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Effects of Caffeine Consumption on Cognitive Performance in Anatomy and Physiology Students

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EFFECTS OF CAFFEINE CONSUMPTION ON COGNITIVE PERFORMANCE IN ANATOMY AND PHYSIOLOGY STUDENTS

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A thesis submitted to the faculty of The University of Mississippi in partial fulfillment of the requirements of the Sally McDonnell Barksdale Honors College.

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ABSTRACT

Caffeine has often been associated with college students and their study habits; however, little research has been done to explore if it is actually beneficial to the students' cognitive performance and academic success. While current studies have explored various aspects of caffeine's influence on specific areas of cognition relevant to their own studies, there is a lack of research on how it influences academic settings. Within the present study, it is believed that caffeine usage will not cause a significant improvement in individual academic performance despite of the known physiological and cognitive effects on the students. The study consisted of two phases. Phase one sought to survey students in a Human Anatomy and Physiology course in order to create a demographic profile of students' caffeine consumption habits. Phase two consisted of a food diary, used for students to record both food and beverage over a 24-hour period to calculate caffeine usage, and a quiz based off profiles of University of Mississippi alumni in order to assess cognitive abilities and academic performance. There was a significant relationship between total caffeine intake over the 24-hour period, the peak amount of caffeine consumed in a single hour, and the number of hours between the peak consumption event and when the quiz was taken, and quiz score. Linear regression Regression analysis showed that 30% of variation in quiz score is affected by peak amount of caffeine consumed in a single hour and the number of hours between the peak consumption event and when the quiz was taken. Results from viewing the students’ perception of caffeine in relation to schoolwork and cognition lean more toward the attitude that caffeine consumption is in fact not beneficial to overall academic and cognitive enhancement. While students reported mixed ideas on whether or not they believe caffeine to be beneficial based off the phase one survey, conclusions from phase 2 results cannot draw a direct link between caffeine consumption and positive increase in cognitive abilities or academic performance.

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DEDICATION

To my Papaw, who taught me to do everything with the best of my ability, no matter how big or small, and whose overwhelming love, unwavering support, and eternal encouragement has shaped me into the person I am today and hopefully, someone he would be proud to call his ugliest and most beautiful, his only, granddaughter.

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INTRODUCTION

Caffeine, found naturally in many foods and beverages as well as a major additive to foods and beverages, is one of the most universally ingested psychoactive stimulants in the world (Brunyé *et al,* 2010). It is often consumed for a variety of reasons and in a multitude of forms, however, the correlation between caffeine and its effects on cognition, more specifically in the collegiate academic setting, has been little explored. This relationship is assumed to be beneficial within general society in terms of improved memory and other cognitive processes in academic settings, specifically in the collegiate setting, however, empirical rather than anecdotal data are few.

Overall Consumption

Caffeine intake in the worldwide population is dictated by factors such as financial income, level of physical activity, overall health of the individual, age, gender, education, etc., although it is noted that caffeine is typically consumed for maintaining or improving overall health and physical performance (Bessada *et al.*, 2018). In the United States, mean per capita caffeine intake was roughly 3 mg/kg of body weight, or approximately 180-210 mg for a 60-70 kg or 132 – 154 lb. individual (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). However, if the individual consumed caffeine on a regular basis, it was found that their mean daily intake was closer to 4 mg/kg of body weight and the 90th percentile would consume on average 5-7 mg/kg of body weight (Institute of Medicine

(US) Committee on Military Nutrition Research, 2001). Bessada *et al.* (2018) found that coffee was the most frequently ingested caffeine source and is the main source of caffeine consumption for many countries across the world ranging from 0.86 kg/year in Indonesia to 12.12 kg/year in Finland per capita.

In the United States, the daily intake of caffeine over the course of the week is equally distributed with no significant differences when comparing Monday thru Friday to Saturday and Sunday, even when looking at the data across the varying age groups (Martyn *et al*., 2018). However, there are significant differences in caffeine consumption when comparing various age brackets (Martyn *et al*., 2018). The majority of caffeine consumption in all age groups (50-66%) occurred in the morning, defined as the hours before noon (Martyn, *et al*., 2018). When looking at adolescents (13-17 years old), however, this group exhibited a more even distribution of caffeine consumption with roughly 1/3 of their caffeine consumption being consumed in the morning, 1/3 in the afternoon, and 1/3 in the evening. In comparison to the trend in all age groups being roughly 61% in the morning, 21% in the afternoon, and 18% in the evening (Martyn *et al*., 2018).

Choice of caffeinated beverage can also play a role in the consumption distribution over time (Martyn *et al*., 2018). For example coffee is mainly consumed (80-84% of consumption) in the morning (Martyn *et al*., 2018). However, energy drinks are consumed relatively even across the morning and afternoon (39-49% in each category), and then consumption decreases during the evening (Martyn *et al*., 2018).

Energy Drinks

Consumption of energy drinks, which differ largely from sodas due to their much higher caffeine content per ml, has also been on the rise. First marketed in the United States in 1997, energy drinks have quickly risen in popularity (Mahoney *et al.,* 2019). Between 2004 and 2009 energy drink sales per unit increased 204% (Burrows, T., *et al.*, 2018). Between 2011 to 2015 the annual energy drink profits increased from roughly $8 billion to over $13 billion (Mahoney *et al.,* 2019) with Red Bull™ leading the market at 42% of market sales and over 4 billion units sold in 160 countries worldwide in 2011 (Burrows *et al.*, 2018).

While energy drinks are popular across all ages, they have become increasingly attractive to teens and young adults across the world (Chen *et al.,* 2018). In the United States, nearly 1/3 of the teenagers between the ages of 12 and 17 drink them regularly (Chen *et al.,* 2018). A European Food Safety Authority report found that roughly 68% of teens have consumed energy drinks before and approximately 12% of those consumed an average of 7 liters of energy drinks per month (Chen *et al.,* 2018).

This popularity among teens is not without its consequences. From 2007 to 2011, according to the National Center of Complementary and Integrative Health (NCCIH), energy-drink-related visits to emergency rooms doubled (Chen *et al.,* 2018). It is thought that the inherent risk with energy drink consumption could be curbed with mandatory labeling and advertising restrictions, however, Chen *et al.,* (2018) hypothesized the impact would be minimal due to the popularity of the energy drinks stemming from the seemingly quick delivery of positive side effects such as feeling as though one is more alert, awake, and productive. Other explanations for likely lack in decrease of sales despite potential harmful side effects are assumed to be that consumers believe that the positive side effects benefits outweigh the possible negative outcomes in addition to a probable caffeine addiction which energy drinks satisfy with their high-volume ratio (Chen *et al.,* 2018).

College Students

Energy drink consumption in college students has surged in popularity. As Mahoney *et al.* reported students consuming at least one energy drink a month with up to 57% of college students drinking them regularly with no significant difference between males and females who consume 173.9 mg/daily vs 173.4 mg/daily, respectively, from energy drinks (Mahoney *et al.,* 2019). It is important to note, however, that males, on average, reported consuming a significantly more caffeine from energy drinks in comparison to females (Mahoney *et al.,* 2019). Also, energy drinks only account for 9% of overall caffeine consumption in the United States (Mahoney *et al.,* 2019).

College students consume caffeine for a multitude of reasons including reduction of fatigue, enhancing physical performance, taste of product, and image enhancement (Mahoney *et al.,* 2019). In a meta-analysis of over 100 research studies, Anitei *et al*., (2011) compiled a list of the following side effects found that moderate caffeine consumption had the following side effects “1) increases energy availability, 2) increases daily energy expenditure, 3) decreases fatigue, 4) decreases the sense of effort associated with physical activity, 5) enhances physical and motor performance, 6) enhances cognitive performance, 7) increases alertness, wakefulness, 8) decreases mental fatigue, 9) quickens reactions, 10) increases the accuracy of reactions, 11) increases the ability to concentrate and focus attention, 12) enhances short-term memory, 13) increases the ability to solve problems, 14) increases the ability to make correct decisions, 15) enhances cognitive functioning capabilities and neuromuscular coordination". However, students also reported that with caffeine use they also experienced lower sleep quality and/or more fatigue the following day (Mahoney *et al.,* 2019). When looking at physical effects in an academic setting where students were asked to consume 100 mg caffeine 1 hour prior to a 75 min lecture and record how the caffeine affected them, students reported that during the lecture they felt as if they have sharper mental clarity, possessed a greater ability to concentrate during the lecture and even felt more awake during as well as post-lecture (Anitei *et al*., 2011).

Caffeine Forms and Dosages

The most common and widely used form of caffeine is 1,3,7-trimethylxanthine, though caffeine also exists in other forms within nature such as 3,7-dimethylxanthine or theobromine and 1,3-dimethylxanthine or theophylline (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). 1,3,7-trimethylxanthine is derived from plants with a chemical structure $C_8H_{10}N_4O_2$ and molecular weight of 194.19 (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). The 1,3,7-trimethylxanthine form is quickly absorbed within the GI tract and distributed from there to other tissues and organs throughout the human body (Bessada *et al.* 2018). Approximately 30 to 60 minutes after ingestion, there is an increase in plasma concentration which can remain elevated anywhere from 2 to 10 hours post-consumption. Total plasma levels are highly dependent on dose ingested and metabolism of the individual consumer (Bessada *et al.* 2018). Caffeine is metabolized primarily in liver via cytochrome P450 1A2 into the primary metabolites theophylline (84%), theobromine (12%), and paraxanthine (4%; Bessada *et al.* 2018). The brain and kidneys are also capable of producing cytochrome P450 1A2 suggesting their ability to metabolize caffeine as well (Bessada *et al.* 2018).

Consumable Forms

Traditionally, caffeine can be consumed in the form of coffee, teas, or chocolate. Recently, new forms of caffeine-containing products have come to market like caffeinated jelly beans, loaded teas, and even caffeinated water. Within each of the various categories and brands, caffeine content can change drastically. Coffee contains on average 91 mg of caffeine and ranges from 25 mg (Starbucks ™ Decaffeinated Coffee) to 180 mg (Starbucks™ Coffee, Blonde Roast) per 8 ounces (Kallmyer, 2005). Sodas on average contain 50 mg of caffeine but range from 22 mg to 115 mg. Coke™ products contain 46 mg and Mt. Dew™ has 68 mg per 12 ounce can (Kallmyer, 2005). Tea contains anywhere from 95 mg (Starbucks™ Chai Latte) to 7.5 mg per 16 ounces (Arizona Iced Tea™, green) and energy drinks range from 300 mg (Bang Energy™) to 160 mg per 16 ounces (Red Bull™; Kallmyer, 2005). The FDA's Center for Food Safety and Applied Nutrition (CFSAN) found that caffeine consumption at 100 mg/person/day or less is not considered a human health hazard (Institute of Medicine (US) Committee on Military Nutrition Research, 2001).

Health Implications

Caffeine consumption comes with a variety of side effects which can include nervousness, anxiety, gastrointestinal upset, excess stomach acid/heart burn, nausea, insomnia, irregular heartbeat, spontaneous abortion, and withdrawal symptoms (Burrows *et al.*, 2018; Institute of Medicine (US) Committee on Military Nutrition Research, 2001). Upon cessation of caffeine ingestion, side effects can include drowsiness, flu-like symptoms, low vigor, fatigue, irritability, and headaches (Institute of Medicine (US) Committee on Military Nutrition Research, 2001).

Caffeine absorption occurs quickly in humans, with 99% being absorbed 45 minutes after ingestion. Once absorbed, caffeine binds reversibly to plasma proteins, and once bound, accounts for 10% to 30% of total plasma pool within the individual (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). Caffeine's half-life, while highly dependent on individual metabolism and dose, ranges from 2 to 10 hours with an average of 5 hours and with 0.5% to 3.5% excreted in urine content (Bessada *et al.* 2018; Institute of Medicine (US) Committee on Military Nutrition Research, 2001). Caffeine is most quickly and completely absorbed when it is ingested in liquid form because it is more easily distributed through the body water with a concentration of roughly 0.7 liters of body water to 1 kilogram of body weight and it is lipophilic allowing it to pass easily through all biological membranes and the blood-brain barrier (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). The lethal oral dose of caffeine is estimated to be 150 mg/kg of bodyweight or roughly 10 to 14 g of caffeine. Lethality from consumption of more than 10 depends largely on the individual's sensitivity to caffeine which can be altered by a variety of factors such a smoking, age, pregnancy status, concurrent drug use, and habitual caffeine usage amounts, and can cause convulsions and vomiting typically progressing to either tachycardia or asystole (Bessada *et al.* 2018; Institute of Medicine (US) Committee on Military Nutrition Research, 2001). Doses of 500 mg or more lead to decreased mental functioning in addition to the other side effects previously mentioned (Institute of Medicine (US) Committee on Military Nutrition Research, 2001).

Studies performed investigating cardiovascular health and caffeine have indicated that caffeine is associated with lower cardiovascular mortality, though it still has large effects in the cardiorespiratory systems in the body (James *et al.,* 2018). For example, during both rest and exercise, caffeine contributes to the increase in a variety of physiological processes such as heart rate, respiratory rate, and blood pressure via epinephrine secretion (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). Additionally, caffeine ingestion, in both men and women can cause an increase in systolic blood pressure by 5 to 15 mmHg and diastolic blood pressure by 5 to 10 mmHg for several hours post consumption (James *et al.,* 2018). In habitual consumption, diastolic and systolic blood pressure tended to increase progressively with the continuation of habitual consumption (James *et al.,* 2018). However, the studies failed to reach statistical significance in regards to caffeine consumption's contributions to persistently-elevated blood pressure (James *et al.,* 2018).

Neurological Response

Cognitive function associated with caffeine consumption seems to be controlled by several mechanisms: antagonism of benzodiazepine receptors, the antagonism of adenosine receptors, the inhibition of phosphodiesterase, the release of calcium from intracellular stores with the inhibiting phosphodiesterase and blocking of adenosine receptors (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). In addition, vasoconstriction caused by ingestion of 200mg of caffeine reduces resting-state cerebral blood flow by approximately 30% in studies where individual ingested a 200 mg dose of caffeine (Heilbronner *et al.,* 2015). In addition to decreased cerebral blood flow, caffeine consumption also decreased oxygenated hemoglobin concentration which was positively correlated change in performance when working on tasks (Heilbronner *et al.,* 2015).

Caffeine and The Brain

How caffeine affects neurological activity of the brain varies widely between studies. When using Stroop testing, Niioka (2003) found no significant difference between raw score and execution time data. Caffeine not only affects memory but can specifically effect the different stages of memory processing which are dependent on the characteristics of the task in which memory is involved (Angelucci *et al.,* 1999). For instance…? Studies have also found that those that believed caffeine had a positive effect on memory retention and consumed it, scored comparably to those that did not believe it had a positive effect on memory retention and consumed caffeine especially when compared to those who performed the same task with the decaffeinated placebo

(Sherman *et al.,* 2016). However, while caffeine had some positive effects on short-term memory, it did not improve long-term memory (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). In studies conducted using the Compound Remote Association (CRA) task, a standard measure of problem solving, Silvia *et al.* (2019) found that when participants consumed 200 mg of caffeine (almost equivalent to a 12 oz cup of coffee) they experienced a significant enhancement in convergent problem-solving ability, yet found no noticeable effect on working memory or divergent thinking in the participants in comparison to those that took the caffeine-free placebo dose.

Caffeine's effects vary based on dosage. Does from 100 mg to 600 mg can produce improved vigilance and enhanced cognitive performance (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). When a single dose of 3 mg/kg of body weight of caffeine was given to undergraduate college students who consumed on average 5.9 cups of coffee per day, it produced an increase in cortical activation and sensitivity (Institute of Medicine (US) Committee on Military Nutrition Research, 2001). The Institute of Medicine (US) Committee on Military Nutrition Research (2001) found that intensity of improved speed and accuracy on attentional tests via visual information processing due to caffeine was dose dependent. In addition, they found that a 70 mg dose of caffeine significantly improved reaction time and at 210 mg the reaction time increased even for habitual users as well as participants experienced a decrease in false alarm rates in the selective attention tasks. Institute of Medicine (US) Committee on Military Nutrition Research, (2001) found that when comparing caffeine consumption forms of a pill, food bar, beverage, and chewing gum, the chewing gum or food bar were found to be the most advantageous forms of delivery. In a different study, comparing 0 mg, 100 mg, 200 mg, and 400 mg dosages of caffeine in non-habitual consumers, Brunyé *et al.* (2010) found that only in the 200 mg or 400 mg that there was a reliable positive effect on the attention network within the subjects. The study also notes that because the sample group were non-habitual users, the dosing might be different for habitual consumers (Brunyé *et al.,* 2010).

The aim of the present study is to gain a better understanding of college students' knowledge of caffeine, their beliefs on how it affects their academic and cognitive performances, and to better understand how it actually affects their academic and cognitive performances. I hypothesize that caffeine usage will not cause a significant improvement in individual academic performance despite of the known physiological and cognitive effects on the students.

MATERIALS AND METHODS

Students enrolled in Human Anatomy and Physiology I (BISC 206) and II (BISC 207) at The University of Mississippi were recruited to participate in this study. Human Anatomy and Physiology at The University of Mississippi is a two-semester course series in which students must receive a C or higher in Anatomy and Physiology I to progress to Anatomy and Physiology II. This study was presented to the students in Anatomy and Physiology I and II as an optional extra credit opportunity. The protocol was approved as Exempt under 45 CFR 46.101(b) (#2&3) (Protocol #21x-085). The study consisted of two different phases. Phase one was extended to the Anatomy and Physiology I (BISC 206) students for participation while phase two of the study was extended to Anatomy and Physiology II (BISC 207). There was some overlap in students participating in both phase one and phase two. All participants were typical undergraduate college students at least above the age of 18 and varying in race and gender.

Phase one consisted of a survey through the Qualtrics™ software (Appendix A). Anatomy and Physiology I students were recruited to participate through a class announcement. If interested, they emailed the PI (Wingfield) for further information. Interested students were provided an information sheet about the study and a the link to the survey through email. The survey consisted of a variety of questions that aimed to better understand students caffeine usage as well as the forms in which they consumed caffeine. It also questioned students on their usage of caffeine in school type settings as well as any side effects that they may have experienced while using caffeine. The responses were recorded on either a numerical scale or open response where appropriate. Details of the survey are provided in Appendix A. Descriptive statistics (e.g., mean, standard deviation, range, etc.) were compiled to create a profile of caffeine consumption and general understanding about the effects of caffeine in college students.

Phase two consisted of a food diary (Appendix B), informational profiles about select University of Mississippi alumni (Appendix C), and a quiz about the alumni profiles (Appendix D). Anatomy and Physiology II students were recruited to participate through a class announcement. If interested, they emailed the PI for further information. Interested students were provided information about the study and each student scheduled a video conference with the PI in order to further explain the procedure for this phase. During the video conference, the PI provided instructions on how to complete the food diary and explained the expectations of the responses as well as the timeline in which they would be filling out the food diary, receiving the passages, and taking the quiz. The student selected the time to start their food diary and were provided the Qualtrics™ link and an example of a completed food diary log at the agreed upon time. Each student recorded their food diary results. Twenty-three hours later, the PI emailed the student a link to a shared google drive containing alumni profiles. The PI allowed access to the Google Drive™ by only sharing the drive with each student for one designated hour to better ensure the integrity of the quiz results by restricting access to the passages while the student completed the quiz and reducing the possibility of other participants being able to access the passage. After one hour, the PI emailed the students the Qualtrics™ link that gave the student access to the quiz. The student was asked to complete the quiz immediately upon receiving the link. The quiz consisted of 25 questions and students had 30 minutes to complete all questions.

Upon receiving the results from the quiz and food diary data, the following information was compiled for each participant: correct number of quiz answers out of 25, total caffeine consumed during the 24-hour period, how much caffeine was consumed during one hour of peak consumption, and how many hours between the peak consumption event and completion of the quiz. Data from phase 2 of the experiment were analyzed with a multiple linear regression in which the quiz score was the dependent variable and total caffeine consumed (over 24 hours), peak caffeine consumed, and hours preceding completion of the quiz in which the peak caffeine consumption occurred were the independent variables.

RESULTS

Phase One

Students were asked to rank on scale from 1 to 5, with 1 indicating no caffeine consumed and 5 indicating a lot of caffeine, how much caffeine they consume on average, if they consume caffeine at all. On the average students reported caffeine consumption of 3.04 (Figure 1). Students were also asked to report the various caffeine sources that they consumed excluding responses that did not include caffeine (Figure 2). On average, most students reported that they drank coffee, with answers ranging from “coffee” to more specific answers such as “iced coffee”, “caramel frappe” or coffee from local coffee houses. Coffee was followed by soda, which too had responses that included “soda” as well as more specific responses such as “Coke™”, “Dr. Pepper™”, and “soda from restaurants”. The other categories “tea”, “energy drink”, “energy tea”, and “food” had the simplistic answer as well as the more specific answers such as “green tea”, “Monster™ energy drink”, “Crystal Light™ energy”, or “chocolate”, respectively. Students were then asked if they knew how much caffeine were in these products, 81 of the 109 responses were “no”.

Students reported an average of 8.08 hours between instances of caffeine consumption (Figure 3). It was assumed that some of the student responses assumed the question only pertained to hours while they were awake and others answered the question on a 24-hour basis. For students that answered 18 hours, it is assumed that they consumed something like a cup of coffee with breakfast then none the remainder of the day on the 24-hour basis and those that answered 1 hour meant that they consumed at least some caffeine every hour that they are awake. When asked about their coffee and caffeinated soda intake, averages for each question were 1.971 and 1.972 respectively, based on a scale that each 1 unit equals 8 ounces (Figure 4). Students were asked for other forms of caffeinated beverages they consumed, as well as the amount on average that they consumed the beverage, with responses typically in the energy drink or tea categories and ranged from 8 ounces to 30 ounces of the liquid indicated. This was followed by asking the students “Do you consume caffeine in other forms than liquid?” with 88.99% of the students reporting their answer being “no”. For those that answered “yes”, they were asked to report what foods they consumed containing caffeine with some of the responses including “chocolate”, “ice cream”, and “energy bites.” The average time for cessation of caffeine consumption was 4:30 pm (Figure 5). When asked about purposefully consuming caffeine, 70.6% reported that they did so on purpose and were then asked to select which of the following reasons they did so: to wake up, to stay awake, to increase focus, or other to self-report additional reasons which included answers such as “because it taste good” or “to prevent headaches” (Figure 6). When comparing concentrated caffeinated beverages (i.e., 5-Hour Energy™ shot) to less potent forms (i.e., cup of coffee), 89.9% of students preferred the less concentrated form. Students were asked “Do you drink caffeine when studying or doing other academically related activities?” and asked to select all that applied to them out of the following list of options: studying, before class, during class, before a test, and when writing papers with majority of students selecting multiple answers showing that they consume caffeine for a variety of academic reasons (Figure 7A). When rating how much they believed caffeine enhanced these activities on a scale of 1 to 10, the average response was 3.44 (figure 7B). Students were then asked to rate their current general knowledge of energy drinks and their effects on mental performance, to which they had the option of selecting terrible, poor, average, good, or excellent (figure 8) with the most common response being "average". Students also reported that if caffeine was found to have a negative effect on mental processing, 70.6% of students would change their consumption habits; 97.4% reported that they would decrease caffeine consumption. However, students also reported that if caffeine was found to have a positive effect on mental processing, 69.7% of students reported they would change consumption habits; 92.1% of those students reported that they would increase their consumption habits. Finally, students were asked "have you ever noticed side effects of your caffeine consumption?" to which 56.8% responded yes. Students were given the option to submit what side effects they experienced and responses were generalized into the following categories: none, bowel movements, energy, jittery/shaky, withdrawal like symptoms without caffeine, acne (figure 9). Not all students responded to this question.

Phase Two

Quiz performance was a mean of 13.97 $\pm$ 5.52 (mean $\pm$ 1SD) Through the use of food diary data, I ascertained/derived/collected total caffeine consumption over the 24-

hour period, the peak amount of caffeine in a single hour, and the number of hours between the peak consumption event and when the quiz was taken. Participants consume 179 $\pm$ 101.046 mg (mean $\pm$ 1SD) of caffeine in a given 24-hour period. Peak consumption was 102.9 $\pm$ 60.980 (mean $\pm$ 1SD) mg of caffeine 6.90 $\pm$ 6.559 (mean $\pm$ 1SD) hours before the quiz was taken. There were correlation coefficients of 0.018 and 0.000 between peak consumption event & quiz score and total caffeine consumption & quiz score, respectively, with little relationship between the two. There was a significant relationship between the total caffeine intake over the 24-hour period, the peak amount of caffeine consumed in a single hour, and the number of hours between the peak consumption event and when the quiz was taken, and quiz score ($F= 3.579$, df = 1,3, $p = 0.028$) (Figure 10, 11, 12). Regression analysis showed that 30% of variation in quiz score is affected by peak amount of caffeine consumed in a single hour and the number of hours between the peak consumption event and when the quiz was taken ($r^2 = 0.300$).

DISCUSSION

Phase One

Most individual seem to be unaware of the amount of caffeine they consume and the side affects that conincide. While the Mayo Clinic reports that the average safe amount of caffeine consumption for an average adult is around 400 mg or roughly 4 cups of coffee, they also note that if you meet this amount or surpass it, you are likely to experience symptoms such as headache, insomnia, nervousness, rapid heartbeat, and/or muscle tremors (The Mayo Clinic, 2020). Most students reported a daily intake of caffeine, with majority of that intake being via coffee or coffee-based beverage closely followed by caffeinated sodas and teas. However, when students were asked if they knew how much caffeine was in the food and drinks that they consume, 74.31% reported that they did not know. For those students who are unaware of how much caffeine they are consuming, it would be relatively easy to surpass the recommended maximum amount without realizing. For example, if one consumed a Venti (591 mL or 19.99 oz) Blonde Roast™ Coffee from Starbucks™, their intake would be 415 mg of caffeine, exceeding the daily recommended maximum without even realizing it. Recommended servings of other popular drinks would reach or exceed the daily maximum [e.g.., Bang Energy™ drinks and Rockstar™ energy drinks (300 mg of caffeine per 16 oz can) Mountain Dew™ (69 mg caffeine per 5.8 ounces)] (Kallmyer, 2005). About 89% of students also reported that they did not consume caffeine in other forms other than liquid which questions if the students are aware of what foods contain caffeine (i.e., chocolate).

Students perceive that caffeine consumption in relation to schoolwork and cognition is in fact not beneficial to overall academic and cognitive enhancement. While 70.6% of students reported they purposefully drank caffeine and 45 of those 77 tying it to increasing focus, this result directly contradicts other survey results in which students believed consuming caffeinated products was only beneficial at a level of 3.44 on a scale of 10. These results indicate student who consume caffeine do not do so for cognitive purposes outside of staying awake and majority of students do not believe that it is beneficial to their cognitive output when consumed in an academic setting. In contrast, Anitei et al. (2011) found that students reported that after the consumption of caffeine that they were more able to concentrate throughout the 75-minute lecture and had sharper mental clarity and a greater concentration ability. In addition, in a Compound Remote Association task, participants experienced a significant enhancement in convergent problem-solving ability after consuming 200 mg of caffeine (Silvia *et al* 2019). These results concur with other studies in which if the subject believed that caffeine had a positive effect on their cognitive abilities, they scored similarly to those who did not believe it had a positive effect in both the caffeine consuming and placebo groups (Sherman *et al.,* 2016).

In retrospect, some phase one questions could be edited to provide further clarification to receive more uniform responses. For example, “When you are awake, how many hours do you go between instances of caffeine consumption?”. It was assumed that some students responded to this only counting awake hours while others answered the question on a 24-hour basis. For clarification, it would be better if the question specified to only count hours awake and active. Additionally, it would have been advantageous to ask students about their caffeine knowledge in both food and beverages. This could be done in a variety of ways such as following up with students that reported “yes” to the question “Do you know how much caffeine is in these products” with asking them to estimate the amount. In order to include those that didn’t report “yes”, additional questions could be added within the survey asking students to estimate the amount of caffeine in each of a list of popular beverages and foods that contain caffeine such as 8 oz of Diet Coke™ or a standard Hershey’s™ chocolate bar. This would allow for a better understanding of the student’s knowledge of their caffeine intake.

Phase Two

The mean overall consumption of caffeine was roughly 179 mg and the mean quiz score was roughly 14. There was no correlation between the two variables. This is in agreement with the phase one results of the students not believing that caffeine consumption was beneficial to their academic success or cognitive abilities. This was surprising as other studies found caffeine consumption to improve retention ability, working short-term memory, convergent problem-solving ability, and improved speed and accuracy on attentional tests (Anitei *et al*., 2011; Institute of Medicine (US) Committee on Military Nutrition Research, 2001). In addition, there was a weak correlation of 0.018 found between the time of peak caffeine consumption and the quiz score, which supports the stated null hypothesis that caffeine has little to no effect on cognitive or academic abilities.

These results, however, are based largely off self-reporting and the assumption that participants following the procedure exactly as presented. These factors could be a confounding variable within the results and could explain why results from this study compare to some other studies but differ from others. During the time of this study, the principal investigator worked around COVID-19 rules and regulations to ensure the safety of all parties involved. Had these restrictions not been in place for phase two of the study, it would have been more reliable to have the students come and read the passages as well as take the quiz in person. While protocols were put into place to ensure timing and avoiding cheating, it would have been more precise the students to read the passages and take the quiz while being monitored. In addition, in-person testing would have allowed for a third phase of the experiment in which the principal investigator would have been able to manipulate the amount of caffeine students consumed and had them preform further cognitive testing in the form of a second quiz to further explore the relationship between caffeine consumption amount and cognitive affects (via a Stroop test) as well as how the timing of caffeine consumption factors in.

When looking closer at phase 2 results, there are additional measurements that could be used in order to have received a more uniform response from students. While students met with the principal investigator via zoom in order to explain the procedures and give the students the ability to ask questions, there was still some confusion from the students in regard to the 24-hour period in which they were to fill out their food diary. When students received their instructions, it included a sample food diary which started at 9 AM and recorded food and drink for the following 24 hours. In the experiment, however, students were given the ability to start the food diary recordings at whatever time they liked as long as they ended 24 hours later. However, some students followed the starting time in the example food diary rather than at the time instructed and did not provide a complete 24-hour record. This could be possibly avoided in a variety of ways including within the instructions, the principal investigator could include more than one example of food diaries to the students that started at different times or having all the students start the food diary at the same time for more uniform reporting. The second option would also enable the principal investigator to better ensure that students were more prompt in reading their passages and taking the quiz that followed, since that timing too was a source of confusion for some students.

Overall Conclusions

Caffeine usage did not make a significant enough improvement on individual academic performance despite students self reporting a variety of physiological and cognitive effects on students. However, these results were more general. In comparison to other studies which looked at specific aspects of academic performance and cognition finding it to have some positive attributes. The present results show the need for further investigation into what exactly would make caffeine cognitively beneficial in other studies when looking into more specific areas such as convergent problem-solving ability or improving retention ability yet do not seem to be overall helpful in regard to academic performance despite both of those being elements within academic performance.

In phase 2, students consumed roughly 179 mg of caffeine in a 24-hour period. One study found that caffeine consumption motivators outside of those in academic settings including “sensory effects, alertness, social factors, health benefits, mood, and habit”, with coffee in particular consumers consumed more so for alertness but also out of habit (Choi, 2020). Choi (2020) also found that college students, specifically, chose to consume energy drinks due to its ability to help improve blood circulation by increasing the heart rate which can in turn help in weight loss). This proposes an interesting idea that student might actually be consuming caffeinated items due to habit stemmed from social influence rather than doing so for academic or cognitive purposes. Future studies could be conducted to find the actual psychological influence behind caffeine consumption, if cognitive enhancement is not the root of the reason for consumption.

A variety of different effects occur when a group of subjects are each given the same amount of caffeine. In a group of college aged Romanian students, Anitei *et al*. (2011) found that the students experienced some acute effects such as improvement in attention retention ability, working short-term memory, and ability to solve difficult problems requiring reasoning. After 30 minutes, students also experienced an improved recall ability (Anitei *et al*., 2011). However, while caffeine consumption increased short-term attention under 30 minutes, caffeine had no profound effect at more than 30 minutes, and even let to a sense of confusion with an altered sense of decision time when trying to complete comparison and analysis tasks (Anitei *et al*., 2011). However, on a cellular basis Deslandes *et al.* (2004) found that groups that consumed caffeine experienced an improvement in cortical activity as was measured by P300 latency shortening in the frontal cortex. This is believed to occur due to caffeine's ability to block adenosine from binding at the adenosine A receptor which leads to a stimulant like reaction in the behavior of the individual (Deslandes *et al.*, 2004). This binding activity in the brain and consequently increasing extracellular levels of acetylcholine and serotonin has also been examined in a longitudinal manner to observe habitual caffeine's effects on cognitive function over time (Van Boxtel *et al.,* 2003). Over a six-year period of time, Van Boxtel *et al.* (2003) found that caffeine did not present a decline in cognitive performance in individuals across a variety of age groups. Additionally, this same study found that habitual caffeine consumption also did not have any effect in reducing cognitive decline that comes with aging either (Van Boxtel *et al.,* 2003).

CONCLUSIONS

In sum, despite students reporting mixed ideas on whether or not they believe caffeine to be beneficial based off the phase one survey, conclusions from phase 2 results cannot draw a direct link between caffeine consumption and positive increase in cognitive abilities or academic performance. While some studies have found that caffeine consumption aids in various, yet very specific, aspects of cognitive abilities or academic performance, the present results suggest that it is not advantageous based off the average consumption patterns of a typical student. In light of these results several questions still arise. For instance, does specific quantity cause an increase in positive cognitive effects and academic abilities, and if so, what specific cognitive enhancement occur at which levels of caffeine consumption? In addition, the present results also indicate a need for further inquiry as to if timing between the peak intake event of caffeine consumption and cognitive testing can enhance cognitive abilities and if so, what is the most optimal time gap between the aforementioned events.

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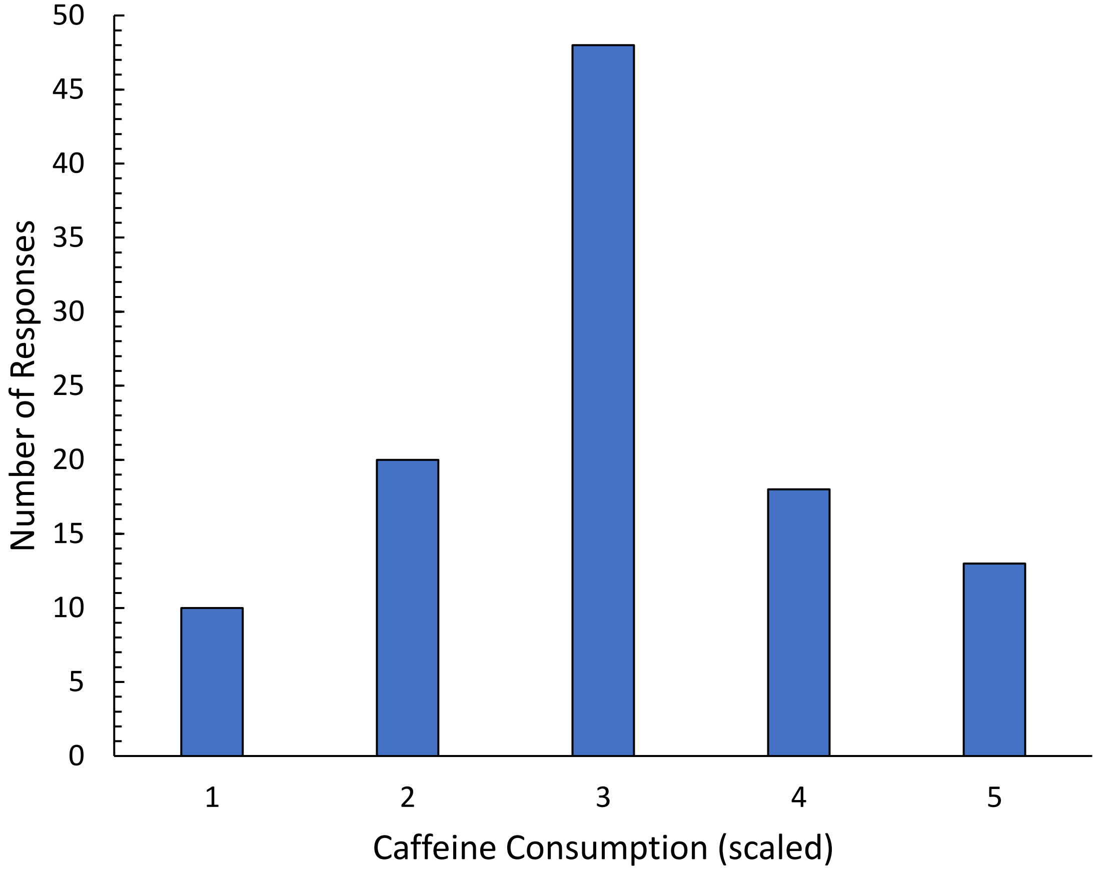

Figure 1 Student responses to the Phase One survey question, "On average, please rank how much caffeine you consume on a scale from 1 to 5? (1=no caffeine consumed, 5=a lot of caffeine consumed)." n= 109.

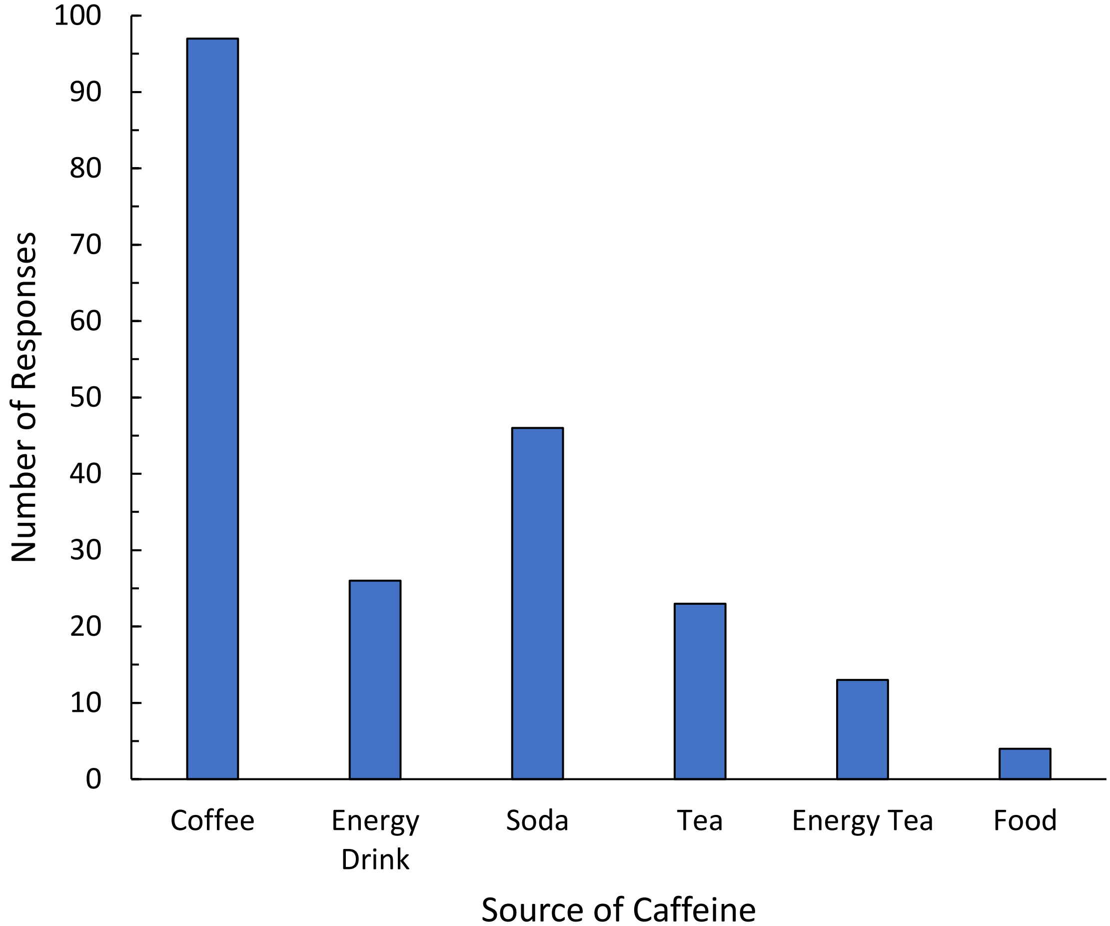

Figure 2 Open response to the Phase One survey question "If you consume caffeine, what is the source?" (n=109).

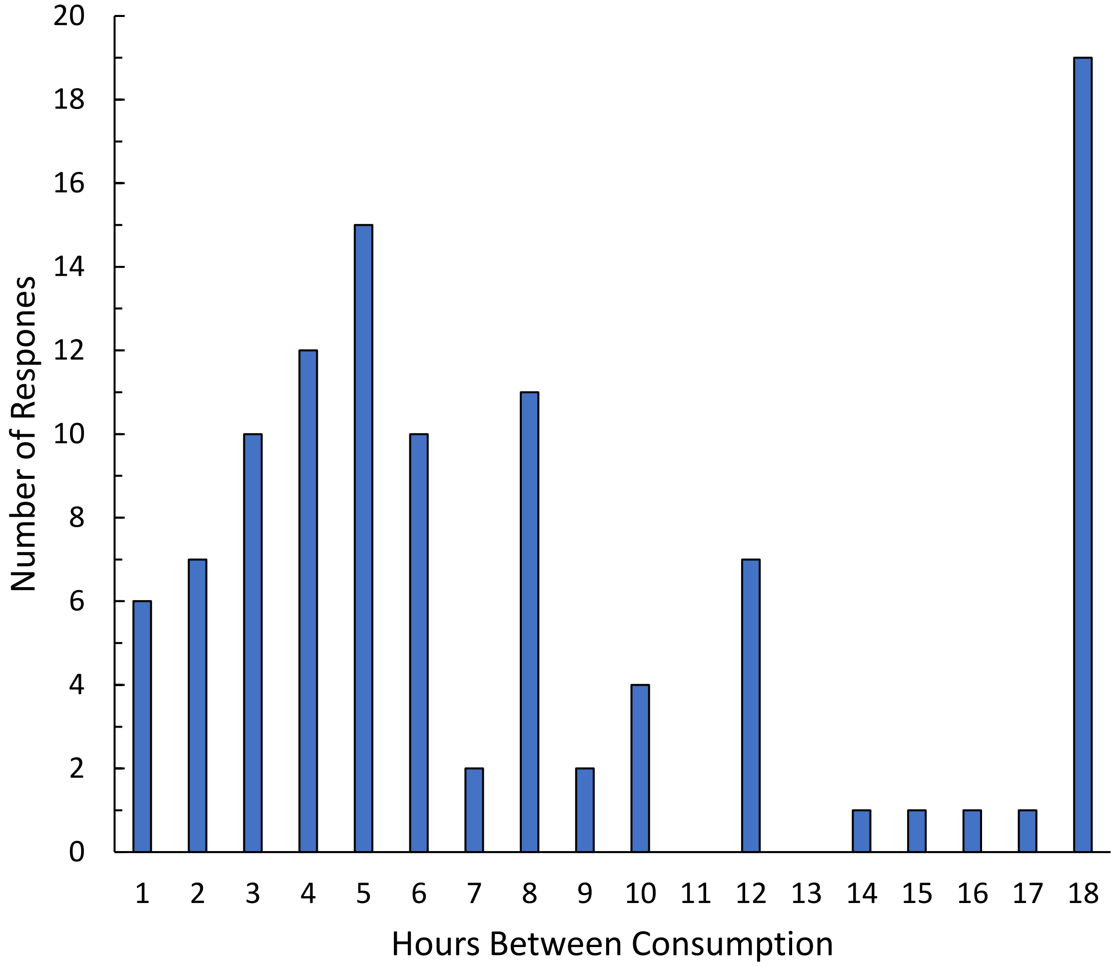

Figure 3 Student reponses to the Phase One survey question, "When you are awake, how many hours do you go between instances of caffeine consumption?" (n =109)

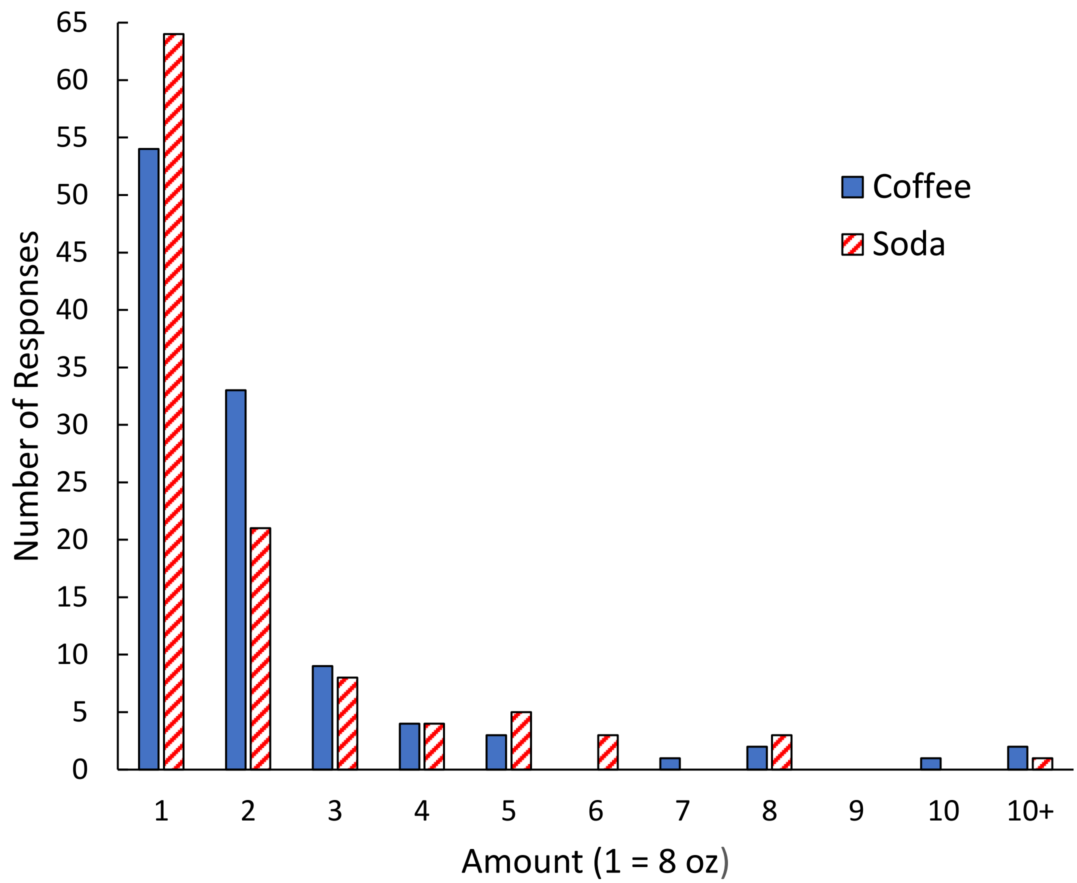

Figure 4 Student responses to the Phase One survey questions, "If you consume caffeine via coffee, how much do you drink?" and "If you consume caffeine via soda, how much do you drink?"

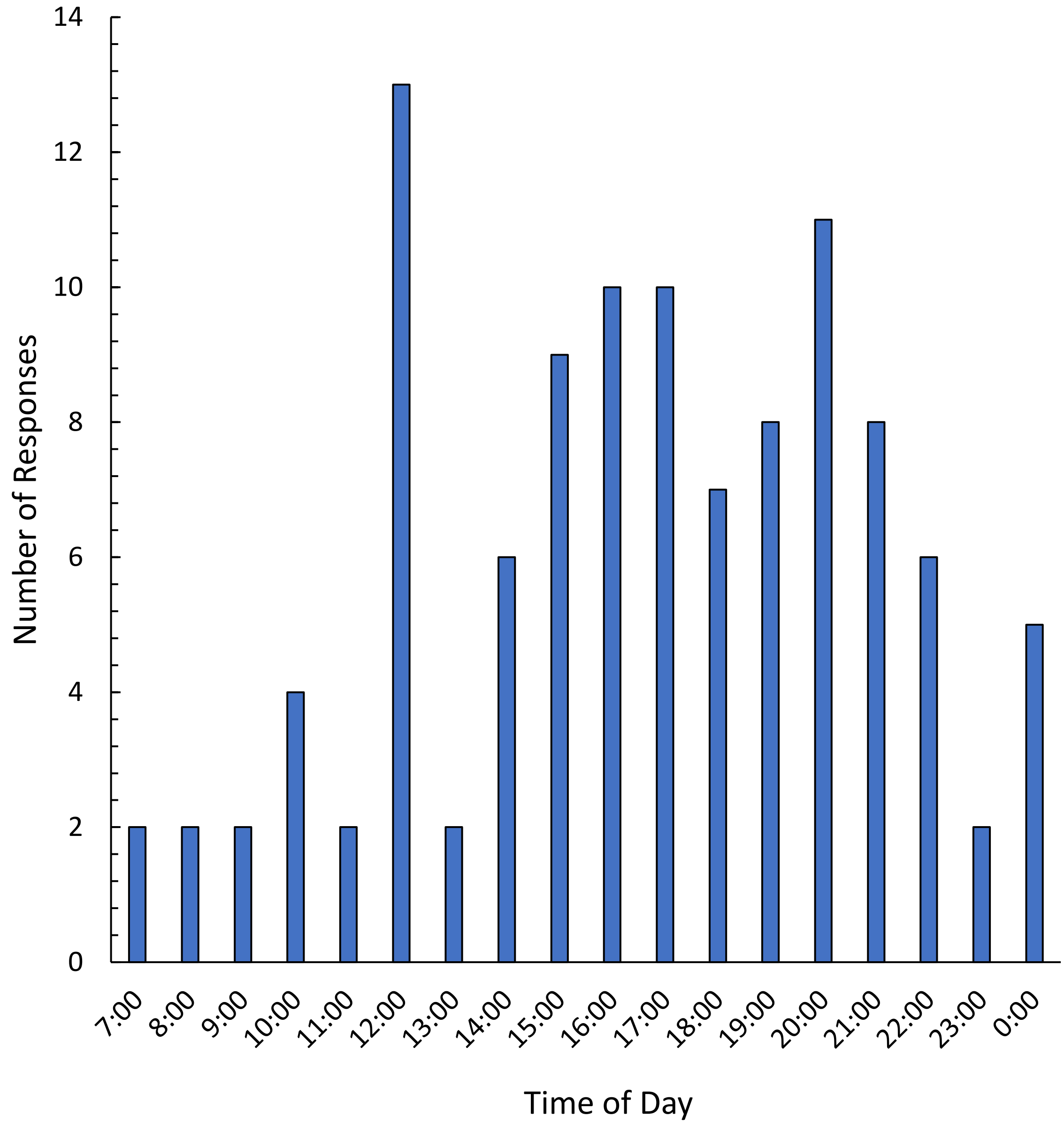

Figure 5 Student responses to the Phase One survey question, "When do you stop drinking caffeine during your daily routine?" (n=109)

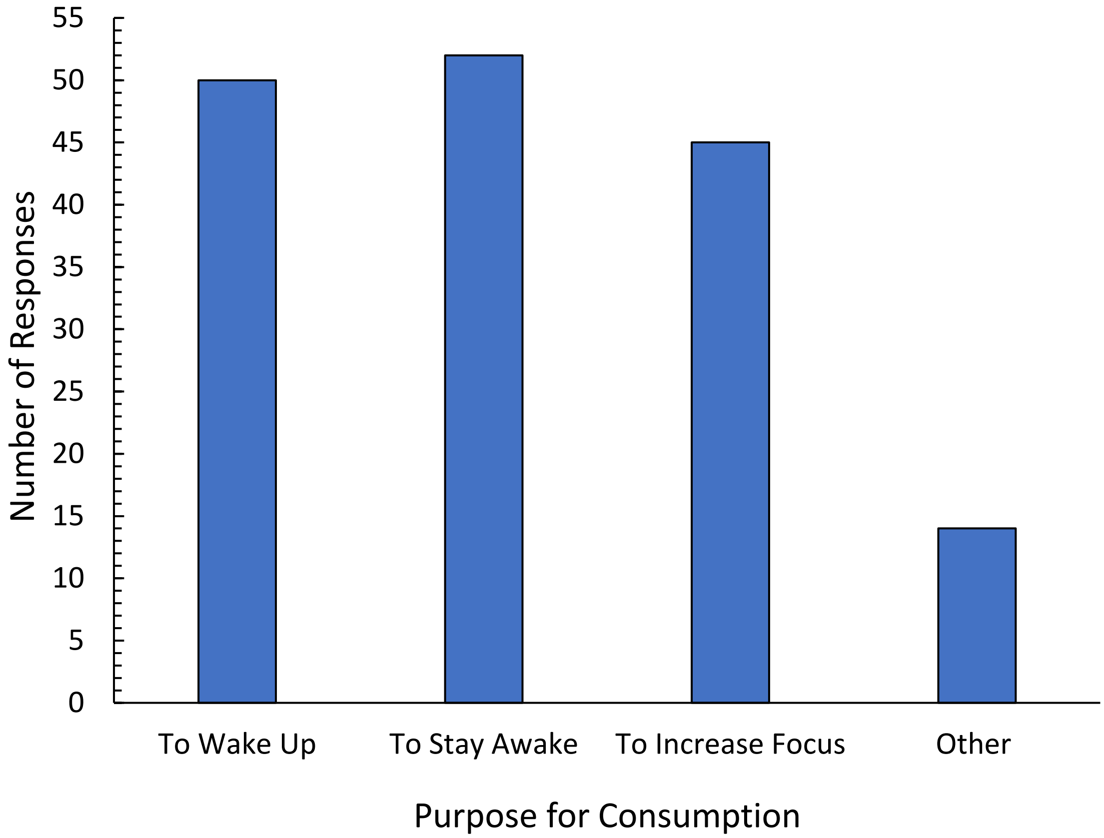

Figure 6 Student responses to the Phase One survey question, "If yes, what is the purpose for which you drink caffeine?" (n = 109) Following the question, "Do you purposefully drink caffiene?".

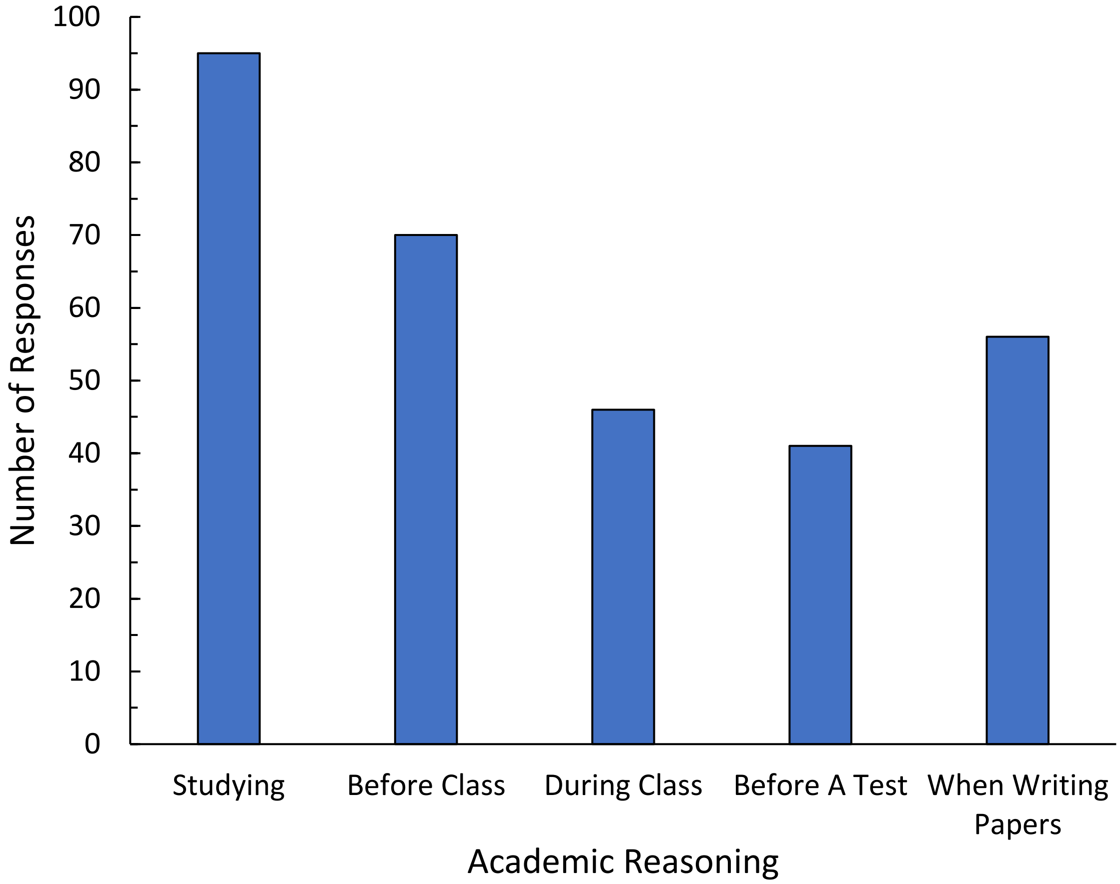

Figure 7A Student responses to the Phase One survey question, "Do you drink caffeine when studying or doing other academically related activities?" (n = 109)

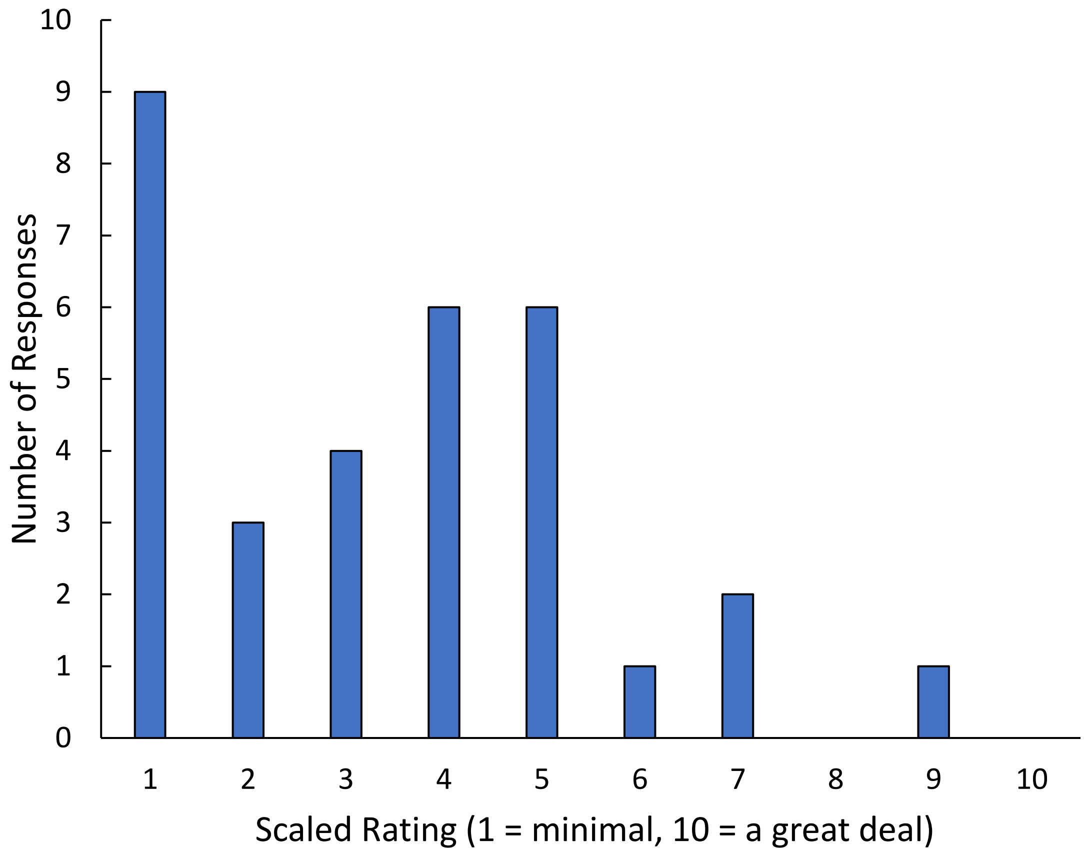

Figure 7B Student responses to the Phase One survey question, "If you selected any of the above, please rate on a scale of 1-10 how much you think it helps your performance?"

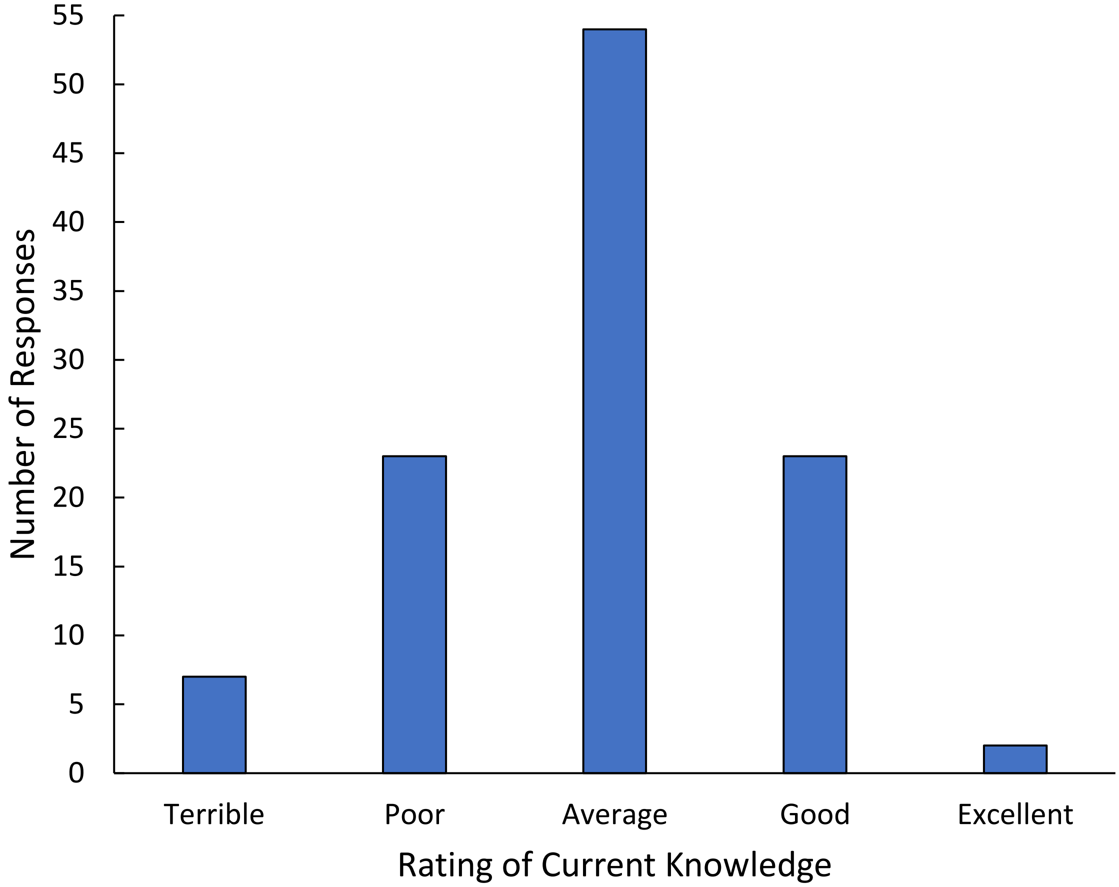

Figure 8 Student responses to the Phase One survey question, "How would you rate your current knowledge of energy drinks and their effects on mental performance?" (n=109)

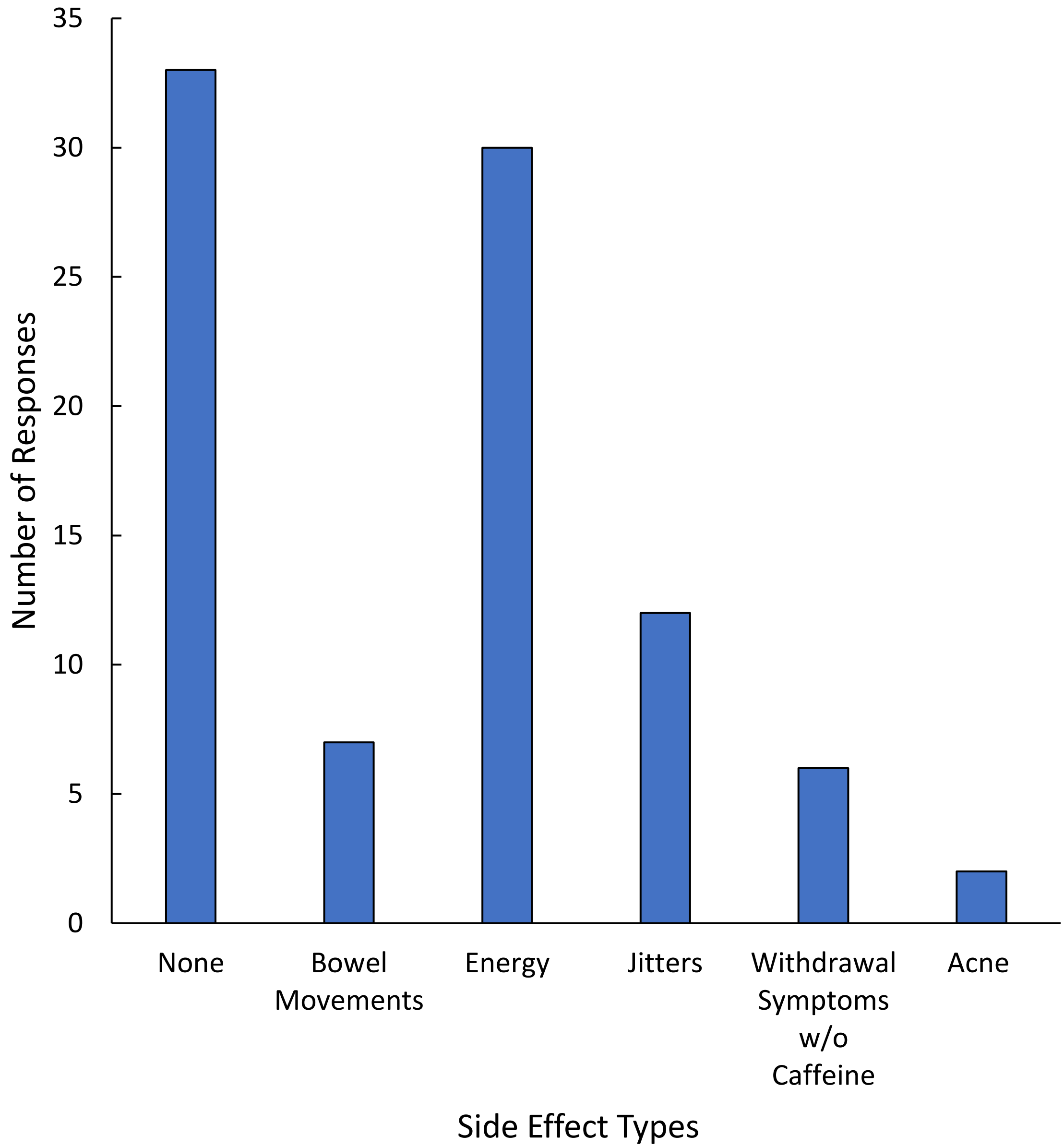

Figure 9 Student responses to the Phase One survey question, "If you answered yes to the previous question, please describe the side effects." Following the question, "Have you ever noticed side effects of your caffeine consumption?"

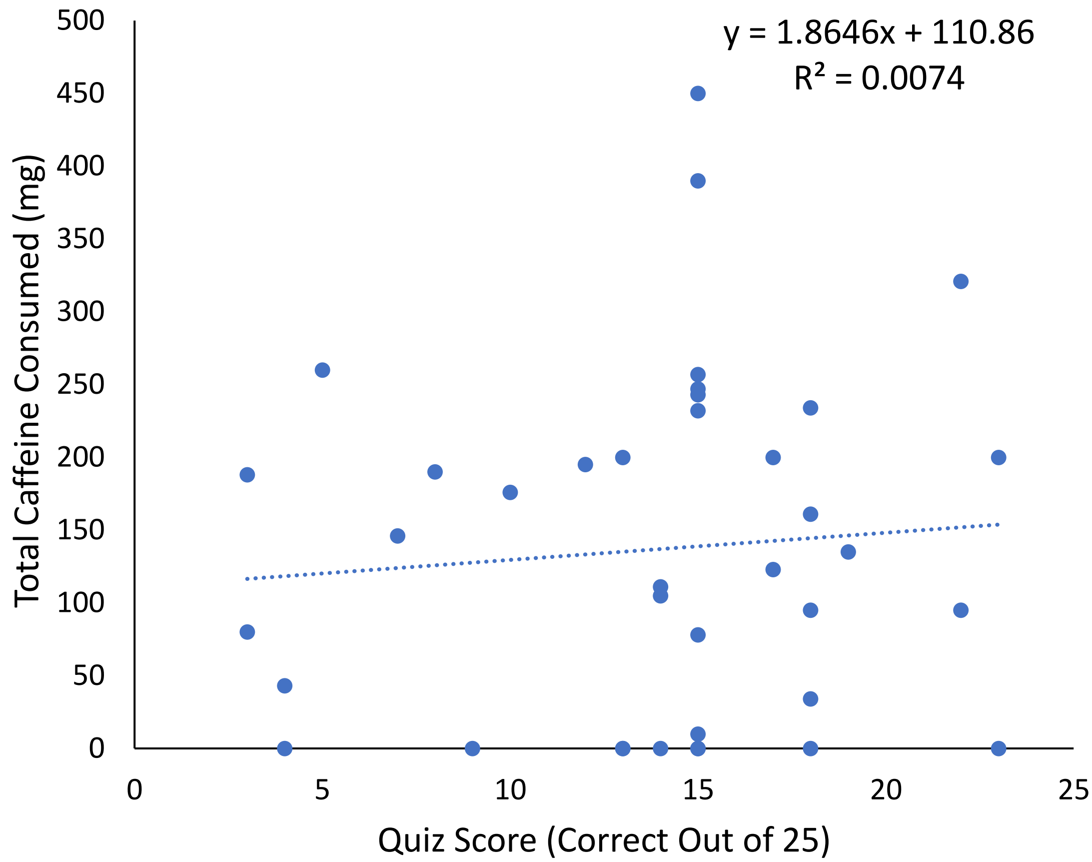

Figure 10 Relationship between total caffeine intake and quiz performance in human anatomy and physiology students.

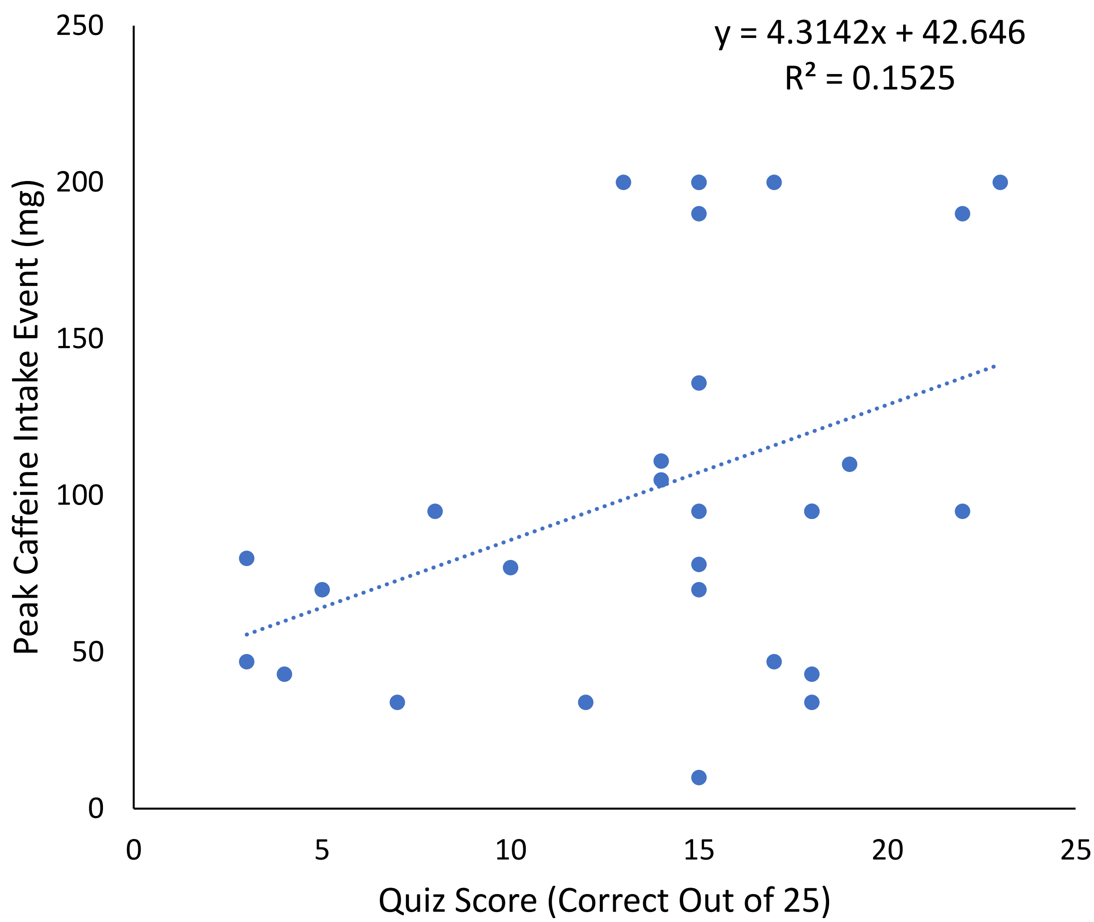

Figure 11 Relationship between peak caffeine intake event and quiz performance in human anatomy and physiology students.

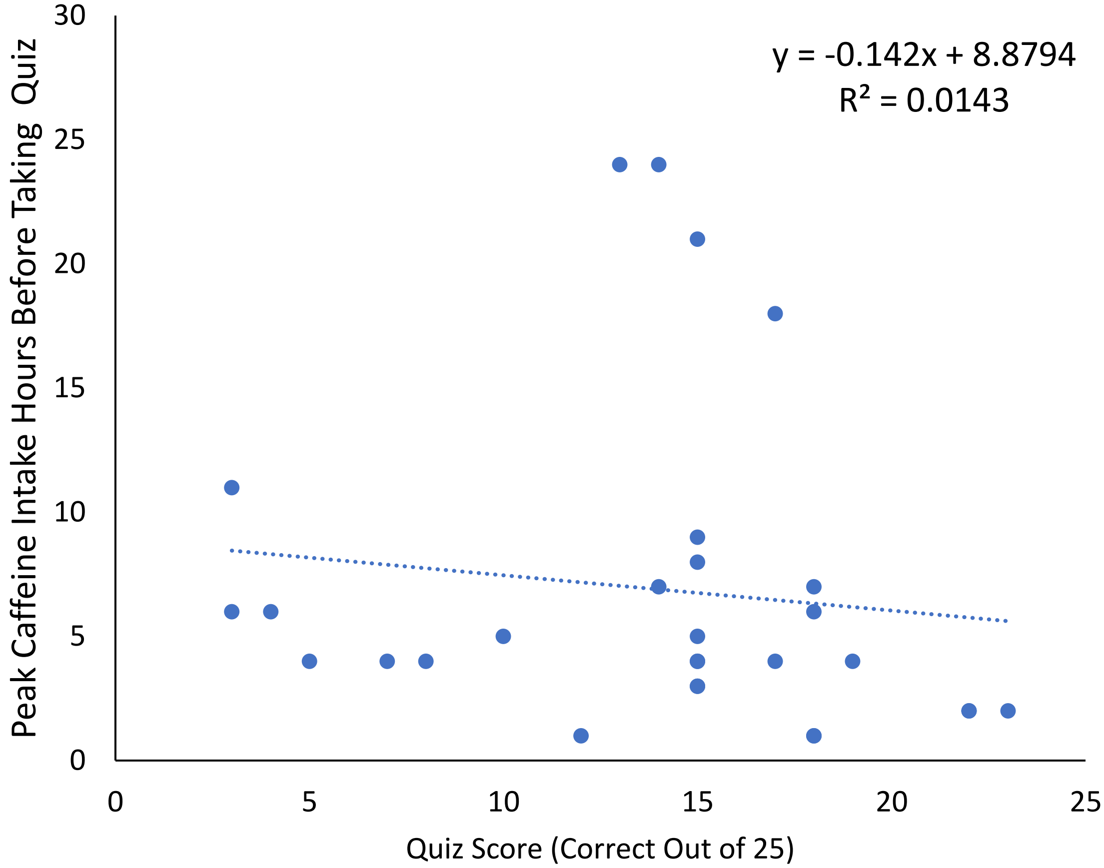

Figure 12 Relationship between peak caffeine intake hours and quiz performance in human anatomy and physiology students.

APPENDICIES

Appendix A - Phase One Questionnaire

1. How much do you weigh?
2. On average, please rank how much caffeine do you consume on a scale from 1 to 5? (1=no caffeine consumed, 5=a lot of caffeine consumed)
3. If you consume caffeine, what is the source? If multiple sources, use additional text entry boxes for each source.
   a. Do you know how much caffeine is in these products?
4. When you are awake, how many hours do you go between instances of caffeine consumption?
   a. 1
   b. 2
   c. 3
   d. 4
   e. 5
   f. 6
   g. 7
   h. 8
   i. 9
   j. 10
   k. 11
   l. 12

m. 13

n. 14

o. 15

p. 16

q. 17

r. 18

5. If you consume caffeine via coffee, how much do you drink? (1 cup = 8 oz)

    a. 1

    b. 2

    c. 3

    d. 4

    e. 5

    f. 6

    g. 7

    h. 8

    i. 9

    j. 10

    k. 10+

6. If you consume caffeine via soft drinks, how much do you drink? (1 cup = 8 oz)

    a. 1

    b. 2

    c. 3

d. 4

e. 5

f. 6

g. 7

h. 8

i. 9

j. 10

k. 10+

7. If you consume caffeine via other drinks not listed above, what do you drink and in what quantity?

8. Do you consume caffeine in other forms than liquid?

    a. If yes, what form(s)?

9. When do you stop drinking caffeine during your daily routine?

    a. 7 AM

    b. 8 AM

    c. 9 AM

    d. 10 AM

    e. 11 AM

    f. 12 NOON

    g. 1 PM

    h. 2 PM

    i. 3 PM

j. 4 PM
k. 5 PM
l. 6 PM
m. 7 PM
n. 8 PM
o. 9 PM
p. 10 PM
q. 11 PM
r. 12 MIDNIGHT

10. Do you purposefully drink caffeine?
    a. If yes, what is the purpose for which you drink caffeine? Select all that apply.
        i. To wake up
        ii. To stay awake
        iii. To increase focus
        iv. Other
11. Do you prefer more concentrated caffeinated beverages (ex: 5-hour energy drink) or in a less potent form (ex: cup of coffee)?
    a. More
    b. less
12. Do you drink caffeine when studying or doing other academically related activities? Select all that apply.
    a. Studying

    b. Before class
    c. During class
    d. Before a test
    e. When writing papers

13. If you selected any of the above, please rate on a scale of 1-10 how much you think it helps your performance? (1=minimal, 10=a great deal)
14. How would you rate your current knowledge of energy drinks and their effects on mental performance?
    a. Terrible
    b. Poor
    c. Average
    d. Good
    e. excellent
15. If you found out that it was proven that caffeine had negative effects on mental processing, would that change your caffeine consumption habits?
    a. If you answered yes to the previous question, would your consumption increase or decrease?
        i. Increase
        ii. Decrease
16. If you found out that it was proven that caffeine had positive effects on mental processing, would that change your caffeine consumption habits?
    a. If you answered yes to the previous question, would your consumption increase or decrease?
        i. Increase

ii. decrease

17. Have you ever noticed side effects of your caffeine consumption?

    a. If you answered yes to the previous question, please describe the side effects.

Appendix B - Food Diary Outline *with sample entries*

Start Date: End Date:

Time	Food Consumed (including brand)	Amount (servings)	Beverage Consumed (including brand and water)	Amount (ounces)
1 AM				
2 AM				
3 AM				
4 AM				
5 AM				
6 AM				
7 AM				
8 AM				
9 AM				
10 AM				
11 AM				
12 NOON				
1 PM				
2 PM				

3 PM				
4 PM				
5 PM				
6 PM				
7 PM				
8 PM				
9 PM				
10 PM				
11 PM				
12 MIDNIGHT				

Food Diary Outline – Example

Start Date and Time: 9/13/2020 at 9 AM End Date and Time: 9/14/2020 at 8 AM

Time	Food Consumed (including brand)	Amount (servings/ size/portion)	Beverage Consumed (including brand and water)	Amount (cups/ounces /size)
9 AM	Quaker Oats Brown Sugar Oatmeal	1 package	Starbucks K-Cup – French Vanilla	8 ounces
10 AM			Water	12 ounces
11 AM	Gala apple – medium	1	Diet Dr. Pepper Water	1 can 8 ounces
12 NOON				
1 PM	Newk's Club Sandwich	1	Newk's Sweet Tea	Large
2 PM			Water	16 ounces
3 PM				
4 PM	Lay’s Potato Chips	8-ounce bag	Orange Gatorade	16 ounces
5 PM				
6 PM	Pizza – Pepperoni	2 slices	Water	12 ounces
7 PM				
8 PM				
9 PM	Popcorn – Orville Redenbacher	1 bag – 3.29 oz	Water	6 ounces
10 PM				

11 PM				
12 MIDNIGHT				
1 AM				
2 AM				
3 AM				
4 AM				
5 AM				
6 AM				
7 AM	Lucky Charms with milk Banana - medium	1 cup/ 1 cup 1	Starbucks K-Cup – French Vanilla x2	8 ounces x2
8 AM			Water	8 ounces

Appendix C - Ole Miss Quizzes

Glen Ballard

Glen Ballard was born May 1, 1953 in Natchez, Mississippi. He graduated from The University of Mississippi with a Bachelor of Arts in 1975 majoring in music. He studied classical piano while at Ole Miss but also picked up the blues guitar as well. After his time at Ole Miss, he made his own production company, AUGURY, where he was able to go on the be one of popular music's most accomplished producers and songwriters whose records have sold more than 150 million copies worldwide. He has worked with Barbra Streisand, Aerosmith, Dave Matthews, Katy Perry, Aretha Franklin, Shakira, George Straight, and Van Halen just to name a few. Ballard also co-wrote and produced Alanis Morrissette's "Jagged Little Pill" which sold 33 million copies worldwide and received 4 Grammys and was named Best Album of the Decade by Billboard Magazine. In addition to the album "Jagged Little Pill", he also notably wrote and arranged "Man in the Mirror" for Michael Jackson. In addition to this, he co-wrote and produced the Grammy-winning and Oscar-nominated song "Believe", performed by Josh Groban, for the movie The Polar Express as well as wrote the lyrics and music for GHOST the Musical which was based on the Academy Award winning film Ghost starring Patrick Swayze and Demi Moore. Ballard is a 6-time Grammy award winner.

Bill Jordan

Bill Jordan graduated from The University of Mississippi in 1973 with a Bachelor of Business Administration. During his time at Ole Miss, he played on the football team and was a wide receiver that caught passes from the legendary Archie Manning. Upon graduation, he went to work at Leon Jordan Marine which was his family's boat dealership. Ten year after returning to the family business, in 1983, he started Spartan Archery Products in the back of the family's boat dealership. Spartan Archery Products developed and manufactured a variety of archery clothing and accessories in basic woodland and WWII camouflage patterns. This would eventually lead to the development of the Realtree pattern which is the world's most effective camouflage pattern. Jordan introduced this pattern at the 1986 Shooting, Hunting and Outdoor Trade show. This would eventually lead to the launch of Realtree Outdoors, a TV show that started airing nationally in 1992. In 1999, Jordan founded Immersion Graphics Corporation which utilizes hydro-graphic film processing to apply camouflage to hard goods such as ATV, bows, and guns. He was induced into the University of Mississippi Sports Hall of Fame for achievements on and off the field in 2012. Also, in 2012, the Ole Miss Chapter of the National Football Foundation and College Hall of Fame honored Bill with its Distinguished American Award, which is presented to individuals who have carried the lessons learned on the football field into a life of service in the community and business.

Pedro "Pete" Rodriguez

Pedro "Pete" Rodriguez was born in 1953 in Brooklyn, NY to Pellin Rodriguez and Elba Lopez Perez. Later his family moved to Bayamon, Puerto Rico where he graduated from La Salle High School with honors. After high school, he went to the University of Puerto

Rico at Mayaguez where he went through 4 different majors before settling on engineering. In 1976, he earned his bachelor's degree in mechanical engineering and was hired by NASA to design special test equipment at the Marshall Space Flight Center in Alabama. He then enrolled at the University of Alabama in pursuit of his masters and earned it in 1982. While pursuing his master's in mechanical engineering, he moved to Florida to work at Pratt and Whitney, a NASA contractor, to work on jet engines. Later in 1997, he would attend The University of Mississippi to earn his doctorate in civil engineering. While at NASA, Rodriguez served as the leader in the investigation of the Solid Rocket Booster accident following the February 2003 Space Shuttle Columbia accident. The led him to be the project manager for the Space Launch Initiative program. During his 32 years at NASA, he authored 13 technical papers, received NASA's Exceptional Service Medal, the NASA invention award for his battery powered seat that helped lift people with degenerative knee arthritis, the Silver Snoopy Award, the Astronaut Corp's highest award for outstand performance contributing to flight safety and mission success, and Marshall Center Director's Commendation Award.

James Barksdale

James Love Barksdale was born on January 24, 1943 in Jackson, Mississippi. He attended The University of Mississippi and received his Bachelor of Arts in Business Administration in 1965. While at Ole Miss, he was a member of the Eta Chapter of Sigma Chi fraternity. After graduation, he went on to marry his college sweetheart in 1965 and become a sales rep for IBM in Memphis. He would then go on to work at FedEx in

Memphis, where he would quickly rise up the corporate later becoming Chief Information Officer in 1979 then Executive Vice President and Chief Operating Officer in 1983. While holding these positions, he helped oversee the development of the first computer system capable of tracking millions of packages. He then went on, in 1992, to serve as president and Chief Operating Officer at McCaw Cellular Communications which merged with AT&T Wireless in 1994. Barksdale served as Chief Executive Officer at AT&T Wireless until 1995 when he joined Netscape. During the first two years serving as president and Chief Operating Officer at Netscape, Barksdale didn't believe that the company was up to its full potential so he refused a salary until he felt like it was performing better. However, in March of 1999, Netscape was purchased by AOL and Barksdale walked away with $700 million. After Netscape he went on to create his own investment firm, The Barksdale Group, which funds e-commerce ventures. On top of being phenomenal businessman, he is also a very philanthropic man, giving The University of Mississippi $5.4 million for the Sally McDonnell Barksdale Honors College and later $100 million to the State of Mississippi to create The Barksdale Reading Institute.

John Vaught

John Howard Vaught born May 6th, 1909 in Olney, Texas. He attended Texas Christian University (TCU) where he was an honor student and was named an All-American in 1932. Then went on the serves as a line coach at the University of North Caroline at Chapel Hill from 1936 until 1941. After serving in World War II in the United States Navy as a lieutenant commander, he took an assistant coaching position at The University of Mississippi in 1946 under Harold Drew. In 1947, he took over Drew's position as Head Coach. He quickly took the team to victory leading them to their first conference title in Ole Miss history. He would also go on to lead the team in Southeastern Conference titles in 1954, 1955, 1960, 1962, and 1963 being the only coach in Ole Miss history to win an SEC football championship. He also dominated the Egg Bowl rivalry going 19-4-2 against the Mississippi State Bulldogs. Vaught also has the longest unbeaten streak in Ole Miss history winning 23 consecutive games. He would also lead Ole Miss to 18 bowl games in his career, winning 10 times. Only Paul "Bear" Bryant (7-6-1) and Robert Neyland (3-2) help winning records against Vaught. He would go on to retire the season after suffering a mild heart attack in October of 1970s. Vaught's overall record was 190-61-12 and he moved Ole Miss up from 9th to 3rd in the SEC during his career at the university. Vaught passed away on February 3, 2006 at the age of 96 in Oxford, MS.

Appendix D - Quiz Questions

1. Where did John Vaught attend College?
    a. University of Mississippi
    b. University of North Carolina at Chapel Hill
    c. Texas Christian University
    d. University of Alabama
2. How long did Pedro Rodriguez work for NASA?
    a. 23 years
    b. 27 years
    c. 32 years
    d. 34 years
3. When did Bill Jordan found Immersion Graphics Corporation?
    a. 1996
    b. 1997
    c. 1998
    d. 1999
4. What was the name of Glen Ballard's production company?
    a. ANGRY
    b. AERO
    c. AUGURY
    d. AMORY
5. What position did James Barksdale hold Netscape?

a. Chief Executive Officer

b. Chief Information Officer

c. Chief Operating Officer

d. Chief Financial Officer

6. How many Grammy has Ballard received?

a. 4

b. 5

c. 6

d. 7

7. How many majors did Pedro Rodriguez go through before settling on mechanical engineering?

a. 2

b. 3

c. 4

d. 5

8. How many consecutive games did Vaught win?

a. 21

b. 22

c. 23

d. 24

9. What was the name of the of Bill Jordan's family's boat dealership?

a. Jordan's Boat

b. Jordan Family Marine

c. Leon Jordan Marine

d. Spartan Marine

10. How many copies did Alanis Morrissette's "Jagged Little Pill" sell?

a. 23 million

b. 27 million

c. 33 million

d. 37 million

11. What did Pete Rodriguez pursue a doctorate in at the University of Mississippi?

a. Chemical engineering

b. Mechanical engineering

c. Civil engineering

d. Aeronautical engineering

12. What year did James Barksdale becomes the Chief Information Officer at FedEx?

a. 1979

b. 1981

c. 1982

d. 1983

13. Who did Glen Ballard not work with?

a. Barba Streisand

b. Katy Perry

c. Van Halen

    d. Led Zeppelin

14. What year did Bill Jordan start Spartan Archery Products?

    a. 1984
    b. 1985
    c. 1983
    d. 1986

15. How much money did the Barksdale's donate to The University of Mississippi for the honors college?

    a. $5.2 million
    b. $5.3 million
    c. $5.4 million
    d. $5.5 million

16. Who was the head coach at Ole Miss that Vaught succeeded?

    a. Robert Neyland
    b. Harold Drew
    c. Paul "Bear" Bryant
    d. Frank Kinard

17. How many games did Vaught tie during his time at Ole Miss?

    a. 11
    b. 12
    c. 13
    d. 14

18. What year did Pete Rodriguez attend The University of Mississippi?

a. 1982
b. 1987
c. 1992
d. 1997

19. What year did Vaught pass away?

a. 2003
b. 2004
c. 2005
d. 2006

20. What year did Bill Jordan debut the Realtree pattern?

a. 1984
b. 1985
c. 1983
d. 1986

21. How much James Barksdale walk away with from the AOL purchase of Netscape?

a. $500 million
b. $600 million
c. $700 million
d. $800 million

22. In what year was Glen Ballard born?

a. 1953

b. 1952

c. 1955

d. 1954

23. Who did wide receiver Bill Jordan catch passes from?

a. Eli Manning

b. Archie Manning

c. Peyton Manning

d. Cooper Manning

24. Where in Puerto Rico did the Rodriguez family move after leaving New York?

a. Mayaguez

b. Bayamon

c. Culebra

d. Elba

25. What chapter of Sigma Chi was James Barksdale in?

a. Delta

b. Eta

c. Rho

d. Nu