

## Low Caffeine (Decaffeine) Could Remembrance My Short-Term Memory: Effects of Caffeine on Short-Term Memory in Jabodetabek College Students

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#### Abstract

Caffeine is believed to improve a person's memory because a person can be awake and affect brain performance. The purpose of this study was to examine the effect of caffeine on short-term memory. This study uses a posttest control group design where two groups will be given treatment, and one group will not be given treatment. The participants of this study were 30 college students (Mage equals 19.4; SD equals 1.27) in Jabodetabek who consumed caffeine at least three times a week. Data collection using a digit span test adapted from Wechsler Adult Intelligence Scale (WAIS). The results showed that caffeine positively affected short-term memory in college students. Decaffeine has more effect on short-term memory than caffeine and mineral water. This research implies that college students can consume decaffeine to improve their short-term memory.

#### Abstrak

Kafein dipercaya mampu meningkatkan daya ingat seseorang karena seseorang dapat terjaga dan meningkatkan kinerja otak. Tujuan dari penelitian ini adalah untuk melihat pengaruh kafein terhadap memori jangka pendek. Penelitian ini menggunakan desain penelitian *posttest control group design* di mana terdapat dua kelompok yang akan diberikan perlakuan dan satu kelompok tidak diberi perlakuan. Partisipan penelitian ini merupakan 30 mahasiswa (Mage sama dengan 19.4; SD sama dengan 1.27) di Jabodetabek yang mengonsumsi kafein minimal tiga kali dalam seminggu. Pengumpulan data menggunakan tes *digit span* yang diadaptasi dari *Wechsler Adult Intelligence Scale (WAIS)*. Hasil penelitian menunjukkan bahwa kafein berpengaruh positif terhadap memori jangka pendek mahasiswa. Dekafein lebih memiliki pengaruh terhadap memori jangka pendek dibandingkan kafein dan

air mineral. Implikasi dari penelitian ini adalah bahwa mahasiswa dapat mengonsumsi dekafein untuk meningkatkan memori jangka pendeknya.



## INTRODUCTION

Short-term memory is a storage system in the brain. Short-term memory stores a small amount of information for short periods (Cherry, 2022; Goldstein, 2010). Information that enters short-term memory can be kept in the brain for several minutes, for example, a recent experience and a few digits in a phone number (Goldstein, 2010; Sternberg & Sternberg, 2016). Short-term memory can store five to nine pieces of information in 15 to 30 seconds, or it is also possible for more than 30 seconds if someone repeats the information verbally (Cherry, 2022; Suparni, 2010).

Short-term memory is very important because memory is a cognitive process that involves logical or intellectual thinking (Savage, 2018). Every individual, especially college students, requires short-term memory in everyday life and lectures. In processing learning, students will enter information originating from sensory input into short-term memory and repeat it so that it can be recorded in long-term memory. Suppose there is a problem with short-term memory. In that case, this will have an impact on information storage, as well as the process of transferring information from short-term memory to long-term memory.

Previous research has examined several variables that can affect short-term memory, namely color in UKM members (Nasution et al., 2019), the effect of brain exercises on the elderly (Triestuning, 2018), and the effect of caffeine on female students (Nasution et al., 2018). This research will examine further the effect of caffeine on short-term memory.

Caffeine, also known as 1,3,7-trimethylxanthine, comes from the German word *Kaffee* and the French word *café*, which means coffee. Caffeine is one of the most consumed ingredients in food and beverages worldwide. This is because

caffeine is easily found in drinks, such as coffee, tea, soda, and products containing cocoa or chocolate, various medicines, and food supplements. Currently, around 80% of people worldwide and 90% of adults in North America consume caffeine daily (Heckman et al., 2010; Sherman et al., 2016).

According to Sembiring (2016), one of the most interested in consuming coffee is students who consume it for academic purposes. In this case, college students generally consume caffeine during the day or night. During the day, caffeine is useful for holding sleepiness during learning and increasing energy. At night, caffeine is useful for increasing concentration and improving brain performance. This is in accordance with the research by (Nasution et al., 2018), which revealed that caffeine helps college students to be able to concentrate more when doing assignments and can help college students in doing assignments late into the night.

In this study, interviews were conducted with two college students regarding the impact of caffeine on them. AK (19 years), a psychology student at Pembangunan Jaya University, explained that it is easier to remember if you consume caffeine.

“When I drink coffee I can usually remember lessons more easily and I can also be more enthusiastic because I feel my energy is replenished.”

This research also interviewed students of the Communication Studies Department at Pembangunan Jaya University, with the initials SV (19 years old), explaining that he can better concentrate when consuming coffee.

“Usually I drink coffee in the afternoon, besides making me fresh because it

makes me not sleepy, I don't know why if I drink coffee, I focus more on listening to the lecturer's explanation."

According to the Statistics Indonesia (Badan Pusat Statistik [BPS], 2020), coffee production in Indonesia in 2019 reached 742 thousand tonnes. Coffee has caffeine as its main ingredient. Besides caffeine, coffee contains magnesium, protein, potassium, sodium, and calcium. The caffeine in coffee has been proven to improve memory, attention, and mood. Caffeine has a similar chemical structure to adenosine, a metabolite of adenosine triphosphate (ATP) that acts in the neurological system, signals inflammation, and regulates cell proliferation (Oktari et al., 2017).

Musika (2018) explains that caffeine can increase concentration, trigger memory, and strengthen the range of thought, verbal fluency, and decision-making. Latunra et al. (2021) also added that caffeine is useful in elevating mood, eliminating sleepiness, and increasing alertness. Consuming low doses of caffeine ranging from 55 to 60 milligrams, can improve performance. However, caffeine also has a bad impact if consumed excessively by humans.

Several previous studies examined the effect of caffeine on short-term memory. Research conducted by Nasution et al. (2018) showed a significant increase in short-term memory after drinking coffee compared to before drinking coffee. Another research by Uhya et al. (2021) showed that the short-term memory of participants who consumed coffee was better than those who did not.

This research differs from previous studies, including using participants with a wider scope, namely undergraduate students in Jabodetabek. Moreover, this study used a quasi-experimental research method, namely the posttest control group design. This study used three groups: group one with high caffeine content, group two with low caffeine content, and group three with non-caffeine. Data collection was carried out online through the Zoom Meetings program.

This study aimed to determine the effect of caffeine consumption on the short-term memory abilities of undergraduate students in Jabodetabek. The hypothesis that this research wants to prove is that caffeine affects the short-term memory of undergraduate students in Jabodetabek.

## METHODS

### Research Design

This research method uses a quasi-experiment with a posttest control group design. Quasi experiment is a research design involving at least two groups, specifically the control and experimental groups. The experimental group is the group that is given the treatment, while the control group is the group that is not given the treatment. Furthermore, the posttest control group design is an experimental design in which the experimental and control groups are measured and compared after the treatment (Gravetter & Forzano, 2018). This experimental design assumes that the two groups are identical before treatment.

The experiments in this research used three groups, which were experimental group 1, experimental group 2, and the control group. In experimental group 1, it was given treatment in the form of high caffeine. In experimental group 2, the treatment was given in the form of low caffeine (decaffeinated). In the control group, no treatment was given, and only mineral water was given. Table 1 is the research design conducted in this study.

Table 1.  
Posttest Control Group Research Design

		<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>
EG 1	R		X	O
EG 2	R		X	O
CG	R			O

Keterangan:

EG 1 = Experimental Group 1

EG 2 = Experimental Group 2

CG = Control Group

X = Treatment

O = Observation or Measurement

R = Random

### Research Population and Sample

The population in this study is college students in Jabodetabek. This research uses nonprobability sampling with a purposive sampling technique. Purposive sampling is a research sampling method in which the sample is determined by certain criteria (Sugiyono, 2010). Characteristics of participants in this study are: (1) active undergraduate students in Jabodetabek; (2) within the age range of 18 to 23; (3) consume caffeine at least three times a week; and (4) willing to participate in the entire series of research.

The sample of this study was 30 participants (15 male participants, 15 female participants, Mage = 19.4, SD = 1.27) who were divided into three groups (experimental group 1, experimental group 2, and control group) with ten participants in each group randomly using random assignment. Random assignment is a way to place participants into different treatment groups randomly (Shaughnessy et al., 2012).

### Research Instrument

Data collection in this study was carried out using the digit span test. The digit span test is a short test to measure a person's short-term memory. The digit span test is part of the Wechsler Intelligence Scale, which measures a person's intelligence (Heerema, 2022). This research was adapted from the digit span subscale on the Wechsler Adult Intelligence Scale (WAIS), which contains number calculations requiring respondents to repeat the numbers mentioned.

WAIS was first published in 1995 by David Weschler, who believed that a person's intelligence could be measured using a number test (Cherry, 2020).

### Research Procedure

The research procedure carried out can be described through the following steps.

1. Researcher compiled a Google Forms containing identity and informed consent, which is a participant's willingness to take part in experimental activities until the end (<https://forms.gle/Z44oqEVGRHiepZ2j9>).
2. Researchers distributed questionnaires online through social media.
3. Researchers divided participants into three groups, which were the control group, experimental group 1 with low caffeine, and experimental group 2 with high caffeine.
4. Researchers ask for participants' willingness to take part in experimental activities on a predetermined date.
5. One day before the experimental activity, the researcher distributed coffee to the participants through a delivery service. The researcher also confirmed to each participant that the coffee was received in good condition.
6. Researchers conducted experimental activities for three consecutive days online in experimental group 1, experimental group 2, and control group: (a) in experimental group 1, researchers provided treatment by asking participants to consume coffee with high caffeine; (b) in experimental group 2, researchers provided treatment by asking participants to consume coffee with low caffeine (decaffeinated); and (c) in the control group, the researchers did not provide treatment (provide mineral water to participants).
7. After 15 minutes, the researcher conducted a posttest by giving individual span digit tests to the participants.
8. The researcher then terminates each participant.

### Data Analysis Technique

In this research, an assumption test was carried out: the normality test using the Shapiro-Wilk test and the homogeneity test using the Levene test. The normality test is used to determine whether the data in each group that has been obtained can be said to be normal or not. A homogeneity test is performed to determine whether the collected data is from the same population. (Gravetter & Forzano, 2018). If the assumption test is met, the hypothesis test is carried out using One-Way ANOVA to test the difference between the two experimental groups and one control group. However, if one or both assumption tests are not met, the hypothesis test is carried out with the Kruskal-Wallis test, the nonparametric equivalent of One-Way ANOVA. Hypothesis testing is a statistical procedure that uses sample data to prove whether the research hypothesis is accepted or rejected (Gravetter & Forzano, 2018). All data in this study were processed using JASP 16.0.0.

## RESULTS

### Description of Research Participants

This study had 30 participants, 16 male participants (53%) and 14 female participants (46%). These participants will be randomly divided into three groups: experimental group 1, experimental group 2, and the control group. An overview of research participants can be seen in Table 2 below.

Table 2.

Description of Research Participants

Gender	Frequency	Percentage
Male	16	53.333
Female	14	46.667
Total	30	100.000

### Assumption Test

This study carried out assumption tests, which are the normality and homogeneity tests. The normality test in this study used the Shapiro-Wilk test. In the normality test results that have been carried out, the p values obtained from experimental group 1, experimental group 2, and

the control group are 0.388, 0.001, and 0.014, respectively. The data will be normal if the p-value of the research results is greater than 0.05 (Gravetter & Forzano, 2018). This result explains that the data for experimental group 1 are normal, but the data for experimental group 2 and the control group are not normal (p-value less than 0.05). The results of the normality test can be seen in Table 3 below.

Table 3.

Normality Test

Shapiro-Wilk	EG 1	EG 2	CG
Statistic	.924	.716	.800
p-value	.388	.001	.014

After carrying out the normality test, the homogeneity test was carried out using Levene's test. Data can have good homogeneity if it obtains a value of more than 0.05 (Gravetter & Forzano, 2018). The homogeneity test results showed a value of 0.370 (p-value > 0.05), so the research data was homogeneous. The results of the homogeneity test can be seen in Table 4 below.

Table 4.

Homogeneity Test

F	df1	df2	p
1.031	2.000	27.000	.370

### Hypothesis Test

Based on the assumption test results, this study's hypothesis test used the nonparametric Kruskal-Wallis test. Based on Table 5, it is explained the distribution of research frequencies. EG 1 has a mean score of 10.2 (SD = 2.044), EG 2 has a mean score of 12.3 (SD = 2.452), and CG has a mean score of 9.1 (SD = 0.800). Based on the mean score, EG 2 (decaffeinated) has the highest mean score, and CG (mineral water) has the lowest mean score. An overview of the overall frequency distribution of participants can be seen in Table 5.

Table 5.  
Description of Frequency Distribution

	EG 1	EG 2	CG
Valid	10	10	10
Missing	0	0	0
Mean	10.200	12.300	9.100
Std. Deviation	2.044	2.452	2.601
Minimum	7.000	8.000	6.000
Maximum	13.000	14.000	12.000

The results of the Kruskal-Wallis test showed that the p-value obtained was 0.014. This explains that caffeine significantly affects the short-term memory of college students in Jabodetabek. The results of the hypothesis test can be seen in Table 6 as follows.

Table 6.  
Hypothesis Test

Factor	Statistic	df	p
Group	8.604	2	.014

This study will specifically see how much caffeine, decaffeinated, and mineral water affect college students' short-term memory. In this study, a post hoc analysis was carried out on the three groups. Based on the data in Table 7, there was a significant difference between students who consumed mineral water and students who consumed decaffeinated (t = -3.010 and p < 0.05). Simultaneously, there was no significant difference between mineral water and high caffeine (t = -1.035 and p > 0.05). Furthermore, there was no significant difference between decaffeinated and high caffeine (t = 1.975 and p > 0.05). Based on these results, it can be concluded that decaffeinated has the most significant effect on improving students' short-term memory.

Table 7.  
Post Hoc Analysis

		95% CI for Mean Difference			
		Mean Diff.	Lower	Upper	ptukey
Water	Decaffeinated	-3.200	-5.836	-.564	.015
	High caffeine	-1.100	-3.736	1.536	.562
Decaffeinated	High caffeine	2.100	-.536	4.736	.138

## DISCUSSION

This study aims to determine whether or not there is an effect of caffeine on short-term memory in undergraduate students in Jabodetabek. Based on the study results, caffeine affects the short-term memory of college students. This result is in accordance with Uhya et al. (2021), who conducted research on short-term memory in medical students at Abulyatama University. The results showed that participants who consumed coffee had better short-term memory than those who did not.

Caffeine can directly stimulate and affect brain performance and has been shown to increase alertness or vigilance (Hartney, 2020). Caffeine contains presynaptic adenosine recep-

tor inhibitory antagonists, inhibiting phosphodiesterase and adenosine. Caffeine has a greater ability to bind to adenosine receptors which can improve memory performance. This is because adenosine has an effect on inhibiting activity in the nerves of the brain. At the same time, the role of caffeine is contrary to adenosine, where caffeine increases activity in the brain's nerves. Caffeine can also carry and enhance some neurotransmitters in the human body. With this, caffeine plays a role in reducing the absorption of adenosine to help stimulate the hippocampus so that caffeine can improve individual memory (Nasution et al., 2018).

In addition, it is also described in research by Oktari et al. (2017) that caffeine plays a role in

inhibiting the adenosine circuit in brain receptors, which can lead to an increase in alertness. This means that if there is an increase in alertness, a person's attention will also increase, affecting the increase in short-term memory.

The use of caffeine consumption at a lower dose, which is around 100 to 144 milligrams, can improve short-term memory performance than higher caffeine (Nasution et al., 2018). This is consistent with the results in this study, which specifically show that subjects who consume low doses of caffeine, or decaffeinate, have the highest scores, which increases their short-term memory performance.

Although caffeine has many positive effects on the body, when consumed in high doses, it can affect the health of the body. Research by Smith & Rogers (Tanjung & Scovani, 2014) states that low doses of caffeine affect cognitive function. Cognitive function, in this case, is included in short-term memory, so it can be concluded that consuming low doses of caffeine is helping the brain's performance in short-term memory.

Higher dosages of caffeine can have a more pronounced effect on the heart, resulting in a more rapid change in heart rate. In addition, if caffeine is consumed in large quantities, it can result in a person experiencing a caffeine overdose (Hartney, 2021). This is similar to studies showing that higher doses of caffeine consumption result in individuals experiencing worse sleep routines, morning fatigue, and experiencing anxiety (Rodak et al., 2021).

Walter (2022) revealed that consuming high doses of caffeine can cause feelings of anxiety, restlessness, high blood pressure, and a racing heart. It can be concluded that consuming high doses of caffeine can interfere with a person's cognitive function due to the side effects. Therefore, consuming low doses of caffeine (decaffeinate) can maintain a person's cognitive function, improving short-term memory.

Limitations in this study include the treatment given to participants online using Zoom

Meetings. This also makes the external variables uncontrollable. In addition, this study only used the posttest and did not use the pretest, giving rise to the assumption that each participant has the same baseline. The advantage of this research is the use of three different groups where the study results show that low caffeine (decaffeinate) is more influential than high caffeine or mineral water on college students' short-term memory.

This research can be a means for college students to gain new insights regarding the benefits of low caffeine (decaffeinate), which can help improve short-term memory abilities. According to Aziz (2017), field research has advantages because field research can be applied in real life since it displays many real-life situations and environmental variations subjects face. Because this research was conducted online, the results may not be very accurate because they are not carried out directly, so researchers cannot see the extraneous variables in the subject.

## CONCLUSION

Based on the research that has been done, it is known that caffeine has a significant effect on short-term memory in college students in Jabodetabek. When viewed more specifically, decaffeinate (low caffeine) has the highest effect compared to high-caffeinated coffee and mineral water. Future researchers can conduct research with a more extensive range of participants and a more significant number of participants to generalize to a broader population. Future researchers may also use different participant characteristics and/or contexts. Lastly, researchers can use true experiment research methods, such as a pretest-posttest control group design, to determine participant differences before and after treatment and increase internal validity.

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