INTERACTIONS OF BINGE-DRINKING BEHAVIOR IN COLLEGE STUDENTS AND EXECUTIVE FUNCTION

An Undergraduate Research Scholars Thesis

by

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Submitted to the Undergraduate Research Scholars program at
Texas A&M University
in partial fulfillment of the requirements for the designation as an

UNDERGRADUATE RESEARCH SCHOLAR

Approved by Research Advisor: Dr. Joseph Orr

May 2018

Major: Psychology

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ABSTRACT

Interactions of Binge-Drinking Behavior in College Students and Executive Function

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The goal of this study is to examine the connection between executive functions and binge drinking in college students. I believe that students who binge drink have decreased executive functions, which controls most behaviors, notably self-control. Finding and demonstrating the link between executive function and binge drinking could lead to a greater understanding of why people binge drink and the steps to identify people with a greater risk of becoming binge drinkers. All participants completed the Student Alcohol Questionnaire (SAQ) and a battery of tasks including Number Letter, Local Global Shape, Letter Memory, Keep Track, Stroop, and Anti-Saccade. I expect to find that students who score high on the Student Alcohol Questionnaire will perform worse in tasks made to single out the executive functions than those who score low on the SAQ. After statistical analysis, I found that the only predictors of binge drinking are age and frequency of other substance abuse.

ACKNOWLEDGEMENTS

I would like to thank my research advisor, Dr. Orr, for his guidance and support over the past two semesters. I would also like to thank Mike and Jesus for their help throughout the research along with my fellow RAs for their help coding data.

NOMENCLATURE

EF	Executive Function
NIAAA	National Institute of Alcohol Abuse and Alcoholism
SAQ	Student Alcohol Questionnaire

CHAPTER I

INTRODUCTION

In a typical month, forty percent of college students ages 18-22 have engaged in binge drinking behavior at least once. Binge drinking is defined by the National Institute on Alcohol Abuse and Alcoholism (2015) by women having at least four drinks or men having at least five drinks over a span of two hours. This is equal to a blood alcohol concentration level of 0.08 g/dL (National Institute of Alcohol Abuse and Alcoholism [NIAAA], 2015). When determining a college student's binge drinking behavior, past studies have found that looking at the previous six months' drinking behavior is the "optimal period to link alcohol consumption and alcohol-related problems…[because it] captures the vacation time of the academic calendar during which students would be more apt to binge drink" (Courtney & Polich, 2009).

Many factors can predict binge drinking. Courtney & Polich (2009) found that being single, having a 3.0 GPA or less, and an early onset of drinking were all characteristics that could predict binge drinking later in life. The NIAAA found in a national survey that 60% of college students drink alcohol. The survey also showed that out of the 60% of students, two out of three were classified as binge drinkers. Binge drinking also leads to many negative outcomes. On average, 1,825 college students a year die from injuries related to alcohol, especially car crashes (NIAAA, 2015). Wechsler and colleagues found that binge drinkers were more likely to drive drunk. They also found that binge drinkers are ten times more likely to have unprotected sex, damage property, become injured, and violate the law (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994). Courtney and Polich (2009) also found that binge drinking is associated with alcohol poisoning, suicide, hypertension, and sexually transmitted diseases.

In this study, I am looking at the relationship between binge drinking in college students and Executive Functions (EF). EF is believed to be the controlling process of most goal-directed behaviors, and underlie self-control. Accordingly, decreased EF ability is associated with many behavioral problems such as a decreased ability to focus, risk-taking, and substance abuse. But measuring EF can be difficult. There are a number of reasons for this, but the biggest one is the task-impurity problem. Most EF tasks have some function attributable to a process other than EF (Miyake & Freidman, 2012). For example, in the Stroop task participants are shown names of a color but the color of the words are either congruent or incongruent. For example, for incongruent trials the word "red" may appear in blue ink while in congruent trials the word "red" would appear in red ink. Participants are then asked to identify the color of the word. The ability to name the ink color when it is different from the word spelled out is attributable to EF, but there are also other processes happening such as color processing and articulation speed. Miyake and Friedman found that using a few tasks that have the same latent variable this helped solve the task impurity-problem. By having multiple tasks that target the same EF, one can choose what is common among the tasks. Miyake and Friedman looked at three EFs; updating, shifting, and inhibition. Updating is primarily working memory, shifting is the ability to change between tasks easily, and inhibition is the ability to stop dominant responses and choose to do something else. They found four conclusions about how these components of EF relate to each other. (Miyake & Freidman, 2012)

The first is the unity and diversity model, which I am using in this study. They found that all three EF sub scores correlate with each other, showing the unity between the three, while there are still unique factors to each EF, showing the diversity (Miyake & Freidman, 2012). What the three EFs have in common are grouped into the Common EF (unity) while the

differences are separated out into updating-specific factors and shifting-specific factors (diversity). The common EF can be described as the ability for one to keep goals and information related to the goal and then use this information to carry out the task at hand. Miyake and Friedman also found that when grouping the factors of each EF, inhibition factor "happens to correlate virtually perfectly with common EF, leaving no inhibition-specific variance" (Miyake & Freidman, 2012).

The third is that measures of EF can predict important clinical and societal behaviors, especially the common EF. These include ADHD, risk taking, conduct disorder, and substance abuse. The individual differences in EF have been linked to these, and other related social issues. This can lead to the ability to test people to predict their susceptibility to many issues and allow them to adapt to the behaviors. (Miyake & Freidman, 2012)

The fourth conclusion is that individual differences between EF are stable throughout life. Miyake and Friedman found this by tracking the twins from their twin study for a longitudinal analysis. They tested the twins at ages 14, 20, 24, and 36 months, when they separated them into two groups based on EF ability, a better self restraint group and a worse self restraint group. When the participants were tested again at age 17, they found that while EF ability increased, the groups remained the same. (Miyake & Freidman, 2012) In an earlier paper, Friedman and colleagues (2008) also found a high heritability, but warned that it is easy to believe that one has no control over their EF and that the EF abilities are "all 'nature' and no 'nurture'… however, contrary to common misconceptions, high heritability does not mean that environmental factors cannot and do not affect executive functions" (Friedman et al., 2008). Williams and colleagues (1999) used the stop-signal procedure to measure inhibition with 275 participants with ages ranging from six to eighty one. They found that the ability to inhibit

prepotent responses improved as the participants' age increased, but began to diminish slighting for those in adulthood. This is consistent with Friedman's conclusions that inhibition ability develops as children develop.

Previous studies have found that when measuring cognitive functions in binge drinkers, there are deficits in frontal inhibitory control (Courtney & Polich, 2009). In Courtney and Polich's study, they found that chronic binge drinkers performed worse on the Iowa Gambling Task, which measures working memory. Binge drinkers showed impairments in the Paced Auditory Serial Addition Test, executive planning tasks, and episodic memory tasks (Courtney & Polich, 2009). In the Paced Auditory Serial Addition Test, participants remember a series of numbers read to them, which utilizes the updating EF. The episodic memory tasks and executive planning tasks also utilize the updating EF. Many recent studies point to the theory that people who engage in binge drinking behavior perform worse in EF tasks compared to people who do not because they lack the ability to stop drinking or the inhibitory component of EF. Working memory deals with the updating component of EF. If a high risk for binge drinking and other negative behaviors can be identified through testing executive functions, this could indicate when preventative measures should be taken and lead to more targeted treatment of these behaviors. (Courtney & Polich, 2009; Miyake & Friedman, 2012)

Scaife and Duka (2009) used the Alcohol Use Questionnaire (Mehrabian & Russell, 1978) to separate their participants into a binge drinker group and non-binge drinker group and had them complete the Paired Associates Learning task (updating), Spatial Working Memory task (updating), Intra/Extradimensional Shift task (shifting), and the Reaction Time task (inhibition). All of these looked at the various EF components. They found that in the Spatial Working Memory task, binge drinkers made more errors compared to non-binge drinkers. They

also found that this discrepancy between the two groups was only present in the female drinkers. They believe that this is because while female drinkers have fewer drinks, they may become drunk more frequently which exposes them to more of the neurotoxic effects. The NIAAA accounts for this in their definition of binge drinking by varying the amount of drinks by gender. This same difference between female binge drinkers and female non-binge drinkers was also found in the Intra/Extradimensional Shift task. In the Paired Associates Learning task, both male and female binge drinkers made more errors than non-binge drinkers. Scaife and Duka found that binge drinkers were faster on the Reaction Time task, which is attributed to motor impulsivity in binge drinkers. (Scaife & Duka, 2009).

Harley and colleagues found in a similar study that in EF tasks, binge drinkers had a significantly lower planning time. They also used the Alcohol Use Questionnaire (Mehrabian & Russell, 1978) to separate their participants into non-drinkers and binge drinkers. They used the Spatial Working Memory task and Stockings of Cambridge task, a planning ability task, to test EF. Harley and colleagues confirmed their hypothesis that binge drinking "result[ed] in poorer cognitive performance… however the possibility that impaired attention and executive function contribut[ed] to the pattern of binge drinking [could not] be excluded" (Harley, Elsabaugh, & File, 2004). Salas-Gomez and colleagues (2016) used the NIAAA's criteria for binge drinking to separate participants into binge drinkers and non-binge drinkers. They found that on the Trial Making Test B, which measured attention and mental flexibility, participants in the binge-drinking category were significantly slower than non-binge drinkers. Their results show that binge drinking has a significant impact on EF, especially cognitive flexibility. (Salas-Gomez et al., 2016)

In a longitudinal study, Bo and colleagues (2017) looked at how EF can predict binge-drinking patterns. 121 participants reported their alcohol use through the Alcohol Use Disorder Identification Test (Saunders et al., 1993) and Alcohol Use Questionnaire (Mehrabian & Russell, 1978) and tested them on working memory, reversal, response inhibition, set shifting, response monitoring, and decision-making. After 18 months, participants were assessed again with the same tasks and questionnaires. They found that decision-making was significantly related to the future severity of the participant's binge drinking, showing that those who made riskier decisions during the task were more likely to have more severe binge-drinking habits 18 months later. (Bo et al. 2017).

Many studies show the connection between binge drinking and poor EF ability. Black and Mullan (2015), on the other hand, took students who drank heavily and had them complete EF training in order to decrease heavy binge drinking. Each participant completed the Tower of London task, which assessed planning ability, four times over a week. In the experimental group, the tasks became progressively more difficult while the control group only completed a fixed, easy version of the task each time. Alcohol use in the experimental group decreased by the end of the study while the control group stayed the same. This result supports the use of EF training for binge drinkers. (Black & Mullan, 2015)

In my study, I am using Miyake and Friedman's unity and diversity model to assess EF ability between binge drinkers and non-binge drinkers. Because of the similarities between shifting, updating, and inhibition, I will use multiple tasks for each component to focus on the target ability. (Miyake & Freidman, 2012) There are a number of tasks that test for the three components and I chose two tasks for each component in order to focus on the latent variables. For inhibition I will use Stroop and Anti-Saccade, for switching I will use Local Global Shape

and Number Letter, and for updating I will use Letter Memory and Keep Track. I expect to find that participants in the binge-drinking group will perform worse on the EF tasks than those in the non-binge drinking group.

CHAPTER II

METHODS

Participants

Participants in this study were undergraduate students ($N = 219$) in the Psychology Subject Pool at Texas A&M University. In the second half of the study, prescreening was used to only allow binge drinkers to enroll. Twenty-nine participants qualified as a binge drinker according to the NIAAA's recommended alcohol questions and completed the study. Twenty-four participants were excluded from the study due to insufficient data, leaving 195 participants. The participants had a mean age of 19 years ($SD = 1.1$) and 133 were female.

Measures and Design

This study was designed as a between subjects study. Each participant completed a Demographics Questionnaire, The Student Alcohol Questionnaire (SAQ) (Engs, 1975), and a battery of tasks from Experiment Factory (Sochat et al., 2016). The Demographics Questionnaire and SAQ acted as the independent variable, and the battery of tasks as the dependent variable. These tasks include Number Letter, Local Global Shape, Letter Memory, Keep Track, Anti-Saccade, and Stroop. The Demographics Questionnaire and SAQ were given through Qualtrics and participants completed all aspects of the experiment on computers in our lab. Participant's data was then split into two groups, non-drinker and non-binge drinkers. The non-binge drinker group was the control group. This was done based on the SAQ data. If participants scored a zero to three on the SAQ were sorted as non-binge drinkers, meaning they may drink some amount of alcohol, but they do not binge drink. Participants who scored four to six were identified as binge

drinkers, meaning they have four to five drinks or more over two hours. The participants were also sorted based on age, gender, GPA, and use of other drugs.

Materials and Procedure

All study procedures were approved by the Texas A&M University Institutional Review Board. When participants entered the lab they were put in individual rooms where they read and signed consent forms. They then completed the Demographics Questionnaire and SAQ on the computer in their room. Once the participant completed the two questionnaires, they then started the battery of tasks, which were shown in a randomized order. After they completed all three sections of the study, they received their debriefing form and credit slip.

Number Letter

Participants were shown a number and letter combination in one of the four quadrants of the screen. If the pair was shown in the top two quadrants, participants identified if the number was odd or even by pressing "Z" for odd and "M" for even. If the pair was shown in the bottom two quadrants, participants identified if the letter was a consonant or vowel by pressing "Z" for consonant and "M" for vowel (Engs, 1975). Figure 1 shows four trials from the Number Letter task. This task is used for the switching component of EF.

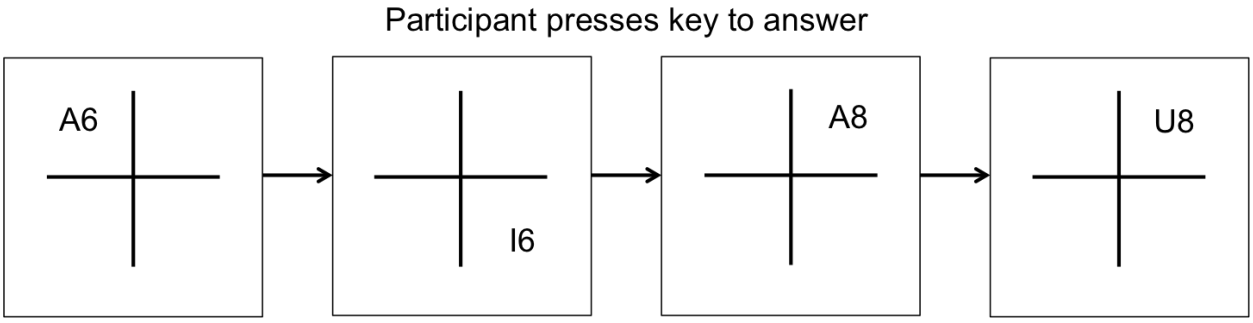

Figure 1. Example of the Number Letter Task. Participants have unlimited time to answer.

Local Global Shape

Participants were shown large blue or black shapes made of smaller shapes. Both the small and large shapes were either a circle, X, triangle, or square. If the shape was black, participants identified the large shape and if the shape was blue, participants identified the smaller shape. This was done by pressing 1 for a circle, 2 for an X, 3 for a triangle, and 4 for a square (Engs, 1975). Figure 2 shows an example of four trials from the Local Global Shape task. This task is used for the switching component of EF.

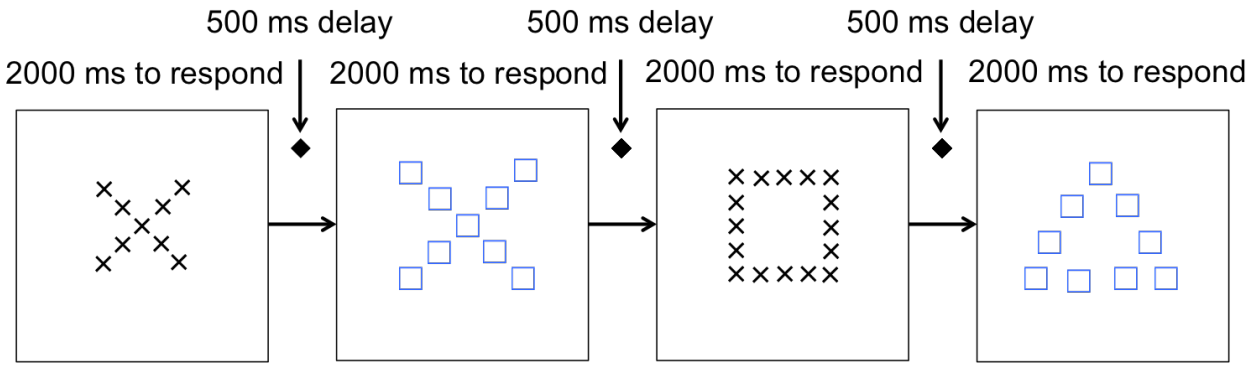

Figure 2. Example of the Local Global Shape Task. Participants press key to respond.

Letter Memory

Participants were shown a series of letters one at a time. The overall number of letters was varied during each block. Participants were then asked to report the last four letters shown (Engs, 1975). Figure 3 shows four of the letters that may be shown in one trial in the Letter

Memory Task. This task is used for the updating component of EF.

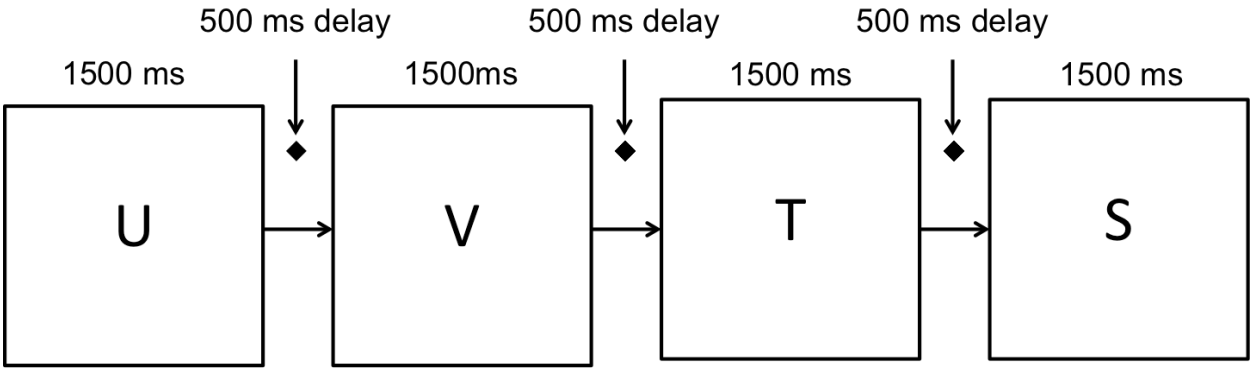

Figure 3. Example of the Letter Memory Task. Participants remember the last four letters shown.

Keep Track

Participants were shown a series of words one at a time. Each word was an animal, color, country, distance, metal, or relative. Three categories were randomly chosen at the end of each block and participants were asked the last word shown from each category (Engs, 1975). Figure 4 shows four of the words that could be shown in a trial of the Keep Track task. This task is used for the updating component of EF.

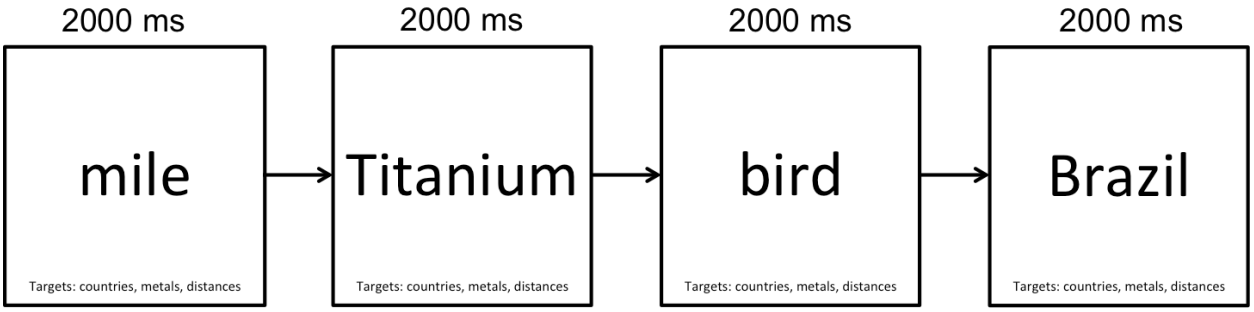

Figure 4. Example of the Keep Track Task. Participants remember the last word for each category.

Anti-Saccade

For each trial, a cross was shown in the center of the screen, which was immediately followed by a black square on either the right or left side of the screen. Participants were then shown an arrow on the opposite side of the black square pointing left, right, or up which was quickly covered by a gray square. Participants were then asked to identify which way the arrow was pointing using the arrow keys (Engs, 1975). Figure 5 shows one trial from the Anti-Saccade task. This task is used for the inhibition component of EF.

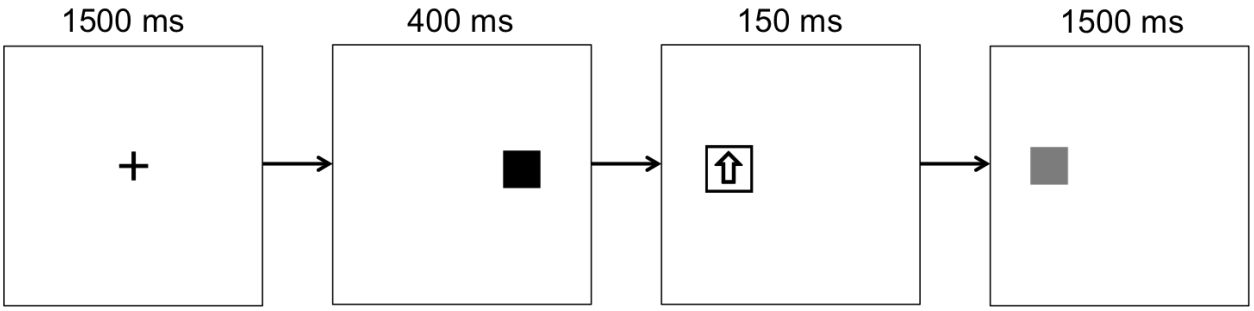

Figure 5. Example of the Anti-Saccade Task. Participants answer when last box is shown.

Stroop

Participants were shown the words red, blue, or green. The ink color of each word was also colored red, blue, or green. Participants were asked to identify the ink color of each word by pressing R for red, B for blue, or G for green. When the ink and word do not match, the trial is considered incongruent and when the ink and word do match, the trial is congruent (Engs, 1975). Figure 6 shows one incongruent trial from the Stroop task. This task is used for the inhibition component of EF.

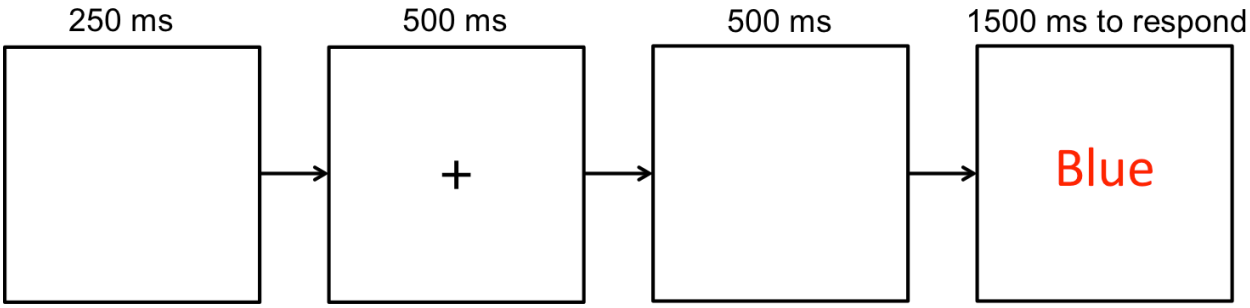

Figure 6. Example of the Stroop Task. Participants respond when word is shown

CHAPTER III

RESULTS

In this study, there was a significant difference between binge drinkers and non-binge drinkers in age, substance abuse, and how important religion was to them. The average age for binge drinkers (M = 19.46, SD = 1.36) was significantly higher than non-binge drinkers (M = 18.89, SD = .74), $t(111.73) = -3.45$, $p = .001$. In the demographics questionnaire, participants were asked to rate their average use of tobacco, opiates/painkillers, stimulants, marijuana, and other drugs from zero to four (zero being never and four being daily). The score of each drug group was then summed to get a substance abuse score. The amount of substance abuse for binge drinkers (M = 1.91, SD = 1.92) was significantly higher than non-binge drinkers (M = .57, SD = 1.34), $t(131.17) = -5.39$, $p = .001$. There was no significance between binge drinkers and non-binge drinkers for gender and GPA, $p > .05$, as shown in Table 1.

Table 1. Statistics for Age, Gender, GPA, and Substance Abuse.

		Binge Drinker	Non-Binge Drinker
Age	M	19.46	18.89
	SD	1.36	0.74
	t-test	**t (111.73) = -3.45, p = .001**	
Gender	Male	40%	25.2%
	Female	60%	73.9%
	Gender Nonconforming	0.0%	0.9%
	Chi-Square	**X^2 (2, N = 195) = 5.33, p = .07**	
GPA	M	3.32	3.3
	SD	.46	0.6
	t-test	**t (164) = .272, p = .786**	
Substance Abuse	M	1.91	0.57
	SD	1.92	1.34
	t-test	**t (131.17) = -5.39, p = .001**	

When asked to rate how important religion is to them on a scale from one to four (one being not important and four being very important) binge drinkers ($M = 2.81$, $SD = 1.07$) had a significantly lower score than non-binge drinkers ($M = 3.24$, $SD = 1.06$), $t(193) = 2.79$, $p = .006$. There was no significant difference between binge drinkers and non-binge drinkers' race or religion, $p > .05$, as shown in Table 2.

Table 2. Statistics for Race, Religion, and Religious Importance.

		Binge Drinker	Non-Binge Drinker
Race	White/Caucasian	90.0%	86.1%
	Black or African American	3.8%	6.1%
	Asian (e.g., Far East, Southeast Asia, or the Indian Subcontinent	3.8%	7.0%
	American Indian/Alaska Native (including peoples of North and South America, including Central America)	1.3%	0.0%
	Hispanic or Latino	1.3%	0.9%
	Chi-Square	**X^2 (2, N = 195) = 2.93, p = .57**	
Religion	Roman Catholic	32.1%	21.9%
	Protestant	41.0%	47.4%
	Jewish	0.0%	0.9%
	Muslim	0.0%	1.8%
	Mormon	0.0%	0.9%
	Hindu	1.3%	0.9%
	Atheist	2.6%	3.5%
	Agnostic	12.8%	7.0%
	Nondenominational Christian	10.3%	14.9%
	Naturalist	0.0%	0.9%
	Chi-Square	**X^2 (9, N = 192) = 8.29, p = .51**	
Religious Importance	M	2.81	3.24
	SD	1.07	1.06
	t-test	**t (193) = 2.79, p = .006**	

After finding a significant difference in substance abuse frequency between binge drinkers and non-binge drinkers, I split the substance abuse category further into tobacco,

opiates/painkillers, stimulants, marijuana, and other drugs. I found that the only significant difference for the individual drug categories was in marijuana, $t(113) = -5.901$, $p = .001$. Binge drinkers ($M = .88$, $SD = 1.023$) had a higher average frequency of marijuana use than non-binge drinkers ($M = .13$, $SD = .57$). As shown in Table 3, the other drug categories were insignificant, $p > .05$.

Table 3. Individual Drug Statistics.

		Binge Drinker	Non-Binge Drinker
Tobacco	M	.36	.19
	SD	.698	1.083
	t-test	***t* (193) = -1.245, *p* = .215**	
Opiates/Painkillers	M	.36	.24
	SD	.601	.488
	t-test	***t* (193) = -1.522, *p* = .130**	
Stimulants	M	.16	.05
	SD	.462	.346
	t-test	***t* (193) = -1.904, *p* = .058**	
Marijuana	M	.88	.13
	SD	1.023	.570
	t-test	***t* (113) = -5.901, *p* = .001**	
Other Drugs	M	.15	.04
	SD	.530	.384
	t-test	***t* (135) = -1.539, *p* = .126**	

After looking at the average accuracy score for Number Letter and Local Global Shape, I discovered that it was much lower than other tasks, to which I attributed to a technical error in the task program. Due to this, I chose not to include Number Letter and Local Global Shape in the analysis. I found no significant difference in Keep Track accuracy, Letter Memory accuracy,

Stroop Effect, or Anti-Saccade accuracy between binge drinkers and non-binge drinkers, $p > .05$, as shown in Table 4.

Table 4. T-test Data.

	t-test
Keep Track Accuracy	t (181) = -.333, p = .74
Letter Memory Accuracy	t (182) = -.307, p = .759
Stroop Effect	t (181) = .701, p = .484
Anti-Saccade Accuracy	t (170) = -1.85, p = .066

Table 5. Multiple Regression Data.

Variable	mean	std	Multiple Regression Weights	
			b	β
Gender	1.34	.487	-.020	-.020
Age	19.21	1.109	.111	.246*
GPA	3.332	.518	.024	.025
Substance Abuse	1.19	1.75	.113	.395*
Updating	.0133	.824	-.028	-.047
Inhibition	-.0388	.727	-.060	-.088

* p < .05

A multiple linear regression was calculated to predict binge-drinking behavior based on gender, age, GPA, substance abuse, Updating EF, and Inhibition EF. The z-scores of Letter Memory accuracy and Keep Track accuracy were averaged to form the Updating EF and the z-scores of Stroop Effect and Anti-Saccade accuracy were averaged to form the Inhibition EF. A significant regression equation was found ($F(6,148) = 6.472$, $p < .000$, with an R^2 of .208. Age

significantly predicted binge drinking behavior when GPA, substance abuse, Updating EF and Inhibition EF are controlled for, (ß = .246, $p < .001$). Substance abuse was also significantly predicted binge drinking behavior when GPA, age, Updating EF and Inhibition EF are controlled for, (ß = .395, $p < .001$). As shown in Table 5, gender, GPA, Updating EF, and Inhibition EF were not significant predictors of binge drinking behavior, $p > .05$.

CHAPTER IV

CONCLUSION

The purpose of this study was to examine the connection between EF and binge drinking behavior. I expected to find that those who scored low on the SAQ (non-binge drinkers) would perform better on the EF tasks than those who scored high on the SAQ (binge drinkers). The t-test showed that the only significant differences between binge drinkers and non-binge drinkers was age, substance abuse, and religious importance. These results were not out of the ordinary. The average age increased between non-binge drinkers and binge drinkers, although both were still under 21, the age when drinking alcohol is legal. The frequency of substance abuse (tobacco, opiates/painkillers, stimulants, marijuana, and other drugs) was greater for binge drinkers than non-binge drinkers. The NIAAA has found that people who use recreational drugs are more likely to drink alcohol (National Institute of Alcohol Abuse and Alcoholism, 2008). The level of personal religious importance was also higher for binge drinkers than non-binge drinkers. Kathol and Sgoutas-Emch (2017) found in a study of the relationship between religion and drinking that participants who believed their religion to be more restrictive drank less alcohol and placed more importance in their religious self. The multiple regression also showed that age and substance abuse were predictors of binge drinking behavior, even when the other factors were controlled for.

I did not find any significant relationship between the Updating EF and Inhibition EF during this study. As stated previously, I chose to not include the Shifting EF due to the extremely low accuracy of the trials, which point towards a technical issue with the task. I believe that a number of factors could have caused this insignificance, the main one being a lack

of motivation. In a study that compared the performance of participants in a credit only group and a group that received money in exchange for participation, they found that participants receiving money had higher motivation and performed better than those given credit. When those in the money group were asked if they were motivated, 50% said yes while only 33% of those in the credit group said yes (Bowen & Kensinger, 2017). Our participants were given class credit or extra credit for their participation. They have an option to write article reports instead of participating in studies, but generally students prefer to participate in studies. I did find that our participant motivation was very low, with some participants clicking through the tasks without trying.

Over the course of the study, 115 participants were identified as non-binge drinkers and 80 were binge drinkers. The second semester of the study I only allowed binge drinkers to participate, but only 30 participants completed the study during that semester. It was difficult to find binge drinkers for the study. Another factor that could have contributed to the lack of significant results is that most of the subject pool is in the Introduction to Psychology course, which is made of mostly freshman students. Out of our participants, 73.8% were freshman. I assumed that most freshman are underage, so they either do not drink or are afraid to admit to drinking due to a fear that they will get in trouble for underage drinking. It is likely that there are binge drinkers in the non-binge drinker group, which could contribute to the EF data being insignificant. This could possibly be another reason that the difference in frequency of substance abuse is significant between non-binge drinkers and binge drinkers. When splitting the substance abuse frequency into the individual drugs, I found a significant difference in the frequency of marijuana use. In a national survey, the Substance Abuse Center for Behavioral Health Statistics and Quality (2016) found that in 2015 more than 11 million people ages 18 to 25 were using

marijuana. I believe that perhaps participants who are willing to admit to underage drinking are also more likely to admit to using illegal drugs.

Studying EF is important because it leads to studies such as Black and Mullan's (2015) study on EF training. They found that after just a week of EF training, binge-drinking behavior decreased in participants. This can also be applied to the other consequences of low EF ability such as attention problems, self-control problems, risk taking, and drug abuse. The Center on Developing Child at Harvard University (2014) has published a guide for activities and games that help develop EF in children. It includes things such as hiding games, imitation games, and sorting games for young children. For adolescence, the guide lists a number of self-regulation tasks they can use throughout the day such as planning, self-talk, and study skills. Tamm, Nakonezny, and Huges (2012) found in a trial with ADHD children that training parents to complete EF training targeted at improving attention and self-regulation with their children was successful in improving visual/auditory attention, working memory, and cognitive flexibility. They believe that this could lead to a more generalizable treatment because the parents would be working with their own children. Understanding how EF works and the problems a poor EF ability can cause along with the ways to improve it could potentially help a range of people dealing with problems academically and socially.

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