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# Relationship Between Alcohol Consumption and Frontal Lobe Functioning Among College Students[1]

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About 25% of college students report experiencing academic consequences due to the consumption of alcohol. Outside of the effect drinking has on one's academics it is essential to consider what such behaviors contribute to adolescent neurological functioning. The frontal lobe is responsible for emotions, motor functioning, problem solving, and memory. Through the Ruff Figural Fluency Test (RFFT), researchers have been able to reliably measure nonverbal fluency within the frontal lobe. If student drinking is related to frontal lobe functioning, then this should be revealed by RFFT scores. Indeed, a negative correlation between drinking and RFFT performance was observed. These results suggest that alcohol may negatively affect essential frontal lobe functioning among college students.

## Introduction

A pattern of high-risk drinking among United States college students continues to be a concerning factor affecting our youth's development and success. According to a recent survey administered by the National Institute on Alcohol Abuse and Alcoholism, 25% of college students report experiencing some consequence academically due to the consumption of alcohol (Engs, Presley, & Wechsler, 2010). It is typical to assume that alcohol abuse directly affects students' performance and capabilities within their academic environment. However, a more important issue is the direct effect of alcohol on adolescent brains and neurological functioning.

Adolescence is a critical period for the development of the human brain (Brown, Tapert, Granholm, & Delis, 2000). During this period of development, the brains effectiveness is increased due to myelination and synaptic pruning (Brown et al., 2000). These processes allow for further development of the hippocampus and prefrontal cortex in the adolescent brain, which are responsible for problem solving, judgment, and self-control (Zeigler et al., 2005). In one study, Acheson, Stein, and Swartzwelder (1998) assessed the effects of ethanol on the performance of semantic and figural memory. They used repeated measures in a placebo-controlled experimental design and found that participants who fell within the age range of the majority of college students appear to be at risk for significant alcohol induced memory impairment (Acheson et al., 1998). They further concluded that alcohol consumption could create further sensitivity to impairment within the collegiate academic setting (Acheson et al., 1998). Researchers like Acheson and his colleagues (1998) have demonstrated the drastic effects of substance usage on the brain. However, little research has been done regarding the localization of the minimal effects alcohol may have on college students and their academic performance.

Throughout adolescence and even into the early twenties, young adults' emotional circuits are typically inconsistent and sporadic ("Adolescent Brain Development," 2002). The frontal lobe, which is still developing and reconstructing itself during these ages, is responsible for emotional control ("Adolescent Brain Development," 2002). In addition to one's emotions, the frontal lobe also contributes to human motor function, problem solving, memory (short term memory and retrieval of long term explicit memories), judgment, and self-control ("Adolescent Brain Development," 2002). All of these brain functions are critical for the lifestyle of a student. If there is enough alcoholic intake, severe cognitive impairments within the frontal lobe will appear (White, 2004). White (2004) stated that when adolescents are intoxicated, the flow of blood through the brain to the frontal lobe increases while metabolism decreases. These metabolic changes in turn disrupt activity occurring throughout the brain by causing a loss of cortical neurons and an increase in density of N-methyl D-aspartate (NMDA) glutamate

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receptors. Due to the fact that with alcohol intoxication college students are able to detoxify quickly (within hours), any existing damage from such toxins are commonly overlooked, especially within a collegiate environment (Littrell, 1991).

It is difficult to explain a majority of brain processes because such functions are not observable by the human eye. One researcher cannot sit down and observe synaptic pruning or the density of NMDA glutamate receptors throughout the brain. However, in more recent years, improvements in medical technology have provided researchers with the ability to use imaging studies to observe select brain functions. Neuropsychological investigations using this advanced technique further demonstrated what prior researchers had hypothesized. There was clear evidence of the negative effects of alcohol within the frontal lobe shown through cerebral blood flow observed through the use of a regionally specific computer derived analysis (Gansler, Harris, Oscar-Berman, Streeter, & Lewis, 2000). This allowed researchers to measure alcohol use, abstinence, and neuropsychological functioning calculated by single photon emission computed tomography (SPECT) (Gansler et. al., 2000). Advances in the medical field used by researchers like Gansler and his colleagues gave way for research and criticism within this area.

Although technology provides researchers with essential information in regards to internal brain functioning, other tools and tests are needed in order to understand how extraneous variables, such as alcohol, affect human behavior. The Ruff Figural Fluency Test (RFFT), created by psychologist Ronald M. Ruff (1996), provides researchers with a reliable and valid method by which one can measure nonverbal fluency. The RFFT consists of five parts in which a different stimulus pattern is presented for each part (Ruff, 1996). Participants must draw as many unique designs as possible, connecting at least two dots out of the five-dot matrix (they have one minute to complete each part) (Ruff, 1996). The RFFT was specifically created with the intention of developing a measure of non-verbal fluency based upon a psychometric method (Ruff, Light, &Evans, 1987). Fluency has been defined as the ability to develop one or more strategies that maximize response production and minimize response repetition (Ruff, Allen, Farrow, Niemann, & Wylie, 1994). Participant's performance on the RFFT has proven to be specifically demonstrative of frontal lobe dysfunction (Ruff et. al., 1994). In one study, a group of 18 to 29 year old men (N=45) were tested using the RFFT and quantitative electroencephalography in order to observe deficits within the participant's frontal lobe of the brain (Foster, Williamson, & Harrison, 2005). The findings of this study provided objective neurophysiological justification for the RFFT as a measure of frontal lobe functioning (Foster et. al., 2005).

The aim of this study was to investigate the minor effects of alcohol on collegiate student's brain functions within the academic setting, specifically focusing on deficits within the frontal lobe. Although studies have been done with imaging technology, chronic alcoholics, and disorders such as Korsakoff's syndrome, it appears not much has been directed towards alcohol's influence within the United States collegiate population. Students from the late teens to early twenties are more susceptible to damage because of the development occurring within the frontal lobe at that critical period. Thus, the expected problem solving techniques, memory processes, and essential judgment and self-control of college students may be compromised as a result of the consumption of alcohol. Concerns such as driving under the influence and other self-destructive behaviors that are likely to occur with intoxication are known, but what is not commonly addressed are the residual effects that are not immediately evident with sobriety. Taking into consideration the developmental sensitivity of frontal lobe functions and the negative impact that alcohol consumption can have on this part of the brain, the hypothesis of this study is that as the reported number of alcohol beverages consumed by students increases, the frontal lobe processes will decrease, becoming increasingly evident as seen through scores on the RFFT.

## Methods

### Participants

There were 81 Robert Morris University college students who participated (23 of the students categorized themselves as non-drinkers, 28 as moderate drinkers, and 30 as frequent

drinkers. The 81 subjects were self-selected from various psychology classes convening at the Robert Morris University, Moon Township campus. Subjects were all volunteers willing to participate without compensation. The ages ranged from 18 to 24 years with education levels from 13 to 15 years. Subjects were assigned to three groups based upon level of alcohol consumption, non-drinkers (n=23), moderate drinkers (n=28), and regular drinkers (n=30). All data were gathered during the fall semester, 2010.

**Materials**

A basic questionnaire was constructed and completed by each student participating in the study in order to confirm their estimated amount of alcohol consumed weekly. Also included in the questionnaire were the student's overall GPA and any past history of traumatic brain injury or concussions (anything that could ultimately impact their score on the RFFT).

The RFFT was used to provide clinical information regarding nonverbal capacity for fluid and conflicting thinking and ability to shift cognitive process. It consists of five individual parts (60 seconds each), each consisting of a different stimulus pattern. Participants were instructed to draw as many unique designs as possible by connecting at least two of the five dots presented as each stimulus. Nonverbal fluency is then determined by the total number of unique designs produced within the one minute time frame. The participants were scored based upon the number of unique designs produced for each of the five stimulus patterns. The more unique designs provided (based upon an a calculated average from the whole group of participants) the higher classified ranking of frontal lobe functioning.

**Procedures**

Prior to the study, all participants were given an explanation of the purpose of the study. They were informed that it was a study regarding brain deficits related to alcohol consumption. A group of approximately thirty participants (at one time) were gathered in an on campus classroom setting in order to complete the study. Before beginning the RFFT, participants were instructed to fill out the same questionnaire consisting of questions regarding their drinking habits, academic GPA, and past brain injuries or diseases (the entire study was completed anonymously). Following the questionnaire, the students were presented with the RFFT booklet and instructed to complete five nonverbal tasks. Each task was completed individually, each with a different stimulus (a 5 dot matrix). For each stimulus, they were asked to create as many unique designs including at least two of the five dots in sixty seconds. The same instructions were used in each of the five tasks until they were all completed. The entire study for each participant took no longer than ten minutes.

**Results**

The total number of unique designs generated by the non-drinkers group (N = 23) ranged from 98 to 114 (M = 108, SD = 4.74), which as a group placed them at about the forty-eighth percentile (T = 49.65) compared to the normative sample.

The total number of unique designs generated by the moderate drinkers group (N = 28) ranged from 94 to 112 (M = 103, SD = 4.94), placing them at about the thirty-fifth percentile (T = 36.3) compared with the normative sample.

The total number of unique designs generated by the frequent drinkers group (N = 30) ranged from 84 to 113 (M = 96.5, SD = 8.17), placing them at about the thirtieth percentile (T = 44.9) compared with the normative sample.

A between-groups analysis of variance (ANOVA) indicated a difference in number designs between non-, moderate, and frequent drinkers, $F(2,78) = 21.62$, $p < .01$.

The correlation found between drinks consumed weekly and scores on the RFFT was significant also, $r(79) = -0.697$, $p < .01$.

**Discussion**

As hypothesized, when the number of alcohol beverages consumed by students increased, the frontal lobe processes were evident through a decrease in scoring on the RFFT. This study also identified specifically the area likely to be

impacted by level of intake. The detection and neurophysiological validation of the RFFT to reliably measure frontal lobe functioning supports the claim of impairments within that area of the brain correlated with the consumption of alcohol.

However, several problems exist that limit the usefulness of the findings. For instance, there was no randomization. The selection of participants could affect the data and findings collected. With randomization, these results could be viewed with a higher reliability rating. Also, it would benefit the study to have a second assessment completed by participants in order to compare the results between measures. For example, if the IOWA or WAIS-R were administered in addition to the RFFT and correlated against each other, as well as the amount of alcohol consumed, it would better support the findings in regards to frontal lobe deficiencies.

Although more research is needed, the findings do provide support for the contention that alcohol consumption contributes to impairment within the frontal lobe of the adolescent brain. Hopefully, the present study will stimulate further investigation into the validation of cognitive impairment in relationship to drinking among college students.

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