

Can you beat my time? A test of reaction times

INTRODUCTION:

My name is Gautam Amirthan and I go to Glendal Primary School. After researching and discussing with my parents and science teacher, Miss Gilligan, I decided to conduct my experimental research on the topic of “Does coffee and milk affect reaction time?”

I came across the topic one morning, when I was watching my mum drink coffee. I asked my mum “Why do you drink so much coffee?” She replied, “It helps keep me awake!” After researching I discovered that 75% of Australians have at least one cup of coffee a day, and 28% have at least three!(1) I decided to design an experiment to find out if coffee truly helps you stay awake.

Similarly, I came across the idea of testing the effect of milk on our alertness when one night I noticed my brother was drinking some before bedtime. “Does milk really make you sleepier?” I thought. I decided to include milk in my experiment to find out if milk makes you sleepier and therefore increase your reaction time.

RESEARCH:

How does coffee keep you awake?

Coffee is made of many chemicals including caffeine. Caffeine affects our brain and nervous system which is made up of millions of nerve cells that transmit messages. It does this by blocking a chemical in our brain called adenosine. Adenosine’s main purpose is to slow down nerves by fitting into a receptor (a lock or keyhole that is on the surface of a cell), and make you feel drowsy and sleepy.(2–5)

Caffeine on the other hand blocks the receptor preventing adenosine from fitting into the receptor. Therefore, without adenosine locked into the receptor activating the nerve you will not feel drowsy and in fact feel more awake and alert.(2–5) (See Figure 1)

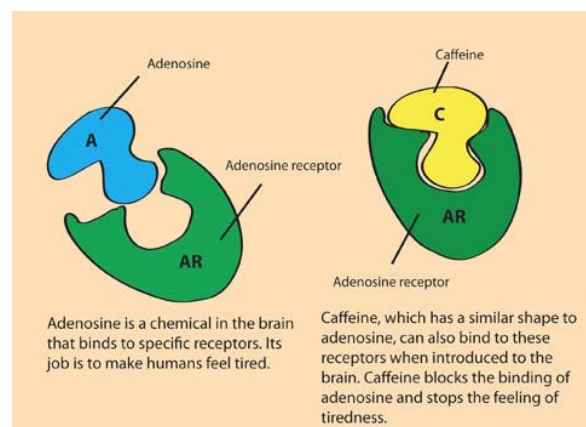


Figure 1: Mechanism by which caffeine molecules blocking adenosine receptors (2)

How does milk make you sleepy?

Milk contains an amino acid called tryptophan. Amino acids are building blocks for proteins in our body. Tryptophan helps to make a neurotransmitter called serotonin. Neurotransmitters are chemicals that help our nerves send messages.(6) Serotonin is used to make a hormone in our brains called melatonin. Our brain produces melatonin when the day becomes dark and tells our body that it is nighttime, and we have to wind down and go to sleep. This change from day to night automatically in our bodies is called the circadian rhythm. It is our biological clock.(7-10)

Therefore, drinking milk increases tryptophan in our body and therefore increases serotonin and melatonin making us sleepy. (7-9,11) Figure 2 is a diagram of how the components of milk can make you sleepy.

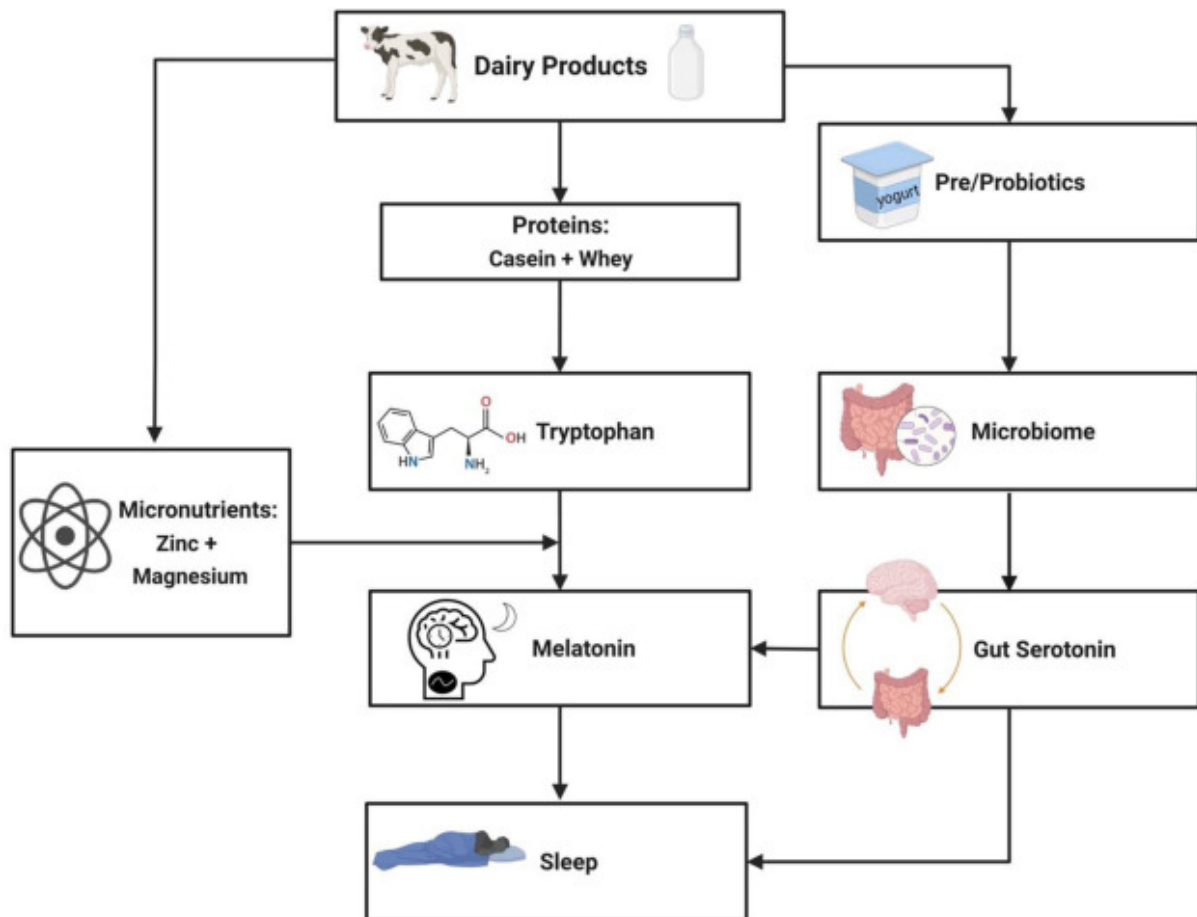


Figure 2: How milk makes you sleepy (8)

Physiology of Reaction Time:

When my mother says that coffee keeps her awake or my brother says that milk makes him sleepy, they are both describing their levels of alertness. A simple way to test alertness is to do a reaction time test.

When there is a change in your environment your sensory system (sight, smell, touch, hearing, taste) detects the change and sends the message to your brain. The brain quickly processes the information and sends a message to your muscles to react to the change in the surroundings. Reaction time is the time taken to undergo this process from the moment of detecting the change to your muscles reacting.(12,13) Figure 3 shows the physiology of reaction time.

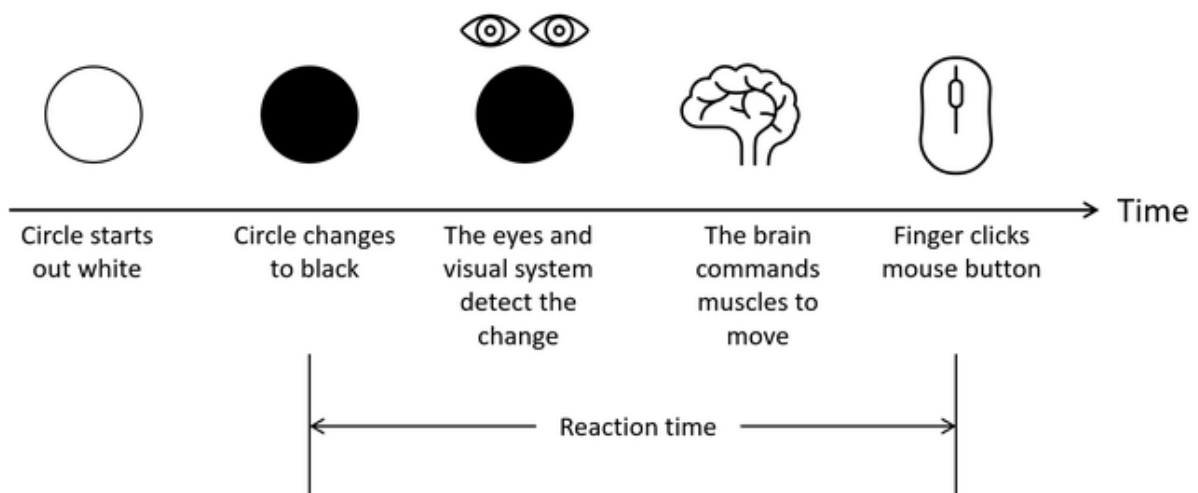


Figure 3: Diagram representing reaction time (12)

AIM:

Primary Aim:

- To find out how coffee and milk affect reaction time compared to the water (placebo)

Secondary Aim(s):

- To find out if gender, time of day, age and fatigues levels affect reaction times in adults prior to any caffeine intake

HYPOTHESIS:

I believe that coffee will improve reaction time compared to water while milk will worsen reaction time compared to water. I anticipate water will not change reaction time.

MATERIALS:

- Scratch account to develop reaction time test
- Online random group generator tool for randomisation of participants into 3 groups
- Device with reaction time test
- Participant Information Sheet (Appendix 1)
- Consent Form (Appendix 2)
- Testing Liquids:
 - ❖ 150ml of Water
 - ❖ 150ml of Coffee (Appendix 3)
 - ❖ 150ml of Milk (*Participant's favourite dairy milk*)
- Data collection sheet (Appendix 4)

METHODS:

A. Participant Selection:

1. Obtain consent from 30 willing adults
2. Email / SMS them participation information sheet and consent form
3. Using the following online tool, the participants are randomised into one of three groups milk, coffee or water.
 - a. [Random Team Generator — Split a list into random groups \(randomlists.com\)](https://www.randomlists.com/) (14)

B. Development of Reaction Time Test:

1. Ask parents to create an account on [Scratch - Imagine, Program, Share \(mit.edu\)](https://scratch.mit.edu) (15)
2. Develop a reaction time test(16) (Figure 4)
3. Weblink to “Gautam’s Reaction Time Test”:
<https://scratch.mit.edu/projects/1030752930>

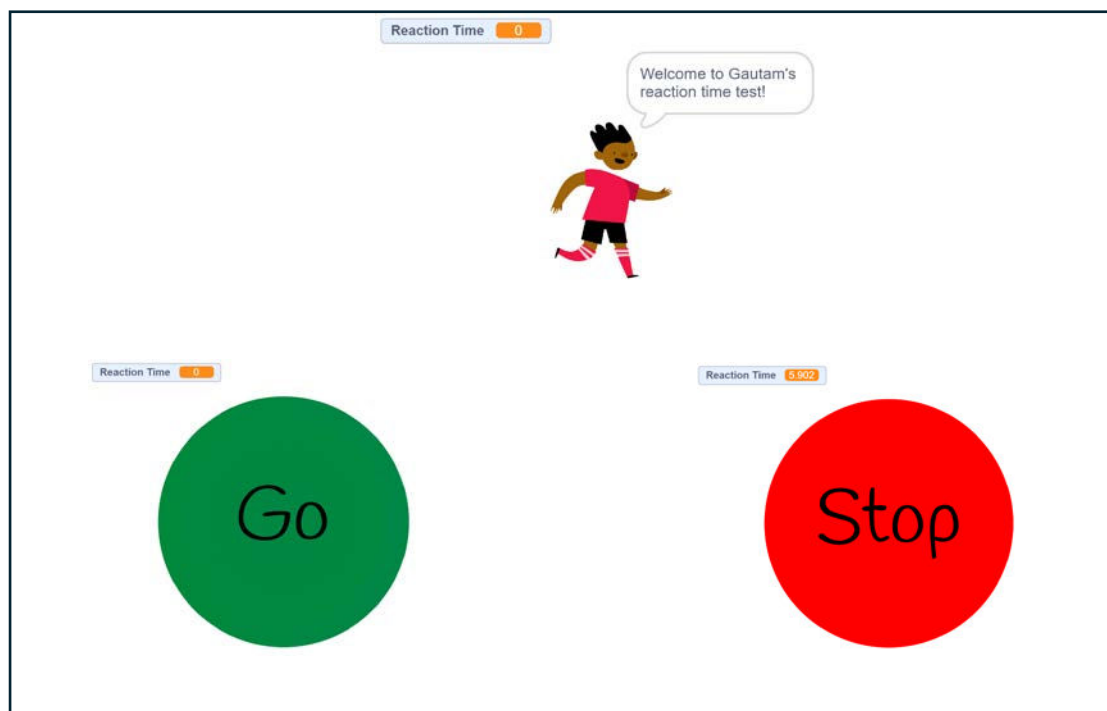


Figure 4: “Gautam’s Reaction Time Test” developed on scratch

C. Experimental Procedure:

1. Complete sleep and fatigue level questionnaire (see Appendix 4)
2. T0 test – Reaction time test undertaken just before consuming testing liquids (coffee, milk or water)
3. T30 test – Reaction time test undertaken 30 minutes after consuming testing liquids
 - i. Each reaction time test at T0 and T30 involves participant taking 10 trials and calculating the average of 10 attempts.
 - ii. The participant will undertake two attempts at T0 and two attempts at T30 and the average of the two attempts will be calculated. *(in total the participant will complete 20 trials before and 20 trials after drinking the test liquid)*

D. Data Management and Analysis

1. Microsoft 365 forms will be used for data collection (Appendix 4)
2. Excel database will be created for data collection and analysis
3. Percentage improvement in reaction time will be calculated for the primary aim when analysing the effect of coffee, milk and water on reaction time. (17)

Percentage improvement is calculated using the formula:

$$\frac{\text{Average T0} - \text{Average T30}}{\text{Average T0}} \times 100\%$$

(negative value indicates worse reaction time, while positive value indicates improvement in reaction time compared to baseline before drinking test liquid)

RISK ASSESSMENT:

Type of Risk	Level of Risk	Hazard	Precaution taken to control	Source of Information
Human Research	Minimal	a) Time of participants (1 hour) b) Consumption of test liquid	Project information provided clearly in participant information sheet Consent form requested of each participant	NHMRC – National Statement on Ethical Conduct in Human Research(18)
Human Research	Minimal	Personal Information such as name, age, gender	De-identified database / data collection	NHMRC – National Statement on Ethical Conduct in Human Research(18)

Table 1: Risk Assessment Table

RESULTS:**A. Demographics**

A total of 30 participants were included in this study (10 in each of the coffee, milk and water groups). Demographic characteristics of the participants are presented in Table 2. The average age of the participants was 41.5 years (range: 19 – 76 years). There were approximately equal numbers of male and female participants (male 47% vs female 53%). Most participants did the experiment before 12 noon (63% before 12 noon vs 37% after 12 noon). On average, participants had 7.5 hours of sleep the night before the experiment. Most of the participants reported their fatigue level as three out of 10, one being not tired at all and 10 being very tired (range: 1 – 8).

	Coffee	Milk	Water
Participants Number of Participants (n=30)	10	10	10
Gender Male (n=14) Female (n=16)	1 9	7 3	6 4
Age 19 - 30 (n=5) 31 - 40 (n=8) 41 - 50 (n=14) 50+ (n=3)	1 3 5 1	2 4 4 0	2 1 5 2
Time of Day AM (Before 12 Noon) (n=19) PM (After 12 Noon) (n=11)	6 4	6 4	7 3
Tiredness and Sleep Mode Fatigue Level Average Hours of Sleep	3 8	3 7	3 8

Table 2: Demographic characteristics of participants

B. Primary Aim: Impact of coffee, milk and water on reaction time

The coffee group had the largest percentage improvement (10.69%), followed by the milk group (3.44%). The water group had a small decline in percentage change (-0.07%) (Figure 5)

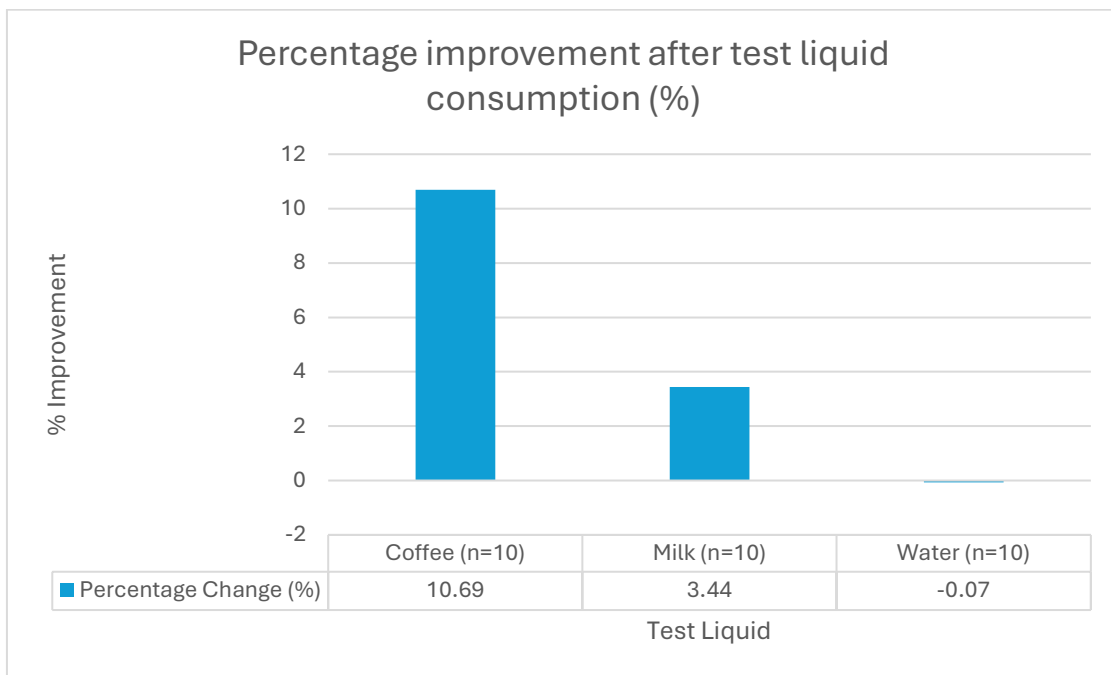


Figure 5: Percentage improvement 30 minutes after consuming test liquid (coffee, milk or water)

C. Secondary Aim: Impact of gender, age, time of test and fatigues levels on reaction times.

Average adult reaction times before any caffeine consumption was similar between genders (0.3932s in females vs 0.3907s in males) and time of test (0.3931s in the AM group vs 0.3844s in the PM group).

Due to small numbers in individual groups fatigue levels were analysed as those rating fatigue levels less than five or more than five. The average reaction times between these two groups were similar (0.3835s in those less than five vs 0.38215s in those more than five).

Average reaction times according to age demonstrated quickest reaction times in the 41 – 50 years age group and slowest in the 31- 40 years age group (Figure 6)

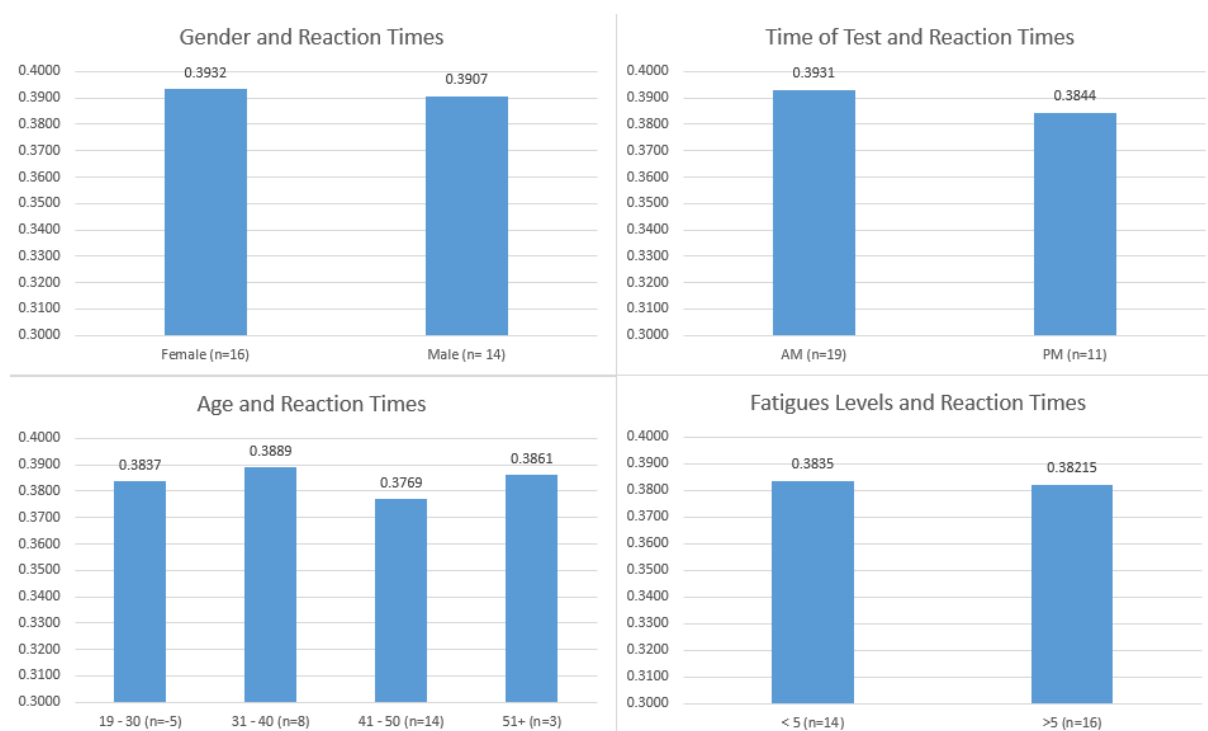


Figure 6: Impact of gender, time of test, age and fatigue levels on reaction times in adults without prior caffeine consumption.

DISCUSSION:

This project showed that coffee does improve the reaction times in adults. Thirty minutes after consuming 106mg of caffeine improves reaction times by about 10.69%. This is consistent with previous studies which have suggested that coffee can improve simple reaction times.(3,19,20)

Interestingly, in this project, participants who consumed milk also showed an improvement in reaction time by 3.44% thirty minutes after consumption. This is different to the original hypothesis that milk would worsen reaction time. This could be related to the increased production of serotonin from the tryptophan in milk. Serotonin is known to improve mood and make you happy and calm.(7,8,11) In fact, increasing serotonin levels in the brain is one way to treat depression.(7) This improvement in mental state and concentration may explain the improvement of reaction time after drinking milk.

While milk also increases the production of melatonin in our body, this effect is likely to occur only at night or when it is dark, which is when the natural production of melatonin in our brains is at its highest.(9,11) All the participants in this study, undertook the test during daylight hours where natural melatonin production was likely at its lowest. It is therefore possible that the combination of higher serotonin levels and lower melatonin levels contributed to an increase in reaction time in the milk group.

There was no significant change in reaction time following the consumption of water in this study.

As expected, there was no difference in average reaction times between gender. I expected reaction times to increase with age, time of day and fatigue levels, however this project was unable to detect this change.(13) This was likely due to very small numbers of participants.

Strengths and limitations of this study

This study randomised participants into three groups to reduce biases. Additionally, by assessing the percentage change in reaction time, I attempted to control for differences in age, time of test and fatigue levels that may affect reaction times. This study also controlled for caffeine consumed by using standardised coffee sachets and volumes of test liquid.

One limitation of this study is the small numbers of participants in each group. Even though I did not find any difference in reaction times between age, time of test and fatigue levels, it would improve the quality of the experiment if all participants

conducted the test at the same time of the day and the participants were limited to a specific age group.

Another variable that was not tested in this study was the baseline caffeine consumption of individual participants. It is unclear whether adults who have a caffeine addiction have a different response after a period of being decaffeinated and then doing the reaction time compared to those were not.

CONCLUSION:

This project was successful in proving that coffee does in fact improve adults' reaction times. However, contrary to popular belief this project showed that milk can improve alertness and reaction times. One explanation for this could be that milk has different effects at different times of the day. Milk could improve concentration and alertness during the day while increasing sleepiness at night.

Areas of further research:

- ❖ Future research could look at the effect of milk on alertness at different times of the day.
- ❖ Future research could look at the effect of baseline caffeine consumption in adults on reaction times.
- ❖ Another area of interest might be looking at the effect of different concentrations of caffeine on reaction times.

ACKNOWLEDGEMENTS:

I would like to acknowledge the contribution of Miss Gilligan, my science teacher from Glendal Primary School for her guidance and supervision of my project. I would also like to acknowledge the contribution of my parents Dr Sumitha Bhaskaran and Dr Amirthan Vinay for subject matter expertise and assistance with designing, data collection and supervision for this project.

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Appendix 1- Participation Information Sheet

Dear Family and Friends,

I have been fortunate to be selected to compete in the Science Talent Search (STS) in 2024. As part of this I have selected to undertake an experimental research project.

The title of my project is “**Can you beat my time? A test of reaction times.**”

This project aims to find out how coffee and milk affect reaction times.

I am hoping that you will be able to help me by participating in my experiment. I am requesting about 60 minutes of your time to complete the test. You will need to take a reaction time test before and 30 minutes after you drink one of coffee, milk or water depending on which group you have been randomised into. Please avoid taking any caffeinated substances before the test.

In addition to this, I will ask you some questions about your age, gender, sleep and fatigue levels before the test. However, all information will be de – identified to protect your privacy.

I am conducting this project under the supervision and support of Mrs Gilligan from Glendal Primary School and my parents. If you have any further questions or enquires regarding this project, please contact me on GAforce@outlook.com.

Your participation is vital for the successful completion of my project, and I greatly appreciate your time and involvement!

Yours Sincerely,

Gautam Amirthan
Glendal Primary School

Appendix 2 – Consent Form

I understand the information that was provided to me in the participant information sheet for the project entitled, **“Can you beat my time? A test of reaction times.”** undertaken by Glendal Primary School student Gautam Amirthan as part of his Science Talent Search 2024 project.

I, _____, consent to participate and contribute to this project.

Signature of Participant: _____

Date: _____

Appendix 3- Caffeine Content Calculation

General instant coffee contains 0.9g of coffee which has 28.3mg of caffeine, using this we can calculate the caffeine content in various types of coffee sold in Australia.

Coffee Type	% of coffee in each sachet	Mass of each sachet	Amount of Instant Coffee(g)	Caffeine content (mg)
General instant coffee	NA	NA	0.9	28.30
Moccona Double Shot Latte	24	14	3.36	105.65
Moccona Latte	12	14.8	1.776	55.85
Moccona Skim Cappuccino	11.5	12.2	1.403	44.12
Moccona Cappuccino	17	13	2.21	69.49
Moccona Strong Cappuccino	19	13.2	2.508	78.86
Moccona Soy Cappuccino	10	18	1.8	56.60

I chose the Moccona Double Shot Latte because, after calculation, I found it had the highest caffeine content (105.65mg). In addition to controlling for the caffeine content, the Moccona Double Shot Latte comes in a sachet, which allows that the amount of coffee consumed by the participants to be controlled.

To make a standard cup of Moccona Double Shot Latte:

- Empty contents of Sachet into a cup
- Mix with 150ml of hot water



Appendix 4- Data Collection Form

Data Collection Sheet

Name: _____

Participant ID: _____

Date of Test: _____

Time of Test: _____

Gender: M / F

Age: _____

How many hours of sleep did you get last night? _____

Group Allocation : Coffee Milk Water

On a scale of 1 to 10 how tired are you at the moment?

1	2	3	4	5	6	7	8	9	10
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Reaction time – T0: Attempt 1: _____ Attempt 2 _____

Reaction time- T30: Attempt 1: _____ Attempt 2 _____