. Not only did this study replicate the female advantage found in previous research, but it also reported a more significant female advantage than previously reported. Along with testing for the female advantage in object memory, this study also utilized the mental rotation task and found a spatial memory advantage for males. However, this spatial memory advantage was a slightly smaller advantage than that found for the female advantage in object location memory. These findings are consistent with previous literature and have been replicated in many other studies.

Much research of object memory focuses on the immediate recollection of objects in the environment. Honda, and Nihei, (2009) conducted a study to test whether there were differences between short and long term object memory and whether a female advantage would be present for both. In this study participants were exposed to an object array and were asked to recall objects after three minutes, and again a week later. This study showed that there was only a female advantage in the three-minute recollection group, and that both males and females had similar recollection after one week. Researchers also looked into whether there was a difference in memory depending on whether objects changed locations or maintained their locations in the array. They found that there was more of a female advantage on the location exchange condition, but again, only after the 3-minute trial. This study implies that there is a strong female advantage in object location. However this advantage is limited to immediate detection of the present changes.

The real world applications of the female advantage were tested by Spiers, Sakamoto, Elliott, and Baumann (2008) while studying participants in a virtual reality grocery store. In this study, researchers wanted to test whether the female advantage would be present in real-world situations. They also utilized a two dimensional object location task along with a mental rotation task. The Virtual Reality Spatial Object-Location Test (VRSOLT) was utilized for this study to simulate a grocery store environment for participants. Researchers found the well-known male advantage in the mental rotation task, and also found a female advantage in both of the object memory tasks. This study reinforces the female advantage in object memory while also demonstrating the real-world applications of said advantage.

Levy, Astur, and Frick, (2005) attempted to find both the female object memory advantage and the male spatial memory advantage. Researchers gave participants an object array task to test object memory, along with an eight arm virtual radial arm maze to test spatial memory. The object array task had multiple measures such as object location, object shift, object exchange and novel object (object substitution). This distinction is important because it measures more than previous studies did, which exclusively examined object location. Researchers found the female object memory advantage across all measures of object memory. However the male advantage was not present in the spatial memory task. This finding is inconsistent with previous research that has found a male advantage in the radial arm maze in both rodent and human participants (LaBuda et al., 2002).

Brain Regions

Different regions of the brain are responsible for different types of memory. The hippocampus is important for both object memory and spatial memory. Some researchers refer to the hippocampus as a “cognitive map”, meaning that it’s responsible for navigating an environment. The hippocampus also plays an important role in object location and shift.

The radial arm maze has been used frequently to test rodents in spatial memory ability. When testing rodents in this type of maze, they are placed inside a physical maze and are left until they complete it. However, with human participants this type of test is normally conducted through virtual reality, on a computer. Astur et al. (2004) wanted to test whether neural activation of the hippocampus would be the same in a virtual reality setting as it is with a physical maze. Researchers tested their hypothesis by having participants complete a virtual eight arm radial arm maze while their neural activity was being monitored via fMRI. Researchers found that the activation in the hippocampus was consistent with brain activation of rodent subjects in a physical maze. There was also activation found in the frontal cortex, which illustrated working memory activation as well. This consistency is important when looking at the male spatial memory advantage and the neurological differences between men and women.

Hayes, Ryan, Schnyer, and Nadel, (2004) also utilized virtual reality. Researchers had participants take a virtual house tour of four different houses where they were asked to pay attention to highlighted objects and their locations. This study measured brain activation for object memory, spatial memory, and temporal-order information while using fMRI. Researchers found activation in the parahippocampal gyrus while retrieving spatial location information. They also found activation of the right dorsolateral prefrontal cortex during temporal-order and spatial location. This is consistent with previous research findings that also found activation in these areas of the brain in spatial and working memory. These consistent brain activations suggest that there is a neurobiological basis for spatial memory and temporal-order information. This suggests that the male spatial memory advantage is something specific to the neurobiological composition of the male brain.

Evolutionary Theories

There are a multitude of evolutionary hypotheses that attempt to explain sex differences in spatial ability. The three major hypotheses are: the dispersal hypothesis, the range size hypothesis, and the hunter-gatherer theory (Jones, Braithwaite, & Healy, 2003; Joseph, 2000). The range size hypothesis and hunter-gatherer hypothesis are both broad theories that encompass other hypotheses. Despite the controversy surrounding these theories, it is still important to include them when researching sex differences in object and spatial memory.

One of the evolutionary hypotheses that is significantly flawed is the dispersal hypothesis (Jones 2003). In this context, dispersal describes a single movement away from home. This hypothesis states that the sex that dispenses, or moves from home the most, will show a superior spatial ability (Jones 2003). When looking at non-human participants, there is a positive correlation between dispersal and performance on spatial memory tasks. The critical flaw in this theory is found when we try to generalize this theory to human participants. Although women disperse more than men, and should therefore have a higher spatial memory ability, men consistently outperform women is spatial memory ability. Although there is some data to support the dispersal hypothesis in non-human subjects, it has not been tested thoroughly enough to apply universally to humans.

The range size hypothesis is the most supported hypothesis in literature and is used as the foundation of many other evolutionary theories. The range size hypothesis suggests that sex differences in spatial memory were found in species where males had larger home ranges than females did. In species where males have larger home ranges, males will have better spatial memory than women due to their need to cover a larger area in order to father more offspring with multiple women for a higher chance of reproductive success. This hypothesis is most consistent with mammalian research. This hypothesis is closely related to the male foraging hypothesis, the male warfare hypothesis, and the female choice hypothesis because they all hypothesize range size.

The final evolutionary theory is the Hunter-Gatherer theory, which was tested by Silverman, Choi, and Peters (2007). The goal of this study was to assess the universality of male spatial memory abilities and female object memory abilities across multiple ethnic groups and countries. This study utilized 250, 000 participants across 40 countries, in an attempt to test how universal the sex difference advantages are. Researchers utilized the object location memory task along with the Peters adapted Three Dimensional Mental Rotation. Researchers found support for the universality of the male advantage in the Three Dimensional Mental Rotation task around the world. However, researchers did not find universal support for the female advantage in the object location memory task, it was only found in 35 out of 40 countries. It is unclear why the researchers did not find a universal female advantage in the object location memory task. It is possible that the measurement for object memory was limiting, as it only tested object location memory. An object array task with multiple object memory measures might have yielded more universal results.

Current Study

Previous research has had difficulties finding both the male spatial memory advantage and the female object memory within the same study. The current study will attempt to absolve the discrepancy found in previous studies. The purpose of this study is to attempt to replicate the female advantage in the object array task and the male advantage on a spatial memory task within the same study population. The two measures utilized for this study were the Object Array Task (Levy et al., 2005) and the Vandenberg Mental Rotation Task (Peters, 1995). This will be the first study to test the female spatial memory advantage with the object array task, while using the Vandenberg and Kuse to measure the male spatial memory advantage.

Methods

Participants

There were 33 participants recruited for this study via convenience sampling at a public, northeastern college. Participants ranged from 19 to 27 years of age (M= 20.39, S= 1.68). There were 7 males (25%) and 22 females (75%). Three participants identified as non-binary, who were all assigned female at birth, and there was one transgender female who was assigned male at birth, all of whom were excluded from analyses. We had hoped to recruit enough non-binary subjects for a third group in our analyses. However we were unable to do this during the limited recruitment time.

Materials

The materials utilized for this study were administered first through Qualtrics via a survey link, followed by in-person testing. The informed consent (Appendix A) and the personal information questionnaire (Appendix B) were administered to participants on Qualtrics. Participants then came to the lab and completed the object array task (Appendix C), and the mental rotation task (MRT) (Appendix D). The object array task was used to measure participant's ability to recognize object shift, replacement and exchange. The MRT was used to measure participant's ability to mentally rotate two-dimensional objects.

Procedure

After receiving informed consent (Appendix A), participants answered a personal information questionnaire (Appendix B) which requested their age, sex, whether they were an assigned male at birth or assigned female at birth, race and SAT/ACT. Participants were asked about their exercise routine, how long they exercised for, what type of exercise and if they were part of a sports/dance team. Additionally, participants were asked if they used nicotine products, how they get nicotine (e.g., cigarettes, vaping, e-cig, gum, etc.), how often they used nicotine, the last time they used it, and how long they have been a nicotine user. Female participants were then asked the date of their last menstrual period, if they were currently menstruating, if they have regular menstrual cycles or if they are pregnant. Females were also asked if they were taking exogenous hormones (e.g., hormone contraceptives/ birth control). They were asked to write the type and brand of exogenous hormones that they were taking. Female participants were given the option of not answering these questions. Most of the questions on the personal information questionnaire are not relevant to the present study and are not analyzed herein.

Subjects were tested one-on-one in the laboratory using pen and paper tasks. Male and female participants were given verbal and written instructions about how to perform each task. The first two parts of the object array task preceded the MRT. After completing the MRT, participants completed the last part of the object array task. The duration of the entire study was about 60 minutes.

Object Array Task

Participants were given an array of black and white line drawings of 31 recognizable objects printed on an 8 ½ x 11 piece of paper. Participants were asked to study the array for 1 minute. After 1 minute, the original array was removed and participants were handed a second array. This array contained all of the same objects as the original array, except seven pairs of objects exchanged positions on the page. Participants were given 1 minute to circle the moved objects. They were then presented with a third array where 14 objects moved to previously unoccupied positions in the original array. Participants were given 1 minute to circle any objects that moved positions in the third array. After participants completed the MRT, they were presented with a fourth object array and asked to circle any objects that were new to the array for 1 minute. The fourth array contained 17 original objects and 14 new objects. Performance on the object array task was measured as the number of objects correctly circled minus the number of object incorrectly circled. The maximum score for each array was 14, because 14 objects were changed in each array. See Appendix C.

Mental Rotation Test (MRT)

The mental rotation test utilized in the present study was a redrawn version of the Vandenberg & Kuse Mental Rotations Test, as previously described (Peters et al., 1995). Participants were provided with a 24 question MRT. Each question contained a target 3-dimensional black and white object on the left and 4 different 3-dimensional black and white objects on the right. Only 2 of the 4 objects on the right represent rotated versions of the target object. Participants were told that they had to mark an “X” over both of the rotated figures on the right in order to have a question marked correct. They were given 4 minutes to complete the first 12 questions, a 4 minute break, and then 4 minutes to complete the final 12 questions of the test. Participants received a score of “1” for each correct answer (correctly marking both rotated objects). The maximum score for the MRT is 24. Appendix D shows a sample MRT.

Results

Object Array

An independent samples t-test was performed to assess sex differences on each object array condition. There was no statistically significant difference between males and females in the object exchange condition exchange $t(27) = -0.82$, $p = 0.418$. There was also no statistically significant difference in the object shift condition $t(27) = 0.85$, $p = 0.418$. There was also no significant sex difference in the novel object condition, although it was approaching significance $t(27) = -1.75$, $p = 0.091$. See Figure 1.

Mental Rotations

Independent t-tests of MRT performance showed no significant differences between these groups, $t(27) = 1.36$, $p = 0.18$). See Figure 2.

Discussion

The purpose of this study was to test a female object memory advantage in the object array task, and to test a male mental rotation advantage in the mental rotation task. This is the first time these advantages were studied with the object array task and the mental rotation task within the same population. Based on the consistent findings for the object array task and the mental rotation task in previous studies, I hypothesized that the current study would find both advantages within the same subject population.

The results of this study were inconsistent with the results of previous studies. In contrast to previous literature, this study did not find a female advantage in the object array task, or a male advantage in the mental rotation task. Prior research that utilized the Vandenberg mental rotation task found a male advantage in spatial memory (Asture et al., 2004; Moffat et al., 1998). In this study, there was no significant male spatial memory advantage found using the MRT. Similarly, this study also did not find a significant female advantage in object memory while using the object array task. The current results are also inconsistent with previous studies that found a female object memory advantage (Levy et al., 2005; Eals et al., 1994). The object array task was specifically chosen for this study due to the strong female advantage that was previously reported using this task (Levy et al., 2005). Although Levy and others (2005) showed significant female object memory advantage, results did not show a significant male spatial memory advantage while using a virtual radial arm maze.

There could be many reasons for discrepancies between the present study and previous reports. The lack of male participants was a major limitation; there were nearly three times as many females than males. Such drastically uneven group sizes compromises the validity of the statistical tests. If the number of male and female participants were more even the statistical test of the hypothesis might have been more valid. If the groups were more even, this study might have yielded results which would be more consistent with previous literature.

Indeed, many studies which have found the male spatial memory advantage have done so with rodent subjects (LaBuda et al., 2002; Seymoure et al., 1996). The main difference between these studies and human studies is that rodent participants are tested in a tangible environment, like a maze, and human participants are tested via paper and pencil tasks or online. It would be difficult for researchers to construct a maze large enough for human participants. This methodological difference may be a reason why many rodent studies consistently find a male spatial memory advantage, and why human studies are more prone to inconsistencies.

Due to the lack of male participants, there was an imbalance in the groups; this could compromise the validity of the statistical tests. In addition, four participants were outliers and needed to be removed from the analysis. Three participants identified as non-binary and were assigned female at birth (AFAB), there was one transgender female participant who was assigned male at birth (AMAB). One of the non-binary individuals had the second highest score on the MRT, even though it's inconsistent for AFAB individuals to outperform AMAB individuals. Two of the non-binary participants had some of the lowest scores on two of the object array conditions, which is inconsistent with AFAB individuals. These inconsistencies led to the exclusions, which further compromised testing the effects of gender. This left researchers with more questions regarding the effects of gender on object memory and spatial ability tasks.

It may be beneficial if future researchers studied the interaction between sex and gender on these spatial and object memory tasks. Non-binary and transgender individuals need to be included in this research, it is unfortunate that the current study excluded them. The addition of more non-binary and transgender participants would allow researchers to analyze data and hopefully help expand the scope of sex difference research. Researchers will also be adding more male participants to this study in order to even out the gender imbalance. More male participants would hopefully give the statistical analyses more validity. Moving forward, future researchers will add to this study and hopefully include more non-binary and transgender participants. Due to the numerous limitations of the current study, these results are not conclusive. The Harburger lab will continue to recruit male subjects to elucidate whether or not there is a sex difference on object memory and mental rotation.

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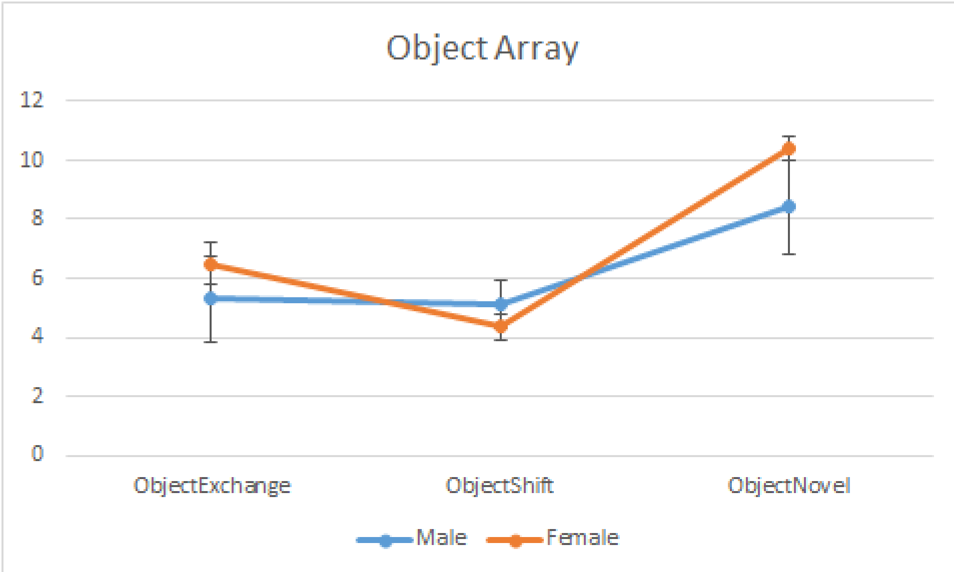


Figure 1.

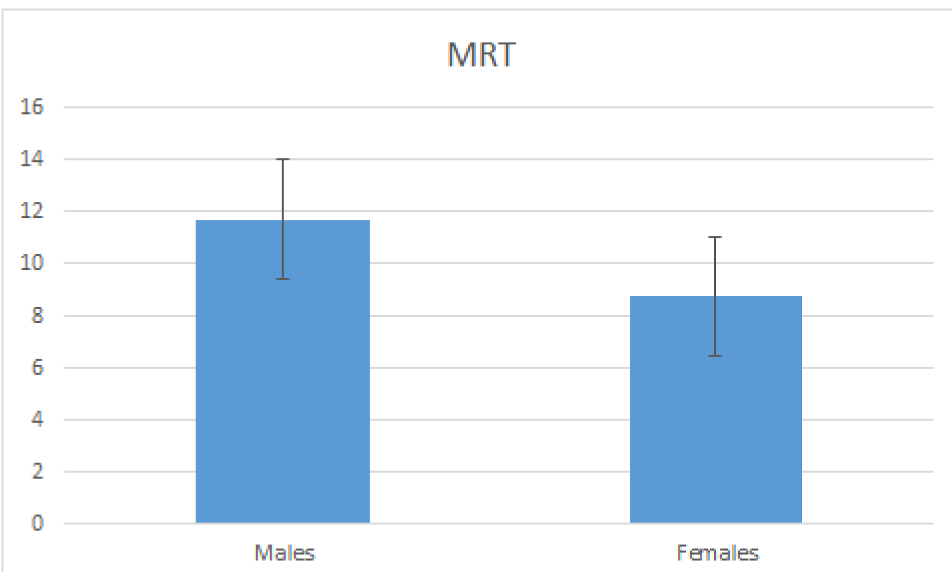


Figure 2.

Appendix A

Informed Consent

Informed Consent Form

Name of Study: The Effects of Exercise, Nicotine and Exogenous Hormone Use on Object Memory and Mental Rotation in Young Men and Women

Researchers: Principal Investigators: Kathleen Beach, Ethan Sua, Lily Otto, Nadia Shadi

Sponsor: Harburger

Contacts: Lauren.harburger@purchase.edu

Sponsor Email: Lauren.harburger@purchase.edu

Purpose: We would like permission to enroll you as a participant in a research study. This study investigates how multiple variables affect cognitive performance.

Procedure: In this experiment, you will be asked to complete a personal information questionnaire. The questionnaire will ask you personal questions ranging from drug and exercise habits to questions about your hormones. After the personal information questionnaire you will be asked to complete two cognitive performance tests. All information collected will be kept anonymous. The study should take approximately 60 minutes.

Costs, risks, and discomforts: This study has minimal risks. The personal information questionnaire may evoke some discomfort from reporting any personal information that one does not wish to share. This study is not mandatory and you can opt out at any time. Your identity will not be reported and will remain anonymous.

Benefits and compensation: The general benefit of participating in scientific research is the satisfaction that comes from contributing to science and the pursuit of knowledge. If applicable, participation in this research will allow college student participants to be compensated through class credit.

Confidentiality: The results of this study may be published in a scholarly book or journal or used for teaching purposes. However, your name and other identifiers will not be used in any publication or teaching materials. Your data will never be associated with your name or any other information that would make it possible to identify you.

Refusal or withdrawal of participation: You do not have to participate in this study. If you decide to participate, you can change your mind and drop out of the study at any time without affecting your present or future interactions with the experimenters and with no loss of credit for participation.

Signature: I confirm that the purpose of the research, the study procedures, the possible risks and discomforts, as well as potential benefits that I may experience have been explained to me. All my questions have been answered. I have read this consent form. My signature below indicates my willingness to participate in this study. I understand that I may contact the chair of the Institutional Review Board if I experience any problems during this experiment or have concerns about the ethics of this research [**irb.chair@purchase.edu**].

Type in your full name as your signature:

Appendix B

Personal Information Questionnaire

Q2
Personal Information Questionnaire

Age:

Q3
Sex:

- Male
- Female
- Non-Binary

Q4
Assigned sex at birth:

- Male
- Female

Page Break

Q5
Race (Choose all that apply):

- White/Caucasian
- African-American/Black
- Mexican-American
- Asian-American/Asian
- Puerto-Rican American
- Pacific-Islander
- Middle-Eastern
- American Indian
- Other Latino/Hispanic Origin
- Other

Page Break

Q6
Relevant Background Information

What were your scores on the SAT? (Type N/A if not applicable)

Reading and Writing

Q7
Math

Q8
What was your score on the ACT? (Type N/A if not applicable)

Page Break

Q9
How many times per week do you exercise? (If none, type 0):

Display This Question:

If

Q10
How many minutes do you spend doing each type of exercise per week?

	0	15	30	45	60	75	90	105	120	135	150	Not Applicable
Stretch Exercise (examples: yoga, a type of dance, zumba)												

Resistance Exercise (example: weight lifting)													
Cardiovascular Exercise (examples: running, swimming, biking)													

Q11

Are you currently part of a sports club, sports team or a dance program?

- Yes
- No

Page Break

Q12

Do you use (or have you used) any Nicotine products?

- Yes
- No

Display This Question:

If

Q13

What forms of nicotine delivery do/did you use? (Choose all that apply):

- Cigarette/Cigar Smoking
- Vaping

- E-Cig
- Hookah/Water Pipe
- Nicotine Gum
- Nicotine Patch
- Chewing Tobacco
- Other

Display This Question:

If

Q14

How long have you been a nicotine user? (Amount in years, months, weeks, or days):

Display This Question:

If

Q15

How many times a day do you use nicotine?

Display This Question:

If

Q16

How many times a week do you use nicotine?

Display This Question:

If

Q17

When was the last time you used nicotine? (Amount in minutes, hours, days, weeks, months, or years):

Page Break

Display This Question:

If

Q18

Females Only:

What was the date of your last menstrual period? (Type N/A if you prefer not to answer):

Display This Question:

If

Q19
Are you currently menstruating?

- Yes
- No
- Prefer not to answer

Display This Question:

If

Q20
Do you have regular menstrual cycles?

- Yes
- No
- Prefer not to answer

Display This Question:

If

Q21
Are you currently pregnant?

- Yes
- No
- Prefer not to answer

Page Break

Display This Question:

If

Q22
Are you currently taking any type of birth control that uses artificial hormones including birth control pills or patch, Norplant, Depo Provera, or others?

- Yes
- No
- Prefer not to answer

Display This Question:

If

Q23
If so, what type and brand?

Page Break

Display This Question:

If

Q24
Are you currently taking any type of estrogen and/or progesterone as prescription hormone therapy?

- Yes
- No
- Prefer not to answer

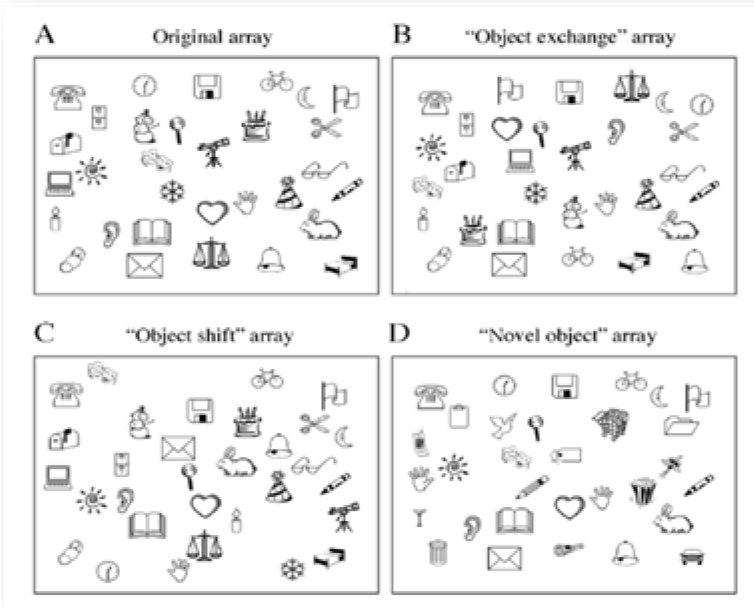
Display This Question:

If

Q25
If so, what type and brand?

Appendix C

Object Array Task



Appendix D

Mental Rotation Task