Reaction time and energy drinks

Food & Diet

This extended essay is an investigation into reaction times in males and females and how they were affected by Red Bull. The research question was “ How significant is the reduction in reaction time due to drinking Red Bull, in males as compared to females between the ages of 16-17.”

To answer this, a simple experiment was carried out to obtain the necessary data. The ruler drop test was conducted using a group of 20 subjects (10 male and 10 female).

The reaction times of the subjects before and after drinking Red Bull were then calculated using the results from the ruler drop test and the formula t = âˆš(2d /a). The mean data was then analysed using the T-Test to see how significant the difference in reaction time was before and after drinking Red Bull. This revealed that even though reaction times in males reduced after consumption of Red Bull, the reduction was not significant. Female subjects showed greater decreases in reaction time after drinking Red Bull even though on average their reaction times were slower than male reaction time. The T-Test showed that in females there was a significant difference in reaction time before and after drinking Red Bull. Finally the mean reductions in reaction time for both males and females were compared using the T-test, which revealed that there was a significant difference in male and female reductions in reaction time. This leads to the conclusion that between the ages of 16-17, Red Bull only significantly reduces reaction time in females and not in males.

Introduction

Research Question

“ How significant is the reduction in reaction time due to intake of Red Bull, in males as compared to females between the ages of 16-17.”

“ It gives you wings” this is the slogan for Red Bull, a popular energy drink. The slogan suggests that Red Bull improves one’s overall performance. Reaction time is one of the physical attributes affected by Red Bull. I wanted to investigate Red Bull’s effect on reaction time and evaluate whether Red Bull really does “ give you wings”. Reaction time is the time taken to respond to any given stimulus. The better the reaction time, the less it is. Fast reactions are useful in many situations, for instance avoiding another car whilst driving, catching a falling glass and even in sport.

Previous research into reaction time has found that Males and females generally have different reaction times with females unfortunately having slower average times. (Der and Deary, 2006).

Energy Drinks are beverages that have a boosting or stimulating effect. They are often advertised as performance enhancing, with improvements in alertness and reaction time. Red Bull is probably the most prominent energy drink. The active ingredients in Red Bull include: Glucose, Taurine, Glucuronolacton, Inosital, Niacin, D-Pantothenol (Vitamin B5), Pyridoxine HCL (Vitamin B6), Vitamin B12 and Caffeine. (Further details in appendix ii.). These chemicals affect the body’s metabolic functions so that overall performance is enhanced.

My approach was experimental in which the Ruler Drop Test (Coach, 1997) was used.

Hypothesis

I hypothesise that Red Bull will cause a decrease in reaction time in all subjects. This is due to the ingredients contained in the drink. Taurine and caffeine are the two ingredients that affect the speed of reaction most. Taurine improves nerve transmission; this means that movements made will be faster. Caffeine boosts adrenaline levels which makes one more alert and therefore more likely to respond faster. Thus, I expect reaction time to decrease in all subjects. I also hypothesise that the improvements in reaction time will be more significant in females as they generally have a smaller body mass meaning that the active ingredients in Red Bull will have more of an effect.

Experiment

Test Subject Selection

It was important to make sure that the results from the experiment were as reliable as possible.

To do this I had to choose test subjects (participants in the experiment) who were similar in age, athleticism and how frequently they take energy drinks. I decided to use subjects within the age range of 16-17 as this is the age range with the most people in my school and therefore there was a larger test subject range. I had to keep the ages similar because age was found to have an effect on reaction time. (Gorus et al., 2008) Generally reaction time decreases with age until a certain point where it begins to increase again. I wanted subjects who were similar in athleticism because people who are more athletic are more likely to have quicker reaction times than non-

athletic people. (Levitt and Gutin., 1971) I also needed subjects who didn't take Red Bull as frequently. It was assumed that people who take energy drinks frequently may develop resistance to its effects.

A questionnaire was used to identify the subjects that fit in with these criteria. It was given to 40 people out of whom 10 males and 10 females were selected using random sampling.

Preparation of Subjects

The test subjects had to be prepared before the experiment to ascertain that it was in fact the Red Bull that was affecting the subject's reaction time and not any other food. The Red Bull was administered an hour after break time. It was assumed that by this time all food (if any) would have been digested. This was important because the Red Bull has to be the only substance ingested prior to the experiment to make sure that the results obtained are from the effects of Red Bull and not any other food substance. Testing took place 10 minutes after consumption to give the active ingredients in the Red Bull enough time to be assimilated.

Procedure

The Ruler Drop Test was carried out using the following method.

A ruler was held so that it was between the index finger and thumb of the subject's stronger hand. The top of the subject's thumb was kept in line with the zero centimetre line on the ruler. The subject then tried to catch the ruler after it was let go. The distance from the bottom of the ruler to the top of the subject's thumb was recorded. To improve reliability of the results the

experiment was repeated again. It would be nearly impossible to manually record the time taken for someone to catch a dropped ruler because this happens very quickly. So to calculate the time taken (and thus reaction time) the following formula was used.

$t = \hat{a}\check{s}(2d / a)$

This was derived from:

$d = vt + \frac{1}{2}at^2$ [11]

d is Distance measured in (cm)

v is Initial velocity which is zero

a is Acceleration due to gravity this a constant value of $981 cm/s^2$

t is Time measured in seconds (s)

Data Collection

The tables below show the results from the ruler drop test conducted on 9. 7. 2010. It shows the distances that the ruler travelled before it was caught by the subjects. The results before and after drinking Red Bull were recorded. The experiment was repeated twice to improve the reliability of the results.

Trial 1

Trial 2

Males

Females

Males

Females

Subject number

Distance Before Drinking Red Bull +/-0. 05 (cm)

Distance After Drinking Red Bull +/-0. 05 (cm)

Distance Before Drinking Red Bull +/-0. 05 (cm)

Distance After Drinking Red Bull +/-0. 05 (cm)

Distance Before Drinking Red Bull +/-0. 05 (cm)

Distance After Drinking Red Bull +/-0. 05 (cm)

Distance Before Drinking Red Bull +/-0. 05 (cm)

1

16

13

16

9

9

6

12

2

15

14

15

17

12

8

9

3

5

9

30

17

7

5

17

4

8

9

22

11

8

5

13

5

15

11

18

12

6

7

15

6

12

7

19

19

10

7

11

7

6

7

15

11

9

8

16

8

14

8

17

10

11

6

10

9

7

6

14

12

5

8

12

10

14

17

14

10

13

15

15

Data Processing

The raw data was processed to give the tables below. The values in red show anomalies, that is data that is erroneous and/or unexpected, in this case distances increasing after taking Red Bull and Reaction Time increasing after taking Red Bull. These values could be generated by an error in the data collection or an error in the experiment. They are therefore ignored when considering the significance.

The tables below show the calculated reaction time before and after drinking Red Bull. Reaction times were calculated using the distances obtained from the experiments which were then substituted into the formula. t = âˆš(2d /a).

The tables also show the difference in reaction time which is the reaction time after drinking Red Bull, subtracted by the reaction time before drinking Red Bull. This was done so that that the improvement in reaction time can be seen. Table (1. a) shows the data from the 1st repeat and table (1. b) shows data from the 2nd repeat and Table (2) shows the mean of both repeats. In this table, most of the errors disappear as the mean uses the data from both sets of repeats to show an average or trend.

Examples:

Calculating Reaction Time

A subject catches the ruler at 16. 0 cm without drinking Red Bull. The subject then catches the ruler at 13. 0 cm after drinking Red Bull. The time taken for the subject to catch the ruler is worked out like this.

Distance before taking Red Bull= 16. 0 cm

Formula: t = âˆš(2d /a)

So

2×16. 0= 32

32/981= 0. 03262

âˆš 0. 03262= 0. 18061

Therefore it took the subject 0. 18061 seconds to catch the ruler before drinking Red Bull.

Distance after taking Red Bull= 13. 0 cm

2×13. 0= 26

26/981= 0. 02650

âˆš0. 02650= 0. 16280

Therefore it took the subject 0. 16280 seconds to catch the ruler after drinking Red Bull.

Calculating Difference

The subject’s Reaction time before drinking Red Bull is 0. 18061 seconds and the subject’s reaction time after drinking Red Bull is 0. 16280 seconds.

To find the difference the subject’s reaction time after drinking Red Bull is subtracted by the Reaction time before drinking Red Bull to give: -0. 01781.

In this example, the calculated difference in reaction time is negative. This shows that after drinking Red Bull, the subject's reaction time improved by -0. 01781 seconds.

Calculating the Mean

In the second repeat of the experiment the subject catches the ruler at 9 cm before drinking Red Bull and then catches the ruler at 6cm after drinking Red Bull. The subject therefore gets these reaction times:

Before drinking Red Bull: 0. 13546 sseconds.

After drinking Red Bull: 0. 11060 seconds.

The mean for reaction time before and after drinking Red Bull can be calculated, using the values from the 1st and 2nd repeats of the experiment.

Mean reaction time before drinking Red Bull:

0. 18061 + 0. 13546= 0. 31607

0. 31607 / 2= 0. 158035 seconds

Mean reaction time after drinking Red Bull:

0. 13546 + 0. 11060= 0. 24606

0. 24606 / 2= 0. 12303 seconds

The mean shows a more reliable value from both repeats.

Table (1. a): Table of results from the first trial of the experiment

Trial 1

Males

Females

Subject number

Reaction Time Before Drinking Red Bull (s)

Reaction Time After Drinking Red Bull (s)

Difference In Reaction Time +/- (s)

Reaction Time Before Drinking Red Bull (s)

Reaction Time After Drinking Red Bull (s)

Difference In Reaction Time (s)

1

0. 0058

0. 0052

-0. 00057

0. 18061

0. 13546

-0. 04515

2

0. 0056

0. 0054

-0. 00019

0. 17487

0. 18617

0. 01129

3

0. 0032

0. 0043

0. 0011

0. 24731

0. 18617

-0. 06114

4

0. 0041

0. 0043

0. 00025

0. 21178

0. 14975

-0. 06203

5

0. 0056

0. 0048

-0. 0008

0. 19157

0. 15641

-0. 03515

6

0. 005

0. 0038

-0. 00118

0. 19681

0. 19681

0

7

0. 0035

0. 0038

0. 00028

0. 17487

0. 14975

-0. 02512

8

0. 0054

0. 0041

-0. 00132

0. 18617

0. 14278

-0. 04338

9

0. 0038

0. 0035

-0. 00028

0. 16894

0. 15641

-0. 01253

10

0. 0054

0. 0059

0. 00055

0. 16894

0. 14278

-0. 02616

Table (1. b): Table of results from the first trial of the experiment

Trial 2

Males

Female

Subject number

Reaction Time Before Drinking Red Bull (s)

Reaction Time After Drinking Red Bull (s)

Difference In Reaction Time (s)

Reaction Time Before Drinking Red Bull (s)

Reaction Time After Drinking Red Bull (s)

Difference In Reaction Time (s)

1

0. 13546

0. 1106

-0. 02486

0. 15641

0. 17487

0. 01846

2

0. 15641

0. 12771

-0. 0287

0. 13546

0. 11946

-0. 016

3

0. 11946

0. 10096

-0. 0185

0. 18617

0. 16894

-0. 01722

4

0. 12771

0. 10096

-0. 02675

0. 1628

0. 13546

-0. 02734

5

0. 1106

0. 11946

0. 00886

0. 17487

0. 1628

-0. 01208

6

0. 14278

0. 11946

-0. 02332

0. 14975

0. 11946

-0. 03029

7

0. 13546

0. 12771

-0. 00775

0. 18061

0. 17487

-0. 00574

8

0. 14975

0. 1106

-0. 03915

0. 14278

0. 13546

-0. 00733

9

0. 10096

0. 12771

0. 02675

0. 15641

0. 14975

-0. 00666

10

0. 1628

0. 17487

0. 01208

0. 17487

0. 1628

-0. 01208

Table (2): Table of mean values from trial 1 and trial 2

Trial 1 + Trial 2

2

Males

Females

Subject number

Reaction Time Before Drinking Red Bull (s)

Reaction Time After Drinking Red Bull (s)

Difference In Reaction Time (s)

Reaction Time Before Drinking Red Bull (s)

Reaction Time After Drinking Red Bull (s)

1

0. 0051

0. 0044

-0. 00065

0. 16894

0. 15641

2

0. 0053

0. 0048

-0. 00052

0. 15641

0. 15641

3

0. 0035

0. 0038

0. 00028

0. 21888

0. 17777

4

0. 0041

0. 0038

-0. 00026

0. 18889

0. 14278

5

0. 0047

0. 0043

-0. 00035

0. 18341

0. 15964

6

0. 0048

0. 0038

-0. 00097

0. 17487

0. 1628

7

0. 0039

0. 0039

0

0. 17777

0. 1628

8

0. 0051

0. 0038

-0. 00128

0. 1659

0. 13917

9

0. 0035

0. 0038

0. 00028

0. 1628

0. 15312

10

0. 0053

0. 0058

0. 00047

0. 17194

0. 15312

Data Analysis

The first step in analysing the data is to compare the reaction times of males and females before and after drinking Red Bull separately using the mean values from table 2. This is done below:

Graph (1. a):

The graph (1. a) shows the comparison of the mean male reaction time before and after drinking Red Bull. The graph shows that generally the blue bar (Male Reaction Time before Drinking Red Bull) is higher than the red bar (Male Reaction Time After Drinking Red Bull) This suggests that Red Bull generally had the effect of reducing reaction time in males.

Red Bull contains Taurine (see appendix ii) Taurine speeds up neural transmission, so nerve impulses are passed along through the nervous system much faster. This means that the time taken for the subjects hand to react to the stimulus (in this case the dropped ruler) is less. Another ingredient that probably affects reaction time most is caffeine. Caffeine blocks adenosine and boosts adrenaline levels. Adrenaline causes the heart rate to increase, the respiratory rate in the lungs to increase and muscle contraction all around the body. These are just some of the effects known as the “ fight” or “ flight” response. The overall effect is that you respond better to stimuli as the body is more alert.

T Test

The T-Test shows how significant the statistical difference between two values is. The T-Test determines the P-Value. In Biology the difference between the two values is considered statistically significant if the P value is below 0. 05 If it is The Null hypothesis is therefore rejected and the alternative hypothesis is accepted.

Null Hypothesis: There is no significant difference in reaction time before and after drinking Red Bull in Males.

Alternative Hypothesis: There is a significant difference in reaction time before and after drinking Red Bull in males.

For this T-Test I compared the mean values of reaction time before and after drinking Red Bull for males. I got a P-Value of 0. 06626028. This is greater than 0. 05 therefore the Null hypothesis has to be accepted.

The T-Test suggests that with males, the difference in reaction time after drinking Red Bull is not significant because the P value (0. 06626028) is greater than the standard critical value (0. 05).

Graph (1. b)

The graph (1. b) shows the comparison of the mean female reaction time before and after drinking Red Bull. Again, the graph shows that generally the blue bar (Female Reaction Time after Drinking Red Bull) is higher than the red bar (Female Reaction Time Before Drinking Red Bull) This suggests that Red Bull generally had the effect of decreasing reaction time in females. This decrease is again due to the ingredients contained in Red Bull. Both taurine and caffeine affect the subjects system so that the speed of movement and response in increased.

T-Test

Another T-Test is carried out to find out how significant the difference in reaction time before and after drinking Red Bull in females is.

Null Hypothesis: There is no significant difference in reaction time before and after drinking Red Bull in Males.

Alternative Hypothesis: There is a significant difference in reaction time before and after drinking Red Bull in males.

For this T-Test I compared the mean values of reaction time before and after drinking Red Bull for females. I got a P-Value of 0. 00068587. This is less than 0. 05 therefore the null hypothesis is rejected and the alternative hypothesis is accepted.

The T-Test suggests that the differences in the female reaction time before and after drinking Red Bull are very significant as the P value (0. 00068587) is far below the standard critical value of 0. 05.

The final step in analyzing the data is to compare male and female change in reaction times.

Graph (2)

Graph (2) shows the Comparison of Male and Female reduction in reaction time. The pink plot points show the mean female difference in reaction time; whilst the blue plot points show the mean male difference in reaction time. The graph shows that generally mean male reduction in reaction times were much lower than the mean female reduction in reaction time. This suggests that females are affected more by Red Bull. Another observation that can be made from the graph also shows that the female data is more varied than the male data. However the data that was collected was too small to make any definite conclusions.

T-Test

A T-Test was carried out to find out how significant the difference in mean male and female difference in reaction time.

Null Hypothesis: There is no significant difference between mean male and female difference in reaction time.

Alternative Hypothesis: There is a significant difference between mean male and female difference in reaction time.

In this T-Test I compared the mean values of difference in reaction time for both males and females. I got a P-Value of 0. 001571698. This is less than 0. 05 therefore the null hypothesis is rejected and the alternative hypothesis is accepted.

The T-Test suggests that there is a big significance in the difference between mean male and mean female difference in reaction times because the P value is much lower than the critical value of 0. 05.

Conclusion

In general, reaction times decreased after drinking Red Bull in both males and females. Males generally had faster times females. However the T-Test shows that in males this difference is not significant whilst in females, it is quite significant. Further calculations showed that there was a significant difference between the reduction of reaction time in males and females. Females generally had greater reductions in reaction time.

The data does not support the first hypothesis, which states that reaction time would decrease in all subjects after the consumption of Red Bull, as there were some instances where the reaction times worsened. These

anomalies may have been due to error in the method however, and had no overall significance to the experiment as they were ignored.

The data supports the final hypothesis, which states that Red Bull would improve reaction time more significantly in females. The results from the investigation show that females had a more significant reduction in reaction time after drinking Red Bull as compared to males. The reason for females being affected more by Red Bull is, Pound for pound females have less water in their bodies than men, so their body parts are more exposed to the active ingredients in Red Bull. This leads to the conclusion that between the ages of 16-17, Red Bull only significantly reduces reaction time in females and not in males.

Evaluation

There were some aspects of the experimental method that may have reduced the reliability of the data.

When the ruler drop test was performed for the second time the subjects – instead of improving reaction time as a result of drinking Red Bull – may have naturally improved their reaction time through practice. Also the subjects knew that they were drinking Red Bull and that Red Bull is said to improve physical performance including reaction time. This again may have caused them to improve their times naturally through the psychological stimulation.

There is no actual proof however that improvement in reaction time was due to practice. It is only a speculation. However if the subjects reaction times were improving as a result of practice then this would affect the data as Red

Bull would not be the only factor improving reaction time. The best way to reduce the effect of this factor would be to carry out the experiment only once. This would reduce the reliability of the data as a mean of both experiments not would be possible to calculate but at the same time it would improve the reliability of the data as subjects would not be getting better with practice and it would be only the Red Bull affecting the subject's reaction time.

I also could have set up another Ruler Drop Test experiment using a different set of subjects but replacing the Red Bull energy drink with a non – energetic drink. The subjects however, would be told that they are having another brand of energy drink. This would test the thought of having an energy drink makes the subject expect to perform better and therefore actually improving their reaction time naturally. A second experiment using the same subjects could then be carried out using but using Red Bull. The results of the second experiment could then be compared with the results from the first experiment to further asses the significance improvement in reaction time due to Red Bull.

Error Analysis

30 cm Ruler (cm)

Absolute uncertainty

+/- 0. 05

Percentage Uncertainty %

0. 25

Overall Uncertainty %

0. 25

Appendix (i)

Questionnaire

How old are you: ____

2. How Much Sport do you do?

None Wednesday Clubs Only

Barely Active Participation

3. Do You Take Energy Drinks Regularly: _____

4. Are You Willing To Participate in this Experiment_____?

Appendix (ii)

Active ingredients in Red Bull:

Glucose

Glucose is a sugar. The body uses glucose in respiration to make energy.

$C_6H_{12}O_6 + 6O_2 = 6H_2O + 6CO_2 + 36ATP$

Glucose + Oxygen = Water + Carbon Dioxide + Energy.

Redbull contains 5. 25 g of glucose.

Taurine

Taurine is an amino acid that is usually made in the body. Each can of Red Bull contains 1000mg of Taurine. Taurine helps move minerals like potassium, sodium, calcium and magnesium through the cells. This helps to generate nerve impulses therefore making neural transmission faster.

Glucuronolacton

Glucuronolacton is a chemical similar to taurine. It affects memory and concentration in the brain. It is known to have effects similar to anti-depressants and stimulants.

Inosital

Inosital is a chemical that has a mood boosting effect and it maximises the brains uses of a serotonin a chemical that is found in most anti-depressants.

Niacin

Niacin is a B vitamin that helps in energy formation. It metabolizes energy from fat and carbohydrates. Niacin can help the body use energy by releasing it from food.

D-Pantothenol

D-Pantothenol is also known as vitamin B5, or Pantothenic acid. It is known to improve mood and boost energy. D-Pantothenol help turn fat into energy and increases metabolism.

Pyridoxine HCL

Also known as Vitamin B6, Pyridoxine HCL helps red blood cells to form and provides better oxygen utilization. It also help to break down sugar that you have stored in your body to use for energy.

Vitamin B12

B12 helps in the formation of red blood cells, for better oxygen utilization. It also help with energy production by breaking down fat and protein.

Caffeine

Red Bull contains 80. 0 milligrams of caffeine which is almost double the amount of all other soft drinks. The caffeine in Red Bull gives you energy by blocking a chemical in your brain called adenosine. Adenosine promotes sleepiness and without it you would not be able to fall asleep. When adenosine is blocked you body releases a boost of adrenaline which wakes you up.