Caffeine Effects on Reaction Time

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INTRODUCTION & BACKGROUND

Caffeine is a widely consumed stimulant, known for its effects on enhancing alertness and cognitive performance. This project investigates the relationship between caffeine intake and reaction time, a measure of how quickly an individual can respond to a visual stimulus. The study explores whether varying levels of caffeine consumption can significantly improve reaction speed and whether timing after consumption influences this effect.

The research question guiding this experiment is: **Does caffeine intake improve reaction time?** Specifically, the study examines the effects of three caffeine doses (0 mg, 100 mg, and 200 mg) over three time intervals (15, 30, and 60 minutes) post-consumption. A two-factor design is employed to analyze the independent effects of caffeine dosage and time elapsed, as well as their interaction, on reaction time. The null hypothesis of our experiment is that caffeine level and time since consumption do not affect reaction time, and the alternative hypothesis is that caffeine level and time since consumption do have an effect on reaction time.

Reaction time is measured using the Just Park Reaction Time Test, a digital tool that provides a consistent and controlled method for evaluating response speed. Participants respond to a stop symbol displayed on the screen, and their reaction times are recorded in milliseconds. Each participant undergoes three trials per condition to ensure reliability, with average reaction times used for analysis.

This experiment is designed to control variability by conducting tests in a distraction-free environment and randomizing participant assignments to treatment groups. Randomization reduces potential biases, while replication strengthens the reliability of findings.

The study is motivated by the practical implications of understanding caffeine's effects on human performance. Faster reaction times can have significant applications, particularly in activities requiring quick reflexes, such as driving or competitive sports. By examining both the main effects and potential interactions between caffeine dosage and timing, this research aims to provide insights into optimizing caffeine use for performance enhancement.

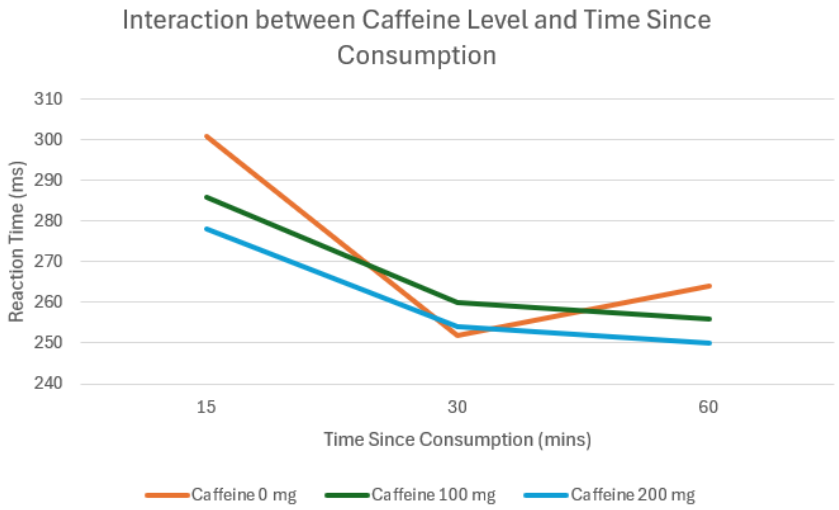
DATA SUMMARY & GRAPHS

We organized our collected sample data by caffeine dose and time after consumption per participant.

		Caffeine = 0 mg			Caffeine = 100 mg			Caffeine = 200 mg	
Time (mins)	**15**	**30**	**60**	**14**	**30**	**60**	**15**	**30**	**60**
	322 ms	297 ms	322 ms	324 ms	307 ms	349 ms	298 ms	328 ms	314 ms
	303 ms	315 ms	289 ms	296 ms	266 ms	270 ms	285 ms	274ms	265ms
	380 ms	349 ms	332 ms	282 ms	291 ms	274 ms	292 ms	271 ms	286 ms
	301ms	292ms	294ms	286 ms	271 ms	328 ms	278ms	264ms	288ms
	275 ms	252 ms	264ms	271 ms	260 ms	256 ms	272 ms	254 ms	250 ms

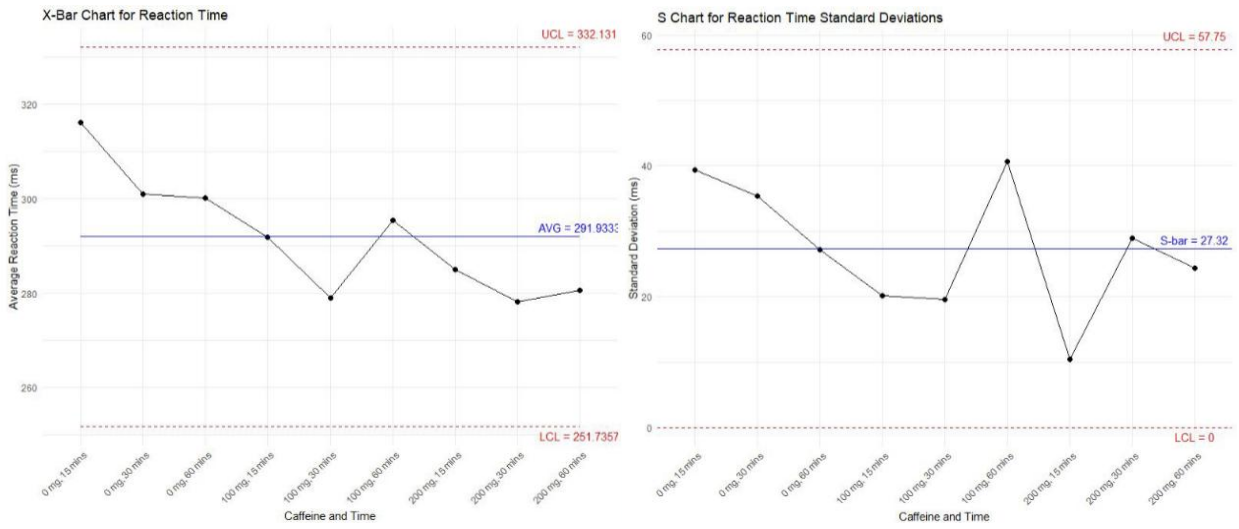
Interaction Graph

We created an interaction graph to illustrate the relationship between caffeine levels and time since consumption within our collected data. The intersecting lines in the interaction graph suggest a potential interaction between caffeine level and time since consumption.



Control Charts

We made an X bar chart and an S chart for reaction time to determine whether our collected data is in control. Both the charts below show that no points were out of control.



ANALYSIS

ANOVA

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Time Since Consumption	1009.6	2	504.8	0.6048	0.551639	3.259446
Caffeine Level	4744.533	2	2372.267	2.84221	0.071436	3.259446
Interaction	665.0667	4	166.2667	0.199204	0.937145	2.633532
Within	30047.6	36	834.6556			
Total	36466.8	44				

We performed a two-factor ANOVA to analyze the effects of two independent variables on the dependent variable. The p-values for both independent variables exceeded the alpha level of 0.05, so we cannot reject their null hypotheses and conclude that there is no statistically significant effect of time since consumption or caffeine level on reaction time. The p-value in the

interaction term was also greater than alpha = 0.05; therefore, we cannot reject the null hypothesis and conclude that there is no statistically significant interaction between time consumption and caffeine level.

F-Test

We conducted F-tests to analyze the main effects of time since consumption, caffeine level, and their interaction on reaction time, using this formula:

$$F = \frac{MS_{Between}}{MS_{Within}}$$

Here, the "between" term represents the variable being tested. We conducted this analysis to evaluate whether the means of our dependent variable (reaction time) differ across multiple conditions. When comparing these calculated F-statistics to F-critical values, we determine the statistical significance of these effects.

Test for Time Since Consumption

Does the amount of time since caffeine consumption have an effect on reaction time? Here, our "between" value is time since consumption.

$$F = \frac{504.8}{834.655} \approx 0.6048$$

With an F-statistic of 0.648 and an F-critical of 3.2594. The F-statistics are less than the F-critical value, indicating that the time since caffeine consumption did not have a statistically significant effect on reaction time.

Test for Caffeine Level

Does caffeine increase reaction time? Here, our "between" value is Caffeine.

$$F = \frac{2372.267}{834.6556} \approx 2.8421$$

With an F-statistic of 2.8421 and an F-critical of 3.2594. The F-statistics are less than the F-critical value, indicating that caffeine consumption alone did not significantly affect reaction time.

Interaction Effect between Caffeine and Time

Is there an interaction between Caffeine and time that affects reaction time? Here, our "between" value is Interaction.

$$F = \frac{166.2667}{834.6556} \approx 0.1992$$

With an F-statistic of 0.1992 and an F-Critical of 3.2594. The F-statistics are less than the F-critical value, indicating no significant interaction effect between caffeine level and time since consumption on reaction time.

CONCLUSIONS

The findings of this study show that neither the caffeine level nor the time since consumption have a statistically significant effect on reaction time. No significant interaction between the dosage of caffeine and time after consumption was observed. These results suggest that, within our tested dosages and timeframes, caffeine does not reliably enhance reaction speed within the context of this experiment.

While our hypothesis that caffeine improves reaction time failed to be supported by the data, the study still contributes valuable insights into the differing effects of caffeine on

performance. Factors like caffeine metabolism, baseline reaction speeds, and other outside variables may influence outcomes and warrant further investigations.

Future research could expand upon our findings by using larger sample sizes, different testing conditions, or even additional factors like sleep patterns or subjects' typical caffeine consumption to better understand the complicated relationship between caffeine and reaction time.