The effect of energy drinks on memory, attention and perceived mental sharpness.

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Abstract

The purpose of this study is to investigate the effects of a post consumption slump after using energy drinks on memory attention and perceived mental sharpness, in a sample of forty volunteers (M=21, F= 19). The age of the participants ranged from 25 to 50. A quantitative between groups experiment was carried out. Participants were randomly assigned into two groups 1: sugar free Red Bull group 2: Placebo group. Three tests to measure memory and attention were given to the participants after 4 hours of consuming the drinks. Analysis showed the Red Bull Groups performance was poorer overall, however the results were only significant in the trial making task.
Introduction

Memory and attention are mental processes we use to retain and understand information. This study examines the effect of energy drink consumption on memory and attention, in particular focusing on when the initial high of the energy drink has worn off and a post consumption slump is being experienced. Firstly the definitions and functions of memory and attention will be explained, continuing then to explain the psychical and metal effects energy drinks can have on memory and attention. This study will examine the process and effects of caffeine withdrawal. Finally looking at the impact energy drink consumption has on memory and attention during the post consumption slump.

What is memory?

"Memory is the process that allows us to record, store, and later retrieve experiences and information" (Passer, p 333, 2009). Memory is the process of maintaining information over time. (Matlin, 2005). It is the means by which we draw on our past experiences in order to use this information in the present (Sternberg, 1999). Without memory everyday tasks would be impossible as we would not remember our past experiences to use today or remember what we need to do in the future. A three stage model of memory was developed by Atkinson and Shiffrin (1968). This model has three major components sensory memory, working memory and long terms memory. Sensory memory receives information through sensory registers, which are the initial information processors. Incoming sensory information is briefly held in sensory memory (Passer, 2009). Sensory memory retains the sensory stimulus after the stimulus itself has ended. A previous study on sensory memory concluded, it is difficult, perhaps impossible to retain complete information in purely visual form for more than a fraction of a second (Sperling, 1960, cited in passer, 2009). In a previous study by
(Winkler et al, 2002) it was found that the echoic store can hold information about the precise details of sound for several seconds (Passer, 2009, p 335). In general, sensory memory holds information just long enough to transfer it to the second memory system (Neath, 2002). Our short term or working memory is a temporary store house for small amounts of information (coon & Deventure, 2004). "It can be difficult to do more than one thing at a time in short term memory" (Miyake, 2001 cited in coon & Deventure, 2004). You can memorise a phone number in your short term memory but if you are suddenly distracted you can easily forget the number. It is thought that information only stays in sensory memory for a short period of time, however according to the three stage model some information can enter the short term/working memory. Memory codes are created to represent information that can then be stored in working memory. It is thought that short term or working memory has a limited duration while long term memory has a vast amount of space for information and it can be stored for years or for life.

**Attention**

Tresiman's Attenuation Model (Tresis ma, 1964) is a theory that builds upon Broadbent's filter Model (Broadbent, 1958). Broadbent suggests that a filtering method is used to attend to specific stimuli. Both Theorists agree that a filter mechanism is used but Tresiman's Attenuation Model does not eliminate stimuli, it "Attenuates", this method is similar to reducing the noise lever on a number of stimuli to focus more on one, if a warning message was sounded in the toned down stimuli it is thought you would still respond to it as the sound was attenuated rather than eliminated, thus it can still be heard. Treisman agreed with Broadbent that attention was like bottleneck, however they did not agree on the location. Treisman conducted experiments on bilinguals playing two different messages to them at the same time but one slightly behind the other, participants were able to reply to both messages.
and confirm the meaning, and these findings showed that Broadbent's Filter Model was not adequate.

Attention is a cognitive process that refers to how we process and focus on information present in our current environment. Stimuli from our environment capture our attention for different reasons, you may be more drawn to the smell of food when you are hungry or you may be drawn to details of a piece of music if you have a passion or interest in music (Passer 209). Dangerous stimuli or any situation posing a threat on our environment can increase the amount of attention we give to the stimuli (Izard, 198 & Oehman 2001 as cited in Passer 2009). Attention is important for many cognitive processes such as memory. Two types of processing have been established bottom-up attention processes and top-down (Jasso and Triesch 2007; Lim and Dinges 2010; Watson and Leverenz 2010). Caffeine can improve aspects of attention as it increases arousal, the evidence for its effects on more complex attention tasks is equivocal. Studies have investigated and showed caffeine can have an effect on attention tasks such as task switching (Tieges, Snel, Kok, Wijnen, Lorist, Richard, 2006). Caffeine consumption contributed to improved performance in measures of attention and memory where found in the study by Scholey and Kennedy (2004).

**Memory and Attention**

In the current study the cognitive performances that will be evaluated are memory and attention. Previous studies have revealed a relationship between attention and working memory capacity (Heitz & Engle, 2007; Unsworth, Schrock & Engle, 2004). As the two cognitive performances have a relationship it was thought that testing the two would provide an insight into the effects the post consumption slump experienced following the consumption of an energy drink has on each one.
Energy Drinks

Energy drinks are drinks that when compared to traditional soft drinks have higher amounts of stimulant ingredients such as caffeine and taurine. The sale of energy drinks in Ireland is legal, however a committee for the food safety board was set up on request of the minister of state who recommend all energy drinks sold must clearly state and display when they have higher content of caffeine than regular soft drinks. There was more than 500 different brands of energy available worldwide in 2006 (Reissig, Strain, & Griffiths, 2008). Red Bull was put on the market in 1987, it was first launched in Austria and Red Bull is now sold in over 79 countries. The creator of Red Bull is Mr Chaleo Yoovidhya a Thai business man who owned his own pharmaceutical company. He initially produced a tonic drink aiming to keep factory workers awake, this drink was made up of water, sugar, caffeine, taurine, inositol and B vitamins. He named this tonic “Krating Daeng”. An Austrian business man Dietrich Mateschitz discovered Krating Daeng while in Thialand and later worked with Chaleo Yoovidhya to produce Red Bull and began to tweak the ingredients and taste and developed a marketing strategy to sell this product globally. Red Bull is sold in a tall shiny silver and blue tin and is also available in sugar free its advertising motto is “Red Bull gives you wings” and claims to increase performance, increase concentration and reaction time, improve vigilance, improve emotional status, stimulate metabolism. Red Bull Sponsor extreme sporting events including surfing, snowboarding, formula 1 racing, and freestyle motor cross. Previous research (Malinauskas, Aeby, Overton, Aeby, & Barber-Heidal, 2007) has shown that the use of energy drinks has grown in popularity and is being used for a variety of different life events. The results found that 51% of 496 students had used an energy drink in the last month, and it found the reasons for doing so are as follows 67% insufficient sleep, 65% to increase energy, 54% with alcohol while partying, 50% to aid study and major
course completion, 45% for driving long periods and 17% for treating hangovers. It is evident from these findings that over half the students use energy drinks.

Research on the relationship between perceived stress and energy drink consumption found that participants who perceived higher levels of stress reported more occasions that they consumed least 1 energy drink (Pettit & DeBarr 2011). This research suggests that during stressful events individuals are reaching for energy drinks, the current study may provide a better understanding of the effects of energy drinks, particularly looking at cognitive ability in the post consumption slump.

A previous study looked at the reason men choose energy drink was related to achieving a sense of masculinity, in the experiment priming was used and the finding showed masculinity primed male participants had a greater desire for the energy drink, when choosing a reward drink (Chiou and Lee 2013)

**Ingredients**

The ingredients in energy drinks differ from brand to brand, typically they include caffeine, guarana, taurine, sugar, sweeteners, ginseng and flavourings. The caffeine, taurine and sugar content are responsible for the occurrence of adverse effects (Clauson, Shields, McQueen, & Persad, 2008; Gavin, 2009). For the purpose of the current study a sugar free version of Red bull will be used to exclude any possible effects of sugar in take or withdrawal in the findings. The ingredients in Red Bull are made up of caffeine a 250ml can contains 80mg of caffeine, B- Group vitamins, niacinamide (vitamin B3), Pantothenic acid (vitamin B5), Vitamin B6 and B12, sucrose and glucose with each 100ml of Red Bull containing 11g of sucrose and glucose combined, Taurine with 1,000mg in a can of 250ml.
Caffeine

Caffeine is a natural ingredient found in coffee beans, tea leaves, cacao pods, kola nuts and many other plants (Einöther, & Giesbrecht, 2013). Caffeine can be consumed in teas, coffees, soft drinks. Eighty percent of people consume caffeinated beverages on a daily basis, with coffee and tea being the primary sources (Heckman, Weil & Gonzalez, 2010). Caffeine is a central nervous system stimulant and it changes the way your brain and body work. Its main effect on your body is to make you feel more awake and alert (Porkka-Heiskanen et al., 2002). Over consumption of caffeine can have negative effects and could lead to symptoms such as raised blood pressure, insomnia, headache, indigestion, faster heart rate or palpitations, anxiety and jittery sensations, tremors, tachycardia, psychomotor agitation, and in rare cases, even death (Reissig et al., 2008). Adverse Symptoms of caffeine are found to be similar with anxiety and mood disorders (Reissig et al., 2008). The length of time it stays in your body depends on sex, body weight, amount consumed and time of day. Once Caffeine is consumed orally it is absorbed into the blood stream via the gastrointestinal tract, it is found to reach, maximum levels of effectiveness within 30 minutes following consumption, it can take between 2.5 to 10 hours for caffeine to be illuminated form your body (Magkos and Kavouras, 2005). For the purpose of this study the tests will carried out 4 hours after the energy drink has been consumed.

Taurine

Taurine is an amino acid in our bodies that can become depleted in times of stress and physical exercise. In normal circumstances taurine is highly conserved in the human body
and on average it is found that a person weighing 70kg is likely to have up to 70g of taurine present in their body. Taurine can be found in fish and red meats, it plays a significant role in physiological processes but mainly synthesis of bile salts.

**Previous Research**

A study on the effects of caffeine on physiological responses and cognitive performance shows that with the consumption of high doses of caffeine there is a consistent pattern of physiological responses such as an increase in blood pressure and an increase in adrenaline secretion (Davidson & Smith, 1989). While physiological responses were consistent it was found that cognitive performances improved recording an increase in alertness and shorter reaction time when moderate amounts of caffeine was consumed (Frewer & Lader, 1991; Lieberman, Wurtman, Emde, Roberts, & Coviella, 1987; Loke, 1990). Further research found that higher doses of caffeine had a negative effect on cognitive performance (Frewer & Lader 1991). A study by Erikson et al (1985) in a series of experiments suggests that caffeine has no affect on how males perform in word list tasks. However they suggest that caffeine inhibited females perform significantly better in such tasks when presented with the information at a slower pace (Erikson et al, 1985).

Another study testing participants on attention, manual dexterity, visual-spatial and frontal functions, memory (immediate, consolidation and working) in placebo, caffeine only, glucose only and a caffeine/glucose combination of groups found that caffeine alone only improved participants reaction times, however the caffeine/glucose combination had positive effects on attention (sequential reaction time tasks) and on learning and consolidation of verbal memory (Adan & Serra-Grabulosa, 2010). The acute effects of Red Bull on cognitive functioning was measured in a previous study, 30 minutes after the consumption of the energy drink, and the results suggested that it can improve cognitive performance on
behavioural control tasks. The reasons for improvement in the cognitive performance are due to caffeine’s ability to sharpen mental ability, reduce cognitive failures, and improve reaction time. Taurine when mixed with caffeine, such as in energy drinks can help improve mental performance as well as its biological benefits to the body. The study that measured cognitive functioning following energy drink consumption focused on recording results while the caffeine was working in the participants, the current study aims to look at the effects caffeine has after the initial effects have worn off and the user is experiencing the post consumption slump. (Howard, Marczinski, 2010).

A study on the effects of caffeine abstinence on psychomotor skills of participants at 4, 6 and 8 hour intervals found that after a period of 4 hours hand steadiness was significantly less than at base level. Overall cognitive performance was also in decline at this stage, before eventually levelling off and returning to base level (Heatherly et al, 2005).

Overall the results of previous studies show that people are increasingly using energy drinks, it has proved that cognitive ability and performance improve while users are experiencing the maximum effects, however it would be beneficial to see if following the high of energy drinks, does memory and attention continue to perform at an increased level or do they diminish, and if so to what degree. This research could be used to educated students and others on the adverse effects using energy drinks can have on the mind, It may encourage users to look at the ingredients and become more familiar with the physical and psychological effects it has on them both positive and negative. It may provide useful information that could have implications on how students, workers and the general public are advised to regulate their consumption of energy drinks. Further research in the area may also be sparked due to this study.
In particular cognitive performance that show improvement following the consumption of caffeine are attention, reaction time, visual search, psychomotor speed, memory, vigilance, and verbal reasoning (Childs & de Wit, 2008; Hewlett & Smith, 2006; Kennedy & Scholey, 2004; Scholey & Kennedy, 2014).

In a study on the effects of Red Bull on cognitive performance, participants reported a higher perceived sense of stimulation and a lower perceived sense of mental fatigue and on the test score reaction time decreased (Howard and Marczinski, 2010).
Hypothesis

H1: The Red Bull group will score significantly lower in the word recall task.

H2: The Red Bull group will take significantly longer to complete the trial making task.

H3: The Red Bull group will report a significantly lower level of mental sharpness.
Methodology

Participants

A convenience sample of 40 adult participants was used in this study (20 men and 20 women). An advertisement was placed on the notice staff notice board, in a large office building seeking participants to volunteer in the study, the notice asked participants to email their interest, and the first 40 responses were used to make up all of the participants. The age of the participants ranged from 25 to 50. All of the participants worked in an office environment and their roles were similar in nature, they all work the same hours and spent the same amount of time working on administration at their desks and the same amount of time taking a lunch break.

An email with recommendations was issued to each participant once they had expressed an interest, advising that it would not be suitable for them to proceed in the experiment if they had any sensitivity to caffeine, taking any medication that may be altered by caffeine or if they were pregnant. All participants were given the option to withdraw from the experiment at this point for health and safety reasons and they were all reminded that they could withdraw at any stage without providing a reason to withdraw as participation was voluntary.

Management were aware and agreeable to the experiment taking place in the work place. The study was given approval by DBS School of Psychology Research Ethics Committee and the experiment adhered to all ethical principles in the Code of Professional Ethics (2010). All participants were provided with the contact details of the experimenter and supervisor from DBS.
Design

The design of this study is a quantitative between groups true experiment.

The design is quantitative as it will produce numerical scores of memory, attention and mental sharpness. The dependant variables are 1: Memory 2: Attention 3: Mental Sharpness. The independent variable in this study is the sugar free energy drink red bull. Participants were randomly assigned to one of two groups via a coin toss. The two groups were the red bull group and the placebo ground.

Materials

A consent form was completed by each participant before the experiment. A private conference room was booked to facilitate the experiment. A coin was used to allocate participants to one of the two groups. 40 opaque cups were used to administer both the Red Bull and placebo drink, 20 cups were white and 20 cups were blue. 20 cans of sugar free Red Bull were used a large bottle of sugar free cordial. A short demographic questionnaire was also used collect information, age, gender, identify which group they were assigned to and to allow participants to rate how they felt their mental sharpness was on a scale of 1 to 10, 10 indicating full mental sharpness. A word recall list was used in the assessment of memory. The word list consisted of 20 words, a mixture of both concrete and abstract words. A lap top and projector was used to display the word recall list on a large screen. Pen and paper was provided for the word recall task. The second page consisted of a two trail making tasks. 40 Stop watches were used to record participant’s time in the trial making task.
Procedure

Permission was sought form the manager of the department to conduct the experiment on staff as well as the use of private conference room and office equipment. Participants were sought by placing a notice on the staff notice board inviting willing participants to contact me by email. The first 40 email responses were accepted to take part in the experiment. A meeting was scheduled with the participants a week in advance of the experiment. Participants were made aware that they would be talking part in an experiment to investigate the effects of energy drinks on cognitive performance. Any participants with sensitivity to caffeine or any other contraindication such as pregnancy were asked to withdraw and replaced at this stage. It was explained to all participants what was required of them on the day of the experiment. The participants were made aware that they would need to consume a drink and then meet in the conference room 4 hours later to conduct the experiment. A consent from was provided and completed by each participant, all participants were reminded that they were free to withdraw from the experiment at anytime. The participants were randomly assigned at this point to either the blue group (sugar free red bull group) or the white group (placebo group) via a coin toss.

On the morning of the experiment I pre prepared drinks, 20 white cups containing sugar free cordial and 20 blue cup containing sugar free red bull. Participants were unaware as to the contents of the cups. At 11am participants were called to the conference room and each consumed the contents of one cup, corresponding in colour to the groups previously assigned. All participants returned to their daily routine for the next four hours. At 3pm the participants reconvened to the conference room. All participants were seated at an individual desk spaced liberally apart. Each participant received a handout, stop watch and pen. The hand out consisted of a small demographic survey, and a blank sheet to answer the word recall test and two trial making tests. The participants then completed the demographic
survey and identified to which group they belonged. The word recall test began by showing a power point presentation of the entire word list, one word appeared on screen at time for a 10 second intervals. The participants were then asked to recall as many words as possible by writing them on the blank page supplied. The participants were then instructed to complete the trial making task and record their personal score for each one on the paper provided. Finally each participant was asked to record their perceived mental sharpness on a scale of one to 10, 10 being fully mentally Sharpe. All the answer booklets were collected from the participants and a verbal debrief session was facilitated and they were thanked for their participation.
Results

Statistical Analysis

The first step in the analysis was to determine if the data met the assumptions to conduct parametric tests. After examination of the data for all the variables, it was found that the data met the requirements for the use of parametric tests. There was however some negative skew in the scores of Mental Sharpness in the Red Bull group. The negative skew was however < 2, thus allowing for parametric tests to be conducted.

Table 1.

*Descriptive statistics*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Red Bull Group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Recall</td>
<td>10.90</td>
<td>4.25</td>
</tr>
<tr>
<td>Trial Making</td>
<td>2.73</td>
<td>.46</td>
</tr>
<tr>
<td>Mental Sharpness</td>
<td>6.95</td>
<td>1.73</td>
</tr>
<tr>
<td><strong>Placebo Group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Recall</td>
<td>11.35</td>
<td>4.64</td>
</tr>
<tr>
<td>Trial Making</td>
<td>2.45</td>
<td>1.72</td>
</tr>
<tr>
<td>Mental Sharpness</td>
<td>7.05</td>
<td>.34</td>
</tr>
</tbody>
</table>
Table 1 gives us an overview of the data collected for both the Red Bull group and the Placebo group. The Placebo group scored higher on both Word Recall (Mean = 11.35) and perceived Mental Sharpness (Mean = 7.05) compared to the Red Bull group (Mean = 10.90 and 6.95 respectively). The Placebo group also scored quicker times (Mean 2.45) on the trial making tasks than the Red Bull Group (Mean = 2.73).

Table 2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Groups</th>
<th>Mean</th>
<th>SD</th>
<th>T</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial Making</td>
<td>Red Bull</td>
<td>2.73</td>
<td>.46</td>
<td>2.22</td>
<td>38</td>
<td>.032</td>
</tr>
<tr>
<td></td>
<td>Placebo</td>
<td>2.45</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Recall</td>
<td>Red Bull</td>
<td>10.90</td>
<td>4.25</td>
<td>.326</td>
<td>38</td>
<td>.746</td>
</tr>
<tr>
<td></td>
<td>Placebo</td>
<td>11.35</td>
<td>4.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental Sharpness</td>
<td>Red Bull</td>
<td>6.95</td>
<td>1.73</td>
<td>.180</td>
<td>38</td>
<td>.858</td>
</tr>
<tr>
<td></td>
<td>Placebo</td>
<td>7.05</td>
<td>1.79</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 is an overview of the results of independent t-tests carried out on the Red Bull and Placebo groups for the following variables: Trial Making, Word Recall and Perceived Mental Sharpness. The Placebo group completed the trial making tasks quicker (Mean = 2.45) than the Red Bull group (Mean = 2.73). When tested an independent samples t-test found a significant difference in time (t(38) = 2.22, p = .032) between the two groups, therefore the null hypothesis must be rejected and H2 must be accepted.

The Placebo scored higher (Mean = 11.35) on the word recall task than the Red Bull group (10.90). When tested an independent samples t-test found no significant difference in scores (t(38) = .326, p = .746) between the two groups, therefore the null hypothesis cannot be rejected. H1 is thus rejected.
The Placebo scored higher (Mean = 7.05) on perceived mental sharpness than the Red Bull group (6.95). When tested an independent samples t-test found no significant difference in scores ($t(38) = .180, p = .858$) between the two groups, therefore the null hypothesis cannot be rejected. H2 is thus rejected.
Discussion

The aim of the study was to see if after consuming an energy drink and experiencing a post consumption slump if memory and attention was affected. The main focus of the study was to try to focus on testing participants as close as possible to when they were experiencing the post consumption slump. Two groups were used so a comparison could be drawn between a post consumption slump from a sugar free energy drink and a placebo group who consumed a sugar free cordial. Sugar free drinks were used for both the energy drink and placebo to exclude any possibility that the results were caused by a sugar slump. The experiment involved testing memory and attention of a placebo group and a group who had consumed the sugar free version of the energy drink Red Bull, all participants consumed the energy drink 4 hours prior to the experiment. The reason for the delay in testing was to try administering the tests while the participant was experiencing a post consumption slump. A perceived effect of mental sharpness was also recorded for compassion between the two drinks.

The results of the experiment showed that overall the Red Bull group showed to have a negative effect on cognitive ability as the results of the tests were poorer. The placebo group reported higher level of perceived mental sharpens than the Red Bull group. In the word recall tasks the placebo group performed better than the Red Bull group. The differences in both these scores were not significant. However the placebo group completed the trial making task significantly quicker than the Red Bull group.

The results showed a varied response to perceived metal sharpness across the Red Bull group and this is consistent with research that suggests the strength and lengths of effects caffeine has on an individual depends on the individual’s age, weight, and caffeine consumption habits (Magkos and Kavouras 2005). The findings that the Red Bull group
generally performed worse across the three tested variables and significantly slower at completing the trial making tasks than is consistent with previous research that shows a moderate dose of caffeine can negatively affect cognitive ability (Frewer & Lader 1991).

The results that were found in the trial making test proving the Red bull group to be significantly slower than the placebo group are in line with the finding of previous research that found psychomotor skills particularly hand steadiness significantly worsened after a 4 hour caffeine abstinence period (Heatherly et al, 2005).

Although the scores from the word recall test and perceived mental sharpness showed that the Red Bull group performed poorer the results were not significant. There may have been an oversight on the experiments part by not taking factors such as height & weight, age, sex and normal consumption of caffeine into consideration. These factors could also cause individuals to have different times of when they have the slump following the consumption of the energy drink.

Mental sharpness could have been measured using a recognised cognitive abilities test to give a more accurate measurement of what the level of mental sharpness was rather than the participant’s perception. It could also have been used a comparison to perceived mental sharpness to highlight any difference in actual mental sharpness and perceived mental sharpness.

Using a test re test experiment procedure could exclude individual capability discrepancies as participants would be tested both at a control experiment and an energy drink experiment allowing for an observation of the energy drinks effects on each individual.

All participants who took part did so voluntarily and they were accepted on a first come first serve basis, each participant works in the same environment and are all
college graduates. During the experiment the participants spent the working day doing similar tasks and taking breaks for the same lengths of time. Random assignment to each group was done via a coin toss. One can of sugar free Red Bull was given to the Red Bull group ensuring that a consistent dose was given to each participant. Both the Red Bull and the placebo drink were administered to the group in colour coded cups, keeping the participants unaware of what was the placebo group. The experiment was conducted in a large conference room allowing for adequate room so that the seating arrangement was set up in a manner to discourage participant to influence each other’s responses. A projector was used to display the word recall list on a large screen ensuring that each participant had a clear visibility of the list. Stop watches were provided for the participants to record the time taken to complete the trial making task, ensuring accurate of time completion. Asking participants to score their mental sharpness was an opportunity for participants to honestly confirm how they felt while completing the task. A debrief was conducted for all participants making them fully aware of what happened over the duration of the experiment, this also provided an opportunity to put forward any questions they may have. SPSS was used to analyse the data, this is a reliable application.

More controlled measures could have been taken to specifically around sex weight, age and normal habits of energy drink consumption. Adjustments to the amount of energy drinks given to each participant could have been decided depending on these variables as the effects of caffeine can vary depending on sex, weight and age. (Magkos and Kavouras 2005).

As the experiment took place four hours after consumption of the energy drink, it is a possibility that participants were tired and they had almost completed a full day’s work by the time they completed the tests. We have natural circadian rhythms linked to our physiological functions for example sleep, arousal, digestion, body temperature and also in
physical performance (Horne & Ostberg, 1976; Hrushesky, 1994). Research has also suggested that memory and attention are affected by our circadian rhythms (Intons-Peterson, Rocchi, West, McLellan, & Hackney, 1999; May, Hasher, & Stoltzfus, 1993).

The range of participants was from age 25 to 50, a valid argument regarding the varied age of participants, could be that older participants didn’t perform as well on the work recall list for biological factors such as memory loss. Decline in Cognitive function is age related (Bopp & Verhaeghen, 2005; Hale et al., 2011; Park et al., 2002).

Detailed information on current energy drink consumption habits could have been recorded as part of the experiment, this would provide an opportunity to investigate if any participant may have a higher or lower tolerance to energy drinks and thus influencing how the participant reacted to the withdrawal and slumping process.

Research shows that psychomotor skills decline after a 4 hour abstinence from caffeine before levelling off and returning to base levels (Heatherly et al, 2005). Future testing could administer caffeine before testing cognitive abilities at intervals after abstinence staggered over several hours (Heatherly et al, 2005) leading to a better of an indication of when each individual was experience the post consumption slump, given the fact that each person could metabolise the energy drink at a different rate (Magkos and Kavouras 2005). Another group could be added where the participants continue to intake of energy drinks throughout the intervals at different dosages in order to try to identify optimal levels of energy drink to maximise cognitive performance as well as psychomotor abilities.

The results of further studies could help benefit students by making them aware of the effects of energy drinks on cognitive ability such as memory and attention as these are necessary skills needed while studying. Students experience stressful events facing exams
and study and research shows that individuals with perceived higher stress levels have consumed energy drinks more regularly. (Howard and Marczinski, 2010).

Professions whereby workers operate heavy machinery or drive for long periods of time would benefit from the information of how energy drinks effect individuals in areas such as concentration over a sustained period of time under varying dosages. Similarly professions in which dexterity and psychomotor abilities are essential components of the job description, such as medical surgeons, would benefit from the awareness of caffeine intake on psychomotor skills as well as cognitive abilities over a sustained period of time at varying dosages.

Further studies could influence the advertising legislation, awareness and the effects of energy drink consumption for consumers. In general results from the current and previous study have shown that initial effects of consuming energy drinks can be beneficial to cognitive and psychical performance. Further research on the withdrawal and post consumption slump would benefit users by education them on the effects and better choices as to when they should and should not use energy drinks.
References


Susan V. Heatherley, Robert C. Hayward, Helen E. Seers, Peter J. Rogers Cognitive and psychomotor performance, mood, and pressor effects of caffeine after 4, 6 and 8 h caffeine abstinence Journal: Psychopharmacology 2005 DOI: 10.1007/s00213-005-2159-9


Appendices

Demographic Survey

Please complete the following questions

1. Sex: Male ☐ Female ☐
2. Colour of your cup: White ☐ Blue ☐
3. Age: ________________

After drinking the contents of the cup on a scale of 1 to 10, can you rate how you now?

1 is mentally fatigued 10 is mentally alert and sharp. ☐
Please join the numbers and letters in the relevant order begin with number 1 connected to A, continue in that order. Please record the time taken to complete this section. Time taken ______