THE EFFECTS OF ENERGY DRINKS ON SLEEP AND DAILY FUNCTIONING

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ABSTRACT

Caffeinated energy drinks are popular among young people (Reissing et al., 2009). The relatively high doses of caffeine in energy drinks and lack of regulations are concerning as caffeine can cause adverse physical and psychological effects, especially at high doses and among non-tolerant individuals. Energy-drink related ER visits doubled from 2007 to 2011, with most cases involving individuals 18 to 25 years old (SAMHSA, 2014). In addition to these serious acute effects, it is possible that energy drinks could be adversely affecting the sleep and daily functioning of users even when consumed at moderate doses that are not likely to cause acute caffeine intoxication. However, there is very little controlled research in this area. The goal of this study was to examine the effects of energy drink consumption on sleep and mood in a sample of young adults. Participants (n=24) consumed one energy drink each day for 28 days. Energy drinks contained no caffeine during the last 6 days of week 1 and all of week 4 and 200 mg caffeine during weeks 2 and 3. Participants were assessed once daily on sleep and liking of the drink and twice daily on mood and other caffeine-related symptoms. Participants reported significantly greater sleep disturbance during weeks they consumed caffeinated energy drinks compared to placebo energy drinks. Furthermore, participants reported greater jitteriness, lower fatigue and fewer headaches during caffeine weeks compared to placebo weeks. These findings are among the first to show a direct causal link between energy drink consumption and greater sleep disturbance and other effects among young adults. These findings warrant further investigation of the possible adverse effects of energy drinks and have implications for the regulation of caffeine content in energy drinks.

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INTRODUCTION

Energy drinks are a largely unregulated multi-billion dollar industry and are used disproportionately by young people (Reissig, Strain & Griffiths, 2009, SAMHSA, 2014). The primary active pharmacological ingredient in energy drinks is caffeine. Caffeine can cause adverse physical and psychological effects, especially at higher doses (> 200 mg) and among non-tolerant users. Energy drinks typically have higher caffeine concentrations (2.1-171 mg per fluid oz.) and a wider range of caffeine content (50-505 mg per can or bottle) than soft drinks, which are limited to 71.5 mg per 12 oz. serving (Reissig et al., 2009). The Drug Abuse Warning Network (DAWN) reported that the number of energy drink related emergency room visits doubled from 2007 (10,068) to 2011(20,783) with 1 in 10 visits resulting in hospitalization (SAMHSA, 2014). Sixty percent of the visits were due to use of an energy drink alone, and most patients were between the ages of 18 and 25 years. Furthermore, the FDA is investigating a number of unexpected deaths among young people after consumption of energy drinks that some have attributed to high doses of caffeine. In addition to these serious acute effects, it is possible that energy drinks could be adversely affecting the sleep and daily functioning of users even when consumed at moderate doses that are not likely to cause acute caffeine intoxication. This study was designed to investigate the effects of consuming an energy drink containing 200 mg caffeine each day for two weeks on sleep and daily functioning among a sample of young adult light caffeine consumers.

Caffeine Pharmacology and Clinical Effects

Caffeine is the primary pharmacologically active ingredient in energy drinks (Giles et al., 2012). With 80-90% of people in North America ages 2 years and older being regular caffeine users (drinking on average 280 mg a day), caffeine is the most commonly used behaviorally

active drug today (Frary et al., 2005; Gilbert, 1984; James, 1991). The most common sources of caffeine are coffee and soft drinks, yet almost half of caffeine consumers are ingesting multiple sources of caffeine throughout the day (Hughes and Oliveto, 1997). Caffeine exposure has been rising in recent years, largely due to its increasing presence in products from toiletries to food to energy drinks (Naish, 2013). The normalcy of caffeine use, especially the rise in energy drink use, may make it difficult for people to recognize and understand its pharmacological effects.

The primary mechanism of action of caffeine is competitive antagonism of adenosine (Fredholm, Battif, Holmen, Nehlig & Zvartau, 1999). By blocking A_1 and A_2 adenosine receptors, the calming and sleep inducing effects of adenosine are suppressed and consequently caffeine stimulates brain activity. Oral administration of caffeine is quickly absorbed in the gastrointestinal track reaching peak blood levels in about 30-45 minutes. Caffeine is eliminated with an average half-life of 4-6 hours (Liguori, Hughes & Grass, 1997). This half-life can be increased or decreased by different metabolism profiles. For instance, smokers develop a faster metabolism to caffeine while pregnancy and oral contraceptives have been shown to slow down the metabolism of caffeine (Fredholm et al., 1999; Grela et al., 2013). Repeated use of caffeine can lead to caffeine tolerance, in part due to the upregulation of adenosine receptors in the brain. That is, users require an increased amount of caffeine to experience the same subjective, physiological and behavioral effects or the same amount of caffeine produces lesser effects.

Subjectively, studies have shown that caffeine when administered in low to moderate (20-200 mg) doses increases energy, alertness, well-being, happiness and sociability (Liguori et al., 1997; Juliano & Griffiths, 2004). Individuals given caffeine have also exhibited enhanced cognitive abilities including faster reaction time and greater vigilance (Smit & Rogers, 2000). However, caffeine can also produce a profile of negative subjective effects, including

nervousness, anxiety, jitteriness, and stomach upset, especially as the dose increases and/or among non-tolerant or sensitive individuals. At very high doses sweating, muscle twitching, cardiac arrhythmia and death have been reported. Clinically significant distress along with negative subjective and physiological effects is consistent with a DSM-5 diagnosis of Caffeine Intoxication (American Psychiatric Association, 2013; Greden, 1974).

Caffeine is also very effective at counteracting sleepiness and can be used functionally to ward off sleep during times when wakefulness is desired (Carrier et al., 2009; Lodato et al., 2013). Caffeine can also produce unwanted sleep disturbances, especially among non-tolerant users. Regardless of the dosage or vehicle, taking caffeine close to the time of planned sleep reduces total sleep time, prolongs sleep onset and disrupts sleep stages (Roehrs & Roth, 2007). In one study that mimicked sleep deprivation in 12 healthy males, those who were not regular caffeine users were more likely to have a longer latency to sleep time, decrease in total sleep time, and lower sleep efficiency compared to more consistent caffeine users (Paterson, Nutt, Ivarsson, Hutson, & Wilson, 2009). Few studies have investigated the effects of caffeine abstinence on sleep. A meta-analysis identified just 3 studies examining sleep after one day of abstinence (Sin, Ho & Chung, 2009). These studies showed that caffeine abstinence for one day led to improvements in sleep quality (Sin et al, 2009).

There is a large body of evidence demonstrating that caffeine produces physical dependence, in which terminating or sharply reducing one's caffeine intake results in withdrawal symptoms including headaches, fatigue, difficulty concentrating, mood disturbances, and flu-like symptoms as defined by the DSM-5 (APA, 2013; Juliano & Griffiths, 2004). Doses as low as 100 mg per day have been shown to be sufficient to produce physical dependence in some

caffeine users, as evidenced by withdrawal symptoms when placebo is substituted for caffeine (Griffiths et al., 1990). Caffeine withdrawal symptoms typically persist for 2 days to 2 weeks.

Some individuals with problematic caffeine use have also been identified. That is, in addition to physical dependence, they experience physical or psychological (e.g., anxiety, insomnia) negative effects from caffeine ingestion but are unable to quit or reduce caffeine despite a desire to do so. The DSM-5 recently added caffeine use disorder as a condition for further study (Meredith et al, 2013).

Caffeine Research among Younger Users

Caffeine is one of the few recreational and behaviorally active drugs that can be purchased by minors. As such it is not surprising that 98% of children and adolescents ingest caffeine at least once a week (Bernstein et al., 1998). Although caffeine has been extensively studied in adult populations there is much less information on how caffeine influences children, adolescents, and young adults.

Sleep is an area that is of particular importance among young people. Sleep is necessary for physical growth as well as brain maturation including memory and plasticity (Spruyt & Gozal, 2012). Insufficient sleep has been linked to breathing problems, limits in memory performance, and less physical activity (Spruyt & Gozal, 2012). As sleep continues to decrease by age chronic sleep loss has been seen to contribute to an increased rate of depression, suicidal ideation and obesity with long term sleep loss linked to lower test scores and overall academic achievement (Lahey, 2014). The United States National Sleep Foundation (NSF) reported in 2014 that only 10% of adolescents receive the optimal amount of 9-9 ½ hours of sleep (NSF, 2014).

There is some evidence that children experience sleep disruptive effects of caffeine. Children 5-10 years of age need at least 10-11 hours of sleep for optimal functioning. In a

secondary analysis of the National Sleep Foundation's Sleep in America poll (2004) with 625 parents rating their children's sleep, health, and factors that influence sleep, the average sleep time was only 9.5 hours with children who consumed caffeine averaging at least 15 less minutes of sleep every night (Calamaro et al., 2011). This pattern of sleep dysfunction appears to continue into adolescence and adulthood. In a survey of 197 high school students, 95% of them report consuming caffeine, with the majority of the adolescents' first use of caffeine being soda in the evening (Ludden & Wolfson, 2010). These sleep disturbances have been linked to an increase daytime sleepiness which can affect overall daily functioning (Roehrs & Roth, 2007; Ho & Chung, 2013). Correlational studies have shown poor overall sleep in college usage is also linked to high caffeine use (Caine-Bisch, 2014; Trokel, Barnes, & Egget, 2000).

There have been very few studies investigating the effects of caffeine on mood and withdrawal among young people. Goldstein and Wallace (1997) compared high consuming caffeine children (greater than 50 mg) and low consuming caffeine children (less than 10 mg) on a 20 item checklist with negative and positive symptoms in a two day study with one day of regular consumption followed by one day of abstinence. Participants with higher caffeine consumption exhibited mood patterns such as feeling wide awake, energetic, happy and thinking clearly. Their symptoms during day 2 abstinence included feeling tired and muscle tension. Headache, a common withdrawal effect among adults, was not reported. Bernstein et al. (1998) examined withdrawal symptoms among 30 children ages 8-12 whose caffeine intake was at least 20 mg/day. The children were administered 120-145 mg of caffeine per day in the form of soda for 13 days and then were given a decaffeinated soda on the fourteenth day. On the decaffeinated day, all children exhibited a decrease in attention (Bernstein, 1998). During the return to baseline testing the children were still less focused in attention tasks showing that there might be a slight

withdrawal carryover and not a full return to baseline (Bernstein, 1998). Similar withdrawal effects have been shown in adolescents (Bernstein et al., 2002).

Energy Drinks

Energy drinks are a popular vehicle for caffeine among adolescents and young adults (Reissig et al., 2009). Advertisers capture this demographic through flavor and color preferences, gender specific ads, and risk taking or jock identity motifs (Bunting, Baggett & Grigor, 2013; Miller, 2008). Young consumers gravitate toward these drinks for reasons ranging from obtaining one's daily vitamins to energy intake, weight loss, and masking alcohol taste (Hoffman, 2010; Malinauskas, Aeby, Overton, Carpenter-Abey, & Barber-Heidal, 2007). With high sugar content and interesting flavors, energy drinks may appeal to those who do not like the bitter taste of coffee. More than half of the market of energy drinks is comprised of young people, which consequently represent a majority of energy drink emergency room visits (Babu, Church & Lewander, 2008; Seifert et al., 2011; SAMHSA, 2014).

Many adolescents consume energy drinks to stay alert for a short period of time; however, excess energy drink consumption can likely lead to sleep disturbances (Reissig et al, 2009). In a survey in Thailand of 2,184 college students 48.1% reported poor sleep quality through the Pittsburg Sleep Quality Index (PSQI) (Lohossonthron et al., 2013). Of those who reported poor sleep quality 63.9% consumed stimulant beverages. Of those who reported good sleep quality 52.8% consumed stimulant beverages. Overall there was a statistical significance between poor sleep quality and those who consumed caffeinated beverages [$p<.0001$] (Lohossonthron et al, 2013). Accordingly, a survey of 496 college students in the United States showed the most prevalent reason for energy drink consumption was to fight insufficient sleep (Malinauskas et al., 2007). In this vicious cycle energy drinks are used to fight fatigue yet excess use can endanger sleep leading to resorting back to energy drinks to combat exhaustion. Sleep

disturbances have been linked to increased anxiety and depressed mood making energy drinks only a temporary fix (Brooks, Girgenti & Mills, 2009; Stasio, Curry, Wagner & Glassman, 2011). Although studies have shown a correlation between greater energy drink consumption and poorer sleep, at this time no prior studies have experimentally manipulated the caffeine content of energy drinks and evaluated the resulting effects on sleep over a period of time.

Energy drink experimental studies primarily have focused on adults with a focus on increased attention, memory, and athletic ability. Results have linked caffeine as energy drink's primary mechanism of action with glucose used to sustain caffeine's effect on cognitive measures such as n-back test and rapid visual information processing (Smit, Cotton, Hughes & Rogers, 2004; Giles et al, 2012). Energy drinks have also been shown to elevate mood similar to caffeine mood effects. Smit and colleagues (2004) showed that an energy drink compared to a placebo void of caffeine and CHO (a complex sugar similar to glucose) produces greater energetic arousal and euphoria in participants after overnight caffeine abstinence (Smit et al., 2004). These results were consistent with other caffeinated energy drink studies in which caffeine reduces fatigue and increases feelings of tension and vigor (Giles et al., 2012; Siedl, Peryl, Nicham, &Hauser, 2000). However, similar to the majority of caffeine research that involves overnight abstinence in regular caffeine consumers, these effects may be a result of withdrawal reversal rather than a true net benefit of caffeine. Studies involving non-tolerant/non-dependent individuals could help decipher to true nature of the observed caffeine effects by ruling out withdrawal reversal as the cause of the differences between caffeine and placebo. To date there have been no studies investigating the long term effects of caffeinated energy drink consumption on mood.

Caffeine intoxication syndrome, while not yet studied experimentally, is a serious detrimental side effect of energy drinks. Some individuals have experienced seizures and heart arrhythmia as well as other caffeine intoxication symptoms after consumption of energy drinks (Iyadurai & Chung, 2007; Kapner, 2004; Reissig et al., 2009). The common practice of mixing energy drinks with alcohol and consuming energy drinks as meal replacements exacerbate this growing problem. While full intoxication effects have not been explored experimentally, jitteriness and anxiety have been reported at moderate levels in previous energy drink studies (Smit et al., 2004; Giles et al., 2012).

Caffeine physical dependence and withdrawal is another potential implication of caffeinated energy drink consumption. Giles and colleagues (2012) were the first to observe withdrawal symptoms while manipulating caffeine, taurine and glucose in energy drinks. Forty-eight medium to high caffeine consumers in a randomized, double-blind, mixed study drank four combinations of taurine and caffeine in the course of 4 weeks after overnight abstinence from caffeine. Between the drinks there was a 3 day washout period where participants consumed 50g of glucose or a placebo. The drinks were as follows: 200 mg of caffeine with 0 mg of taurine, 0mg of caffeine with 200 mg of taurine, 0 mg of caffeine and taurine, and 200 mg each of caffeine and taurine(Giles et al., 2012). Participants were tested on cognitive measures, the POMS, and a withdrawal questionnaire (WQ). The WQ developed by Evans and Griffiths contained 5 subscales: headache/poor mood, activity/alertness, physical symptoms (ie jittery and lightheadedness), tiredness and flu-like symptoms. Participants reported a reduction in headache symptoms and tiredness and increase in alertness. Taurine alone reduced headaches symptoms yet exacerbated other withdrawal symptoms. When combined however, caffeine was more

influential than taurine. No prior research studies have investigated the development of physical dependence among energy drink consumers.

Current Study

This study explored the effects of daily caffeinated energy drinks among 24 young adults who were light caffeine consumers. Participants were administered one energy drink each day for 4 consecutive weeks. Energy drinks contained 0 mg of caffeine during the last 6 days of week 1, 200 mg of caffeine during weeks 2 and 3, and 0 mg of caffeine during week 4. A dose of 200 mg caffeine was chosen as it is sufficient to produce a pharmacological effect but not likely to cause clinical significant disruptions in daily functioning. It is also roughly the amount of caffeine in a dose of popular energy drinks and energy shots on the market. Sleep, mood, caffeine intoxication, and caffeine withdrawal were assessed daily. It was predicted that caffeine administration would produce sleep disturbances relative to placebo. The effects of energy drinks on daily mood symptoms were also examined with a prediction that caffeine consumption would increase self-reported anxiety. A caffeine withdrawal measure was administered to investigate if caffeine withdrawal symptoms would manifest during the final placebo week after two weeks of daily caffeine exposure. Caffeine intoxication symptoms were also monitored daily but clinically significant caffeine intoxication symptoms were not anticipated.

CHAPTER 2

METHOD

Participants

Participants were recruited from the campus of American University through flyers and web postings. One hundred participants expressed interest in participating in the study. Upon receiving information about the study 39 participants did not continue on with the email screen process to determine eligibility (31 did not continue the email process to determine eligibility, 4 did not believe they could commit to the study, 2 did not think the study was healthy, and 1 did not want to consume carbonated drinks).

Of the remaining 61 participants who answered the eligibility questions 28 participants were ineligible. Four participants were excluded for not being between the targeted 18-25 year old age range. Cigarette smokers (n=3) or those taking oral contraceptives (n=12) were also ineligible to participate as both affect caffeine metabolism (Fredholm et al., 1999; Grela et al., 2013). Individuals who consumed more than 100 mg of caffeine per day or consumed caffeine more than 5 days per week (n = 9) were also excluded as they may be physically dependent on caffeine and thus be susceptible to withdrawal the first week of receiving placebo energy drinks (see Griffiths et al., 1990). Thirty-four participants remained eligible but eight could not participate due to scheduling conflicts leaving twenty-six participants eligible to participate.

Twenty six participants began the study which lasted from February to June of 2014. One participant was discharged due to non-compliance (drank all of the energy drinks by day 2) and one dropped out during week 2 due to the negative effects the participant believed the drinks were having on his sleep. Thus, there were 24 treatment completers (48% female) with a mean age of 20.68 years (SD=1.82). The racial breakdown was as follows: 40% Caucasian, 20% African American, 16% Asian, 16% Hispanic, and 8% other race. Participants were compensated

$74 for their participation. Students in psychology courses (11.54%) were given the option to earn extra credit points plus $44.

Measures

Demographic Questionnaire. This 12-item questionnaire was developed for this study and contained questions about the participants' age, gender, educational status, and race. Participants were also asked if they had any previous sensitivity to caffeine, energy drinks, or any energy drink ingredients.

Caffeine Exposure Questionnaire (CEQ). The CEQ assesses total exposure to caffeine from all sources. Participants were asked to indicate the number of servings, typical serving size, typical brand, and number of days per week they consumed coffee, tea, caffeinated soft drinks, energy drinks, chocolate, and caffeine containing medications/dietary supplements and foods. For the purpose of this study this questionnaire was administered using a 30 day timeline-follow-back-procedure (Sobell & Sobell, 1992) with participants being shown a calendar and retracing their caffeine intake of the previous month.

Patient-Reported Outcomes Measurement Information System-Sleep Disturbance Short Form (PROMIS-SD). The PROMIS-SD sleep scale was used to measure one's overall sleep during the course of the study (Yu et al., 2011). Participants were asked to complete the 8-item questionnaire on a 5-point scale from "1" ("Not at all") to "5" ("Very much") each morning upon awakening. This short form correlates with the original and has a high reliability (alpha=.95; [Yu et al., 2011]). Four items including overall sleep quality were reversed scored and a total score was derived. Clinically significant sleep disruption is indicated by a t-score of 59.4 or greater.

The measure demonstrated high internal consistency in the present study (averaged Cronbach's alpha=.828). One additional item that was analyzed separately asked participants if

they "slept longer than intended." This measure was developed to measure sleep disturbance on a weekly basis but was adjusted to measure daily sleep disturbance in the present study.

Profile of Mood States-Brief Form (POMS-BF). The POMS-BF (McNair, Lorr, Heuchert & Droppleman, 2003) is a 30 item self-report measure designed to assess various dimensions of mood that correlates highly with the full 60 item POMS. The POMS has been shown to be sensitive to the effects of caffeine in many prior studies (Griffiths et al, 1990; Childs & Wit, 2005; see Juliano & Griffiths, 2004). Participants rated each item on a 5-point scale from "0" ("Not at all") to "4" ("Extremely"). The measure has six subscales: Tension/anxiety, depression/dejection, anger/hostility, vigor/activity, fatigue/inertia and confusion/bewilderment. All the items score positively except for the item "efficient", which is reverse scored. A total score for total mood disturbance is also calculated. Internal consistency for total mood disturbance in the present study averaged alpha= .755 and the individual factors were as follows: Tension/anxiety= .635, depression/dejection= .628, anger/hostility= .602, vigor/activity= .880, fatigue/ inertia= .860. and confusion/bewilderment= .209. Confusion-bewilderment was not analyzed due to very low internal consistency.

Caffeine Intoxication. Ten items reflective of caffeine intoxication were assessed on a 5 point scale from "0" ("Not at all") to "4" ("Extremely"). These items were: dizziness, difficulty breathing, rapid heartbeat, muscle twitching/tremors, confusion, restlessness, irregular heartbeat, anxious, nervous, and jittery. This measure was developed for this study and was included to monitor potential adverse effects. These items were combined for analyses and exhibited good internal consistency when combined (average Cronbach's alpha=.702). The items anxiety, nervous, and jittery were also analyzed individually as these effects have been shown after caffeine administration in prior studies.

Caffeine Withdrawal Symptom Questionnaire (CWSQ). The CWSQ is a 23-item self-report measure of caffeine withdrawal symptoms (Juliano, Huntley, Harrell, & Westerman, 2012). There are seven factors: fatigue/drowsiness, low alertness/difficulty concentrating, mood disturbances, low sociability/motivation to do work, nausea/upset stomach, flu-like feelings and headache. Each item was rated on a five point scale from "0" ("Not at all") to "4" ("Extremely") with 8 items reverse scored. In addition to the original 23 items in the CWSQ the additional suggested item of queasiness was added and nausea/vomiting was separated into two items resulting in a total of 25 items (Juliano et al., 2012). The total withdrawal score had an average coefficient alpha in this study of .823. The individual factors internal consistencies on average were as follows: Fatigue/ drowsiness= .821, low alertness/difficulty concentrating= .780, mood disturbances= .794, low sociability/ motivation to do work = .748, nausea/upset stomach=.644, flu-like feelings= .463. Headache is a single item.

Open Ended Questions. Three open-ended questions were added to assess the nature of symptoms and any functional impairment as follows: 1. If reporting a headache, please describe the nature of the headache (e.g., throbbing, fullness, one-side or all over, sharp pain, dull pain, sensitive to movement, etc.); 2. Is there anything else you are feeling right now?; and 3. Did you have any difficulty completing your expected or normal routine today or fulfilling your usual responsibilities (e.g., going to class, work, the gym, studying, socializing, etc.). If yes, please describe.

Energy Drink Rating Scale. This measure was included to distract participants from the primary aims of the study and reduce potential demand effects. Each evening participants rated 11-items describing various aspects of the energy drink. The following 9 items were rated on an 11-point scale ranging from "0" ("Not at all") to "10" ("Extremely"): smells good, tastes good,

strong, pleasant, caffeine content, bitter, sour, sweet, carbonated. Additionally participants were asked "how much do you like this energy drink" from "0" ("Not at all") to "10" ("Very much so") and "would you chose to drink the energy drink once again" from "0" ("Definitely not") to "10" ("Most Definitely"). Items of caffeine content and drink liking were analyzed individually to assess blinding effects and possible condition taste preference (Temple et al., 2012).

Energy Drink

An energy drink was developed for this study so that caffeine content could be manipulated while holding taste constant. A combination of Fresca, apple juice, seltzer water, and various Kool-Aid flavorings were mixed to mimic the taste and appearance of an energy drink. Truvia (a 0-calorie sweetener) was used to limit caloric content resulting in a drink with about 55 calories per serving. To control for caffeine content, a 20ml caffeine water solution (10 mg/ml solution) or 20 ml of flattened tonic water was added to each drink. Participants were blind to the caffeine content of the energy drinks but the experimenter was not. Drinks were bottled in a clear 12oz glass bottle with red caps and a red label that said "Energy Drink" and placed in generic cardboard six-pack holders.

Procedure

Interested volunteers were screened for eligibility via email. They were given a detailed description of the study and requirements. They were told that this was a four week study involving daily consumption of energy drinks "that may or may not contain sugar, taurine, caffeine, guarana, aspartame, vitamins, artificial flavorings, and or other substances often found in energy drinks". They were also told that they would be required to abstaining from all caffeinated products including energy drinks, except for the ones provided to them. Those who met the eligibility requirements were scheduled to attend a baseline appointment where informed consent was obtained. Then participants completed the demographics questionnaire, PROMIS-

SD, POMS-BF, caffeine intoxication, CWSQ, and open ended questions scales via surveymonkey.com. Next, the participant received an energy drink with 200 mg of caffeine as a challenge dose to make sure that the participant would not experience any strong adverse effects to this dose of caffeine. After consumption participants completed a paper version of the energy drink rating scale and the CEQ time-line follow back interview with the experimenter. The CEQ not only provided information on the participant's drinking pattern for the last month but also allowed the participant time to absorb the caffeine dose while the researcher was present. Once 30 minutes had elapsed since the participant consumed the energy drink, they then completed measures of POMS-BF, caffeine intoxication, CWSQ, and open-ended questions. The participants then received 6 bottles of an energy drink that contained 0 mg caffeine. Instructions given to participants upon conclusion of baseline:

> For the next week you will receive six more bottles of the energy drink. You are to consume one drink per day, before 3pm. This is your only source of caffeine for the next four weeks. Through the study you will receive emails containing surveys twice daily. Please complete morning surveys as soon as you wake up or by 10 pm and evening surveys between 10pm-12 am. Your next appointment is one week from today. Please return the bottles at your next appointment.

One week from the baseline day participants returned to the lab. For the second lab visit participants once again provided a saliva sample. This served as a bogus pipeline procedure and a measure of compliance in addition to participants returning the bottles at each visit. Next the participant had 30 minutes to drink and rate the energy drink, this time containing 200 mg of caffeine. The participants also received another 6 pack (with each drinks containing 200 mg of caffeine) for the next week. This process continued for the remaining two weeks, with the third week's drinks containing 200 mg of caffeine and the fourth weeks' drinks containing 0 mg caffeine. This is considered an ABBA design. Although many studied use an ABAB design it

was important in this particular study to return participants back to baseline without dependence to caffeine.

Each day participants completed measures in the morning and afternoon that were emailed to them through www.surveymonkey.com and could be completed on their computers or smart phones. The morning surveys included the PROMIS-SD, POMS-BF, CWSQ, caffeine intoxication, and open-ended questions. The evening surveys included the energy drink rating scale, POMS-BF, CWSQ, caffeine intoxication, and the open-ended questions. Participants were compensated $0.50 for every survey they completed ($24) and $10 for every lab visit they attended for a maximum total of $74. On the final lab visit participants provided a saliva sample, completed an experiment evaluation form, were compensated and debriefed.

Table 1. Demographic Information

Characteristics	**Percent (%) of participants**
Sex	
Male	52
Female	48
Age (In years)	20.68 (1.82)
Race	
Caucasian	40
African American	20
Asian	16
Hispanic	16
Other	8
Height (in inches)	66.88 (3.76)

Weight (in pounds)	163.95 (46.69)
Year in School	
Freshman	28
Sophomore	20
Junior	20
Senior	20
Graduate School	12

CHAPTER 3

RESULTS

Compliance. Eighty-six percent of survey opportunities were completed (i.e., 14% missing data). As shown in Table 1, week 1 showed the best compliance with only 26 surveys skipped out of 350 survey opportunities. Weeks 2 and 4 showed the worse compliance with 65 and 66 skipped surveys respectively. With the exception of week 4 the majority of missing data came from evening surveys.

Caffeine Use. The caffeine exposure questionnaire given via the time-line-follow-back-technique (Sobell & Sobell, 1992) allowed the experimenters to assess participant's caffeine consumption in the past month. In the last month the participants consumed caffeine an average of 9 days. The primary sources of caffeine were as follows: 48% consumed coffee, 20% consumed soda, 12% consumed tea, 12% consumed no caffeine 8% consumed energy drinks and 8% had a varied response in their caffeine consumption including over the counter medications. Of those who consumed caffeine, caffeine consumption over the previous month ranged from 80mg to 2168 mg. Participants consumed a mean of 22.33 mg on average per day (SD = 19.22) and 60.67 mg (SD=33.97) per day on days they consume caffeine.

Table 2. Compliance per Week.

Week	Morning	Evening	Total
1	172 (98%)	152 (87%)	324 (93%)
2	146 (83%)	139 (79%)	285 (81%)
3	146 (86%)	143 (85%)	289 (86%)
4	133 (80%)	137 (82%)	270 (80%)

Baseline Measure. The POMS-BF was compared through a paired t-test the two times administered during baseline, before the drink was administered and after the drink was administered. The post measure was added after 5 participants has completed baseline so these results are based of the last 20 participants. Table 3 shows the results by factor as well as total mood disturbance. Thirty minutes after caffeine was administered there was a significant increase in vigor and a significant decrease in depression, fatigue, confusion, total mood disturbance and a trending decrease in anger. There was no significant difference between pre and post drink in tension/anxiety. In addition the the single item of anxiety did not show significance in the pair t-test of pre [M=.55 (SD=.89)] and post [M=.40 (SD=.60)] challenge dose t (19) = 1.00, p = .330, d=.20.

Table 3. POMS-BF Pre and Post Energy Drink

Subscale	Pre ED M(SD)	Post ED M(SD)	*P*	*d*
Tension/Anxiety	.29 (.48)	.23 (.28)	.481	.15
Depression/Dejection	.23 (.31)	.04 (.08)	.011	.84
Anger/Hostility	.12 (.26)	.02 (.06)	.096	.53
Vigor/Activity	.67 (.53)	1.2 (.90)	.005	.72
Fatigue/Inertia	1.16 (.88)	.63 (.61)	.003	.70
Confusion/Bewilderment	.73 (.41)	.41 (.25)	.036	.94
Total Mood Disturbance	1.60 (1.38)	. 24 (1.33)	.000	1.00

Analytic Strategy. For the primary dependent measures, means were calculated for each week so that the caffeine and placebo weeks could be compared. The PROMIS sleep measure

was given only in the morning and thus weekly means were based on the 7 morning values. Weekly means for the measures of mood, intoxication, and caffeine withdrawal included morning and evening ratings (max 14 observations for each). Energy drink ratings were assessed only in the evening and thus weekly means are based on the 7 evening values. Headache was calculated both in terms of the total number of headaches reported each week as well as the number of individuals who reported a headache in a given week.

Using paired samples t-tests, weeks 1 and 4 (placebo weeks) were compared to weeks 2 and 3 (caffeine weeks) to examine the effects of caffeine on sleep, mood, and caffeine intoxication. To evaluate possible caffeine withdrawal effects weeks 3 and 4 were compared using paired samples t-tests on the CWSQ and POMS-BF. However, a significant difference could represent an effect of caffeine rather than a withdrawal effect. Thus, significant differences were followed up with a comparison of weeks 1 and 4 to test if week 4 ratings were significantly different from baseline, which provides evidence of a withdrawal effect rather than a caffeine effect (Juliano & Griffiths, 2004; Evans & Griffiths, 1999). Headache incidence was compared across the weeks using chi-square.

Sleep. Paired samples t-test revealed that sleep disturbance was significantly greater during caffeine weeks than placebo weeks, $t(23) = -4.56$, $p < .001$, d=.52. As shown in Figure 1 participants had a mean sleep disturbance score of 18.34 (SD= 3.27) during caffeine weeks and 16.77 (SD= 2.68) during placebo weeks. Sleep disturbance was in the clinically significant range (t score > 59.4) 18 times during the study for 8 different participants. Eighty-nine percent of clinically significant sleep disturbance scores were observed during the caffeinated weeks.

Mood. Participants reported less fatigue (POMS) during caffeine weeks [M= .75 (SD=.59)] than placebo weeks [M = .91 (SD=.65)], t (23) = 2.26, p = .035, d=.20 (See Figure 2).

There was a trend for greater total mood disturbance on the placebo weeks [M=1.32 (SD=1.23)] than the caffeine weeks [M=1.05 (SD=1.44)], t (23) = 1.725, p = .101, d=.20. There were no significant differences on any of the other POMS factors.

Caffeine Intoxication. The total caffeine intoxication score did not differ when caffeine weeks were compared to placebo weeks. Participants did report a marginally significant increase of jittery on caffeine weeks [M=.14 (SD=.32)] compared to placebo weeks [M=.09 (SD=.21)], t(23)=1.93, p=.065, d=.18 (see Figure 3). There were no differences on the individual items of anxiety and nervous.

Caffeine Withdrawal. The PROMIS showed a significant difference between weeks 3 and 4 with less sleep disturbance in week 4 [M= 16.47 (SD= 3.74)] than week 3 [M=18.81 (SD= 3.64)], t (23) = 4.146, p <.001, d=.90. However, a caffeine withdrawal effect was not evidenced as there was no difference between week 1 (baseline) and week 4 (see Figure 1). On the single item "I slept more than intended" there was a trend of sleeping more on week 4 [M=2.43 (SD=.85)] than week 3 [M=2.18 (SD=.67)], t(23)=1.83, p=.081, d=.33. Yet there was no significant difference between weeks 1 and 4 suggesting that this was an effect of caffeine.

On the POMS-BF, participants reported significantly less vigor in week 4 [M= .69 (SD= .70)] compared to week 3 [M= .84 (SD= .77)], t (23) =2.12, p = .046, d=.20. However as seen in Figure 4, there is no difference between weeks 1 and 4 suggesting that this may be a caffeine effect rather than withdrawal effect. No significant differences between weeks 3 and 4 or 1 and 4 were seen on any of the other POMS factors or total mood disturbance.

The total caffeine intoxication score did not show any differences between weeks 3 and 4. The single item jittery was lower in week 4 [M=.08 (SD=.27)] compared to week 3 [M=.12 (SD=.34)], t(23)=1.66, p=.110, d=.13. Although as seen in Figure 3, there is not a significant

difference between weeks 1 and 4 suggesting that this may be a caffeine effect rather than a withdrawal effect. No significant differences between weeks 3 and 4 or 1 and 4 were seen on the other single items of anxiety or nervous.

There were no differences between weeks 3 and 4 on any of the CWSQ factors or the total withdrawal score. Seven individuals reported a headache during the first two days of week 4 (upon switching to placebo energy drinks) compared to only 2 individuals reporting headache the first two days of week 3, and 2 reporting headache the first two days of week 2. However, the high rate of headaches during week 1 with 8 people reporting headaches in the first 2 days, suggests that these difference cannot be attributed to caffeine withdrawal (see Table 4).

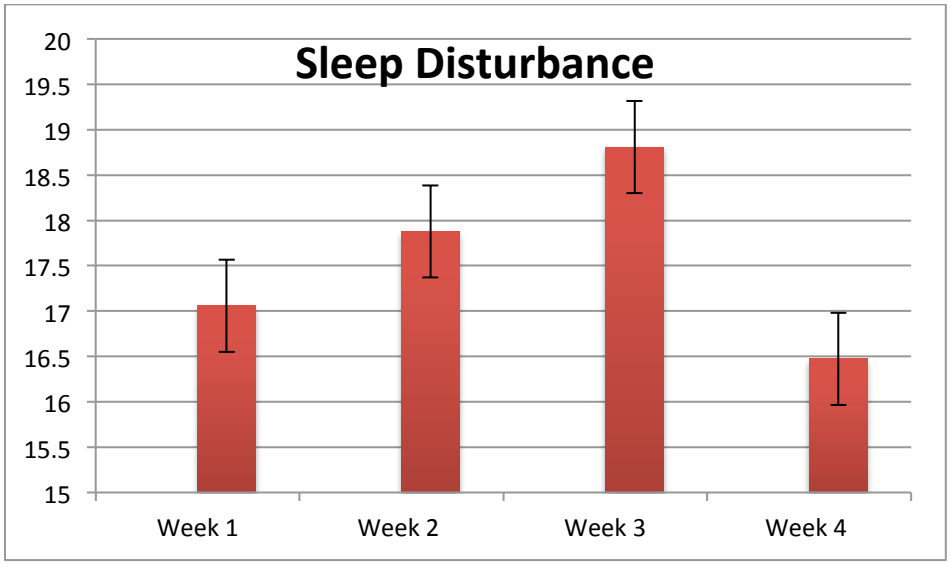

Figure 1. Total Sleep Disturbance

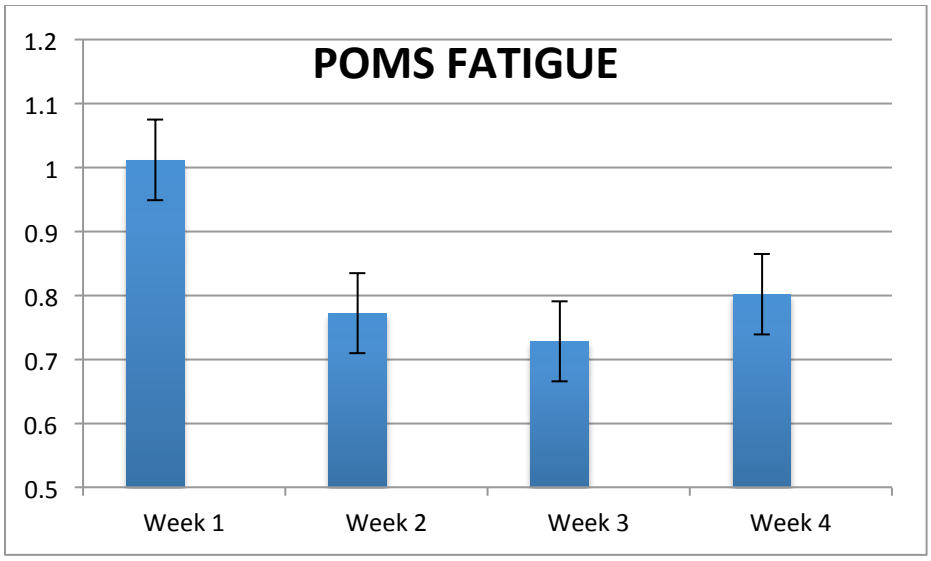

Figure 2. POMS Fatigue

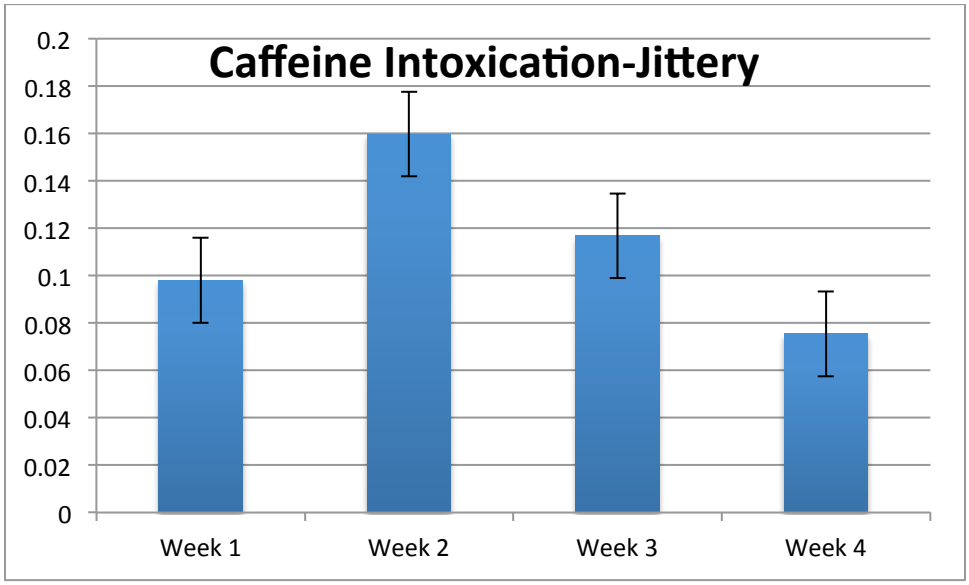

Figure 3. Jittery

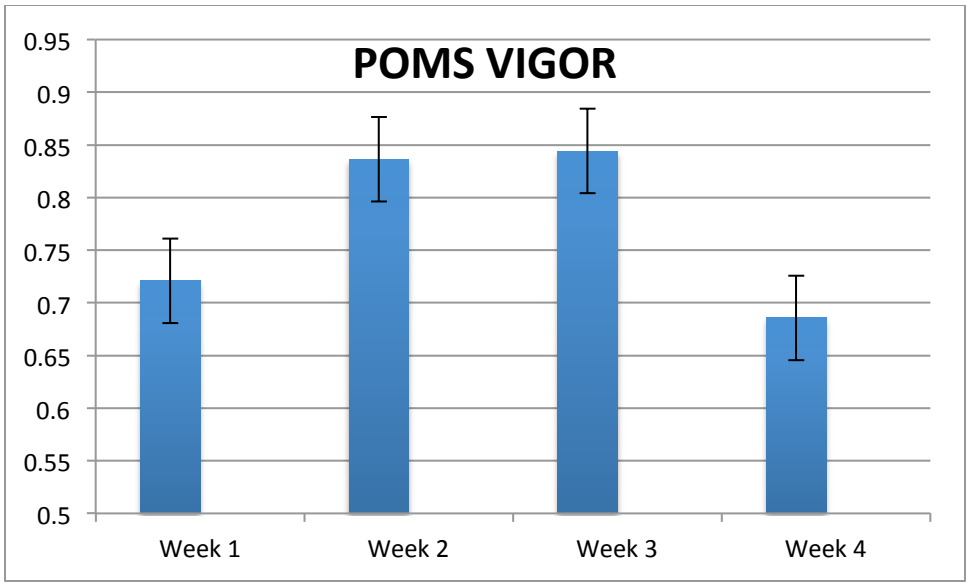

Figure 4 POMS Vigor

Table 4. Reported Headaches

Week	Headache instances first 2 days	Headache instances per week	People with headaches first 2 days	People with headaches per week
1	13	35	8	12
2	4	17	2	8
3	2	16	2	10
4	10	25	7	12

Open Ended Questions. With the exception of the describing a headache, participant's responses for open-ended questions decreased over time. On the question "Is there anything else you are feeling right now?" the number of responses per weeks were 23, 16, 10 and 8. Of these

responses 20 reflected oncoming sickness, 16 reflected feeling tired, 4 reflected feeling hungry, 3 reflected feeling hungover, 3 reflected jitteriness, 2 reflected disappointment, 2 reflected urinary issues and 1 response each in feelings of boredom, dry mouth and stress. On the question "Did you have any difficulty completing your expected or normal routine today?" responses per week were 27, 21, 13 and 11. Of these responses, 37 instances were due to feeling tired or sleeping longer than intended, 12 instances were academic related, 6 instances were due to missing normal routines such as gym and work, 5 instances were due to headaches, 4 instances were due to sickness, 3 instances were due to feelings of jitteriness, 2 instances were due to decreased sociability and 1 instances each was due to decreases appetite and urinary issues. The most common headache descriptors can be found on Table 5.

Energy Drink Ratings. The question of energy drink liking showed that in general the placebo drink was rated higher in liking [M=6.77 (SD= 2.12)] than the caffeine drink [M=5.53 (SD=2.23)], t (23) =3.25, p =.004, d=1.10 (See Figure 5). The caffeinated drink liking was rated higher in week 3 [M=5.82 (SD=2.48)] than week 2 [M=5.09 (SD=2.36)], t(23)=1.93, p=.066, d=.30 (See Figure 4).

Table 5. Most Common Headache Descriptors.

Descriptor	Week 1	Week 2	Week 3	Week 4
Dull	12	4	6	7
Fullness	3	2	1	4
Light	5	1	0	1
Severe	2	0	0	2
Sensitive to light	2	3	1	2

Sensitive to movement	3	3	2	3
Sharpness	1	0	2	3
Throbbing	8	7	7	4

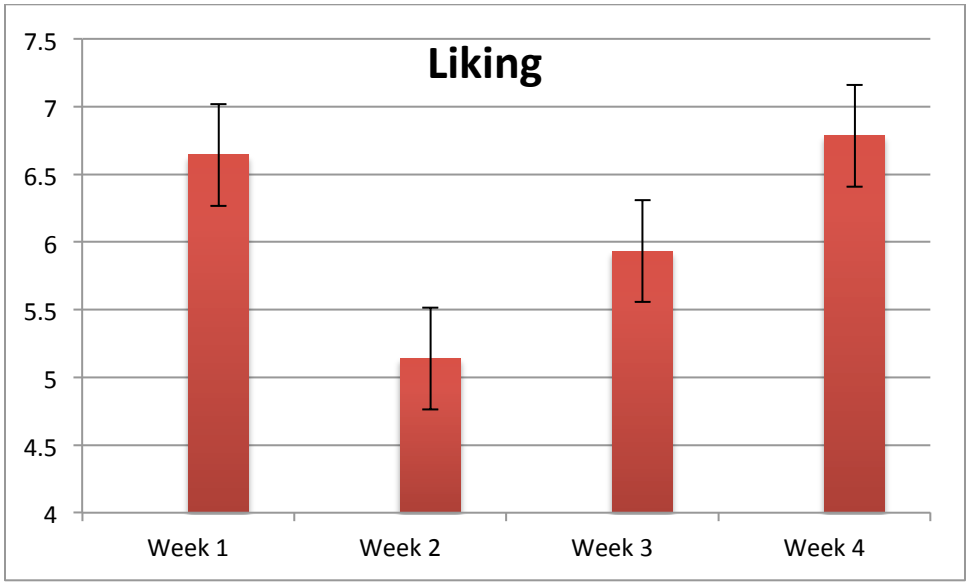

Figure 5. Liking of the Energy Drink

Caffeine Content Rating. This single question rating caffeine content on an 11 point scale from 0 to 10 provides some information on whether participants remained blind to caffeine content. There were no significant difference between caffeine [M=4.10, (SD=2.10)] and placebo weeks [M=4.18, (SD=2.14)], $t(23)=.377$, $p=.710$, $d=.04$, suggesting that the integrity of the single blind design remained intact even after participants consumed the drinks.

CHAPTER 4

DISCUSSION

This study is the first to directly manipulate caffeine in energy drinks while evaluating sleep and other effects over an ended period of time in a young adult sample consisting of light caffeine consumers. Energy drinks were chosen as the caffeine vehicle due to their popularity among young people and college students. Two studies have observed the immediate effects of energy drinks on alertness but no prior studies have examined effects of sleep over an extended period of time (Giles et al., 2012; Smit et al. 2004). The aims of the current study were to investigate if administering and withdrawing a moderate caffeine dose to light caffeine users in an energy drink would affect their sleep and other aspects of daily functioning. Symptoms of mood, caffeine intoxication, and caffeine withdrawal were also assessed two times each day.

As predicted the caffeine weeks did result in significantly greater sleep disturbance than the non-caffeinated weeks. This experimental study is consistent with previous correlational studies in which those who consume more caffeine report greater sleep disturbance (Lahey, 2014; Roeths & Roth, 2007). The single item "sleeping more than intended" demonstrated trending result of participants sleeping more on week 4 than week 3. Throughout the study there were 18 reports of clinically significant sleep disturbance among 8 participants with 89% of such reports during caffeine weeks. By instructing participants to consume their caffeine by 3pm, these energy drinks were not consumed with the typical goal of combating sleep. Energy drinks consumed by adolescents and young adults later in the day as is likely often the case would show even greater clinical sleep disturbance. The open-ended questions added to the majority of statistical data with fatigue and sleeping being the common topic of most interest for both impairments in daily functioning and other symptoms. One participant dropped out of the study due to reported negative effects on sleep.

Comparing caffeine and the placebo weeks also showed significant mood results with less fatigue reported during caffeine weeks than placebo weeks. Although placebo weeks allowed for less sleep disturbance they showed an increase in fatigue compared to the caffeine weeks. The increase in fatigue is a result of missing caffeine's subjective effects of alertness and energy. These results are consistent with previous energy drink studies (Giles, 2012; Smit et al., 2004). The POMS total mood disturbance and remaining subscales showed no significance between caffeine and placebo weeks. However it is important to note that the POMS may have lack sensitivity due to an experimental error as participants were asked to report how they felt at that particular time rather than how they felt throughout the day. Given that caffeine was taken before 3pm and participants completed surveys in the morning and before bedtime, the measures likely did not capture the acute effects of caffeine and thus the lack of findings are not surprising.

Caffeine intoxication did not produce significant results with the exception of the item jittery. Jitteriness was significantly greater during the caffeine weeks than placebo weeks and significantly decreased from weeks 3 to 4. Due to the lack of a significant difference between weeks 1 and 4 jittery was interpreted as an effect of caffeine. Jitteriness is a common feature of caffeine in light caffeine consumers (Rogers, Heatherly, Mullings, & Smith, 2013). The 200 mg dose of caffeine did not produce significant caffeine intoxication in our sample. However, consuming multiple energy drinks throughout the day or energy drinks with greater caffeine amounts would likely result in greater reports of intoxication symptoms. Future research that can ethically test energy drink intoxication would be valuable in helping develop warnings for energy drink consumers.

This acute administration of a 200 mg dose of caffeine over a period of two weeks did not appear to result in the development of physical dependence in our sample as a whole.

Griffiths et al. (1990) did find significant caffeine withdrawal in 4 out of 7 regular caffeine consuming participants when consuming 100 mg of caffeine for 9-14 days followed by 12 days of placebo capsules suggesting that that withdrawal is possible among some individuals at low doses. The poor wording of the CWSQ instructions may have decreased the sensitivity of the measure in identifying caffeine and withdrawal effects in that participants were asked to rate in the morning and evening how they felt "at this time". Future studies should assess how participants are feeling at other times throughout the day. The statistical analyses testing caffeine withdrawal were also highly conservative in that any differences observed between 3 and 4 were not deemed withdrawal symptoms unless week 4 (placebo) also showed differences from week 1 (placebo). The more common approach of just comparing a caffeine and placebo period may have resulted in the conclusion that caffeine withdrawal was evidenced in our study by significant differences on measures between weeks 3 (caffeine) and 4 (placebo). Our conservative strategy relies heavily on the assumption that participants were not experiencing any withdrawal symptoms during the first week of the study. However, it is notable that the incidence of headache and other symptoms were strikingly high during the first week when the energy drinks contained placebo. Although we purposefully recruited light caffeine consumers, it cannot be ruled out that some participants were experiencing caffeine withdrawal due to the abrupt cessation of caffeine during this time. If this were the case, then our conservative strategy was not capable of detecting caffeine withdrawal effects. Future research should analyze biological samples to validate self-reported caffeine consumption among participants who claim to be light caffeine consumers to rule out this possibility or involve a longer baseline period with at least 2 to 3 weeks of placebo (i.e., after two weeks withdrawal symptoms should have subsided).

Responses to the "liking" item on the energy drink rating scale indicated that participants liked the placebo drinks more so than the caffeinated drinks. This is likely due to the bitter taste of caffeine. It is interesting to note that liking of the caffeinated drink increased significantly from weeks 2 to 3 of the study. This is consistent with previous research that has shown that the preference for previously neutral flavors that are paired with caffeine increase after repeated exposure (Temple et al., 2012). Despite differences in liking, there were no differences in ratings of caffeine content between weeks the energy drink contained caffeine and placebo. This suggests that blinding was successful and serves to rule out dose expectancy effects as a potential confound.

The POMS-BF baseline differences in relation to the challenge dose highlights 200mg as a dose responsive to these light consumers. This challenge dose of caffeine did have significant results similar to previous POMS-BF response to caffeine with a decrease in total mood disturbance, depression, anger, fatigue and confusion as well as an increase in vigor (Juliano & Griffiths, 2004). There was no significance in tension/anxiety and anxiety showing that this challenge dose did not affect these participants adversely.

There are a number of limitations of the study that should be noted. First, as already discussed, the two time a day administration of measures may have not been sensitive enough to detect effects of caffeine due to the energy drink as such effects tend to be short-lived (i.e., caffeine peak effects occur within one hour of administration). Aside from the PROMIS sleep questionnaire the measures in this study instructed participants to rate how they felt "right now" as opposed to throughout the day. Participants were given instructions on when to consume the energy drink and times to complete the survey. The participants were told to complete the morning survey as soon as they woke up, consume the drink by 3PM to avoid sleep impairment,

and to complete the survey between 7-12PM. This no doubt led to a great deal of variability between the time the energy drink was consumed and the time that surveys were completed. Future studies should attempt to measure effects closer to the time that caffeine is consumed as well as asking participants when they did consume the energy drink.

The participants rated energy drinks liking greater in the placebo phase. The difference in liking in these drinks do suggest that the formulation was detectable between the two. Light caffeine consumers are not use to caffeine's bitter taste and could easily dislike a different tasting drink. These drinks may have also become unappetizing after an extended period of time. Only two participants were regular energy drink consumers and therefore use to energy drinks distinct flavor profile. This particular energy drink recipe may need further refinement to make the formulation more palatable to participants.

The present investigation demonstrated that caffeine administration has a direct negative effect on sleep functioning. Future studies should expand on the sleep component on this study and ask more in-depth sleep questions as well as include objective measures of sleep such as actigraphy. Future studies should also be designed such that any differences between caffeine and placebo can be attributed to caffeine net effects or withdrawal effects by having an appropriate baseline comparison condition. This may require an extended baseline period (< 2-3 weeks) to ensure that participants are not experiencing caffeine withdrawal at baseline. Future studies that varied the dose levels of caffeine in the energy drinks could evaluate the dose response effects of caffeine on sleep, mood, and withdrawal. Future studies could also vary the length of time that participants are exposed to caffeine and evaluate the development of tolerance and physical dependence.

Findings from this four-week controlled experimental study provide direct evidence that caffeine taken prior to the evening hours disrupts sleep. Furthermore, greater jitteriness, lower fatigue and fewer headaches were reported during caffeine administration. Given the importance of sleep among young adult populations, these effects need to be further addressed. This study also demonstrates the feasibility of administering caffeine via energy drinks over an extended period of time. Additional studies of this kind will further increase our understanding of the world's most commonly used psychoactive drug.

APPENDIX A

INFORMED CONSENT

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

TITLE OF STUDY: Energy Drink Preferences

PRINCIPAL INVESTIGATORS: Rachael Burgower and Laura Juliano, Ph.D.

INTRODUCTION

We would like to invite you to be part of a research study at American University. Individuals who are 18 years and older and who read and write English are eligible to participate in this study. Individuals who smoke cigarettes and/or take oral contraceptives are not eligible to participate because of the effects that these substances have on caffeine clearance.

This form gives you information about the study. We will answer any questions you have about the study and this consent form. You will be given a copy of this form to keep for your records.

PURPOSE OF STUDY

The purpose of this study is to evaluate your preferences for energy drinks that may or may not contain sugar, taurine, caffeine, guarana, aspartame, vitamins, artificial flavorings and/or other substances. We will provide you will different energy drinks throughout the study and assess your reactions to the drinks.

PROCEDURE

This study takes place over the course of four weeks. If you agree to participate we will ask that you abstain from all caffeinated products including energy drinks for the full length of the study. Your compliance with this requirement will be assessed with saliva samples that will be collected each week and sent out for biochemical analyses. In addition you will be asked to attend an hour-long screening visit (today) in which you will complete questionnaires pertaining to your background, energy drink and caffeine usage, behaviors, moods, and beliefs. You will then be asked to consume and rate an energy drink. This energy drink may or may not contain sugar, taurine, caffeine, guarana, aspartame, vitamins, artificial flavorings and/or other substances often found in energy drinks. You will then be asked to consume one energy drink each day for the next four weeks. You will receive a week supply of energy drinks at a time and return to the laboratory each week for a refill. You will also be asked to complete a short questionnaire each morning and evening of the study. These questionnaires can be access via your computer or smart phone. At the end of the fourth week you will be asked to return to the lab to complete questionnaires, receive compensation, and learn more about this study.

POTENTIAL RISKS/DISCOMFORT

Consuming energy drinks that contain caffeine or abstaining from caffeine can produce anxiety or jitteriness, sleeplessness, sleepiness, nausea, fatigue, headache, and general feelings of discomfort.

CONFIDENTIALITY
All data collected from you will be kept completely confidential. A numeric code will be used in place of your name on all forms. Your records will be stored in a locked file cabinet in the Behavioral Pharmacology and Health Promotion Laboratory (Asbury Room 137) and in computer files that are password protected.

POTENTIAL BENEFITS
Participating in this research will provide no direct benefits to you. The ultimate goal of this research is to better understand energy drink consumption and energy drink effects to better inform the larger population of energy drinks consumers.

ALTERNATIVES TO PARTICIPATION
Participation in this study is entirely voluntary. If you decide to participate, you can change your mind and drop out of the study at any time. You can also decide at any time that you do not want us to use the data we have collected from you. Your decision to discontinue participation will not affect your entitlement to receive compensation for the time you have already put in.

COMPENSATION
You will earn $74 for your participation in the study. You will receive $10 for laboratory visits on the first and last day of the study. Each time you complete a questionnaire outside of the laboratory you will earn 50 cents (2 per day for a total of 48 questionnaires = $24) plus one chance to win a lottery prize of $100 (odds of winning are 1 in 12). You will also receive $10 every time you visit the lab to fill out forms and pick up the energy drinks for the following week. If you are a student and prefer to receive research credit, you can receive 3 research credits in lieu of payments for the laboratory visits. You will still earn compensation for completing forms outside of the laboratory.

This study has been approved by the Institutional Review Board, American University. If you have any questions or concerns about this study you can contact the supervisor for this study, Laura Juliano at juliano@american.edu or 202.885.1715. You may also contact the Chair of the Institutional Review Board Anthony Ahrens at ahrens@american.edu or 202.885.1714 if you have any concerns about your rights as a research participant.

Printed Name of Participant: _____

Signature of Participant: _____Date:_____

INVESTIGATOR'S AFFIDAVIT: I certify that I have explained to the above individual(s) the nature and purpose of the study, potential benefits, and possible risks associated with participation in this study. I have answered any questions that have been raised.

Printed Name of Individual Obtaining Consent: _____
Signature: _____ Date: _____

APPENDIX B

MEASURES

I. Demographic Questionnaire

These initial questions are for us to gain some background information on you. We'd like to remind you that your name will not be placed with any of this information, and that all information is strictly confidential.

1. What is your age? _____

2. What is your gender?
- ☐ Male
- ☐ Female

3. What race or ethnicity do you consider yourself to be?
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Hispanic/Latino (non-white)
- ☐ Native Hawaiian or Pacific Islander
- ☐ White
- ☐ Other, please specify _____

4. What year are you in here at American University?
- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Graduate student

5. What is your current smoking status?
- ☐ Current smoker
- ☐ Former smoker
- ☐ Never smoker

6. Are you currently taking any oral contraceptives(birth control)?
- ☐ No
- ☐ Yes, please specify_____

9. Are you particularly sensitive or allergic to the effects of caffeine, aspartame, guarana or certain vitamins that could be found in energy drinks?
- ☐ No
- ☐ Yes

If you answered yes please describe _____

II. Caffeine Exposure Questionnaire Interview-Time Line Follow back

TODAY
Think back on today, have you consumed any caffeinated products? Keep in mind that there is caffeine in coffee flavored products such as yogurt, as well as caffeine in chocolate, and certain medicines.

Circle: YES NO

If YES what was it

Caffeinated product	Serving	Serving size	Usual brand

Is this a typical day of caffeine use for you?

YES NO

If NO, is this more or less than the normal amount of caffeine you usually consume? What makes today different?

On a typical day do you consume:			(serving, serving size, brand)
Coffee (roasted or ground)	NO	YES	_____
Coffee (Instant)	NO	YES	_____
Tea (bag or leaf)	NO	YES	_____
Tea (instant)	NO	YES	_____
Soft Drinks	NO	YES	_____
Coca and chocolate	NO	YES	_____
Caffeine containing medicines	NO	YES	_____
Energy Drinks	NO	YES	_____

Other caffeine containing food or medicine?? _____

YESTERDAY
Now take a moment to think back about yesterday. Did you use any caffeinated products yesterday?

Circle: YES NO

If YES what was it

Caffeinated product	Serving	Serving size	Usual brand

Was yesterday a typical day for you?
If NO, is this more or less than the normal amount of caffeine you usually consume?
What made yesterday different?

WEEK
Think back on this past week. Try to remember important events and milestones that shaped this week. Think of meals and moments of stress, calm and tired and energy. Did you consume some caffeinated products?

Circle: YES NO

If YES what was it

Caffeinated product	Serving	Serving size	Usual brand

Has this been a typical week of caffeine consumption?

YES NO

If NO, is this more or less than the normal amount of caffeine you usually consume?
What made this week different?

_____

_____

On a typical week how frequently do you consume some caffeinated product?

___ usually everyday
___ 5 to 6 days
___ 3 to 4 days
___ 2 or less days

On a typical week do you consume:		(serving, serving size, brand)
Coffee (roasted or ground)	NO	YES _____
Coffee (Instant)	NO	YES _____
Tea (bag or leaf)	NO	YES _____
Tea (instant)	NO	YES _____
Soft Drinks	NO	YES _____
Coca and chocolate	NO	YES _____
Caffeine containing medicines	NO	YES _____
Energy Drinks	NO	YES _____

Other caffeine containing food or medicine??

Look at this calendar; do you remember any major events or stressful day that would cause a change in your normal caffeine consumption over the past month?

_____
_____
_____
_____

III. Promise Sleep Scale

The following questions are about your sleep. Please answer how much you agree or disagree with the following statement.

	Not At all	A little bit	Somewhat	Quite a bit	Very Much
1.My sleep was restless	1	2	3	4	5
2. I was satisfied with my sleep	1	2	3	4	5
3. My sleep was refreshing	1	2	3	4	5
4. I had difficulty falling asleep	1	2	3	4	5
5. I had trouble staying asleep	1	2	3	4	5
6. I had trouble sleeping	1	2	3	4	5
7. I got enough sleep.	1	2	3	4	5
8. I slept more than I usually do	1	2	3	4	5
9. My sleep quality was	Very Poor 1	Poor 2	Fair 3	Good 4	Very Good 5

IV. POMS Questionnaire

Below is a list that describes feelings people have. Please read each one carefully. Then place an X on one of the numbers to the right that best describes HOW YOU ARE FEELING **RIGHT NOW**.

The numbers refer to these phrases:

0 = Not at all

1 = A little

2 = Moderately

3 = Quite a bit

4 = Extremely

Tense:	0 1 2 3 4	16. Nervous:	0 1 2 3 4
Angry:	0 1 2 3 4	17. Lonely:	0 1 2 3 4
Worn out:	0 1 2 3 4	18. Muddled:	0 1 2 3 4
Lively:	0 1 2 3 4	19. Exhausted:	0 1 2 3 4
Confused:	0 1 2 3 4	20. Anxious:	0 1 2 3 4
Shaky:	0 1 2 3 4	21: Gloomy:	0 1 2 3 4
Sad:	0 1 2 3 4	22: Sluggish:	0 1 2 3 4
Active:	0 1 2 3 4	23: Weary:	0 1 2 3 4
Grouchy:	0 1 2 3 4	24: Bewildered:	0 1 2 3 4
Energetic:	0 1 2 3 4	25: Furious:	0 1 2 3 4
Unworthy:	0 1 2 3 4	26: Efficient:	0 1 2 3 4
Uneasy:	0 1 2 3 4	27: Full of pep:	0 1 2 3 4
Fatigued:	0 1 2 3 4	28: Bad-tempered:	0 1 2 3 4
Annoyed:	0 1 2 3 4	29: Forgetful:	0 1 2 3 4
Discouraged:	0 1 2 3 4	30: Vigorous:	0 1 2 3 4

V. Caffeine Intoxication

Below is a list of feelings/experiences people have. Circle the number that best describes how you are feeling/what you are experiencing **RIGHT NOW**.

	Not at all	A little	Moderately	Quite a bit	Extremely
1. Dizziness	0	1	2	3	4
2. Difficulty breathing	0	1	2	3	4
3. Rapid heartbeat	0	1	2	3	4
4. muscle twitching/ tremors	0	1	2	3	4
5. Confusion	0	1	2	3	4
6. Restlessness	0	1	2	3	4
7. Irregular heartbeat	0	1	2	3	4
8. Anxious	0	1	2	3	4
9. Nervous	0	1	2	3	4
10. Jittery	0	1	2	3	4

VI. CWSQ

Below is a list of feelings/experiences people have. Circle the number that best describes how you are feeling/what you are experiencing **RIGHT NOW**.

	Not at all	A little	Moderately	Quite a bit	Extremely
1. Drowsy/sleepy	0	1	2	3	4
2. Self-confidence	0	1	2	3	4
3. Yawning	0	1	2	3	4
4. Alert	0	1	2	3	4
5. Tired/Fatigued	0	1	2	3	4
6. Content	0	1	2	3	4
7. Difficulty Concentrating	0	1	2	3	4
8. Irritable	0	1	2	3	4
9. Heavy feelings in arms and legs	0	1	2	3	4
10. Depressed Mood	0	1	2	3	4
11. Grouchy	0	1	2	3	4
12. Urge to do work related activity	0	1	2	3	4
13. Flu-like feelings	0	1	2	3	4
14. Headache	0	1	2	3	4
15. Talkative	0	1	2	3	4
16. Sluggish	0	1	2	3	4
17. Upset stomach	0	1	2	3	4
18. Clearheaded	0	1	2	3	4
19. Desire to socialize	0	1	2	3	4
20. Energetic	0	1	2	3	4
21. Nausea	0	1	2	3	4
22.Vomitting	0	1	2	3	4

23. Muscle pain /stiffness/ache	0	1	2	3	4
24. Discouraged	0	1	2	3	4
25. Queasy	0	1	2	3	4

VII. **Energy Drink Rating**

Instructions: Please rate your energy drink today on the following items by **circling the appropriate number**.

1. Smells Good

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

2. Tastes good

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

3. Strong

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

4.Pleasent

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

5. Caffeine content

0 1 2 3 4 5 6 7 8 9 10

None at all Very high

6. Bitter

0 1 2 3 4 5 6 7 8 9 10

Not at all Extremely

7. Sour

0	1	2	3	4	5	6	7	8	9	10
Not at all										Extremely

8. Sweet

0	1	2	3	4	5	6	7	8	9	10
Not at all										Extremely

9. Carbonated

0	1	2	3	4	5	6	7	8	9	10
Not at all										Extremely

10. How much do you like this energy drink ?

0	1	2	3	4	5	6	7	8	9	10
Not at all										Very Much So

9. Would you choose to drink this energy drink again?

0	1	2	3	4	5	6	7	8	9	10
Definitely Not										Most Definitely

APPENDIX C

RECRUITMENT FLYER

Research Participants Wanted for Energy Drink Study

The Behavioral Pharmacology & Health Promotion Laboratory at American University is recruiting individuals to participate in a study investigating energy drinks. Participants will be asked to consume and rate energy drinks for four weeks while attending 5 lab visits.

EMAIL Rachael at:

Bphpstudy29@gmail.com

You could receive up to **$74** for complete participation and a chance to win an additional **$100 (odds are 1 in 12)**
Psychology students can receive 3 research credits and $44

Supervisor: Laura Juliano, Ph.D.
Department of Psychology

APPENDIX D

EXPERIMENT EVALUATION

Instructions: The next few questions will ask about the experience you had participating in this experiment. Answer each question by placing an X in the appropriate space or by writing in the answer, if indicated.

1. How would you rate your experience as a research participant in this project?

 excellent good neutral poor very poor

2. Would you like to be a research participant again in the future if the opportunity arises?

 definitely yes most likely yes maybe most likely not definitely not

3. Would you recommend this study to friends or family?

 definitely yes most likely yes maybe most likely not definitely not

4. How interesting was this study for you?

 very interesting somewhat interesting neutral somewhat uninteresting very uninteresting

5. Did you enjoy participating in this study?

 yes, I liked it a lot yes, I liked it a little neutral no, I disliked it a little no, I disliked it a lot

6. Did you learn anything from participating in this study?

 no yes (please describe in the space below)

_____

_____

7. If you had to describe to someone the purpose of this study, what would you tell them?

_____

_____

_____

8. Do you think there is more to this study than meets the eye?

 no yes (please describe in the space below what you think may have been going on under the surface of the study)

_____

_____

_____

_____

9. Is there anything about the study that you disliked?

 no yes (please describe what you disliked about the study in the space below)

_____

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