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Jenna Howden and Hailey Remme

ABSTRACT

Objective: To investigate if brake reaction times improve for college aged students after consuming an energy drink (ED).

Design: Cross-sectional.

Setting: College Setting

Participants: 103 college aged participants (1=35, 2=34, 3=34). Brake reaction time tested 30 minutes post consumption of ED drink containing either 150 mg of caffeine, 34 mg of caffeine, or 0 mg of caffeine (placebo). Completion of Rand SF-36 general health and the General Knowledge Questionnaire for Adults surveys.

Results: All groups improved brake reaction time from pre-to post-test. When comparing brake reaction time between groups, no statistical differences occurred.

Conclusions: The majority of college students consumed caffeinated EDs primarily to improve their focus. However, consuming these drinks did not influence brake reaction times during sudden stops or while anticipating a stop. Therefore, college aged students should avoid relying on these drinks for safety when operating a motor vehicle.
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INTRODUCTION

The popularity of consuming energy drinks (ED) has increased since their inception in 1997. Currently, about 51% of U.S. college students report consuming EDs occasionally and 36% report consuming them habitually (Kelly & Prichard, 2016). As of 2016, college students are the top consumer of EDs. Reportedly, they drink these beverages because they enjoy the taste, they improve their focus on study/work, and they feel more alert (Hardy et al., 2021).

College students have limited driving experience, usually between 2-6 years. This may negatively affect reaction time while driving as it may be underdeveloped when compared to older and more experienced drivers (Svetina, 2016). Therefore, younger drivers may consume EDs in an effort to improve their reaction times. EDs have been shown to increase alertness, which directly influences reaction time capabilities (Chandrapakumar, 2020). Alertness is improved by EDs because EDs contain caffeine along with other ingredients including taurine, herbal extracts, and vitamins (Heckman, Sherry, & De Mejia, 2010). However, there are risks associated with ED consumption that may be overlooked by college-aged drivers (Reissig, Strain, & Griffiths, 2009). EDs contain about 72-300 mg of caffeine per 8oz serving (Higgins, Tuttle, & Higgins, 2010). Caffeine in this range could cause headaches, increased anxiety, and heart palpitations, all which could impair driving (Reissig, Strain, & Griffiths, 2009).

With these associated risks, it is important to know if brake reaction times improve after consuming these beverages. Therefore, we sought to investigate if brake reaction times are affected for college-aged students after consuming an ED. We hypothesized that consuming EDs would improve reaction times when making a sudden stop or when anticipating a stop.

METHODS

Study Design and Participants
Approval from the Institutional Review Board of the University of Minnesota was gained before the beginning of this experiment. Students attending the University of Minnesota, Morris participated in this investigation. Inclusion criteria required that participants were English speaking, at least 18 years or older, currently a college student, no history of any heart condition or driving disability, and were not currently pregnant. Recruitment of participants consisted of two emails. The first email informed them of the study and provided them with the time and location. The second email served as a reminder email. Participants received a gift of choice worth $15 for participating.

Procedure
Before their brake reaction time was tested, participants were made aware of the risks of participation and signed an informed consent form. All brake reaction times were tested on a brake reaction time simulator (RT-2S Reaction Time Tester, ATP MEDICAL, LLC, Glen Allen, VA). This simulator has been used in other published research (Dickerson, Reistetter, Burhans, 2022).
Two different variations of reaction time were tested. A sudden stop where participants had to quickly press the brake pedal when the stoplight changed from green to red, and an anticipated stop where participants pressed the brake pedal after the light changed from green to yellow to red. A pre-test was administered which the participants performed three trials with each braking variation. Next, the students randomly were randomly placed in caffeine consumption groups by picking a card that had the group’s name (1, 2 or 3) on it out of a hat and consumed the beverage with the corresponding number. Participants had five minutes to drink the unidentified beverage. Next, the participants waited 30 minutes before completing their post-test. This waiting time was used in other published research (Jee, Lee, Bormate, & Jung, 2020). During this 30-minute break, students completed a survey consisting of demographic questions, the Rand SF-36 health survey (SF-36), and the General Knowledge Questionnaire for Adults (GNKQ). Beverage 1 was a lemon drop flavored energy drink with the brand name Bang (150 mg caffeine) and manufactured by Vital Pharmaceuticals (Weston, FL). Beverages 2 and 3 were selected to taste as similar to beverage 1 as possible. Beverage 2 was a Mello Yello (34 mg caffeine) manufactured by Coca Cola, and the placebo was beverage 3 which was Squirt (no caffeine) manufactured by Keurig Dr. Pepper. Following the 30-minute break, participants had their brake reaction time re-tested. Published investigations have followed this procedure (Bliss & Depperschmidt, 2011). Experimentation took place on October 25, 2021 and October 27, 2021.

Survey Design
Participants answered demographical questions to collect data on gender, age, cumulative college GPA, if a nutrition course was taken during high school and/or college, and participation in collegiate sports. Furthermore, the participants were asked about their ED behavior. The participants were first asked if they consumed EDs (yes/no), and if they responded with yes, a series of questions followed. The seceding questions were what brand of EDs consumed (Red Bull, Rockstar, Monster, Nos, Amp, XS, Xyience Xenergy, 5-hour energy, Full Throttle, Jolt Cola, Kickstart, Verve, other), why they consumed them (i.e., focus your studying and/or work, enhance your athletic performance, enjoy the taste, feel more alert, as a mixer for alcoholic beverages, leisure and/or social reasons, other), their average weekly consumption of EDs (i.e., less than 1 per week, 1–2 per week, 3–4 per week, 5–6 per week, 7–8 per week, 9–10 per week, 11–12 per week, 13–14 per week, 15 or more per week), if they felt that EDs were beneficial (yes/no), and if so, how (i.e., enhanced athletic performance, better focus, increased productivity, increased memory, increased alertness, reduced post-workout muscle pain, other), have you had negative side effects (yes/no), what type of negative side effects (i.e., trouble sleeping at night, shaking and/or tremors, chest pain, heart palpitations, difficulty breathing, dizziness, tingling and/or numbing of the skin, headache, stomach ache and/or gastrointestinal discomfort, vomiting, allergic reaction, addiction to the energy drinks, other), and if they feel the benefits of drinking EDs outweigh the negative effects (yes/no). These demographical and ED behavior questions are the same questions used in previous ED investigations (Hardy et al., 2021; Hardy, Kliemann, Evansen, & Brand, 2016).

The SF-36 health survey consists of 36 questions relating to eight different areas of health. Physical functioning (10 questions), bodily pain (2 questions), role limitations due to physical health problems (4 questions), role limitations due to personal or emotional (4 questions), emotional well-being (5 questions), social functioning (2 questions), energy/fatigue (4
questions), and general health perception (5 questions). The range of scores for each category is 0-100, with a higher score reflecting a superior health status and quality-of-life. The questionnaire has evidence of internal consistency (Cronbach’s alpha was above 0.85 for all health categories but social functioning), high test-retest reliability (91-98% of cases within 96% confidence interval), and high construct validity (Brazier et al., 1992).

The GNKQ consists of 95 questions where one correct answer to one question corresponds to one point, for a possible total score of 95 points. The questionnaire can be divided into four different categories: dietary recommendations (66 questions), sources of foods/nutrients (11 questions), choosing everyday foods (7 questions), and diet-disease relationships (11 questions). The GNKQ has a high internal consistency in all sections (Cronbach’s alpha=0.70 ±0.97), a high test-retest reliability (greater than 0.7), and a high construct validity (Parmenter & Wardle, 1999). The GNKQ has been used as a judgement of health knowledge in similar research investigations (Hardy et al., 2021; Hardy, Kliemann, Evansen, & Brand, 2016).

**Statistical Analysis**

A priori power analysis with 80% power was conducted to determine that we needed a sample size of at least 102 participants. Percentages were used to explain self-reported demographics. A paired T test was conducted to compare the participants’ pre-beverage consumption brake reaction time to their post-beverage consumption brake reaction time. An unpaired T test was used to compare the male and female pre-test and post-test scores. Sex was divided based upon self-reported gender identity. A one-way ANOVA with Tukey Post Hoc was used to compare the scores of the SF-36 health survey and the GNKQ between caffeine consumption groups. Using a one-way ANOVA with Tukey Post Hoc, brake reaction times prior to consuming ED was compared between the three groups. Using this same statistical test, brake reaction times were compared between the three groups 30 minutes after consuming an ED. All statistical analyses were computed using Graph pad Prism (San Diego, CA). Statistical significance was said to be significant if the value of $p < .05$.

**RESULTS**

The recruitment email was sent to the student population at the University of Minnesota, Morris. In response to this email, 103 (n=44 males, n=59 females) students came to participate. All participants met the eligibility requirements and completed all parts of the experiment. Of the participants 57% (n=59) used EDs, 96% (n=99) were between the ages of 18-22, and 82% (n=84) had a GPA between 3.01-4.0. In regard to nutrition classes taken, 48% (n=49) of participants reported taking a nutrition class in high school and 13% (n=13) reported taking a nutrition class in college. Regarding athletics, 48% (n=50) of the population participated in a varsity sport (Table 1).

There was no statistical difference between the number of individuals that identified themselves as male or female when comparing each group ($P=0.57$). Table 2 displays the mean scores, standard deviation, and $p$-value of participants’ pre-test and post-test brake reaction times amongst caffeine level consumption groups. The 150 mg caffeine consumption group showed a statistically significant increase ($P = 0.03$) in brake reaction time in the sudden stop simulation, but not in the anticipatory stop simulation ($P = 0.18$). The 34 mg caffeine consumption group
and the placebo group both showed a significant increase in brake reaction time in both the sudden stop ($P=0.00$ and $P=0.01$, respectively) and anticipatory stop simulation ($P=0.00$ and $P=0.00$, respectively).

Table 3 distinguishes if self-reported gender played a role in affecting brake reaction time. There was no significance in the pre-test scores for the 150 mg caffeine consumption ($P=0.75$, $P=0.37$), 34 mg caffeine consumption ($P=0.37$, $P=0.94$), and placebo groups ($P=0.28$, $P=0.68$). There was a trending towards significance in the post-test scores between male and females in the 150 mg caffeine consumption group for the sudden stop simulation ($P=0.05$) and no statistical significance was found in the anticipatory stop simulation ($P=0.08$). The placebo group undergoing the sudden stop simulation showed a statistically significant difference between the scores of the male and female participants ($P=0.01$).

There were no significant differences when comparing pre-test to pre-test and comparing post-test to post-test brake reaction times between groups, as noted in Table 4 and Table 5, ($P=0.67$, $P=0.99$; Table 4) ($P=1.00$, $P=0.50$; Table 5).

There was no statistical significance amongst caffeine level groups compared to the scores of each category of the SF-36 health survey and GNKQ. No statistical significance between caffeine level groups suggests that both groups were similar in perceived health and knowledge of human nutrition.

**DISCUSSION**

The majority of college students in this investigation reported consuming energy drinks to feel more alert. This finding is supported by research from Brice & Smith (2001) who suggested that caffeine increases alertness in low arousal situations such as when operating a motor vehicle. Due to this, it would be plausible to assume that caffeine would improve brake reaction time. However, we found that this is not necessarily accurate. This is because, regardless of caffeine content, the presence of caffeine was not a factor in our investigation as there were no statistical differences found when comparing brake reaction time between three groups (150 mg caffeine, 34 mg caffeine, and placebo). Although brake reaction time improved for each group 30 minutes after beverage consumption, this was likely due to individual learning curves (Dar-EL, 2013). Each group was comparable as there was not a difference in sex, perceived health status, or nutritional knowledge.

Our findings are in line with research by Bliss & Depperschmidt (2011) who reported that ED consumption does not affect collegiate flight students’ pilot skills. Complex turns, straight and level flight, and inflight emergencies all require quick reaction times. Likewise, when driving a car, quick reaction times are required when making sudden stops and anticipated stops. Reaction time improvement has been touted as a reason to consume EDs (Howard & Marczinski, 2010). Within our investigation, reaction times did improve after consuming EDs, regardless of caffeine consumption. Goel, Manjunatha, & Pai (2014) reported similar findings when evaluating auditory reaction time. They reported that, for both the ED and control groups, reaction time improved from pre-test to post-test. The participants were asked to push a button on a handheld switch immediately after hearing a click sound.
While driving a car, both sudden and anticipated braking events occur. According to Hancock and Wright (2018), the average brake reaction time for a sudden stop is 2.7 seconds and for a stop light/stop sign is 0.6 seconds. We tested both sudden stop and stop light events. The average time of our participants’ reaction to a sudden stop and stop-light event were both 0.5 seconds. Within our investigation, all groups were below the reported average reaction time. We did not find a statistically significant difference when comparing pre-ED consumption reaction times between the three groups and when comparing post ED consumption reaction times between the three groups. This suggests that consuming energy drinks may not affect brake reaction times.

The improvements in reaction times following consumption, or the belief that consumption of an ED took place, may be explained by the placebo effect. A placebo effect occurs when a participant experiences an outcome related to a specific stimulus, without the actual presence of such stimuli (Harrington, 1999). According to Geers, Rose, Fowler, & Brown (2015), the placebo effect can occur because of the placebo’s taste, texture, color, or smell that mirrors the stimulus. This mirroring tricks the participant’s brain into believing they are consuming the actual stimulus. In the current study, all beverages were similar in taste, so the participants were unable to tell if they were actually consuming a beverage containing caffeine, or how much caffeine their beverage contained. In a similar investigation, Salciunaite and Leonas (2019) compared reaction time of participants after they consumed either caffeinated or decaffeinated coffee and reported no significant differences in reaction times between the two groups.

In the present study, we tested brake reaction time 30 minutes after consuming caffeinated/non-caffeinated beverages. However, in some people, it may take longer than 30 minutes to feel the full effects. Research has suggested that caffeine improves reaction time when the time between caffeine consumption and reaction time testing exceeds 30 minutes (45 -97 minutes) (Smit & Rogers, 2000; Sainz, Collado-Mateo, & Del Coso, 2020).

With every investigation, there are limitations to this study. First, this study was performed at a single institution. Therefore, these results may not be generalizable. Second, individuals experience the effects of caffeine at varying time periods, so testing brake reaction time thirty minutes after caffeine consumption may not be ideal for each person. Third, the survey and data were only collected at a single point of time. Consequently, change was unable to be measured. Future studies may consider testing brake reaction times 15, 30, 45, and 60 minutes after consumption of an ED. This would give a timeline as to when brake reaction time is affected following consumption of an ED.

CONCLUSION

The majority of college students consumed caffeinated EDs primarily to improve their focus. However, consuming these drinks did not influence brake reaction times during sudden stops or while anticipating a stop. Therefore, college aged students should avoid relying on these drinks for safety when operating a motor vehicle.
REFERENCES


