Juan Marino

Professor Okerblom

Human Physiology

15 November 2023

Independent Project: The Physiological Effects of Caffeine on the Heart

Observe/Background

The initial observation I made is the interest in understanding how caffeine consumption influences heart rate. This interest stemmed from my daily consumption of caffeine in the form of black coffee in the morning to get me up and going, and from my personal experiences with its effects I determined that there is a link between caffeine and increased cardiovascular activity. Once ingested into your body, the caffeine messes with a neurotransmitter called adenosine. Adenosine usually calms things down and helps the body feel sleepy/relaxed but caffeine blocks adenosine's effects.

Question

With that in mind, the following question is proposed, how does the dose-dependent nature of caffeine intake influence the heart, and what are the potential cardiovascular implications at varying doses of caffeine concentration?

Hypothesis

The dose-dependent nature of caffeine intake significantly influences the heart, and varying doses of caffeine concentration may have distinct cardiovascular implications. Therefore I hypothesize that as the dosage of caffeine increases, there will be a corresponding escalation in cardiovascular responses, mainly expected to impact heart rate the most but can also include blood pressure. At lower doses, caffeine may act as a mild stimulant, leading to a modest increase in heart rate and blood pressure but not a drastic increase in the heart rate. In contrast, higher doses of caffeine may result in a more pronounced and potentially adverse cardiovascular response, mainly including elevated heart rate at varying levels, increased blood pressure, and alterations in cardiac function.

Experiment

Objective:

To investigate the effects of caffeine on heart rate by comparing baseline readings with readings taken 30 minutes and 60 minutes after the ingestion of different caffeinated beverages.

Materials:

To understand the effects of caffeine we will need the following materials, to be ingested we will need the following beverages, A regular 8 oz black coffee(70mg), 16 oz Monster Energy Drink(86mg), 8 oz Black Tea(7mg). In order to conduct the experiment a heart rate monitor and a stopwatch or timer, for this experiment we will be utilizing the ECG functions of an Apple watch and can simultaneously set a timer as well.

Experimental Procedure:

In order for the results to be accurate, abstain from caffeine for 24 hours prior to the experiment. CAUTION: do not perform all three experiments on the same day, allow a minimum of **10 hours** between experiments to avoid the possibility of sleep problems, increased anxiety, and increased blood pressure. For more accurate results set up a quiet and comfortable space for the experiment

Part A: Control(no caffeine intake)(water, 0mg of caffeine)

1) Record Baseline Measurements (Time: 0 minutes): using the heart rate monitor.
2) Administer the caffeine-free placebo
3) Ensure the participant consumes the assigned beverage within 10-15 minutes.
4) Record heart rate readings at the following time points: 30 minutes and 60 minutes after caffeine ingestion. Use the stopwatch or timer to ensure accurate timing.

Experimental Groups:

Part B: Black Coffee Group (8oz, 70mg of caffeine):

5) Record Baseline Measurements (Time: 0 minutes): using the heart rate monitor.
6) Administer the 8oz black coffee.
7) ensure the participant consumes the assigned beverage within 10-15 minutes.
8) Record heart rate readings at the following time points: 30 minutes and 60 minutes after caffeine ingestion. Use the stopwatch or timer to ensure accurate timing.

Part C: Monster Energy Drink Group (16oz, 86 mg of caffeine):

9) Record Baseline Measurements (Time: 0 minutes): using the heart rate monitor.
10) Administer the 16 oz Monster Energy Drink.
11) Ensure the participant consumes the assigned beverage within 10-15 minutes.
12) Record heart rate readings at the following time points: 30 minutes and 60 minutes after caffeine ingestion. Use the stopwatch or timer to ensure accurate timing.

Part D: Black Tea Group (8oz, 7 mg of caffeine):

13) Record Baseline Measurements (Time: 0 minutes): using the heart rate monitor.
14) Administer the 8oz black tea.
15) ensure the participant consumes the assigned beverage within 10-15 minutes.
16) Record heart rate readings at the following time points: 30 minutes and 60 minutes after caffeine ingestion. Use the stopwatch or timer to ensure accurate timing.

Analyzing Results

Part A: Control(no caffeine intake)(water, 0mg of caffeine)

Initial Reading (0 Min):

Juan Marino
Date of Birth: Nov 4, 2001 (Age 22)
Recorded on Nov 29, 2023 at 9:37 PM

Sinus Rhythm — ♥ 66 BPM Average
This ECG does not show signs of atrial fibrillation.

Second Reading (30 Min):

Juan Marino
Date of Birth: Nov 4, 2001 (Age 22)
Recorded on Nov 29, 2023 at 10:14 PM

Sinus Rhythm — ♥ 72 BPM Average
This ECG does not show signs of atrial fibrillation.

Final Reading (1 Hr):

Juan Marino
Date of Birth: Nov 4, 2001 (Age 22)
Recorded on Nov 29, 2023 at 11:24 PM

Sinus Rhythm — ♥ 71 BPM Average
This ECG does not show signs of atrial fibrillation.

Nothing much to discuss, the control heart rate averages at around 70 beats per minute. This number will be used as a baseline to see the differences in changes from the other averages obtained from the remaining parts.

Part B: Black Coffee Group (8oz, 70mg of caffeine):

Initial Reading (0 Min):

Juan Marino

Sinus Rhythm — ♥ 69 BPM Average

This ECG does not show signs of atrial fibrillation.

Second Reading (30 Min):

Juan Marino

Sinus Rhythm — ♥ 92 BPM Average

This ECG does not show signs of atrial fibrillation.

FInal Reading (1 Hr):

Juan Marino

Sinus Rhythm — ♥ **92 BPM Average**

This ECG does not show signs of atrial fibrillation.

25 mm/s, 10 mm/mV, Lead I, 512Hz, iOS 17.1.1, watchOS 10.1.1, Watch7,5, Algorithm Version 2 — The waveform is similar to a Lead I ECG. For more information, see Instructions for Use.

These results were the second highest out of all the caffeinated beverages, the average heart rate for a plain black coffee is 84 beats per minute, these results display a 14 beat per minute difference in heart rate after the caffeine in the drink was ingested. The results were no surprise as coffee had the second highest caffeine count with a total of 70mg of caffeine. While this heart rate is a bit high it's not super fast and is a manageable pace.

Part C: Monster Energy Drink Group (16oz, 86 mg of caffeine):

Initial Reading (0 Min):

Juan Marino
Date of Birth: Nov 4, 2001 (Age 22)
Recorded on Nov 28, 2023 at 7:49 PM

Sinus Rhythm — ♥ 64 BPM Average
This ECG does not show signs of atrial fibrillation.

Second Reading (30 Min):

Juan Marino
Date of Birth: Nov 4, 2001 (Age 22)
Recorded on Nov 28, 2023 at 8:24 PM

High Heart Rate — ♥ 118 BPM Average
This ECG does not show signs of atrial fibrillation but does show a high heart rate.

If you repeatedly get this result, or you're not feeling well, you should talk to your doctor.

Final Reading (1 Hr):

These results were the highest out of all the caffeinated beverages, the average heart rate for an energy drink(Monster energy drink) is 92 beats per minute, these results display an astonishing 22 beats per minute difference in heart rate after the caffeine in the drink was ingested. These results were expected as the energy drink has the highest caffeine concentration out of all of the beverages, coming in at 86 mg of caffeine in total. This agrees with my hypothesis because it proves(alongside coffee) that as the dosage of caffeine increases, so too does the response from the cardiovascular system. The interesting part is the differences between the two highest performers, the energy drink came out to 94 bpm average with 86 mg of caffeine and black coffee came out with 84 bpm average with 70 mg of caffeine. This displays that as a result of the additional 16 mg of caffeine in the energy drink caused an additional 10 bpm when compared to just normal caffeinated black coffee.

Part D: Black Tea Group (8oz, 7 mg of caffeine):
Initial Reading (0 Min):

Juan Marino

Sinus Rhythm — 69 BPM Average
This ECG does not show signs of atrial fibrillation.

Second Reading (30 Min):

Juan Marino

Sinus Rhythm — 74 BPM Average
This ECG does not show signs of atrial fibrillation.

Final Reading (1 Hr):

Juan Marino

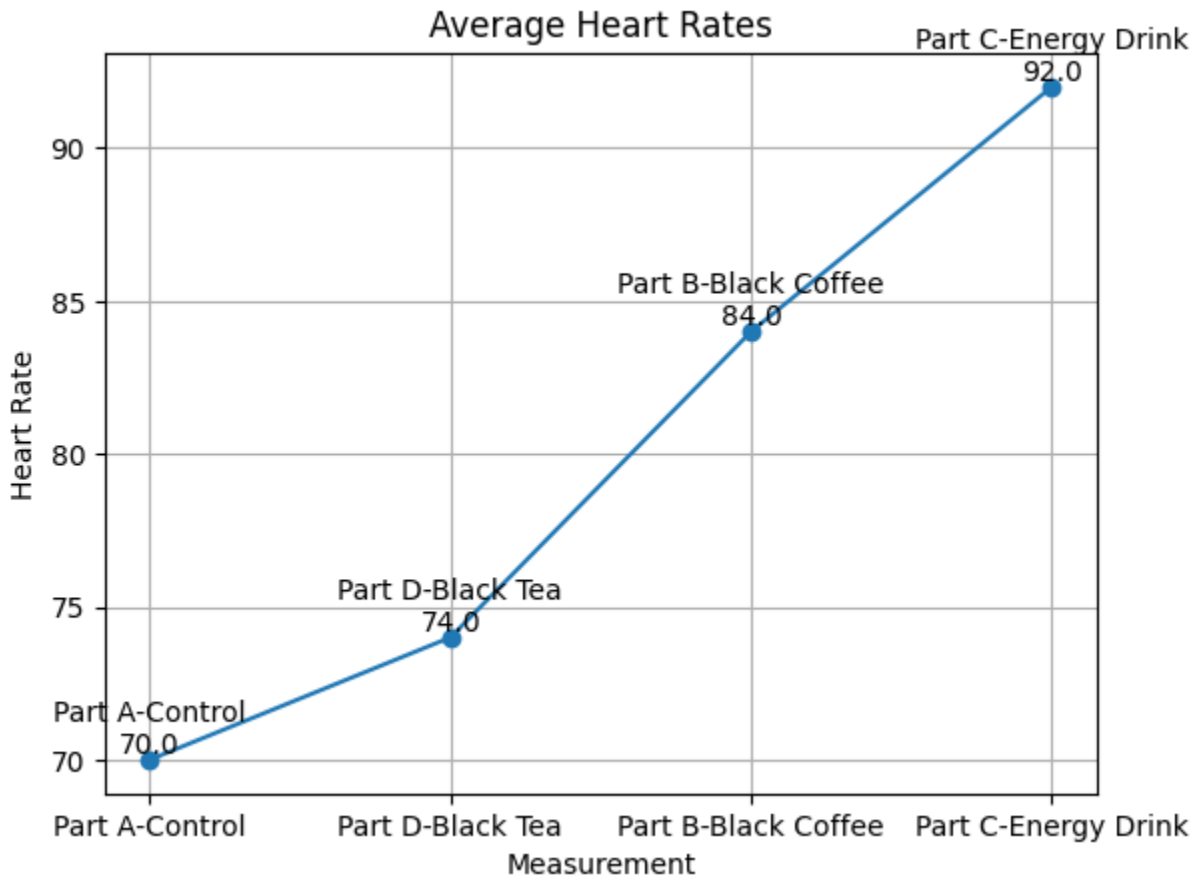
Sinus Rhythm — ♥ 92 BPM Average

This ECG does not show signs of atrial fibrillation.

25 mm/s, 10 mm/mV, Lead I, 512Hz, iOS 17.1.1, watchOS 10.1.1, Watch7,5, Algorithm Version 2 — The waveform is similar to a Lead I ECG. For more information, see Instructions for Use.

The average heart rate for black tea is 74 beats per minute, these results display only a 4 bpm change in heart rate after the caffeine in the drink was ingested. The results for black tea were expected as it has the lowest caffeine count out of all of the beverages, coming in at only 7 mg of caffeine in total. This agrees with my hypothesis that at lower concentrations caffeine would act as a mild stimulant.

Averages of Parts A-D



Conclusion

The caffeine and heart rate experiment was quite revealing. The data showed that caffeine does have a say in our heart rates. At lower dosages the data proves that it can indeed act as a mild stimulant but after sifting through the heart data it became clear that at the higher doses of caffeine it does do more than just wake you up. Increased doses leads to a more pronounced and intense cardiovascular response, displaying a clear correlation between the dosage of caffeine and how high heart rates soared. Specifically, it proves that higher doses of caffeine indeed do result in a more pronounced and adverse cardiovascular response, mainly including elevated heart rate. Therefore it can be said with certainty that as the amount of caffeine increases, so too does beats per minute in the heart and vice versa.