The Effects of Caffeine on Reaction Time

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Purpose

This is a sample lab report. It was also an attempt to see if a normal dose of caffeine would have a noticeable effect on reaction time. (I have included some comments about the report in red. I spent about 2 1/2 hours writing this up.)

Methods

An on-line reaction test was performed before drinking a cup of coffee, after about half of the coffee was consumed, and then again after the coffee was finished in order to try and observe the effects of caffeine on reaction time. (The test used was the one for Firefox users on the lab web page .) The results were analyzed statistically. The coffee used was Tim Horton's, from the kiosk in the Science building at WLU. The experiment was performed at about 2:00 on a Friday afternoon. The experimental subject, (the author), had not consumed any coffee for a few hours prior to the experiment.

The amount of coffee was about 320ml. (The experiment was a sudden idea, and so some experimental details are not as specific as they might be in a more carefully planned experiment.) An uncertainty of 30ml in the volume is probably reasonable, mostly due to having to estimate after the fact since the coffee cup was not graduated.

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About 7±1 minutes passed during the drinking of the first half cup, and about 12±1 minutes passed during the drinking of the second half cup. The uncertainty in the time was relatively large since the amount of time taken to drink the coffee was not considered an important variable and so was not measured precisely.

Results

Since no uncertainty is given for the reaction time tester, but all times are given to 0.001s, an uncertainty of 0.001s has been assumed for these calculations.

Trial number	time 1 (s)	time 2 (s)
1	0.316	0.408
2	0.506	0.338
3	0.270	0.300
4	0.310	0.291
5	0.391	0.355
$\bar{t}$	0.359	0.338
σ	0.093	0.047
α	0.042	0.021
$\bar{\Delta}t$	0.042	0.021

Table 1: Before coffee

Note that in Table 1 the two average times agree within their uncertainties. (If I were going to include sample calculations of $\bar{t}$, σ, α, and $\bar{\Delta}t$, I would do it here. I used a spreadsheet, so the calculations only took me about 10 minutes.)

After drinking a half cup of coffee, and repeating the test, as shown in Table 2, the average times are shorter. Note that the two repetitions of the test agreed with each other within their uncertainties, as in the case before coffee above, however, they did not agree with the average times before coffee. The reaction time was shorter after one half cup of coffee.

Trial number	time 1 (s)	time 2 (s)
1	0.350	0.353
2	0.306	0.294
3	0.264	0.279
4	0.262	0.277
5	0.292	0.352
$\bar{t}$	0.295	0.311
σ	0.036	0.038
α	0.016	0.017
$\bar{\Delta}t$	0.016	0.017

Table 2: After 1/2 cup of coffee

Trial number	time 1 (s)	time 2 (s)
1	0.298	0.322
2	0.381	0.372
3	0.305	0.319
4	0.348	0.358
5	0.297	0.304
$\bar{t}$	0.326	0.335
σ	0.037	0.029
α	0.017	0.013
$\bar{\Delta}t$	0.017	0.013

Table 3: After coffee

The test was repeated after all of the coffee was consumed, and again the two tests agreed with each other within uncertainties. The results are shown in Table 3. Again, however, the results did not agree with the results in the previous case. In other words, after all of the coffee the reaction times did not agree with the times after half of the coffee. The reaction times were longer after a cup of coffee than after one half cup of coffee. (This was something I had not expected. I thought that if any effect was observable, it would be monotonic; ie. more coffee would have a greater effect.)

Statistic	Before	After 1/2 cup	After coffee
$\bar{t}$	0.349	0.303	0.330
σ	0.070	0.036	0.032
α	0.022	0.011	0.010
$\bar{\Delta}t$	0.022	0.011	0.010

Table 4: Summary (all values in seconds)

Since each pair of 5 trials were consistent, they can be combined into 3 sets of 10 measurements, as shown in Table 4. Note that the results for sets of 10 are consistent with the results for sets of 5; the average after half a cup doesn't agree with the times before or after, although the before and after times agree with each other.

Discussion of Uncertainties

As has been previously stated, this experiment was not planned in advance, so there is a greater uncertainty in both the time taken and the volume of coffee consumed than would have been the case otherwise. However, since the intention was to see if an effect was noticeable, this is acceptable. The uncertainty in the reaction time measurements was actually quite small, enough that a few things can be noted. First of all, in each of the 3 cases, (before, halfway through, and after coffee), the two sets of 5 trials agreed with each other within uncertainties, so the amount of coffee consumed seems more important than other factors such as how many times the test had previously been performed. Second, the change in the average times from before the coffee to after half a cup is significant, and so it suggests that the coffee itself was the important difference. The most unexpected result was that the average times after coffee agreed with the times before coffee, but not with those after 1/2 cup. This may indicate that there is more than one process at work. To improve this experiment, along with taking more careful measurements of the volume of coffee, it would be useful to ensure that the subject has had no coffee for at least 12 hours prior to the experiment. It would also be useful to substitute a non-caffeinated hot drink, such as herbal tea, to see if the effect may be due to hot water rather than coffee specifically. Performing

the experiment at different times of day, as well as on both an empty and a full stomach would help to potentially eliminate other variables.

Conclusions

Before coffee, reaction time was measured to be $\bar{t} = 0.35 \pm 0.02$s.
After one half cup of coffee, reaction time was measured to be $\bar{t} = 0.30 \pm 0.01$s.
After one cup of coffee, reaction time was measured to be $\bar{t} = 0.33 \pm 0.01$s.
The times before and after coffee agree within their uncertainties. The times before and after 1/2 cup don't agree. There is a

$$\left|\frac{0.35 - 0.30}{0.35}\right| \times 100 = 14\%$$

difference.
The times after 1/2 cup and after a whole cup also don't agree. There is a

$$\left|\frac{0.33 - 0.30}{0.30}\right| \times 100 = 10\%$$

difference.
Because of these differences, it would appear caffeine does have a significant effect on reaction time, although it appears to be more complex than anticipated.