Red Bull versus a Placebo:
Tests of Reaction Time,
Executive Functioning and
Basic Motor Skills

Barry Moore
Student Number: 1551361

Submitted in partial fulfilment of the requirements of the Bachelor of Arts degree (Psychology Specialisation) at DBS School of Arts, Dublin.

Supervisor: Dr. Patricia Frazer
Head of Department: Dr. S. Eccles

March 2014
Department of Psychology
Dublin Business School
School of Arts
# TABLE OF CONTENTS

ACKNOWLEDGEMENTS.............................................................................................................1

ABSTRACT.................................................................................................................................2

INTRODUCTION..........................................................................................................................3

METHODOLOGY.........................................................................................................................19
  Participants..............................................................................................................................19
  Design....................................................................................................................................21
  Apparatus/Materials................................................................................................................23
  Procedure...............................................................................................................................30

RESULTS....................................................................................................................................34

DISCUSSION..............................................................................................................................38

REFERENCES...........................................................................................................................53

APPENDICES.............................................................................................................................56
ACKNOWLEDGEMENTS

I would like to take this opportunity to thank all of those who volunteered their time to participate in the study and particularly for the support, interest and encouragement many expressed after participating. Without their input, this research would not have been possible.

A very special thank you to my girlfriend Clara for her patience, understanding and encouragement.

Lastly, I would like to express my gratitude and special thanks to Dr. Patricia Frazer for her supervision, support and guidance in writing the thesis. It was invaluable and greatly appreciated throughout the process.
ABSTRACT

A between participants design was employed to test for the effects of Red Bull on cognitive abilities in a placebo controlled experiment outside of a laboratory setting. A total of 49 volunteer participants took part and were randomly allocated to either the Red Bull (250ml’s) (N=15), placebo beverage (250ml’s) (N=20) or control group (no drink) (N=14). An online computerised experiment tested measures of reaction time, executive functioning and basic motor skills. A one-way analysis of variance (ANOVA) showed no significant differences in performance between the three groups in relation to any of the four variables. As such, for the current study the effects of Red Bull on reaction time, executive functioning and basic motor skills appear to be no greater than those achieved by a placebo or control group.
INTRODUCTION

Functional Energy Drinks

Since the 1980’s, functional energy drinks have consistently risen in popularity demonstrating sustained healthy growth and remaining the most dynamic segment of the soft drinks market (Zenith International, 2011). With over 4.8 billion litres sold in 2011, the success of these drinks has been mainly attributed to their promotion as both for fun and to increase functionality (Zenith International, 2011). To investigate these products and potential issues surrounding them, a Stimulant Drinks Committee was launched by Safe Food (a food safety promotion board appointed by the Minister of Health in the Republic of Ireland) to commission independent scientific research into the health effects and usage of energy drinks in the UK and Ireland. The committee defined functional energy drinks as a beverage typically containing caffeine, taurine and vitamins but that may also contain an energy source (e.g. carbohydrate) and/or other substances, marketed for the specific purpose of providing real or perceived enhanced physiological and/or performance effects (Finnegan, 2003).

The Rise of Red Bull

Inspired by a functional energy drink from Thailand, Red Bull was launched in 1984 creating not only a new drink but an entirely new product
category and quickly became the market leader capturing 36.7% of the market, over double the size of its nearest rival (Zenith International, 2011). The manufacturers advertise and promote their product on the key attributes of fun and functionality stating that drinking Red Bull enhances physical endurance, concentration, reaction speed and overall performance due to the combination of ingredients; sugar, taurine, glucuronolactone and caffeine (Red Bull GmbH, 2012). The energy drink’s consistent association with extreme sports, the claims made by the manufacturer and the ingredients of the product itself coincide directly with the definition provided by the Stimulant Drinks Committee as well as the research findings of Zenith International.

A Note on Ecological Validity

A major influence for conducting the research exists specifically in relation to reliability and validity. Traditionally, cognitive psychology experimentation was conducted in a laboratory setting where the researchers could apply rigorous controls for confounding variables. By doing this, the researchers were afforded the chance to single out the aspect that they were interested in as well as infer reliable causality between variables. However, this method can be prone to lacking ecological validity, or the acknowledgement that human behaviour is situated and strongly influenced by contextual factors (Nestor and Schutt, 2012). As a consequence, the results of the experiment
may not be ecologically valid or generalizable as if the same tests or experiment were conducted in the participant’s natural environment they could yield significantly different results (Nestor and Schutt, 2012).

With this in mind, the current study was conducted in a community location in order to gather data in as natural a setting as possible to that of the average participant in an attempt to achieve generalizability and validity. While this type of approach may suffer from a lack of some of the tight controls possible in a laboratory, these issues were considered and the compromise was made in light of the benefits of ecological validity. Similarly, the subjects were not asked to refrain from drinking coffee or any other caffeinated or stimulating beverages that they would normally consume within the course of an average day but questions about this information were included on the demographic sheet for recording and later analysis.

*The Role of Caffeine and Other Active Ingredients*

Several previous studies have theorised that caffeine is the active ingredient in Red Bull and therefore responsible for any of the main benefits experienced from consumption rather than a combination of the ingredients as a whole (Howard & Marczinski, 2010; Ferreira, de Mello, Pompeia, & de Souaz-Formigoni, 2006; McCusker, Goldberger, & Cone, 2006). In light of this, it is appropriate to mention a piece of research investigating the effects of
caffeine and placebo expectation. The experiment required participants to undertake a 28 hour period of sleep deprivation and then assessed the effects of caffeine and placebo expectation on vigilance, cognitive performance, heart rate and blood pressure. (Sun, Zhang, He, Liu & Miao, 2007). The participants (n=10) completed five treatment periods of 28 hours separated by 1 week recuperation intervals. Each participant was told that the capsules being given were caffeine, however, a combination of caffeine and placebo capsules were administered. Volunteers were also provided with information regarding the effects of caffeine consumption to increase expectancy and in return, enhance the placebo effect. Vigilance and cognitive performance were assessed by a letter cancellation task, a continuous addition task and the Stroop test. Most relevant to the current studies measures, the findings showed a significant difference (P < .05) in the group that received a combination of caffeine and placebo capsules when performing the Stroop test and the continuous addition test.

As the participants were under the impression that all the capsules they received were caffeine, it was inferred that regardless of whether the individuals experienced positive performance enhancements as a result of their caffeine expectancies or the effects of the genuine caffeine capsules, any significant improvements in physical performance or cognitive abilities could
be attributed to caffeine as the active ingredient. Furthermore, as caffeine quantities in functional energy drinks are not regulated in a similar manner to other products, stimulant drinks have been found to have a caffeine content that ranges from 50mg to 505mg. Such heightened levels of caffeine within the drink make it a likely candidate to be the ingredient that is most active (Howard & Marczinski, 2010).

Woojae (2003) conducted a review of the collective research into the individual ingredients in Red Bull and concluded that although taurine has been attributed with significant improvements in cognitive performance, none of the studies published to date have conclusively shown it to be able to create these effects as an independent ingredient. Additionally, the results of the various studies were shown to be very similar to those found when testing the effects of caffeine alone. Unlike caffeine, taurine is an amino acid that plays an integral role in neuroprotection and neurotransmission. As such, it is already present in substantial quantities within the brain which casts doubts and raises the question; what form of significant contribution could be made by the consumption of a substance that is already available in relatively large amounts? Alternatively, caffeine does not exist within the brain naturally like taurine but it is able to diffuse across the blood brain barrier a lot more easily. With this in mind, it could be suggested that a substance not already present
within the body but that can readily gain entry through the blood brain barrier, when added, creates the effect.

As discussed, caffeine has been indicated to be the main active ingredient in Red Bull by several studies as well as Sun et al. (2007) demonstrating that a combination of caffeine capsules and placebo expectation can produce significant differences for both the caffeine and placebo groups when compared with a control group (Howard & Marczinski, 2010; Ferreira et al., 2006; McCusker et al., 2006). Aligned with the research, for the current study it was hypothesised that an experiment comparing Red Bull and a placebo will yield significantly different results when compared with a control group. However, despite evidenced support for this hypothesis, contradictory findings have been produced when utilising the between-participants design and so the topic is worthy of further investigation.

Choice Reaction Time

Improvements in reaction time, both simple and choice, is by far the most tested claim made by Red Bull and consequentially, the most developed area of research in relation to stimulant beverages effects on cognitive abilities. However, several studies have produced conflicting findings in relation to choice reaction time, defined as a measure of the time taken to
initiate a response once a stimulus has indicated which of multiple responses is to be performed (Simon, Elliott & Anson, 2013).

Howard and Marczinski (2010) investigated the acute effects of Red Bull on a behavioural control task. 80 participants in total were randomly assigned to one of five conditions - three groups with pre-determined varied levels of Red Bull per kg, a placebo group and a control group. The participants completed a cued go/no go task as well as subjective measures of stimulation, sedation and mental fatigue in a within-participants design. The findings supported Red Bull’s claims by demonstrating that when compared with the placebo and control group, consuming Red Bull significantly decreased reaction times, increased subjective stimulation ratings and decreased mental fatigue ratings.

In 2001, Alford, Cox and Wescott examined the effects of Red Bull on human performance and mood. A total of 36 volunteers were assessed on psychomotor performance (reaction time, concentration, and memory), subjective alertness and physical endurance. Three studies were conducted over a period of three years with the initial study measuring the effects of Red Bull on participants against that of carbonated mineral water. For the second study a no drink control group was added and the final study gained the addition of a placebo or “dummy” energy drink as a comparative measure.
When assessed against the performance of the placebo and control groups, Red Bull was shown to induce significant \( (P < .05) \) improvements in aerobic and anaerobic performance as well as choice reaction time, concentration (number cancellation) and memory (immediate recall) (Alford et al., 2001).

In contrast, research into attention and reaction times in university students, post-consumption of Red Bull, published conflicting results to the previous two studies. In the double-blind study, Red Bull, Sugar Free Red Bull and a flavour matched placebo were administered to 36 volunteer students. The participants were assessed using a computerised continuous performance task 30 minutes before ingesting the drink. The continuous performance task consisted of visual attention and reaction time tests from which the participants overall ability to discriminate between targets and non-target stimuli was calculated. The researchers refrained from requesting the participants to fast overnight to achieve ecological validity by creating experimental conditions similar to those of the average context in which the participants would consume energy drinks. This step was also taken to combat the claims that any significant effects displayed from consuming Red Bull can be attributed to the reversal of withdrawal symptoms. Despite the outcomes of previous experiments, no significant differences \( (P < .15) \) were discovered between any of the groups and the researchers concluded that the effects of
Red Bull or Sugar Free Red Bull, in relation to visual attention and reaction time, are negligible and no greater than the potential psychomotor enhancements from that of a placebo (Gendle, Smucker, Stafstrom, Helterbran & Glazer, 2009).

Concurrently, choice reaction time was selected as a test variable for two main reasons. Firstly, Red Bull specifically state that their product reduces reaction times and so it was chosen as a direct measure of a claim and secondly, as a measure of comparison to the findings of the previous studies. For the current studies initial hypothesis, it was hypothesised that there would be a significant difference in choice reaction time for the Red Bull group when compared with the placebo group and for the placebo group when compared with the control group but not when compared with the Red Bull group. Although Gendle et al. stated that the effects of Red Bull are negligible no greater than that of a placebo, judgement for the hypothesis erred on the side of caution and in favour of the findings of the former two studies discussed as well as Red Bull GmbH being willing to publicly claim that their products improve reaction time.

Executive Functioning

Within the literature, no single agreed upon operational definition of executive functioning exists but for explanatory purposes executive
functioning shall be defined as the ability to maintain an appropriate problem solving skill set for attainment of a goal, including an intention to inhibit a response or defer it to a later time, a strategic plan of action sequences and a mental representation of the task (Barkley, 2012). Essentially, executive functioning is a form of higher level reasoning or cognition beyond that of what is involved in reacting to stimuli such as simple or choice reaction time tasks. To name a few, it encompasses flexible thinking, inhibition, problem-solving, planning, impulse control, concept formation, abstract thinking and creativity (McCloskey & Perkins, 2013). At the time of writing no study was found that aimed to measure the effects of Red Bull on executive functioning as a whole nor directly aimed at an individual aspect, however, research has been conducted that could be said to have measured several executive functions such as inhibition, problem-solving, planning, impulse control and creativity in responding.

Frazer (2006) carried out an experiment investigating the effects of Red Bull on computer gaming ability in a repeated measures, placebo controlled experiment. A total of 21 participants were assessed on their performance in a ‘first-person shooter’ computer game as well as other measures of attentional performance; the ability to respond rapidly to a variety of different stimuli, the ability to suppress inappropriate responses and short and long term spatial
memory. Although presented with a different label, these assessment methods could be interpreted as measures of creativity, abstract thinking, inhibition, impulse control, planning and problem-solving capabilities. A two-way repeated measure ANOVA found that Red Bull had a significant effect (P < .05) on overall computer gaming performance but not in relation to the difficulty levels, computerised reaction time, attentional performance or spatial memory tasks. As overall computing gaming performance envelopes several aspects of executive functioning as listed above, Red Bull does appear to have a significant effect on executive functioning. It is also important to keep in mind the previously mentioned significant effect of Red Bull in relation to the Stroop test found by Sun et al (2007).

Although the former and latter studies have been interpreted as relational measures of executive functioning for the purpose of discussion and support of the current study, research is evidently limited and further investigations are required. In light of this, two measures of executive functioning were included in the current study; a colour-word inhibition task (variation of the Stroop test) and an image sorting task in which participants were asked to select the best match image from one of four previously displayed pictures based on the criteria of species, number or colour. Aside from the intention to further expand this particular area of research, these
measures were also selected to explore the idea that ingesting a substance that improves energy levels and reaction times may decrease performance on tasks of executive functioning that require aspects of flexible thinking, problem-solving and concept formation but predominantly inhibition and impulse control. Fundamentally, the tasks require a level of restraint for processing as opposed to an immediate reaction and selection of the correct stimuli. Consideration must also be given to the fact that participants may be primed to react quickly as a result of the choice reaction time task that was completed immediately prior to the colour-word inhibition and sorting tasks, in accordance with the pre-constructed order of the online test battery. With these factors taken into account, it was hypothesised that Red Bull will not significantly improve executive functioning in a colour-word inhibition or an image sorting task.

**Basic Motor Skills**

Red Bull has been consistently marketed as a functional energy drink with the ability to improve physical endurance and performance, commonly being associated with athletes, particularly within the realm of extreme sports. Similarly with that of reaction times, improving performance and physical endurance would be a strong claim to make without substance in the form of independent research in place to support it. Concurrently, it has been
demonstrated that Red Bull can significantly (P < 0.05) improve performance and physical endurance. This was assessed by measuring the participant’s ability to maintain max speed on an ergociser exercise bike, the result of which was then compared with that of the placebo and control groups, providing strong support for physical endurance claim.

In line with this, an experiment designed to investigate the positive effects of Red Bull in counteracting sleepiness and driving impairment during prolonged periods of driving, showed significant improvements in several parameters such as a reduced standard deviation of speed and subjective driving quality but most relevantly, it reduced the level of mental effort required in performing the task when contrasted with the placebo group (Mets, Ketzer, Blom, van Gerven, van Willigenburg, Oliver & Verster, 2011). Although dissimilar to the performance measure being utilised in the current study, the results further support Red Bull’s claims of physical ability performance enhancement.

However, most closely related to the measure in this experiment is the aforementioned research conducted by Frazer (2006) which utilised a keyboard tapping task to establish levels of manual dexterity. This was measured as it was known to be a necessity for a computer gamer in first person shooters to be able to hit the various buttons on a controller in a
speedy and varied manner. For this, the participants were asked to push a button on a counter with their thumb as fast as possible for ten separate five second trials, alternating between their right and left hands. In the current study a similar keyboard tapping method was employed as a means of testing the effects of Red Bull on basic motor skills. This task was included as a technique to examine the energy drinks effects on physical endurance and performance enhancement. The finger tapping task also served as both a method of comparison to the manufacturer’s claims and as a mode of testing without the requirement of large exercise equipment or other apparatus beyond the researcher’s resources.

Similarly to choice reaction time, it was hypothesised that there would be a significant difference in basic motor skills performance for the Red Bull group when compared with the placebo group and for the placebo group when compared with the control group but not when compared with the Red Bull group.

*The Placebo Effect*

To get a baseline understanding of the effect an item has, it is necessary to measure it against a control. However, to gain a comprehensive understanding of the items power it is necessary to measure it against another substance such as a placebo. Without this it would be impossible to know if the
item itself had contributed any real effect at all (Chiodo, Tolle and Bevan, 2000). Generically speaking, a placebo is an inert substance that has no power of effect over what it is being administered for, except for in the case of active placebo drug trials where the placebo does produce activity but not for the target disease or condition (Rajagopal, 2006). Research has also evidenced that placebo’s can be very effective as a treatment in an array of psychological and psychiatric conditions as well as physical ailments through placebo medication prescriptions and placebo surgeries, for example. Rajagopal (2006) notes that that patient expectations have been found to be vital in determining the potential power of the placebo as treatments believed to be stronger exhibit a more significant effect than treatments perceived to be weaker. Furthermore, placebos are also subject to a form of hierarchy in which injections are more powerful than oral placebos, capsules are stronger than tablets, brighter tablets are more effective than lighter coloured ones, larger are better than smaller and two are better than one (Rajagopal, 2006). In summary, in order for a medication’s claims and effectiveness to be validated, it must be able to outperform an identical placebo medication by having a significantly higher response rate, eliciting a stronger response, or both (Castro, 2007).
The Necessity for a Placebo Group

Adapting the approach of placebo controlled trials from the pharmaceutical industry, the same principles and criteria for medication assessment can and have been previously applied to test Red Bull’s claims of improving reaction time, concentration and physical endurance against that of an equivalent volume, flavour-matched placebo beverage. However, at the time of writing, only a small number of studies have been carried out utilising this method and the findings to date have proved inconclusive both in support and opposition of the products powers of effect. As a result, a placebo group was included in the current study in light of the principles utilised when assessing medications, to validate Red Bull’s claims and to further explore the use of placebos as a comparative measure against Red Bull as previous studies have produced varied discoveries.

Overall, previous studies have demonstrated mixed findings in relation to the effects of Red Bull on reaction times and there is an evident lack of research into the effects of the stimulant on executive functioning. Additionally, as Red Bull GmbH market their products on their ability to improve reaction time, concentration and physical endurance, it is essential that independent research is conducted to verify and validate the information as well as further exploring an area that is still vastly under developed.
METHODOLOGY

Participants

A total of 49 volunteer participants were gathered based on opportunity sampling for the purpose of examining the effects of Red Bull energy drink on reaction time, executive functioning and basic motor skills. Cohen’s d, or standard effect size measure, was calculated from a previous study investigating the effects of Red Bull versus a placebo on computer gaming ability. With consideration to the nature of the previous study, this was judged to be a fair representative sample of a test of executive functioning and therefore appropriate for calculating the effect size for the current study in order to determine the required sample size. Utilising the effect size found of 0.429, G* Power yielded a recommended sample size of 54 participants (Faul, Erdfelder, Lang & Buchner 2007; Frazer, 2006). Sampling was also restricted to include only individuals over eighteen years of age both to simplify the volunteering and consent process as well as in light of ethical considerations in administering a functional energy drink in conjunction with a form of minor deception.

The participants (30 male, 19 female) ranged in age from 21 to 48 years with a mean age of 28.84 years (SD = 5.95). Although several participants were from rural areas, the majority were from an urban population. The participant
sample was collected based on convenience and snowball sampling. Participants were recruited mainly through Facebook but also from word of mouth and emails. The post on Facebook explained the experimental aims, what would be expected of the individual, the time commitment needed and the inclusion and exclusion criteria (Appendix A). Upon receiving replies, the potential participants were contacted to discuss any preliminary questions they may have had. This was carried out either by private messaging or a phone call as dictated by the individual. If happy to proceed, the participant was then provided with several proposed dates to attend, however, the dates were highly flexible in order to facilitate attendance. Furthermore, as the experiment offered no incentives for participation it was predicted that it would be difficult to gather participants and so anyone who replied was also asked to share the post and inform any friends or family members that they felt might be interested in taking part.

The inclusion criteria consisted of being willing to consume 250ml’s (1 standard can) of Red Bull, a time commitment of approximately one hour for the experiment and being able to travel to the location. The exclusion criteria stated that participants could not take part if they were less than 18 years of age, pregnant or breastfeeding, allergic to any of the ingredients in Red Bull or have any medical reason or otherwise for which they have has been
recommended not to consume energy drinks. All participants who took part met the inclusion and exclusion criteria and completed the experiment without any data exclusions.

Three groups were constructed for the research; a Red Bull group, a placebo group and a control group with allocation to each of these groups being randomised by rolling a dice for selection. The Red Bull group (n = 15) consisted of eight males and seven females who ranged in age from 22 to 35 (Mean = 28.87, SD = 4.61). The placebo group (n = 20) was made up of fourteen males and six females with the youngest participant being 22 and the oldest 48 (Mean = 30.95, SD = 7.13). The control group (n = 14), included to establish baseline performance levels for comparison, had eight males and six females with an age range of 14 from 21 to 35 years old (Mean = 25.79, SD = 4.10).

**Design**

The design of the study was a between-participants quantitative true experiment with randomised assignment to each of the three groups, respectively, with the aim of empirically testing for potential causal relationships using systematic variation (*Figure 1*). Three groups were created for comparative purposes; a Red Bull group (n= 15), a placebo group (n= 20) and a control group (n= 14). The participants were randomly assigned to one of
the three groups by rolling a dice. Each numbered side of the dice represented one of the conditions (two sides per group) and whatever number the participant rolled was the group that they were assigned to.

Each participant in each group was subjected to the same test battery on an approved online experiment website (www.quantified-mind.com). Participants had to complete four tasks of approximately one minute duration each in the order prearranged on the website. Task one was a choice reaction time test, task two was a colour-word inhibition test, task three was an image sorting test and task four was a keyboard tapping test. The between-participants design was selected and favoured over repeated measures to avoid any repetition or practice effects from previously completing the task, as it was noticed to be a possible issue in pre-tests when formulating the experiment. The website produced statistics and an overall scoring that accounted for correct responses, reaction time and readiness. This overall score was collected and used for the data analysis. Post-testing all participants were asked to fill out a brief questionnaire that gathered information regarding gender, age, coffee intake or any other caffeinated beverage that day and whether they believed they had consumed Red Bull or the placebo drink (for the control group this question was simply marked CONTROL).
**Apparatus/Materials**

The four computerised task based variables were pre-constructed and readily available on the free experiment website ([www.quantified-mind.com](http://www.quantified-mind.com)) as part of an alcohol test battery. As previously stated, the website produced an overall score calculated based on correct responses, reaction time and readiness and it was the overall score that was collected and used for the data analysis.

Figure 1. *Diagram illustrating the between-participants research model and the interaction with the variables.*
Choice Reaction Time

The test stimuli consisted of three transparent circles on the screen that were numbered 1, 2 and 3 respectively. In a randomised pattern, one of the circles would light up green and the participants were required to hit 1, 2 or 3 in correspondence to the circle that had lit up (See Figure 2). A total of forty stimuli (lit circles) were presented during the task. On average, the task took between 50-60 seconds to complete.

Figure 2. Screenshot of Choice Reaction Time task
**Colour-word Inhibition**

Based on the same concept as the Stroop test, the participants were asked to type the letter R, G or B for red, green or blue, dependent upon which instruction they were being asked to follow. The instructions randomly alternated between requesting the first letter of the colour or the first letter of the word (See *Figure 3*). A total of fifty two stimuli (word or colour requests) were presented and the average participant took between 50-70 seconds to complete the task.

![Screenshot of Colour-Word Inhibition task](image)

*Figure 3. Screenshot of Colour-Word Inhibition task*
Sorting

Similar to the colour-word inhibition test, the sorting task was another measure of executive functioning, particularly impulse control and flexible thinking. Participants were presented with four pictures in the middle of the screen; one red snail, two green octopuses, three blue whales and four yellow dinosaurs. These images stayed exactly the same and remained on the screen for the duration of the task. A variation of one of the images appeared underneath and the participants were asked to match the image that flashed up with one of those on the top row. The variations were based on matching the species, colour or number and participants made their choice by selecting the corresponding number from 1 to 4 on the keyboard (See Figure 4). A total of fifty two stimuli (variations of images) were presented throughout the test and the average time to complete the task was approximately 60-80 seconds.
Figure 4. Screenshot of Sorting task

**Keyboard Tapping**

The final task was a keyboard tapping task to measure basic motor skills. The task consisted of four separate ten second trials that alternated between the right and left hand, two trials for each hand. The participants had to tap the space bar of the laptop as rapidly as possible until the ten seconds countdown ran out. They were then required to repeat the same process with their opposite hand and continue until the four trials had been completed (See Figure 5). Participants took between 40-50 seconds to finish the task.
Equipment Required

In order to run the online experiment, a Toshiba Satellite S70 Series laptop was used. The laptop had Windows 7 Home Premium installed and Internet Explorer was used to access the website as problems occurred when logging in through other browsers such as Mozilla Firefox. Pen and paper were also used to record the participant’s data for each variable as it was discovered during the pilot study that the website was inconsistent in recording the scores for later download.
Demographics

A demographic questionnaire was handed to each participant to fill out once they had completed the four tasks. The questionnaire requested details on gender, age, coffee, tea and other caffeinated beverage consumption pre-testing and whether the participants believed they had consumed Red Bull or the placebo drink. Three separate demographic sheets were used with a code on top of each of them to represent a particular group. A01 represented the Red Bull group (Appendix C), B02 represented the placebo group (Appendix D) and C03 represented the control group (Appendix E). The three forms were constructed in such a way so that it was possible to gather demographic and other relevant information from the participants while still knowing which group they were in but without being able to identify any individuals. Dependent on which group the participant self-selected for by rolling the dice, the relevant form was prepared with the date and participant number.

The Placebo

For the Red Bull group, standard 250ml cans of Red Bull were given. The placebo group, however, received a drink that was created in accordance with a formula previously used in Alford et al. (2001) and Frazer’s (2006) research which employed placebo groups. The beverage was created from 12 parts soda water (158ml’s), 3 parts lime concentrate (39ml’s), 3 parts apple juice (39ml’s)
and 1 part blackcurrant concentrate (13ml’s) per 250ml serving. The control group received no drink. The ‘XTRA’ brand of mints were selected for chewing immediately before consuming the drink as pre-testing found them to be strong enough to mask the flavour of the placebo.

**Procedure**

Once participants had volunteered to take part, it was ensured that they satisfied the inclusion criteria and did not meet any of the exclusion criteria. Each individual was then largely free to decide the time and date that was best suited to them and the arrangement was marked in a diary to avoid overlap or double booking. When the participants first arrived they were asked to take a seat in a waiting room where they were handed a consent form to review (Appendix B). Before signing, the participants were also given the opportunity to ask any further questions they may have and were assured that their personal information would be handled in a confidential and professional manner.

To ensure randomised assignment to a group, the participants were requested to roll a dice, the numbers for which had been previously grouped to represent a particular experimental condition (1 and 3 = Control group, 2 and 4 = Red Bull group and 5 and 6 = Placebo group). In accordance with the number rolled, the Red Bull group received one 250ml standard can of Red
Bull, the placebo group received 250ml’s of a placebo beverage and the control group received no drink. The participant then remained seated in the waiting area while the appropriate drink was prepared and poured into a tall opaque mug with a straw. The drinks were served in this way to mask the placebo, if applicable, as Red Bull has a very distinctive appearance compared to the largely transparent colour of the placebo drink. This was deemed a necessary step as if any participants had seen the liquid and realised that it was not Red Bull, it would have compromised the validity of the experiment or at least their part in it. However, as the exact flavour of Red Bull also proved difficult to replicate, immediately before consuming the beverage the participants were given two breath mints and asked to chew them and then drink their beverage as soon as possible after the mints had been swallowed. The breath mints were added to slightly overwhelm or prime the individual’s taste buds with a strong flavour in an attempt to mask the taste of the placebo, further de-risking the possibility of the deception being discovered. The straw was added simply to make drinking from the tall mugs more convenient.

After the full 250ml’s had been consumed, the exact time was noted and the participants were instructed to watch television for 30 minutes, an allowance based on the required time frame for caffeine to be absorbed into the body as performed in previous studies (Alford et al., 2001; Frazer, 2006).
Although it may be viewed negatively as a stimulant, television was deemed appropriate for participants to watch before taking part as in a similar manner a newspaper, magazine, radio or the individuals own thoughts represent an equal chance of increasing or decreasing stimulation pre-testing. During this time the participants were also asked to refrain from using their mobile phone or any other similar devices in order to maintain consistency across the groups. When the 30 minutes had passed, each individual participant was asked to enter a separate room on the next floor where the experiment took place. The laptop, a chair and a table had been previously setup for the online experiment before each person entered.

The participants began each of the four tasks by reading the instructions that were listed at the top of the screen and clicking ‘Start Test’ when they understood the task and were happy to proceed. If an individual was unclear about what was needed, the instructions were briefly expanded upon for clarity. After the four tasks had been completed, the participants were handed an experiment debriefing sheet to read which explained that minor deception had been used in the form of a placebo as well as information regarding the true aims of the experiment, the hypotheses and contact details for both the researcher and supervisor (Appendix F). Each participant also received a copy of this to take home. The participants were then asked to fill out the A01, B02
or C03 demographic sheet depending on which experimental group they had taken part in. The experiment was then complete and if the volunteers had no further questions, they were thanked for their participation and free to go.
RESULTS

In order to check for significant differences between the groups, the data was analysed using SPSS Version 21. To begin, the underlying assumptions for parametric tests were checked to establish if a parametric or non-parametric test was to be used. All variables were found to meet the underlying assumptions required to employ parametric testing and so a one-way analysis of variance (ANOVA) was performed to check for significant differences between the Red Bull, placebo and control group (P < 0.05).

In relation to choice reaction time, it was hypothesised that there would be a significant improvement in performance for the Red Bull group when compared with the placebo group and for the placebo group when compared with the control group but not when compared with the Red Bull group. A one-way ANOVA was conducted to test for significant differences between the groups, however, no significant differences were found (F (2, 46) = 0.56, p < .577).

In relation to colour-word inhibition (executive functioning), it was hypothesised that there would not be a significant improvement in performance for the Red Bull group when measured against the placebo group or the control group. For this, a one-way ANOVA was conducted and found
that there were no significant differences between the groups \((F(2, 46) = 0.08, p < .923)\).

In relation to sorting task (executive functioning), it was hypothesised that there would not be a significant improvement in performance for the Red Bull group when measured against the placebo or control group. A one-way ANOVA was conducted and found no significant differences between the groups \((F(2, 46) = 0.394, p < .677)\).

In relation to the keyboard tapping task (basic motor skills), it was hypothesised that there would be a significant difference for the Red Bull group against the placebo group, and for the placebo group when measured against the control group but not when measured against the Red Bull group. A one-way ANOVA was conducted and found no significant differences between the groups \((F(2, 46) = 0.925, p < .404)\). Table 1 displays the overall results of the four variables when tested for between group differences.
Table 1: *Red Bull, placebo and control group ANOVA statistics across the four psychological measures.*

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
<th>Df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice</td>
<td>Red Bull</td>
<td>460.67</td>
<td>139.70</td>
<td>0.557</td>
<td>2, 46</td>
<td>0.577</td>
</tr>
<tr>
<td>Reaction Time</td>
<td>Placebo</td>
<td>457.10</td>
<td>125.12</td>
<td>0.557</td>
<td>2, 46</td>
<td>0.577</td>
</tr>
<tr>
<td>Time</td>
<td>Control</td>
<td>502.50</td>
<td>132.59</td>
<td>0.557</td>
<td>2, 46</td>
<td>0.577</td>
</tr>
<tr>
<td>Colour-word</td>
<td>Red Bull</td>
<td>607.47</td>
<td>200.57</td>
<td>0.080</td>
<td>2, 46</td>
<td>0.923</td>
</tr>
<tr>
<td>Inhibition</td>
<td>Placebo</td>
<td>623.00</td>
<td>177.84</td>
<td>0.080</td>
<td>2, 46</td>
<td>0.923</td>
</tr>
<tr>
<td>Sorting</td>
<td>Control</td>
<td>633.36</td>
<td>142.33</td>
<td>0.080</td>
<td>2, 46</td>
<td>0.923</td>
</tr>
<tr>
<td>Keyboard Tapping</td>
<td>Red Bull</td>
<td>473.47</td>
<td>88.25</td>
<td>0.925</td>
<td>2, 46</td>
<td>0.404</td>
</tr>
<tr>
<td></td>
<td>Placebo</td>
<td>476.15</td>
<td>106.55</td>
<td>0.925</td>
<td>2, 46</td>
<td>0.404</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>519.79</td>
<td>116.17</td>
<td>0.925</td>
<td>2, 46</td>
<td>0.404</td>
</tr>
</tbody>
</table>

Further tests were also conducted to check for differences in males and females between the groups. However, analysis with one way ANOVA’s showed no significant differences for choice reaction time ($F (1, 47) = 0.035, p < .853$), colour-word inhibition ($F (1, 47) = 0.402, p < .529$), image sorting ($F (1, 47) = 0.00, p < .988$) or keyboard tapping ($F (1, 47) = 0.298, p < .588$), respectively. *Table 2* shows a breakdown of males and females mean scores and standard deviation across the four tasks.
Table 2: Cross-reference table displaying the mean and standard deviation differences in males and females in the Red Bull, placebo and control group.

<table>
<thead>
<tr>
<th>Experiment Group</th>
<th>Gender</th>
<th>Choice reaction time</th>
<th>Colour - word inhibition</th>
<th>Sorting</th>
<th>Keyboard tapping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Red Bull</td>
<td>Male</td>
<td>459.20</td>
<td>142.27</td>
<td>615.0</td>
<td>203.5</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>463.60</td>
<td>150.82</td>
<td>592.4</td>
<td>217.0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>460.67</td>
<td>139.70</td>
<td>607.4</td>
<td>200.5</td>
</tr>
<tr>
<td>Placebo</td>
<td>Male</td>
<td>468.08</td>
<td>133.82</td>
<td>602.9</td>
<td>175.0</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>436.71</td>
<td>114.07</td>
<td>660.2</td>
<td>190.6</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>457.10</td>
<td>125.12</td>
<td>623.0</td>
<td>177.8</td>
</tr>
<tr>
<td>No drink</td>
<td>Male</td>
<td>506.00</td>
<td>151.26</td>
<td>717.7</td>
<td>135.8</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>499.00</td>
<td>123.20</td>
<td>549.0</td>
<td>93.92</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>502.50</td>
<td>130.59</td>
<td>633.3</td>
<td>142.3</td>
</tr>
</tbody>
</table>

*Figures had to be shortened to one decimal place in order to facilitate fitting the table to the document. The complete unedited table with figures to two decimal places is present in Appendix H.*
DISCUSSION

Hypothesis One – Choice Reaction Time

For the first hypothesis, it was stated that there would be a significant difference in choice reaction time for the Red Bull group when compared with the placebo group and for the placebo group when compared with the control group but not when compared with the Red Bull group. As no significant differences were found between any of the groups, the results contradict the research findings of Howard and Marczinski’s (2010) study as well as that of Alford, Cox and Wescott (2001) which demonstrated significant improvements in choice reaction time after consuming Red Bull. However, the results do tie in with the findings of Gendle et. al. (2009) that stated that the effects of both regular Red Bull and Sugar Free Red Bull were negligible and no more significant than that of a placebo. With this in mind, the hypothesis was partially true in predicting a non-significant result for the Red Bull group but was not successful in demonstrating a significant improvement between either the Red Bull or the placebo group in comparison with the control. Overall, there are equal quantities of research both in favour and against Red Bull’s capabilities of improving choice reaction time and so whether or not it can remains inconclusive, despite the manufacturer’s claims. Consequentially, further research is needed into the area.
**Hypotheses Two and Three – Executive Functioning**

For the second and third hypothesis, it was hypothesised that Red Bull will not significantly improve executive functioning in relation to colour-word inhibition and an image sorting task. Similar in nature to the first inhibition task, the sorting task was the third tested variable and a more complex measure of executive functioning. The hypotheses were decided in light of the previous hypothesis predicting a significant improvement in reaction time which requires a more instant response to the stimuli and is dissimilar to that of the inhibition and sorting tasks which more so require a level of restraint and impulse control for processing as well as flexible thinking.

Although a negative contrast, the study that can most accurately be discussed for comparison is that of Sun et.al. (2007) which investigated the effects of caffeine and placebo expectation on vigilance and cognitive performance. To assess cognitive functions, the participants completed a Stroop test, a measure of executive functioning and the original test that the colour-word inhibition task is a variation of, and it was shown that significant differences in cognitive performance were achieved in the group that received both a caffeine and placebo capsule.
As the participants believed that both capsules were caffeine and produced a significant result, then if caffeine is the active ingredient in Red Bull as theorised in previous research, it stands to reason that similar significant findings would be found when directly testing Red Bull as a whole on an adaptation of the Stroop test and an image sorting task, as both are similar measures of executive functioning. However, this was not the case as no significant findings were discovered and within the specific context of the current research. This outcome in particular bodes well and offers support to Red Bull GmbH’s claim that it is the combination and interaction of the ingredients as a whole that makes the difference, as if it was solely caffeine then a significant difference should have been observed. However, the fact that none was observed does not necessarily reflect negatively towards Red Bull either, rather it may be an indicator of a confounding variable that appeared to be present throughout the study, competitiveness, which may have led to increases in the placebo and control group performances that matched those of the Red Bull group.

Hypothesis Four

For the final variable, basic motor skills, it was hypothesised that there would be a significant difference in performance for the Red Bull group when compared with the placebo group and for the placebo group when compared
with the control group but not when compared with the Red Bull group. Perhaps the most relational research is that of Alford et al. (2001) who found that participants produced significant improvements in anaerobic performance, measured by maintaining max speed on cycle ergometers, when compared with a placebo and control group. As this involved pedalling as fast as the participants were able to and maintaining their max speed for as long as possible, it is not dissimilar from the current method, more a similar measure with a different apparatus.

Although on a keyboard, the tapping task did require the participants to hit the spacebar as many times as possible and to continue to do this for four separate ten second trials, alternating hands for each trial. As such for the highest possible outcome the participants needed to maintain max speed in pressing the space bar for the full length of each trial as well as being able to show endurance in keeping that pace for the full four trials. However, as somewhat of a contradiction to the research mentioned, no significant differences were found between any of the three group’s performance levels and so it was concluded that the effects of Red Bull on basic motor skills are no greater than that of a placebo or no drink at all.
Competitiveness

A possible confounding variable highlighted throughout the study was competitiveness. It was noted that immediately before taking part the vast majority of the participants asked was the experiment a measure of intelligence and several expressed concerns about not being able to understand or complete the tasks. However, it was also noted that immediately after the tests over 80% (N=41) of the participants asked questions similar to how did they perform in the test, what was the average score and were their results better or worse than the person who went before them. Throughout the experiment, if a participant selected an incorrect response to the stimuli, either by typing the wrong key or being too early with their reply, they also expressed a certain level of mental anguish and audible annoyance based on what the error might do to their scores. This pattern continued and was consistent with participants throughout the experiment regardless of reassurances from the researcher that the tasks did not measure intelligence and were simply a tool to produce scores that could be used to compare the performance of the groups, as documented in Question 6, Appendix G.

As this task performance based competitiveness appeared to be a priority goal if not the only goal for a large number of the participants, it may
have had a part to play in the non-significant results found between the three groups across the four tasks. It is possible that the apparent urge to perform at their best may have been a strong motivational factor driving the participants to try and outperform each other while confirming their own belief that they would be able to ‘win’. Therefore the lack of significant difference between the placebo and control groups in relation to each other and with the Red Bull group may be attributable to these factors. Although it remains unclear as to why this wouldn’t have a similar effect on the Red Bull group enhancing any benefits received from the energy drink.

Unfortunately, it was not realised how potent a concern this would be for participants until after the experiment had been initiated and so it was not possible to enlist a competitiveness questionnaire or similar measure to further examine this aspect between the groups. However, if the experiment were to be repeated or further research conducted involving a placebo and control group, competitiveness would be included as a variable and measured accordingly to facilitate the investigation of correlations between the scores of the questionnaire and that of the tasks. Additionally, similar steps would also be recommended to other researchers when making comparisons across groups.
Group Allocation

Ideally, each group would have consisted of a total of 18 participants, or simply equal numbers to maintain balance for cross-comparisons and statistical analysis. However, it was vital to apply randomised allocation to the groups in order to limit the effects of experimenter expectancies or bias and ensure that each individual had an equal opportunity of being placed into any of the three experimental groups. As the assignment to groups was entirely based on probability, the placebo group (n = 20) consisted of one third more participants than the Red Bull (n = 15) or control group (n = 14) but it is believed that the numbers per group would have achieved a much closer equilibrium had more participants taken part and that differences at the levels witnessed in a sample size of 49 are negligible and did not significantly alter the findings of the research. However, it is not debated that a larger sample size would have been desirable to reinforce reliability and validity in generalising the findings.

Ecological Validity

In relation to reliability and validity, a pre-determined community location was utilised for the experiment both to make participation readily accessible and also to try and maintain as similar an environment as possible to that of the individual’s day-to-day life. In comparison, if the experiment took
place in a traditional setting such as a laboratory, the researchers are afforded
the opportunity to apply rigorous controls for confounding variables and have
a significant chance of being able to identify the aspects responsible for a
change in performance, establishing a causal link. In contrast, this is a lot more
difficult to achieve in an experiment conducted in community setting and runs
a higher risk of looser controls and confounding variables, such as that
highlighted by competitiveness. However, this design was still chosen as
although research conducted in a laboratory can be thoroughly and relatively
cleanly dissected, it can often lack ecological validity or the acknowledgement
that human behaviour is situated and strongly influenced by contextual factors
(Nestor and Schutt, 2012). As a consequence, the results of the experiment
may not be generalizable and valid within a population at any level as if the
same tests or experiment were conducted in an environment more closely
aligned to that of the individuals natural one, they could yield significantly
different results (Nestor and Schutt, 2012). With that in mind, it is interesting
to note that this may provide a plausible link between the difference in the
results for the current study and some of the previous research that produced
significant findings (Alford et. al, 2001; Howard & Marczinski, 2010).
Caffeine Withdrawal

In keeping with this approach, prior to taking part none of the participants were asked to refrain from consuming coffee or any other caffeinated beverages or products that they would normally consume within the course of an average day. Within the literature, there exists a debate around the issue of whether or not any effects from a caffeinated product, on participants who were asked to refrain from consuming caffeine prior to taking part, can be reliably attributed to the administration of caffeine in the research or if the caffeine simply provided an alleviation of withdrawal symptoms raising the individual back to their normal level of performance (Juliano & Griffiths, 2004). In relation to the current study, it was believed that effects recorded in previous studies were most likely from withdrawal alleviation and in addition, it would not be desirable to enforce restrictions in order to maintain ecological validity.

However, information about each participant’s caffeine intake was recorded on the demographic questionnaire. A total of 17 individuals stated that they had consumed between 1 to 3 cups of coffee on the day before taking part (Red Bull Group N = 5, Placebo Group N = 8 and Control Group N = 4), however, as the breakdown of people who consumed coffee per group is not hugely uneven yet no significant results were observed between any of the
groups, it is believed that prior coffee consumption did not create an effect within the study and the results lend support to the alleviation of withdrawal symptoms side of the debate. Although it is also recognised that a thorough statistical analysis and possibly a recreation of the study would be required to form a conclusive viewpoint on the issue.

**Placebo Orientated Findings and Further Implications**

A total of eight out of the fifteen participants in the placebo group commented on the taste of the drink, summarily stating that the mints gave the Red Bull a strange taste with a small amount reporting that their drink tasted very fruity and flat compared to Red Bull they had tasted before. However, despite the suspicions in initial questioning, over 50% (11 out of 20) of the participants filled in the demographic questionnaire stating that they believed they had consumed Red Bull. This incorrect ruling by the majority highlights two key points. Firstly, considering the uniquely distinctive taste and characteristics of Red Bull, over half of the participants mistaking the placebo for the energy drink offers positive support for the placebo formula adapted from the research of Alford et al. (2003) and Frazer (2006), respectively and reinforces its validity and reliability for use in future research within this context. Secondly, and perhaps more importantly, a form of Catch 22 situation
(a frustrating situation in which one is trapped by contradictory regulations or conditions) was observed and evolved throughout the study (Anon, 1997).

Before recruiting participants, several documents were prepared, one of which was a sample question and guideline answer sheet (Appendix G) based on queries it was presumed might arise. This was deemed necessary both to maintain consistency in the replies given to the different participants and in an attempt to control for the possibility of achieving the placebo effect being compromised from inquisitive questioning and flawed or inadequate responses. A commonly asked question was ‘why do we have to take mints before drinking the Red Bull?’ As this was naturally a reasonable question to expect, the answer had been drafted in advance stating ‘The mints are given because the research is also testing a theory of taste perception as it is believed that chewing a breath freshener such as a mint immediately before drinking a beverage can dramatically distort its flavour, even if the beverage has a particularly strong flavour such as Red Bull and so it was the perfect candidate.’ Another common comment made was ‘my Red Bull tastes weird, is there something else in it?’ However, this was also a question that was pre-empted and the guideline reply was ‘No, nothing extra has been added to the drink, it has simply been poured from a can into the opaque mug for serving.'
Any difference in taste you are experiencing is most likely due to the mints you ate previously.’

As the study continued and these questions were more often received, the responses became a lot more fluid and consistent which in turn appeared to make the individuals accept and agree with the replies a lot quicker, despite their initial instinct making them think otherwise. Prior to running the experiment, the taste of the placebo and the requirement for participants to chew two mints before drinking their beverage were highlighted as the two most vulnerable parts of the study in relation to the deception being stumbled upon and the real aims of the study being discovered. Although many of the participants in the placebo group initially verbalised some suspicions and curiosities regarding the flavour of the drink and the need to chew mints, the so-called Catch 22 scenario evolved wherein the belief that the drink tasted strange and was possibly not Red Bull was counteracted by the ‘awareness’ of the effects of eating two strong mints on taste buds immediately prior to consuming Red Bull, as given in the guideline sample answers.

In summary, queries about the mints received a reply that primed the individual for any detectable differences in the taste of the placebo drink and as a consequence, it alleviated suspicions and appeared to weaken their conviction in questioning the taste. In an unforeseen positive consequence,
pre-preparing the sample answers for potential questions meant that the two aspects discussed above were no longer remotely as vulnerable and susceptible to questioning as once perceived and largely strengthened the possibility of observing the placebo effect. Therefore, it is plausible that the high rate of participants mistaking the placebo beverage for Red Bull could be attributed to the circular nature of the two replies, despite many initially doubting the taste of the drink.

As the approach of using a placebo group to test the effectiveness of Red Bull was adapted from that utilised within the pharmaceutical industry to test medications, it is interesting to apply a reversal of the process to see if it is possible to transfer any benefits from the findings back to the medical industry. The Catch 22 situation that evolved within the study may offer this possibility. As the placebo effect is entirely dependent upon whatever substance is being given as a placebo genuinely being believed to be what the participant was told they would be receiving, the placebo itself was the most vulnerable part of the experiment to begin with (Brown, 2013). However, the requirement to chew two mints, initially added to obscure the taste of the placebo, appeared to create a distraction that subsequently strengthened the belief and significantly decreased the chances of the placebo being discovered thereby given the placebo a greater opportunity to have an effect. If a similar
yet relevant measure was added in the testing of medications, it is possible that placebo treatments may have far greater effectiveness and reliability. In turn this may aid in further encouraging their use as an option for treatment rather than predominantly as a means for effectiveness comparisons with trial medications. However, the real dilemma still persists as to how to convince people of the power of a placebo even if they are aware they are taking one which would reduce liabilities on prescribing practitioner’s and allow for a much wider spread provision of placebos as treatments.

Conclusion

In conclusion, the study set out to explore the effects of Red Bull energy drink against that of a placebo in tests of reaction time, executive functioning and basic motor skills. A total of 49 participants volunteered bringing the experiment extremely close to the effect size required. However, even with that, no significant results were found between any of the groups in relation to any of the four variables. Further research is also required to explore the wide variety of different cognitive functions and how they are affected by functional energy drinks. In addition, it is recommended that competitiveness between participants is measured with a questionnaire and monitored throughout further studies to explore the possibility of it being a confounding variable. As far as Red Bull GmbH’s claims of their products ability to improve reaction
time, concentration and physical endurance, with consideration to previous research, the validity of at least the two claims tested in the current study remain inconclusive.
References


APPENDICES

Appendix A: Facebook Recruitment Post

Hello all!!
I need participants to take part in an experiment for a psychology thesis. The aim of the experiment is to test the effects of Red Bull energy drink on cognitive abilities and will involve drinking one regular can of Red Bull, watching television for approximately 30 minutes and completing 4 basic tasks on a laptop (max. 5 minutes)

Participants must be:
- Willing to consume 250ml’s of Red Bull (One standard can)
- Able to commit approximately one hour to take part
- Able to travel to location

Unfortunately, you cannot participate if you:
- Are under 18 years of age
- Are pregnant or breast feeding
- Are allergic to any of the ingredients in Red Bull such as caffeine, taurine, apple, lime or blackcurrant concentrate
- Have a heart condition or any reason, medical or otherwise, for which you have been recommended not to consume energy drinks

An information sheet with further details will be provided to each participant when taking part and you are free to withdraw from the study without reason at any time.

The dates of the experiment have yet to be decided but will be organised to best suit the people taking part.

Please contact me by commenting or private message if you are interested in taking part and share this post with any other people you feel may be interested.

Thank you,
Barry Moore
Appendix B: Consent Form

EFFECTS OF RED BULL ON COGNITIVE PERFORMANCE

CONSENT FORM

I __________________________ [Block Capitals] consent to taking part in an experiment that will involve drinking 250ml’s of Red Bull (1 regular can) and committing approximately 1 hour for participation. I have been informed of both the purpose of the study and my role within the experiment and that I can withdraw from the experiment at any time without cause. I also understand that the research will be submitted as part of a thesis and may be further utilised in presentations.

Concerning health risks, at the time of signing, I am not pregnant, breastfeeding or allergic to any of the ingredients in Red Bull and have not been recommended to avoid energy drinks as a result of any pre-existing medical conditions or otherwise.

_______________________       _______________
Signature         Date
Appendix C: Demographic Question Sheet A01

A01: DEMOGRAPHIC QUESTION SHEET

Participant No.: Date:

Please take a moment to answer the questions below.

Q1 Are you male or female?
__________________________________________________________

Q2 What age are you?
__________________________________________________________

Q3 Have you had any cups of coffee today? If yes, how many?
__________________________________________________________

Q4 Have you had any other drink containing caffeine? E.G. Soft drinks/Tea
__________________________________________________________

Q5 Do you think you consumed Red Bull or the placebo drink?
__________________________________________________________
Appendix D: Demographic Question Sheet B02

B02: DEMOGRAPHIC QUESTION SHEET

Participant No.:                      Date:

Please take a moment to answer the questions below.

Q1 Are you male or female?

__________________________________________________________

Q2 What age are you?

__________________________________________________________

Q3 Have you had any cups of coffee today? If yes, how many?

__________________________________________________________

Q4 Have you had any other drink containing caffeine? E.G. Soft drinks/Tea

__________________________________________________________

Q5 Do you think you consumed Red Bull or the placebo drink?

__________________________________________________________
Appendix E: Demographic Question Sheet C03

C03: DEMOGRAPHIC QUESTION SHEET

Participant No.:        Date:

Please take a moment to answer the questions below.

Q1 Are you male or female?

________________________________________________________________________

Q2 What age are you?

________________________________________________________________________

Q3 Have you had any cups of coffee today? If yes, how many?

________________________________________________________________________

Q4 Have you had any other drink containing caffeine? E.G. Soft drinks/Tea

________________________________________________________________________

Q5 Do you think you consumed Red Bull or the placebo drink?

________________________________________________________________________
Appendix F: Experiment Debriefing/Information Sheet

EFFECTS OF RED BULL ON COGNITIVE PERFORMANCE

EXPERIMENT DEBRIEFING

The experiment that you have participated in is concerned with the effects of Red Bull on cognitive performance. However, it also involves a minor form of deception as not all participants will receive Red Bull. A placebo drink is being utilised with one third of the participants to test for placebo expectancy effects. For example, if you believe you have consumed Red Bull, will you perform equally as well as those who have actually consumed Red Bull?

How is this tested?

All participants will perform the same online experiment testing choice reaction time (picking the corresponding number to that of the lit up circle on screen), motor skills (tapping the spacebar alternating between right and left hands) and executive functioning (matching the example shown on screen to the correct image). However, the experiment is divided into three groups – a Red Bull group, a placebo group and a control group as a baseline for average performance without any beverage. Upon completion of the experiment, the scores of each group will be analysed against each other to check for differences in performance.

Hypothesis and main aims

This study has hypothesised that Red Bull will significantly improve both simple and choice reaction times as well as motor functioning but not executive functioning. It is also hypothesised that the placebo group will show a significant difference in performance when compared with the control group but not the Red Bull group and lastly, that there will be a significant difference in gender performance across the three groups.

What if I want to know more?

If you would like to receive a summary of the findings once completed or have any concerns regarding your participation, please contact Barry Moore (Researcher) on

or by email at

Alternatively, you may contact Dr. Patricia Frazer (Supervisor) at.

N.B. As participants testing dates may vary, please do not discuss this information with anyone else, as they may be a potential participant, until after 24th March 2013.
Thank you for your participation

Appendix G: Sample Questions and Guideline Answers

SAMPLE QUESTIONS AND GUIDELINE ANSWERS

Q1: Why do I need to sign a consent form?

A: You need to sign a consent form as you are participating in research and will also consuming an energy drink that has certain exclusion criteria such as being over 18 years of age, not pregnant or breastfeeding and have not been recommended not to consume energy drinks for a medical reason or otherwise.

Q2: Why do we have to roll a dice?

A: The dice is rolled to decide which group you will be taking part in E.g. Odd numbers for the Red Bull group and even numbers for the control group (no drink).

Q3: Why do we have to take mints before drinking?

A: The mints are given because the research is also testing a theory of taste perception as it is believed that chewing a breath freshener such as a mint immediately before drinking a beverage can dramatically distort its flavour, even if the beverage has a particularly strong flavour such as Red Bull and so it was the perfect candidate.

Q4: My Red Bull tastes weird, is there something else in it?

A: No, nothing has been added to the drink, it has simply been poured from a can into the opaque mug for serving. Any difference in taste you are experiencing is most likely due to the mints you ate previously.

Q5: Why is the drink in an opaque mug?

A: The drink is in an opaque mug so that if two or more participants are being tested at the same time, neither will be able to tell what the other is drinking. This is important when someone is in the control group and only has water in their mug. N.B. Participants were tested one at a time and the control group received no drink, however, it was necessary to
have a plausible excuse for the opaque mugs so as not to arouse suspicion.

Appendix G: Sample Questions and Guideline Answers (Continued)

Q6: Is this a measure of intelligence?

A: No, the tests are in no way a measure of intelligence. However, in order to make comparisons between groups it is necessary to have them perform a task so that the scores can be compared for significance. For example, if two people ran 100m in a field, one who had drank Red Bull and one who had had no drink, and the person who drank the Red Bull finished three seconds sooner, then you could say that Red Bull can improve your sprint performance by three seconds (X%). The same stands for the current study except the tests are measuring reaction time, executive functioning and basic motor skills.

Q7: Did I perform better than others?

A: Unfortunately it is not possible to tell until all the data is collected and analysed, however, even then individual participant scores will not be calculated against each other. If you would like a copy of the overall results of the research for between groups analysis these can be emailed onto you once the thesis is completed.

Q8: What do you do with the scores?

A: The scores will be gathered together and analysed at a later time to see if there are any significant differences in performance between the groups. If you would like a copy of the results once completed, please let me know.

Q9: What did I drink?

A: Code on top of demographic sheet was checked first to confirm which group the participant was in. If Red Bull the participant was simply informed that it was Red Bull, if placebo, the participant was informed of the ingredients of the placebo drink as well as the quantity of each ingredient in terms of parts per 250ml.
Appendix H: Unedited cross-reference table displaying the mean and standard deviation differences in males and females in the Red Bull, placebo and control group to two decimal places

<table>
<thead>
<tr>
<th>Experiment Group</th>
<th>Gender</th>
<th>Choice Reaction Time</th>
<th>Colour - word Inhibition</th>
<th>Sorting - Matching</th>
<th>Keyboard Tapping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Red Bull</td>
<td>Male</td>
<td>Mean 459.20</td>
<td>SD 142.27</td>
<td>Mean 615.00</td>
<td>SD 203.59</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>463.60</td>
<td>150.82</td>
<td>592.40</td>
<td>217.04</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>460.67</td>
<td>139.70</td>
<td>607.47</td>
<td>200.57</td>
</tr>
<tr>
<td>Placebo</td>
<td>Male</td>
<td>468.08</td>
<td>133.82</td>
<td>602.92</td>
<td>175.08</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>436.71</td>
<td>114.07</td>
<td>660.29</td>
<td>190.64</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>457.10</td>
<td>125.12</td>
<td>623.00</td>
<td>177.87</td>
</tr>
<tr>
<td>No drink</td>
<td>Male</td>
<td>506.00</td>
<td>151.26</td>
<td>717.71</td>
<td>135.89</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>499.00</td>
<td>123.20</td>
<td>549.00</td>
<td>93.92</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>502.50</td>
<td>130.59</td>
<td>633.36</td>
<td>142.33</td>
</tr>
</tbody>
</table>