

Cognitive Connections: The Relationship Between Decaffeinated Coffee and Students' Memory Performance

Wenrui Liang

HD Beijing School, Beijing, China
2303180@stu.hdschools.org

Abstract. The impact of coffee and the placebo effect on individuals' academic performance is examined in this analysis. It checks the effects of caffeinated, decaffeinated, and no celebrating coffee on word memory and mental state. A brand-new experimental design is used for the study. It changes the order in which participants drink these three kinds of beverages. This enables us to understand both the psychological impact of eating and the simulated activity. The findings show that caffeinated and decaffeinated coffee warmly affect cognitive function and practice. According to this, the placebo effect may include a significant influence on food's opportunities, which are similar to those of caffeine. Additionally, the study demonstrates that coffee drinkers' opinions and beliefs can have a significant influence on how they perceive its advantages. These reports suggest that caffeine and psychological factors, such as interests and the placebo effect, does contribute to the perceived development in academic performance as a result of coffee consumption. Coming research needs to examine how growing psychological expectations may increase the impact of coffee on academic performance as well as the internal mechanisms that underlie coffee use.

Keywords: caffeine, decaffeinated coffee, placebo, cognitive memory

1. Introduction

In recent years, some individuals have started to believe that drinking coffee does improve academic performance, pretty as test scores and homework efficiency. Whether or not caffeine contributed to this development or just a placebo effect is unknown at this time. This report explores this complex relationship by examining the effects of caffeinated, decaffeinated, and quasi-caffeinated coffee on a child's word memory and mental state.

A tale-based method was employed in the exploration. It changed the order in which participants drank the three coffee. This technique improves our understanding of how caffeine and the placebo effect change private and cognitive outcomes. Contrary to typical details that simply apply one placebo control, this method makes it possible to thoroughly examine the effects of caffeinated and decaffeinated coffee on a foundation.

Past research has shown that even without caffeine, the desire of obtaining caffeine can significantly affect a child's performance and feelings. According to a research, people who believed they were consuming caffeinated coffee, regardless of whether they were having regular coffee or

caffeine, performed well on attention testing. This demonstrates how the placebo effect might affect how people perceive coffee use.

In this study, Participants were arbitrarily chosen to consume either caffeinated, decaffeinated, or no coffee during this analysis. The implementation process was followed throughout the classes. This approach allows for a more appropriate assessment of the impact of each drink in order to reduce the impact of individual differences and possible prejudices.

Pie charts were used to assess the outcomes to show how evenly distributed they were under various conditions. This visual information compares the effects of caffeinated, decaffeinated, and no coffee on word memory and mental state. In each circumstance, the bread stand provides valuable insight into the similarities between the effects of caffeine and admonish on participants' cognitive performance and feelings.

The findings suggest that while caffeinated coffee does have a measurable effect on alertness and attention, the placebo effect also plays an important role in improving performance. Participants who thought they had consumed caffeine, even if they were actually drinking decaffeinated coffee, also showed better cognitive function and mood. This suggests that the psychological expectation of improved performance may be just as important as the actual physiological effects of caffeine.

The results suggest that the placebo effect drastically improves functionality, despite the fact that caffeinated coffee is known to have obvious implications on alertness and attention. As well as decaffeinated coffee, participants who reportedly ingested caffeine reported better thoughts and cognitive function. This suggests that alcohol's certain physiological effects could be close to the psychological expectation of performance improvement.

Additionally, the study emphasizes how various coffee's effects are on a person's mental and cognitive says. Decaffeinated coffee had a small amount of caffeine, but it still had a beneficial effect on alertness and reaction time. This finding suggests that chlorogenic acid and various substances play a role in food's psychoactivity. It contests the notion that coffee's caffeine content serves only as a mental benefit.

Therefore, this document meticulously examines the connection between the placebo effect and coffee use. More in-depth research into how caffeine and the placebo effect affected women's cognitive and psychological state was made possible by the amazing experimental design, which altered the buy in which coffee was consumed. The results demonstrate how important psychological factors, such as goals and ideas, are in determining how coffee affects academic performance. Future research may look into the effects of food on the placebo effect and the potential contribution of further coffee grounds to cognitive enhancement.

2. Literature review

2.1. Effective improving of memory by coffee or placebo: a contextual exploration

Coffee is still being investigated to see if it has the potential to improve memory or work as a phony. Based on their ability to assess the impact of coffee use on academic performance, these documents' opinions are based. There is still no sacrifice on what makes coffee "effective" for boosting output, despite numerous studies that have attempted to understand this problem. By taking a quick look at recent studies, particularly meta-analyses of research on coffee and thought, you put this work in the right context.

2.2. Meta-analysis 1

The positive effects of caffeine on cognitive function have been well-documented across numerous studies. For instance, research by Smit and Rogers demonstrated that even low doses of caffeine, such as 12.5 mg, can significantly enhance the cognitive performance and emotional state of habitual caffeine consumers [1]. This finding underscores the sensitivity of the human brain to caffeine, even at minimal levels. Similarly, Lieberman et al. found that caffeine can improve information processing speed and attention, which are critical components of cognitive function [2]. These studies collectively highlight caffeine's ability to increase alertness and reaction speed by stimulating the central nervous system.

2.3. Meta-analysis 2

A different meta-analysis that argues that there were no significant association was found between decaffeinated coffee and cognitive performance [3]. Their cognitive performance was assessed using the CERAD test, the animal fluency Test, and the Number Symbol Substitution Test (DSST). The tests assessed working memory, language, processing speed and executive function. Coffee and caffeine intake were obtained through two 24-hour dietary recall interviews. Use the U.S. Department of Agriculture's (USDA) dietary source database to identify coffee beverages and caffeine. Coffee consumption was determined by food frequency questionnaires in household interviews. Participants were asked whether they drank coffee, as well as the amount and type of coffee they consumed. Caffeine intake (mg/ day) was divided into quartiles, with the lowest quartile as the reference category. Total coffee consumption (g/ day) was divided into four groups with no coffee intake, 1-266.4 g/ day, 266.4 to 495 g/ day, and 495 g/ day and above. However the age range of participants are not same as this research and the testing way are also not the same, so result are quite different.

3. Materials and methods

This section proposes some substances and methodology in the experiments. Going to talk about which kinds of solution are using and how to do this experiment.

3.1. Solution

For this experiment, three distinct types of solutions were utilized to investigate their effects on cognitive performance, specifically memory recall. These solutions included:

1. Water: This was the control solution, used to establish a baseline for comparison with the coffee solutions.
2. Decaffeinated Coffee: The decaffeinated coffee used was a soluble coffee product that was made from a blend of Nestlé Switzerland decaffeinated coffee. This brand was chosen because for its consistent quality and reliable decaffeination process, which can ensures the minimal caffeine content while keeping the flavor similar to regular coffee.
3. Caffeinated Coffee: The caffeinated coffee was using the G7 black instant coffee. Each coffee package contained 6 grams of coffee powder, dissolved in 300 milliliters of boiled water. This amount was for a standardized caffeine concentration for accurate testing of its effects on cognitive function.

3.1.1. Preparation and customization

To make sure the coffee solution tastes great and fits typical consumption habits, the participants can add milk and saccharin to customize their coffee according to their own taste. This flexibility was important because of two reasons: First of all, it makes sure the participants can drink coffee comfortably, which is super important for getting reliable results. Second, it lets the researchers mimic real - world coffee - drinking situations where people often adjust their drinks according to their tastes.

However, the study discovered that adding milk to black coffee had no effect on the memory test results, even with the personal choices of students. This means that caffeine, whether present or absent, rather than other elements like milk content, was probably the main cause of the cognitive effects seen.

Have a special fondness for adding milk to coffee among participants is an interesting aspect of this study. Specifically, about 40% of the participants choose to drink their coffee black, without any milk, while the remaining 60% chose to add milk to their coffee. This preference highlights the varied tastes among the teenage participants, with some enjoying the strong, bold flavor of black coffee, while others prefer the milder taste that milk provides. Figure 1 shows people who added milk.

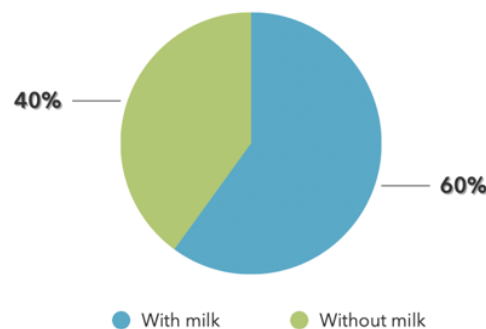


Figure 1. Bar chart of people who added milk

3.1.2. Consistency in taste and caffeine content

When it comes to the 6-gram serving size, this was determined to be the maximum value for both the decaffeinated and caffeinated coffee solutions. This standardization was crucial for maintaining consistency in taste and ensuring that the coffee solutions were comparable in terms of flavor intensity. By using the same quantity of coffee powder for both types, researchers aimed to isolate the effects of caffeine on cognitive performance, without the confounding influence of varying taste profiles.

Additionally, the assessment made it clear that the flavors of the caffeinated and decaffeinated coffee were intended to be related. Through careful choice of coffee tracks and arranging, this was accomplished. The study's single-blind method, which made it possible for participants to choose between decaffeinated and caffeinated coffee purely based on their style, was important. In turn, this reduced the possibility of bias and made positive any uncovered cognitive effects, as opposed to design-related versions, could be more safely caused by caffeine.

All in all selecting and making the coffee alternatives completely ultimately was the pillar of this exam. The investigation sought to provide a thorough and reliable analysis of how caffeine affects baby memory remember by using conventional levels and allowing for individual freedom while keeping taste consistency. The results from this research is contribute valuable insight into the cognitive effects of coffee use among young people, help to persuade dietary recommendations and more research in this area.

3.2. Participants

The recruitment process for this study involved a thorough screening of 50 potential participants, all of whom were healthy teenagers attending high school. These adolescents were drawn from various grades, ensuring a diverse representation across the typical high school age range of 13 to 16 years old. This age group is particularly interesting for research as it encompasses a critical period of cognitive and physiological development.

There were some interesting differences between these participants ' due perceptions and preferences on coffee use. Some youngsters were ardent coffee drinkers, generally enthralled by the well-known beverage's flavor and energizing effects. Some participants, on the other hand, were eager to try coffee for the first time in this review. A special opportunity to examine the possible variations in cognitive reactions based on previous caffeine contact was provided by this combination of coffee fanatics and amateurs.

Girls participants made up 68 percentage of the research team's full in terms of gender distribution. This gap may be the result of more girl commitment to participating in these reviews or a higher recruitment bias. People accounted for 32 % of the boy participants. This gender distribution makes it possible to study the possible gender differences in how coffee intake affects mental ability in the context of this study. In order to more investigate any potential gender representation to further investigate any potential gender-specific responses to caffeine. Figure 2 shows the male-female ratio of participants

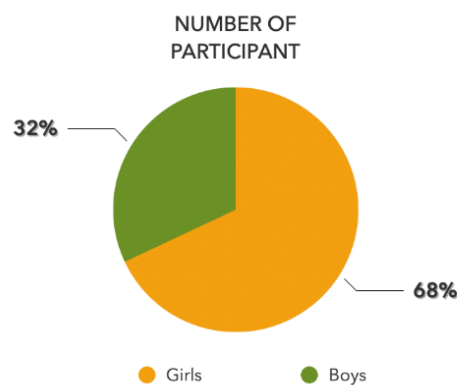


Figure 2. Male-female ratio of participants' bar chart

3.3. Cognitive measures

3.3.1. Test procedure

In this study, the cognitive measures were designed to assess the short-term memory capabilities of participants under different conditions. On three separate occasions, each member had to eat all

three types of beverages: water, decaffeinated, and caffeinated. The participants' distribution of the remedies was randomised to prevent any potential interference with the results. This randomisation reduced the likelihood of bias according to experience or anticipation by ensuring that each member had a diverse selection of beverages.

3.3.2. Memory task

After having each answer, participants were given a memory task to assess their ability to recall information. The developer read a list of 15 different words to the participants loudly. The thoughts were chosen carefully to maintain familiarity and modest difficulty, keeping things simple and memorable. To give a balanced challenge, the list contained a mix of nouns, verbs, and adjectives [4].

As the comments were previously read over, the participants were instructed to pay close attention. After the developer finished reading the list, participants were given five hours to emotionally practice and memorise the words' collection. This small time frame examined the participants' instant recall ability, a crucial brief-term memory component.

3.3.3. Recall process

Participants were asked to recall and verbally express as many terms as they could realise in the proper order at the end of the five seconds. The focus on purchase tested their ability to recall the words and keep the order in which they were presented. This process feature is significant to understanding how various beverages affect cognitive functions related to memory, concentration, and retrieval [5].

3.3.4. Scoring and data collection

After each beer consumption, the number of words that were recalled correctly in the correct order was considered for each student. This quantitatively measures their small-word storage performance under each issue. After performing this task, we examined the data to see if there were any significant differences between the three types of solutions regarding memory performance.

3.3.5. Additional considerations

There were several steps taken to ensure the dependability of the memory task:

1. Regular Environment: For each member, the testing environment was kept as constant as possible throughout the entire three times. To reduce the impact of physical factors on memory performance, it was important to maintain the same room, light, and noise levels [6].
2. Standardised Instructions: The guidance given to participants was standardised and repeated precisely for each check program. This prevented participants from being influenced by variants in how the process was explained, ensuring everyone understood it the same way each time.
3. Blinding: Despite the study's single-blindedness, efforts were made to keep participants abreast of the remedy they ingested daily. The same package was used for all three beverages, and the drink order was not revealed until after the investigation [7].

3.3.6. Potential influences on memory performance

Many factors could affect the benefits of this memory task:

1. Caffeine Content: The study's central hypothesis was that stimulant coffee may boost short-term memory performance compared to water and decaffeinated coffee. Caffeine is known to act as a central nervous system stimulant, which could improve cognitive functions such as alertness, attention, and memory [8].

2. Individual Differences: Participants' baseline memory abilities, experience with the terms used in the test, and personal choices for the beverage may all influence their performance. For instance, participants who often consume caffeine may respond differently to the sweetened drink than those who seldom or never drink coffee [9].

3. Milk and Sweeteners: Although previous research suggested that the addition of milk and sugar substitutes did not affect memory outcomes, it is still possible that individual preferences and the sensory experience of drinking the beverages could have a subtle impact on cognitive performance [10].

3.4. Result

1) The positive effects of caffeinated coffee on memory recall

First, let's explore the effects of caffeinated coffee on memory recall. As a stimulant of the central nervous system, caffeine can temporarily drive away sleepiness and restore energy. In the student population, this property of caffeine is widely utilized to help them stay awake and focused during studying or exams.

As is evident from the tabular data below, most students scored generally higher after drinking caffeinated coffee than after drinking water and decaffeinated coffee. This phenomenon can be explained by the direct effects of caffeine on the brain. Caffeine blocks receptors for adenosine, a neurotransmitter that accumulates in the brain and promotes sleep. By blocking the effects of adenosine, caffeine reduces fatigue and increases alertness and concentration, which may enhance memory recall.

Caffeine also increases the level of dopamine in the brain. Dopamine is a neurotransmitter associated with feelings of pleasure and reward. This increase may have further enhanced learning motivation and memory consolidation processes, thereby improving memory recall performance.

2) Placebo effect of decaffeinated coffee

Next, we explore the effects of decaffeinated coffee on memory recall. Although decaffeinated coffee does not contain caffeine, tabular data showed that students who drank decaffeinated coffee generally scored higher on memory recall tests than those who drank water alone. This phenomenon may be attributed to the placebo effect.

The placebo effect is the improvement in health that a person experiences due to the desired effect after taking a fake drug or receiving a fake treatment. In this case, students may have performed better on tests because they believed that coffee (even decaffeinated) would help them improve their cognitive function.

This psychological anticipation may work by reducing test anxiety and increasing self-confidence. When students believe they are taking steps to improve their performance, they may feel more relaxed and confident, which in turn may improve their cognitive performance, including memory recall.

In summary, the tabular data below (Table 1 and Table 2) support the idea that drinking caffeinated coffee can significantly improve students' memory recall, mainly due to the direct positive effects of caffeine on the brain. Meanwhile, drinking decaffeinated coffee was also associated with improved memory recall, although this effect may be attributed more to the placebo effect, in which students' expectations of coffee improved their performance. These findings

highlight the importance of psychological anticipation and physiological effects in cognitive function and provide valuable insights into education and learning environments. Through these analyses, we can better understand the impact of different drinks on cognitive function and thus provide students with more effective learning strategies.

Table 1. Results of the boys

Name	Score of water	Score of caffeinated coffee	Score of decaffeinated coffee
Franklin	15/3	15/6	15/6
Ivan	15/5	15/4	15/9
Vin	15/7	15/15	15/13
Calan	15/9	15/15	15/13
Tiger C	15/7	15/11	15/8
Tiger Z	15/6	15/9	15/13
Max Z	15/6	15/15	15/9
Max Y	15/4	15/11	15/9
Eric	15/8	15/13	15/10
Fred	15/3	15/8	15/4
Cloud	15/8	15/14	15/10
Nathen	15/10	15/9	15/11
Leo	15/7	15/10	15/13
Jack	15/11	15/14	15/9
Tom	15/4	15/9	15/5
Andy	15/7	15/11	15/6

Table 2. Results of the girls

Name	Score of water	Score of caffeinated coffee	Score of decaffeinated coffee
Vivian	15/6	15/13	15/9
Tiffany	15/4	15/11	15/7
Amy H	15/8	15/12	15/8
Amy C	15/6	15/9	15/12
Cindy	15/6	15/14	15/12
Sarah X	15/7	15/15	15/11
Sarah F	15/5	15/10	15/6
Daisy Deng	15/4	15/8	15/8
Daisy Dai	15/7	15/7	15/8
Lisa D	15/9	15/15	15/9
Lisa Y	15/6	15/12	15/5
Chloe	15/3	15/6	15/4
Layla	15/9	15/14	15/12
Jonna	15/7	15/12	15/7

Susie	15/8	15/15	15/11
Suzi	15/6	15/9	15/13
Regina	15/7	15/14	15/12
Annie	15/3	15/7	15/5
Emma	15/7	15/12	15/14
Becky	15/5	15/8	15/8
Angela W	15/7	15/12	15/10
Angela Z	15/6	15/11	15/8
Betty	15/9	15/13	15/7
Kiki	15/10	15/15	15/8
Nelly	15/12	15/15	15/15
Susan	15/7	15/10	15/11
Elyn	15/6	15/11	15/9
Rose	15/8	15/13	15/11
Wendy	15/6	15/9	15/11
Hermine	15/8	15/9	15/6
Catherine	15/6	15/8	15/11
Miya	15/6	15/12	15/10
Jessie	15/9	15/11	15/8
Yoko	15/4	15/15	15/9

4. Conclusion

There for when compared to caffeinated coffee, decaffeinated coffee and water did not exhibit a significant impact on the outcome measures of the word memory test. However, some effects were still detected in the outcome measures. Specifically, in contrast to caffeinated coffee, there was some evidence to suggest that decaffeinated coffee may bring about some improvements to attention and reaction time performance. These improvements were measured by the word memory task. The contrast in findings regarding caffeinated coffee and decaffeinated coffee suggests that any improvements to cognitive performance that were observed with decaffeinated coffee are most likely not attributable to caffeine.

References

- [1] Areshkin, D. A. (2002). Self-consistent environment-dependent tight-binding: Methodology and applications [ProQuest Dissertations & Theses]. <https://www.proquest.com/docview/305550418?pq-origsite=primo>
- [2] Cg, S., & B, T. (1988). The effects of age on the response to caffeine. *Psychopharmacology*, 94(1). <https://doi.org/10.1007/BF00735876>
- [3] Dong, X., Li, S., Sun, J., Li, Y., & Zhang, D. (2020). Association of Coffee, Decaffeinated Coffee and Caffeine Intake from Coffee with Cognitive Performance in Older Adults: National Health and Nutrition Examination Survey (NHANES) 2011-2014. *Nutrients*, 12(3), 840-. <https://doi.org/10.3390/nu12030840>
- [4] Kennedy, D. O., & Wightman, E. L. (2022). Mental Performance and Sport: Caffeine and Co-consumed Bioactive Ingredients. *Sports Medicine (Auckland)*, 52(Suppl 1), 69–90. <https://doi.org/10.1007/s40279-022-01796-8>
- [5] McHugh, P. R. (2008). Try to remember: Psychiatry's clash over meaning, memory, and mind. Dana Press.
- [6] Monnier, C., & Syssau, A. (2008). Semantic contribution to verbal short-term memory: Are pleasant words easier to remember than neutral words in serial recall and serial recognition? *Memory & Cognition*, 36(1), 35–42. <https://doi.org/10.3758/MC.36.1.35>

[//doi.org/10.3758/MC.36.1.35](https://doi.org/10.3758/MC.36.1.35)

- [7] Smit, H. J., & Rogers, P. J. (2000). Effects of low doses of caffeine on cognitive performance, mood and thirst in low and higher caffeine consumers. *Psychopharmacology*, 152(2), 167–173. <https://doi.org/10.1007/s002130000506>
- [8] Tasya, A. R. A., Pramesti, A. A., Komarudin, A. A. Z., Putri, W. Z., & Farisandy, E. D. (2023). Low Caffeine (Decaffeine) Could Remembrance My Short-Term Memory: Effects of Caffeine on Short-Term Memory in Jabodetabek College Students. *Jurnal Sains Psikologi (Online)*, 12(1), 50–58. <https://doi.org/10.17977/um023v12i12023p50-58>
- [9] Xiang, H., Liu, M., Zhou, C., Huang, Y., Zhang, Y., He, P., Ye, Z., Yang, S., Zhang, Y., Gan, X., & Qin, X. (2024). Tea Consumption, Milk or Sweeteners Addition, Genetic Variation in Caffeine Metabolism, and Incident Venous Thromboembolism. *Thrombosis and Haemostasis*, 124(12), 1143–1151. <https://doi.org/10.1055/s-0044-1786819>
- [10] Young, T. P., Erickson, J. S., Hattan, S. L., Guzy, S., Hershkowitz, F., & Steward, M. D. (2024). A Single-Blind, Randomized, Placebo Controlled Study to Evaluate the Benefits and Safety of Endourage Targeted Wellness Formula C Sublingual +Drops in People with Post-Acute Coronavirus Disease 2019 Syndrome. *Cannabis and Cannabinoid Research*, 9(1), 282–292. <https://doi.org/10.1089/can.2022.0135>