Effects of Nicotine Use on Cognitive Performance

by

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Abstract

Research on the relationship between nicotine and cognitive function have largely been studied to develop therapeutic treatments for dementia, Alzheimer's, and schizophrenia (Powledge, 2004). Previous literature supports that there are cognitive benefits from nicotine use (Dawkins et al., 2013; Domier et al., 2007; Ernst et al., 2001; Mendrek et al., 2006; Schlienz et al., 2013). The amount of research on nicotinic effects on object memory and spatial ability is scarce so the present study would benefit existing literature. Thus, to elucidate the effects of nicotine, the present study examined the effects of regular nicotine use on object memory and spatial ability. We hypothesized that regular nicotine users would perform better on spatial and object memory tasks than individuals who don't use nicotine. The Mental Rotations Test and the Object Array Task were used to study spatial abilities and object memory. We recruited 29 young adult volunteer participants from Purchase College (State University of New York) with a range of ages from 18-25 years old. Regular nicotine users performed better than did non-nicotine users on all object array conditions while regular nicotine users and non-nicotine users had similar scores on the mental rotations test. The results of the object array task highlight nicotine's ability to enhance cognition, memory in particular. The beneficial effects of nicotine on the object memory task may be mediated by the perirhinal cortex. Results of the mental rotations test are not consistent with previous research supporting that nicotine is a cognitive enhancer and suggest regular nicotine use may not affect spatial tasks, which may be mediated by the hippocampus.

Keywords: nicotine, cognitive performance, object memory, spatial ability

Effects of Nicotine on Cognitive Performance

Nicotine is a highly addictive stimulant drug found in leaves of the tobacco plant and is heavily used in the United States in the form of tobacco cigarettes (CDC, 2011). Cigarette smoking is one of the leading preventable causes for lung cancer, strokes, emphysema, heart disease, and other diseases. The smoking of cigarettes has caused more than 480,000 deaths per year in the United States (CDC, 2017). It is not only cigarettes that harm a human's biological systems but nicotine itself poses several health hazards as well. With new delivery systems of nicotine through products like the e-cigarette, "vape pens", patches, gum, and the Juul, Americans are getting the base nicotine instead of the more toxic tobacco; a much safer alternative but not without its drawbacks. Unlike tobacco, The International Agency for Research on Cancer (IARC) has not listed nicotine as a carcinogen, and yet there is research that shows nicotine being instrumental in causing cancer as it causes cell proliferation, oxidative stress, apoptosis, and DNA mutation which is all characteristic of mechanisms leading to cancer (Mishra et al., 2015). Nicotine also increases the risk of having cardiovascular, respiratory, and gastrointestinal disorders.

The harmful effects of nicotine on health have been well reported but there is less media coverage on the cognitive effects of nicotine. Studying the cognitive effects of nicotine would allow researchers to look into the problems of withdrawal and relapse issues since nicotine's highly addictive nature has strong reinforcing capabilities. Previous literature has suggested that there are cognitive benefits from nicotine use (Dawkins et al., 2013; Domier et al., 2007; Ernst et al., 2001; Mendrek et al., 2006; Schlienz et al., 2013). However, nicotine deprivation and abstinence have been shown to lead to a "cognitive dampening" effect showing deficits in selective attention, recognition and recall, and other working memory skills. (Ernst et al., 2001).

Research on the effects between nicotine and cognitive function have largely been studied to develop therapeutic treatments for dementia, Alzheimer's, and schizophrenia (Powledge, 2004). The amount of research on nicotinic effects on object memory and spatial ability is scarce so the present study would greatly benefit the existing literature. Thus, to elucidate the effects of nicotine, the present study examined the effects of regular nicotine use on object memory and spatial ability.

The Effects of Nicotine on Cognitive Abilities

There has been a widespread debate on whether nicotine use improves or impairs cognitive function in humans. A variety of research has presented evidence indicating that the use of nicotine improves cognitive performance while the deprivation of nicotine impairs it. Dawkins et al. (2013) informs us that the nicotinic effects on memory, specifically prospective memory (memory of a planned action), has not been well enough explored. Some studies have previously investigated the effects of smoking cigarettes on prospective memory, but their study was the first to investigate the effect of nicotine from an electronic cigarette and its impact on prospective memory. Dawkins et al. (2013) hypothesized that nicotine from an e-cigarette would improve prospective memory. They had two groups that were either in a nicotine-administered condition or a placebo condition and independently completed time-based and event-based prospective memory tests. The results of the study demonstrated that the nicotine condition group had performed better than the placebo condition in time-based prospective memory. These results suggest that nicotine improves strategic performance but not automatic processing. The importance of Dawkins et al. (2013) is to underline the presence of research that nicotine improves cognitive performance.

Domier et al. (2007) adds to the growing body of research on the cognitive effects of nicotine. Their study explored the effects smoking has on one's concentration and selective attention. Similar to Dawkins et al. (2013), their study shows that nicotine use improves cognitive functions. It was hypothesized that smokers who were abstinent from smoking would lead to increased errors in selective attention and that termination of smoking cessation (smoking a cigarette after abstinence) would enhance selective attention. They also hypothesized that there would be no changes in selective attention for non-smokers. The experiment involved a two-block Stroop test for smokers and non-smokers. Smokers either took the Stroop test after an overnight abstinence from smoking or only a brief (one hour) abstinence. Smokers from both abstinence groups smoked a cigarette in between the two test blocks, and non-smokers did not smoke any cigarettes. The non-smokers had no change in selective attention in between test blocks. Smokers from the overnight abstinence experienced deleterious effects in cognition for the first test block of the Stroop test. Smokers performed significantly well after the brief (1-h) abstinence. Both abstinence groups performed well on test block two after the cigarette break. The results of their study supported their hypothesis that smoking deprivation causes a cognitive-dampening effect. The results also illustrate the cognitive benefits of nicotine use.

Several previous studies have investigated nicotine's effect on simple cognitive tasks. The study by Ernst et al. (2001) explored which cerebral mechanisms were at work during nicotine use while working on a cognitive task. They used neural brain imaging (a PET scan) to measure cognitive brain activation during a working memory task. They used 11 abstinent smokers and 11 ex-smokers where a nicotine gum condition group and a placebo gum condition group had an even mix of abstinent and ex-smokers. There were no significant differences between the two groups for the short-term memory task. Despite the lack of significant results,

the study reported that in the placebo gum group there was predominant activation in the left hemisphere of the ex-smokers and predominant activation in the right hemisphere of the abstinent smokers. These findings support the claim that nicotine improves memory performance but only in casual or non-habitual smokers. Their study's results suggest that the chronic use of nicotine builds tolerance and has the same cognitive-dampening effect that smoking deprivation has.

The study by Hasenfratz & Bättig (1993) is one of the earlier studies that tested the effects of nicotine on cognitive performance. This study tested to see if cigarette-abstinent participants would perform rapid information processing tasks slower than pre-session smoking participants. Twenty female regular smokers either abstained from smoking the day before the rapid information processing task or smoked right before the session began. This study reported no positive significant cognitive effects on the rapid information processing task from the pre-session smoking participants. The study's results are one of the few studies that are inconsistent with previous literature on nicotine's positive impact on cognitive performance. The limited subjects pool and different tasks used to study cognition might be responsible for the inconsistent data, but these results might also suggest that this phenomenon is more complex.

In 2006, Mendrek et al. investigated the effects of nicotine on cognitive performance in a short-term memory task. This study recruited 15 smokers and 22 non-smokers who were all administered working memory tasks. Each participant had to complete two test blocks over two days where (similar to Domier et al.'s study) the smokers had to stay abstinent for 13 hours for the first test block and abstinent for an hour for the second block test; non-smokers never smoked at all for both blocks. The results were consistent with previous studies such that the 13-hour abstinence scores were poorer on the working memory task compared to the one-hour abstinent

scores. The results of Mendrek et al. (2006) are relevant to the present study because it shows that nicotine use improves cognitive performance while withdrawal symptoms from smoking deprivation have a diminishing effect on cognitive performance. The results of the study are similar to Domier et al.'s (2007) research that showed a cognitive-dampening effect from smoking cessation.

The study by Schlienz et al. (2013) builds on the growing literature that suggests that nicotine is a cognitive-enhancing drug that can have adverse cognitive effects when abstaining from use or experiencing withdrawal symptoms. This study investigated whether overnight smoking abstinence would disrupt one's performance during a cognitive task called a flanker task. A flanker task tests to see if a participant's reaction time to stimuli is affected by "flanked," interrupting, or irrelevant stimuli. A performance monitoring system was also utilized, and performance-based monetary rewards were incentivized to see if the monitoring system would highlight a performance effect on smokers. Twenty-five smokers were recruited for the experiment and they were either placed in a group of non-abstinence or a group of overnight abstinence. Only half of the participants experienced the performance-based monetary rewards. The results reported that the abstinent smoker's performance was weaker than the non-abstinent smokers. The participants who were abstinent smokers and experienced the performance-based rewards did, however, have an increased score compared to the abstinent smokers who had no rewards. There was no significant difference in performance between the "rewards" and "no rewards" participants of the non-abstinent smoker group. The results of Schlienz et al. (2013) are important and relevant to the present study because it supports the idea that nicotine is a cognitive-enhancing drug. More research into a cognitive perspective on smoking and abstinence may help with successful smoking cessation.

Underlying Brain Regions Involved in Object and Spatial Memory Tasks

As was mentioned earlier, there has been a scarcity in research examining the effects of nicotine on object memory and spatial ability. In order to understand how nicotine might affect object memory and spatial ability there needs to be a discussion on the brain regions that process and facilitate these cognitive actions. Winters & Bussey (2005) explained that object memory is impaired in humans with amnesia as well as animal models of amnesia. They reported that subjects with permanent brain damage reveal the importance of the perirhinal cortex in object memory. Winters & Bussey (2005) examined rats and their encoding, retrieval, and consolidation in object memory; these distinct stages require glutamate receptor activity within the perirhinal cortex. These distinct stages of object memory were disrupted by a transient blockade of AMPA receptor-mediated synaptic transmissions. This research demonstrated the importance of the perirhinal cortex for object memory.

Kinnavane et al. (2016) also examined the interaction between the perirhinal cortex (PRh) and object memory. They explain that the (PRh) focuses on object-based memory information for the hippocampus (HPC). Their idea for investigating this theory involved comparing hippocampal c-Fos expression in rats with or without perirhinal lesions. These rats either discriminated novel from familiar objects or explored pairs of novel objects. The perirhinal lesions showed a preservation of behavioral sensitivity to novelty but impairment in the ability to discriminate novel from familiar objects.

Levin et al. (2005) reported that females perform better on object memory while males perform better on spatial cognition tasks. This study attributed the PRh for object memory and the HPC for spatial ability. They examined both behavioral and neural sex differences in sex-

specific spatial abilities. In the first experiment, male and female participants completed computerized mental rotations and spatial working memory tasks. In the second part of the experiment, participants completed slightly modified versions of the same tasks while brain activity was observed using fMRI. In both experiments, males outperformed females on the mental rotations task. There was no behavioral sex difference observed on the spatial working memory task. Males showed more activation in left parahippocampal gyrus, right medial frontal gyrus, inferior parietal lobe, and inferior frontal gyrus in the task. Females showed activation in the left parahippocampal gyrus only. The study's results suggest that the HPC may be responsible for mediating spatial abilities.

Melichercik et al. (2012) also designated the perirhinal cortex as being involved in object memory and the hippocampus as the potential center for spatial working memory. The study reports that nicotine systemically facilitates both object and spatial memory. They compared the roles of perirhinal and hippocampal nicotinic acetylcholine receptors (nAChRs) in object and spatial recognition memory. They examined this using spontaneous object recognition and object-location tasks for rats. The results showed that rats who acquired nicotine had successful facilitations of object and spatial memory compared to rats with a 72-hour delay of nicotine. The infusions of nicotine into the perirhinal cortex facilitated object memory and the infusions of nicotine into the hippocampus facilitated spatial-object memory. The study interestingly found that infusions of nicotine into the hippocampus facilitated both object and spatial-object memory, and nicotinic infusions into the perirhinal cortex also facilitated both object and spatial-object memory. This demonstrates that these effects are a result of nAChRs in either the perirhinal cortex or the hippocampus. However, the lack of nAChRs do not show object memory facilitations in the PRh and spatial-object memory facilitations in the HPC. In conclusion, there

is a stronger interactive relationship between the HPC and PRh in object memory than previously suggested.

The Present Study

For the present study we used two cognitive tasks to measure nicotinic effects on cognitive performance. We used the object array task and the mental rotations test. There are three advantages for using these two cognitive tasks. First, there is no supporting research concerning nicotine and cognitive performance that utilize the object array task. Second, there is no supporting research concerning nicotine and cognitive performance that utilize the mental rotations test. Finally, the current study would add a diverse layer of research to the scarce amount of studies on nicotine and their influence on object memory and spatial ability.

The Object Array Task was first introduced in Levy et al. (2005) to examine sex differences in object memory. The Object Array Task gives participants one minute to study an image (A) of assorted objects to memorize. They are then given one minute each for 3 images (B, C, D) to complete 3 tasks. Participants are instructed to circle objects that had been (B) exchanged from the original, (C) shifted from the original, and (D) added to the array.

The other task we used to test cognitive performance was the Mental Rotations Test (MRT) which is a spatial ability test that was first introduced in Shepard & Metzler (1971). Its validity and reliability were tested by Vandenberg & Kuse (1978) who found it to have successful test re-test reliability. The task gives participants a 2-D image of a 3-D shape (the criterion or target figure) and then four alternatives. Two of the alternatives are correct rotations of the criterion and the other two are either mirrored images of the criterion or rotated images of another criterion.

We want to emphasize that the implications of this study are not an advertisement for people to take up smoking and use or abuse nicotine but to show the effects of nicotine as it is. It has shown to be an effective cognitive enhancer where further research would benefit schizophrenia, dementia, and Alzheimer's therapy. We hypothesized that regular smokers or individuals that regularly use nicotine through other delivery systems, will perform better on spatial and object memory tasks than individuals who don't smoke or use nicotine.

Method

Participants

We recruited 29 young adult volunteer participants from Purchase College (State University of New York) through undergraduate psychology in-class announcements and emails. As compensation, participants in the experiment received extra credit points towards their final grade in their psychology class. Participants ranged from ages 18-25 (*M = 20*). Informed consent from the participants was obtained before administering the study in a laboratory. The majority of participants were female (*n = 21*), and the ethnicity was predominantly Caucasian.

Questionnaire

After receiving informed consent (APPENDIX A), participants answered a personal information questionnaire (APPENDIX B) requesting their age, sex, their assigned gender at birth, birth control use, menstrual cycle information, exercise routines, smoking habits, etc. To maximize participant recruitment, the questionnaire included variables from other researchers' studies, but the current study only focused on nicotinic variables. Participants were asked if they smoke or use nicotine, how they get nicotine (cigarettes, vaping, e-cig, gum, etc.), how often they use nicotine, the last time they used it, and how long they have been a nicotine user. The

questionnaire was completed by participants through a Qualtrics link before coming to the laboratory to complete the two cognitive tasks.

Tasks

The two cognitive tasks used in the present study were the Mental Rotations Test (MRT) and the Object Array Task. The typical duration of an entire experiment was approximately 30 minutes.

Object Array Task

The Object Array Task is a task that measures object memory and was first used in Levy et al. (2005). 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. The second array contained all of the same objects as the original array, except seven pairs of objects had exchanged positions on the page (object exchange). 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 (object shift). 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 were asked to circle any objects that are new to the array for 1 minute (object novel). 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 objects incorrectly circled. The maximum score for each array is 14, because 14 objects will be changed in each array (APPENDIX C).

Mental Rotations Test (MRT)

The mental rotations test that was used in the present study was a redrawn version of the Vandenberg & Kuse (1978) Mental Rotations Test. 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 have to mark an "X" over both of the rotated figures on the right in order to have a question marked correct. They had 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 then received a score of "1" for each correct answer (correctly marking both rotated objects). The maximum score for the MRT is 24 (APPENDIX D).

Results

Independent samples t-tests were conducted to compare performance on the tasks (Object Array Task and MRT) between regular nicotine users and non-nicotine users. Nicotine users performed better than non-nicotine users on all object array tasks (*see figure 1*). In the object exchange condition of the object array task there was a significant difference in the scores for the nicotine users ($M = 8.0$, $SD = 3.77$) and non-nicotine users ($M = 5.33$, $SD = 3.77$); $t(27) = 2.39$, $p = 0.024$. In the object shift condition of the object array task there was a significant difference in the scores for the nicotine users ($M = 5.64$, $SD = 2.06$) and non-nicotine users ($M = 4.11$, $SD = 1.71$); $t(27) = 2.15$, $p = 0.040$. An independent samples t-test showed that there was no significant difference in the object novel condition of the object array task. Although there wasn't a significant difference in the object novel condition, there was a noticeable trend in the

scores where nicotine users performed better (M = 10.82, SD = 1.72) in comparison to the non-nicotine users (M = 9.11, SD = 3.20); t (27) = 1.62, p = 0.116. Nicotine users and non-nicotine users had similar test scores on the mental rotations test (*see figure 2*). An independent samples t-test showed there was no significant difference between the scores of the nicotine users (M = 10.09, SD = 6.04) and non-nicotine users (M = 10.06, SD = 4.65); t (27) = 0.018, p = 0.986.

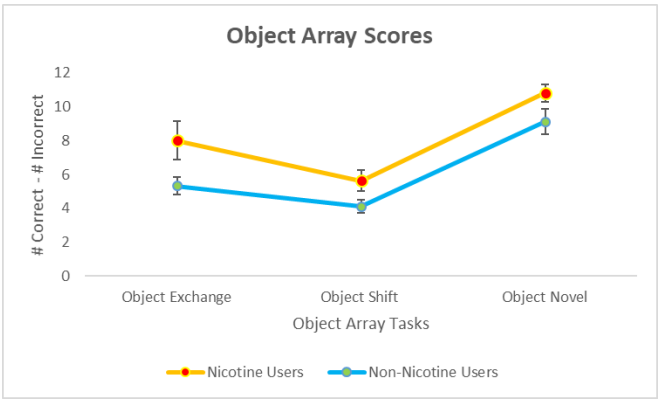

Figure 1. Performance in the Object Array Task. Nicotine users performed better than participants who do not use nicotine in all object array tasks. Each symbol represents the mean (± *SEM*) number of objects correctly circled minus the number of objects incorrectly circled.

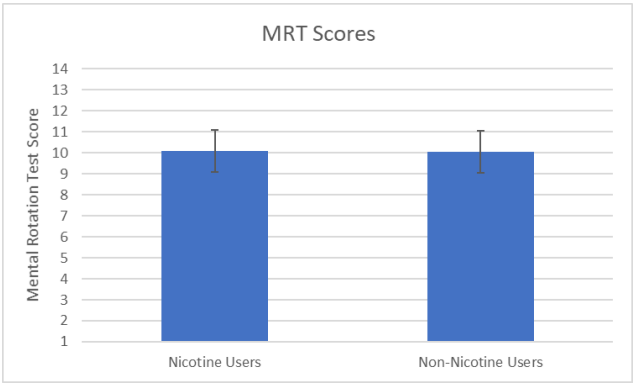

Figure 2. Performance on the Mental Rotations Test. Nicotine users and non-nicotine users had similar scores on the mental rotations test. Each bar represents the mean (± *SEM*) for each group.

Discussion

The present study examined the effects of regular nicotine use on object memory and spatial ability. As was stated earlier, we had hypothesized that regular nicotine users would perform better on spatial ability and object memory tasks than individuals who don't use nicotine. The results of the object array task showed that nicotine users performed better than those who do not use nicotine on all object array tasks. These findings are consistent with previous research that suggested nicotine is a cognitive enhancer (Dawkins et al., 2013). Dawkins et al. (2013) reported that nicotine improved prospective memory on prospective memory tasks. These findings are consistent with the present results demonstrating enhanced memory performance in nicotine users.

In contrast with these studies, Hasenfratz & Bättig (1993) failed to show significant improvements in cognition from nicotine use on rapid information processing tasks. Nevertheless, the present study also showed no significant effect of nicotine use on a spatial ability task. We had originally hypothesized that participants who had abstained from nicotine for a set of time would have impaired memory based on previous studies reporting cognitive dampening from nicotine abstinence in chronic users (Schlienz et al., 2013). However, in the present study chronic nicotine users who had abstained from nicotine for at least a day or more, still performed well on cognitive tasks. This is inconsistent with the Schlienz et al. (2013) study that reported deleterious effects after abstaining from nicotine. Perhaps the tasks used in the present study were not sensitive to this effect.

The results of the mental rotations test are not consistent with previous research supporting that nicotine is a cognitive enhancer (Dawkins et al., 2013; Domier et al., 2007; Ernst

et al., 2001; Mendrek et al., 2006; Schlienz et al., 2013). The MRT scores between nicotine users and non-nicotine users were similar in the present study. These findings are also inconsistent with the Melichercik et al. (2012) study that reported nicotinic infusions to the hippocampus of mice facilitated spatial ability. It is possible that we did not see a significant difference in performance on the MRT from nicotine use because both groups scored well on this task. Perhaps a more difficult spatial task would demonstrate beneficial effects of nicotine in users. Nevertheless, the results of the present study suggest that nicotine may not affect hippocampal tasks but is beneficial to performance on object memory tasks that may utilize the perirhinal cortex.

The beneficial effects of nicotine on the object memory task may be mediated by the perirhinal cortex. Indeed, the results of this study are consistent with Melichercik et al. (2012) that reported nicotinic infusions to the perirhinal cortex of mice led to successful facilitations of object memory. Previous studies using the object array task have suggested that this task may utilize the perirhinal cortex (Levy et al., 2005) and therefore, future research should further investigate the beneficial effects of nicotine use on the perirhinal cortex and perirhinal cortical tasks in humans.

A possible limitation for the present study could be that some participants had not smoked or used nicotine for some time before completing the cognitive tasks while others had used nicotine recently before the experiment. In the future, we would like to control for this possible confound. We understand that there might be a confound for having the MRT act as a statistical data distractor for the Object Array Task. We cannot control for this confound as we are more interested in the performance between regular nicotine users and non-nicotine users rather than how an individual performs between the tasks. It would also be interesting to look at

the statistical interaction that sex and nicotine has on cognitive performance. The current study had a large number of females compared to males so the idea of examining the interaction was not plausible.

This is the first study to report enhanced object memory performance in nicotine users. Future studies should focus on obtaining a larger sample size in order for data to be truly representative of the population. Further research should also focus on an even distribution of gender as the majority of our participants were female, and it has been well-documented that females generally perform better than males on object memory array tasks. Controlling for how recently a participant had used nicotine would certainly allow researchers to see the effects smoking abstinence has on an individual's cognitive performance.

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Appendix A

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

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 How many times per week do you exercise? (If none, type 0): Text Response Is Greater Than 0

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

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

Q14
How long have you been a nicotine user? (Amount in years, months, weeks, or days):

Display This Question:
If Do you use (or have you used) any Nicotine products? Yes Is Selected

Q15
How many times a day do you use nicotine?

Display This Question:
If Do you use (or have you used) any Nicotine products? Yes Is Selected

Q16
How many times a week do you use nicotine?

Display This Question:
If Do you use (or have you used) any Nicotine products? Yes Is Selected

Q17
When was the last time you used nicotine? (Amount in minutes, hours, days, weeks, months, or years):

Page Break

Display This Question:
If Assigned sex at birth: Female Is Selected

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 Assigned sex at birth: Female Is Selected

Q19
Are you currently menstruating?

- Yes
- No
- Prefer not to answer

Display This Question:
If Assigned sex at birth: Female Is Selected

Q20
Do you have regular menstrual cycles?

- Yes
- No
- Prefer not to answer

Display This Question:
If Assigned sex at birth: Female Is Selected

Q21

Are you currently pregnant?

- Yes
- No
- Prefer not to answer

Page Break

Display This Question:
If Assigned sex at birth: Female Is Selected

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 Are you currently taking any type of birth control that uses artificial hormones including birth...Yes Is Selected

Q23
If so, what type and brand?

Page Break

Display This Question:
If Assigned sex at birth: Female Is Selected

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

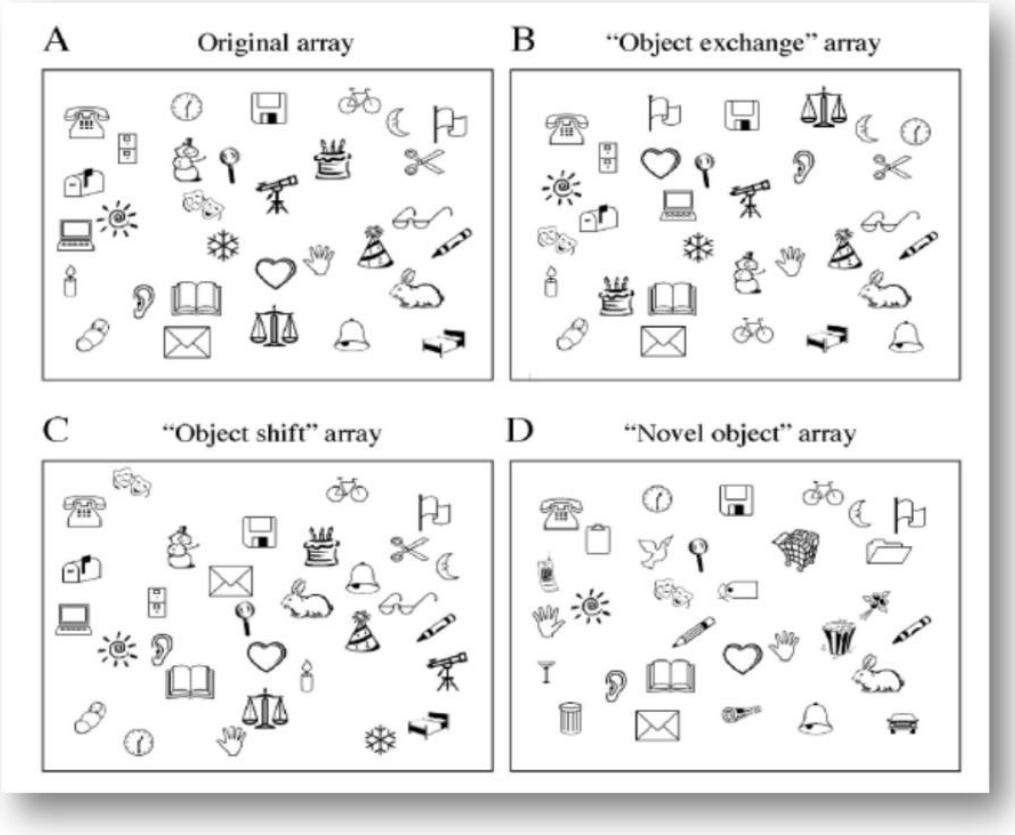
- Yes
- No
- Prefer not to answer

Display This Question:
If Are you currently taking any type of estrogen and/or progesterone as prescription hormone therapy? Yes Is Selected

Q25
If so, what type and brand?

Page Break

Appendix C


A
Original array
B
"Object exchange" array
C
"Object shift" array
D
"Novel object" array

Appendix D