The effects of caffeine and exercise on reaction and reflex time.

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Grosse Pointe North High School, Applied Medical Research 2015

GROSSE POINTE PUBLIC SCHOOL SYSTEM

Introduction

Want an advantage in your next game? Many athletes believe that ingesting caffeine will give them an advantage in their sport. However, many do not fully understand what caffeine actually does to their body and more specifically, their reflex and reaction times. Caffeine is a psychoactive stimulant, and it is widely used around the world to relieve or prevent drowsiness and to increase one's energy level. Because reactions are known to be slower when someone is tired, we hypothesized that ingesting caffeine will increase reaction and reflex speed.

In a recent survey of American high-school athletes, 32 percent reported drinking energy beverages. In another survey of 16,000 adolescent athletes, 27 percent said that they used caffeine, usually in the form of energy drinks, to improve their performance on the field (Reynolds, 2010). However, does it really give you an edge, or is it all in your head?

In a study done by BH Jacobson and SW Edwards in 1990, 30 subjects were randomly assigned to one of three groups to determine the effect of different doses of caffeine on a patellar ligament reflex. One group receive a placebo (control), another received a 3mg/kg dose, and the third received a 6mg/kg dose. Results showed that the 6mg/kg group was significantly different than the other two groups (Jacobson, Edwards, 1990).

In this study, two subjects were tested to see if drinking energy drinks affected their reflex and reaction times before and after exercise. Our team believes that the stimulating caffeine will lead to a faster reflex and reaction speed which may benefit an athlete before competition.

Rationale

An increase in caffeine may provide an increase in the amount of energy in the human. When caffeine is ingested, adenosine is reversibly blocked to its receptor, which prevents the feeling of drowsiness. For this reason, this leads us to believe that if a person is less drowsy, they will have a faster reaction and reflex time because they will be more awake.

Hypothesis

If caffeine is ingested by high school students, then the reaction and reflex rates will become faster than those without caffeine.

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Methods

Model:

Two high school seniors, one age 17 and 135 lbs and the other 18 and 175 lbs with active lifestyles consumed an energy drink before exercising to detect whether reaction and reflex rates would speed up or slow down compared to their normal baseline reflex and reaction times.

First, we ran a control test to see what the reflex and reaction rates were of the students before ingesting caffeine.

To test reaction time, we used a reflex hammer and hit the patellar tendon. This would cause the knee to reflex, giving us our data.

To test reaction time, we used the reflex hammer and hit the table without the student looking. As soon as they heard the sound, they would kick their knee to show their reaction time.

Electrodes were hooked up to the student to connect the responses to our logger pro to show us our results.

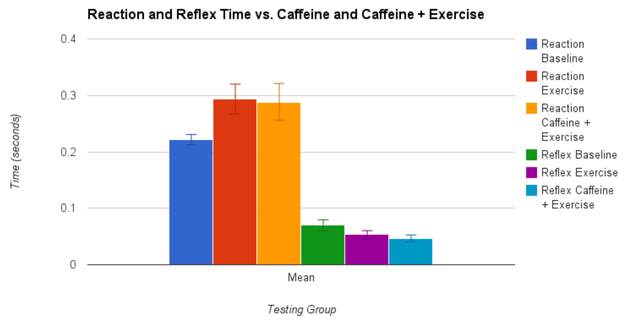
Data points were collected for approximately 25 seconds, and the cleanest 3 waveforms from each test were used in our graphs.

After the baseline data was completed, the two subjects were asked to do a series of exercises like running up and down stairs and stationary things like jumping jacks and push ups. After finishing the exercises, the subjects again were hooked up to the Logger Pro program and the same tests were run.

After these two pieces of data were collected, the students consumed a 12 oz Red Bull drink, and 90 minutes later tests were done again, following the same exact guidelines. There was 150 mg of caffeine in each of the cans.

We then interpreted the results using a t-test and an ANOVA test to see if there was significant difference in the data to show a correlation between drinking caffeine and reaction or reflex rate.

Results



The above graph shows all six of our testing groups. The two "Baseline" columns were the control groups and the other four columns were the experimental groups. As you can see in the reaction side of the graph, the addition of exercise and caffeine increased the variance of the data, but did not change the mean enough to be statistically significant. As expected, there was a statistically significant difference between the reflex rate and the reaction rate with a two-tailed P value equal to 0.0287. This means that there is a time difference between the reflex arc (only going to the spinal cord and back), and a reaction (going all the way to the brain).

Reaction: All of the reaction data was compared using a one-way ANOVA (variance test) the following result was found: This test will be performed only if K>2 and the analysis of variance yields a significant F-ratio. There is no statistically significant difference between the three reaction tests. baseline, exercise, and exercise with caffeine. Also, we compared each group with every other group using a T-test at a 0.05 significance level. The first t-test compared the Reaction Baseline group to the Reaction Caffeine + Exercise group, we found a P value of 0.0787. The other reaction T-test we ran compared the Reaction baseline group to the Reaction Caffeine It can be said that the the specific tests that we ran with our our parameters and dosages had no statistically significant effect on the reaction time of our subjects.

Reflex: All of the reaction data was compared using a one-way ANOVA (variance test) the following result was found: This test will be performed only if K>2 and the analysis of variance yields a significant F-ratio. Since the tukey test was not run, there is not a significant difference between the data points (F-ratio) was not statistically significant. So it can be said that the the specific tests that we ran had no statistically significant effect on the variance of the reflex time.

Acknowledgements

Special thanks to:

The taxpayers of Grosse Pointe and The Grosse Pointe Public School System for funding this breakthrough research.

Our teacher, Mrs. Susan Speirs, in the Applied Medical Research class for the opportunity to pursue this experiment and become Student Researchers.

Our Parents, Dr. and Mrs. MacAskill, Dr. Blunden, Dr. Blunden, Mr. and Mrs. Eger, and Mr. and Mrs. Burke for fostering our interest in the sciences, and allowing us to be inquisitive for knowledge.

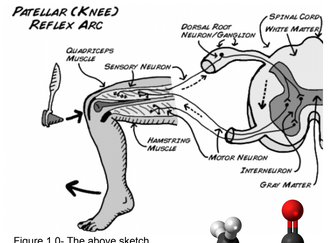


Figure 1.0- The above sketch illustrates the knee reflex arc we used to test our hypothesis.

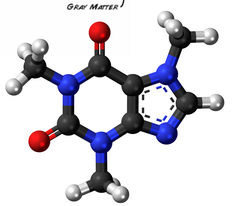


Figure 1.1- The molecule to the right is a 3D model of Caffeine.

Summary of Results

There was an extremely statistically significant difference between all of the reaction time means and all of the reflex time means. This is expected because of the nature of the path the neural impulses take. A trip to the brain is shorter than a trip to the spinal cord by almost a factor of two each way.

As expected from the previous studies (BH Jacobson and SW Edwards, 2009), the effect of caffeine on reflex and reaction time in both fatigued and fresh subjects is not statistically significant.

In the first subjects exercise portion, we found a statistical significance between his baseline and his exercise only. However we found no statistical significance between the means for all of our subjects. So this is only anecdotal in nature, no conclusions can be drawn from this.

Conclusions

After conducting the tests, it was found that there was no significant difference between the initial tests without caffeine, and the ones with caffeine. In words, these results showed that ingesting one energy drink before a competition will not give you an advantage based on your reflex and reaction rates.

Due to the fact that we didn't want to have too much caffeine for various reasons, we had to limit the amount we had before conducting the experiment.

Unfortunately, there was no significant difference between the two points, and we could attribute this largely to the fact that we didn't ingest a large amount of caffeine.

Based on similar studies done by researchers using larger amounts of caffeine we can hypothesize that ingesting larger amounts of caffeine would have made a more significant correlation between the data.

Future Directions

Verify whether this pattern of exercise versus reaction and reflex time includes both cardiovascular exercise as well as muscular exercise.

Attempt larger quantities of caffeine and larger amount of exercise. We were limited on the amount of caffeine we could ingest because we are in High School and the subjects were under 18.

The second study cited below illustrates similar results as we found. At a ~3mg/kg there is no statistical significance between caffeinated and non-caffeinated performace.

References

Reynolds, Gretchen. "Phys Ed: Do Energy Drinks Improve Athletic Performance?." New York Times Blogs: Well . New York Times, 8 Dec. 2010. Web. 23 Feb. 2015. <http://well.blogs.nytimes.com/2010/12/08/phys-ed-do-energy-drinks-improve-athletic-performance/>.

H, J. B., & W, E. S. (1990, July). Effects of ingested doses of caffeine on neuromuscular reflex response time in man. Int J Sports Med, 11(3). doi:10.1055/s-2007-1024790