

The Effect Of Caffeine Consumption On Attention: An Experiment Conducted At The Department Of Psychology, Atma Jaya Catholic University In Indonesia

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Abstract

Caffeine, which contains a psychoactive substance that has a stimulating effect, plays a part in societal lifestyle, as well as being part of college students' lifestyle. College students often consume caffeine during the night and morning to help them improve their attention and performance in doing assignments and attending classes. This study aims to see whether there is a significant effect of caffeine consumption on the attention of college students. This research used an experimental method with an analysis of covariance control group design. Respondents were first-year students of the Faculty of Psychology, Atma Jaya Catholic University in Indonesia ($N = 36$). They were divided into two groups: an experimental group and a control group, with the experimental group consuming caffeine. Convenience sampling technique and randomization procedure were used to assign participants into experimental and control groups. To measure attention, oral Stroop Test was used after the administration of caffeine. The research also controlled participants' sleep duration using statistical control techniques (ANCOVA). The experimental result shows that caffeine has no impact on the level of attention after controlling sleep duration of the participants.

Keywords: *Attention; Caffeine; Experiment; Stroop Test*

1. Introduction

Caffeine is a psychoactive substance that has a stimulant effect and is widely used worldwide. Caffeine can be found in beverages, supplements, and sweets, making it the most widely used stimulant in the world (Snel & Lorist, 2011). Caffeine (1,3,7-trimethylxanthine) is an alkaloid chemical compound found in coffee beans, tea leaves, cocoa beans, and cola. Caffeine is also the most commonly consumed pharmaceutical ingredient in drugs such as headache remedies and painkillers (Murphy and Benjamin, in Nawrot, Jordan, Eastwood, Rotstein, Hugenholtz, & Feeley, 2003). More than 80% of the world's population consumes caffeine daily, either as stimulants, as a medication additive, or as a lifestyle trend (Liveina & Artini, 2014).

According to Santrock (in Dewi, Anwar, & Amalia, 2009), caffeine is one of the most widely used stimulants, including among teenagers. Teenagers tend to have a habit of consuming soft drinks, tea, and coffee frequently (Hurlock in Puri, 2007). In

2016, the National Coffee Association of the United States revealed an increase of coffee consumption among people aged 18-24 years from an average of 2.7 cups a day to 3.2 cups a day.

Consumption of caffeine in low doses provides some benefits. In a study by Smit and Rogers (in Liveina & Artini, 2014), they described that consumption of 100 mg caffeine could have positive effects on cognitive functions, such as restoring one's awareness and attention and keeping up the cognitive functions that were reduced by the lack of sleep (Snel & Lorist, 2011). A study by James and Keane (2007, in Purdiani, 2014), however, suggested that caffeine has a negative effect on one's physical and mental performance when consumed on regular basis. According to Glade (in Purdiani, 2014), excessive caffeine consumption can also have a negative impact on sleep patterns, attention, and daytime drowsiness.

Attention is a selective or focused concentration on a stimulus. Solso (in Andri, Kamid, & Rusdi, 2016) also mentioned that the purpose of attention

mechanisms is to protect the brain system, which has a limited capacity, from information overload. Giving attention means focusing on a stimulus while ignoring irrelevant stimulus, therefore producing the readiness of an individual to respond to upcoming stimuli (Strickland, 2001). Meanwhile, according to Sternberg and Sternberg (in Salehah, Anward, & Rachmah, 2015), attention is the way individuals actively process a limited amount of information from the vast amount of information available through the five senses, memories, and other cognitive processes. Based on the definitions described above, attention can be defined as a mental process involving the concentration of the human cognitive system on particular objects or actions.

Teenagers in the United States consider that caffeine consumption can help increase their vigilance and attention. In fact, the research team from the National Sleep Foundation (in Purdiani, 2014) revealed that about 75-98% of teenagers consume at least one caffeinated beverage each day, and 31% of them consume more than two caffeinated drinks each day. The widely held belief of the effect of caffeine on attention is consistent with Jarvis's (1993) finding that consumption of more than three cups of coffee can lead to an increase in performance and in verbal memory ability in a short amount of time. Caffeine consumption can also lead to increased performance and increased speed in completing tasks.

Since past studies focusing on the effect of caffeine consumption in teenagers showed different results based on the doses, this research aims to see if there was any influence of low doses of caffeine consumption on the attention of college students. First-year students in the Department of Psychology, Atma Jaya Catholic University in Indonesia (FP UAJ) participated in the current research, in which a Stroop Test was used to measure attention. Through an experimental design, this study intends to find a causal relationship between caffeine consumption and attentional level of college students.

According to a survey conducted by the researchers to 100 students of the FP UAJ, coffee and tea are the variations of caffeine that are most often consumed daily by college students. Coffee and tea are generally consumed in the morning before starting activities because they are considered to increase energy and attention. However, in addition

to morning time, the researchers found that 54% of the respondents also consumed caffeine at night. Based on interviews conducted by researchers with the students who consumed caffeine at night, they claimed that they consumed caffeine at night to stay awake while working on their assignments and to keep their attention to ensure they can stay focused.

Furthermore, 38% of respondents who consumed caffeine at night eventually ended up consuming more caffeine in the morning to help them stay awake and feel refreshed. However, they confessed that with caffeine consumption at night and morning, they feel sleepier when attending classes in the morning and afternoon. This leaves them unable to focus while in class and their attention eventually decreases. Of course, this finding contradicts the expectation that caffeine consumption can increase their attention while in the classroom. Therefore, the researchers wanted to see if there was any effect of certain doses of caffeine consumption on attention. Additionally, taking into account the possibility that the duration of sleep may affect attention, it is hence hypothesized that there is a significant effect of caffeine consumption on the level of attention after controlling sleep duration.

2. Methods

Sample. The research team used convenience sampling to obtain participants. The research team first announced the characteristics of the research participants to FP UAJ 2016 by a broadcasting message in social media. After performing convenience sampling and determining that the sample used in this experiment would consist of 36 first-year students of FP UAJ (enrollment class of 2016), the researchers then randomized the participants to either the experimental or the control group. Each group (experimental and control) consisted of 18 participants, with a total of 30 females and 6 males whose ages ranged from 18 to 19 years old participating. Randomization techniques were used to control the resistance and tolerance toward caffeine.

The chosen participants had to have never been enrolled in Experimental Psychology or a Research Methods course. This limitation was imposed to ensure internal validity of the study by restricting participant sophistication. Participant sophistication is a condition where the knowledge and familiarity of the research subjects on the research topic or

experimental methods performed can influence the results of the study (Seniati, Setiadi & Yulianto, 2005).

Research Design. This research used a laboratory experiment design with an Analysis of Covariance Control Group Design, which was considered proper because one of the variables in the current research, namely caffeine (IV), was manipulated in the study to see its effect on attention (DV). The researchers used this design so that the control technique should be done as one of the requirements of experimental research.

The independent variable in this study was caffeine in the form of coffee, while the dependent variable was attention as measured by the number of correct answers in the Stroop Effect Test performed orally. In addition, the environment where the experiment was held is a secondary variable that was controlled by holding it constant. Both the experimental and control groups were therefore given the same room with the same conditions, temperatures, and noise to ensure that both groups were exposed to the same room conditions. The same constancy technique was also used to control the equipment used and the time of the day during which the research was conducted. In particular, the experiment was conducted at 10 AM to 12 PM for both the control and the experimental groups.

In addition, the length of sleep the participants had the previous night was also considered and measured after the study was conducted. The researchers asked participants about the number of hours they slept the night before and about the quality of the sleep itself. However, the researchers did not control the amount of average caffeine consumption by the participants although participants were asked to provide information regarding their caffeine habit on the demographic data form. Most of the participants revealed that they had not had any caffeine that week. Following completion of the research, the statistical control technique ANCOVA was performed using SPSS. The covariate used in this study was the participants' sleep duration the night before the experiment.

Instrument and Measurement. The researchers used the Stroop Effect Test to measure the selective attention of FP UAJ 2016 students. This test is used to measure attention by giving participants some words that indicate a color that is either colored in the same way (congruence), differently

(incongruence), or colored black (black), and by then asking the participants to name the color of the words (Stroop, 1992). Past observation has shown that both semantic interference and semantic facilitation disappear when participants are not instructed to name the color of the stimulus but instead are asked to pronounce the word, regardless of the color the word is printed in. This so-called Stroop asynchrony is often explained by the difference in processing speed between colors and words (Cohen et al., 1990; Roelofs, 1992 in Maanen, L. V., Rijn, H. V., Borst, J. P., 2009), or the difference in automaticity between color naming and word reading (e.g., Lovett, 2005)

The test was given through PowerPoint, which was administered through each researcher's laptop. The participants answered verbally and there was a time limit for each question, which was 1 second. The researchers avoided using a written response, as it may give more time for the participants to react. After finishing the entire experiment, the researchers then calculated the total correct answer and compared the scores of the Stroop Effect Test obtained by both groups to see whether there were any differences that would suggest an effect of caffeine on attention. The researchers also measured the significance of sleep duration using SPSS to find the connection between sleep duration and the other variables in the experiment.

Procedure. Each individual session of the experiment consisted of four participants because the administration of the Stroop Effect Test was done individually. Participants were asked to come 10 minutes before the study began. One researcher stood by in front of the classroom to brief participants who had come to fill in the registration list. After entering the classroom, two other researchers were in the classroom to help direct participants to the previously prepared seats. One researcher would then begin the experimental procedure. Firstly, the participants were instructed to fill out informed consent forms to affirm their willingness to be involved in the research. The researcher read the informed consent loudly to ensure that the participants understood the side effect they would probably experience after the experiment was done. After that, the researcher handed out a demographic data sheet to the participants to fill out.

In the demographic data sheet, participants were asked to provide personal data information,

including age, occupation, and health record. The purpose of such information was to find out whether the participants had color blindness, as well as to obtain the measurement of how many hours the participants slept. If during the process the researcher discovered a participant with color blindness, their score would be eliminated from the final data analysis. Participants in the control group were presented with a glass of 100 ml water, while the experimental group was presented with 50 mg of coffee containing a 113.5 mg dose of caffeine, mixed in with 50 ml of water. Then, both groups of participants were given time to finish the glass contents together under directions from the researchers. After that, the researchers guided the participants to their seats and instructed them to watch a Shin-Chan cartoon for 20 minutes to fill the time while waiting for the caffeine to work. In addition, the cartoon was also used to make participants feel relaxed.

Throughout the process, the participants watched the cartoon using a headset and were seated back to back to prevent interaction between them. After the video ended, the researcher returned and started the Stroop Effect Test. The researcher combined three parts of the test, which are congruence, black, and interference. There were 90 questions of Stroop Effect Test that were administered through PowerPoint displayed on each researcher's laptop. First, the researchers explained the Stroop Effect Test research procedure. Each slide showed one color word displayed in the same color, one color word displayed in a different color, or one color word displayed in black. Each item was displayed within one second with a timed slide. Participants were then required to answer verbally. While the participants responded to the test, the researchers recorded the answers given by the participants on the answer sheet for scoring purposes. Key answers were closed using a board, so participants were unable to see the notes made by the researchers. The researchers then closed the board after the Stroop Effect Test was completed and invited the participants to return to the chair located in the middle of the room.

At the end of the session, the research team stood in front of the classroom and thanked the participants for their contribution, before explaining the true purpose of the experiment. The research team also reminded the participants that the entire experiment process and the results were to be kept secret, additionally asking the participants to keep the

experimental procedure a secret. After the process was complete, the participants were given rewards to thank them for their cooperation. The researchers then collected the scores obtained by calculating the total correct answers given by the participants to determine whether caffeine had any effect on their attention during the experimental process, which in turn may affect their the Stroop Effect Test scores. The last step in this experiment was data processing and interpretation.

3. Results

Based on the Shapiro-Wilk normality test, we obtained a significant result for the correct sum ($p = 0.013$). It was found that the data set for the correct sum of Stroop Effect Test participants are not normally distributed. Meanwhile, Levene's Test revealed a nonsignificant variance of the dataset ($p = 0.379$).

Table 1.
Experimental Results

Group	Results				
	Sum of Square	df	Mean Square	F	Sig.
Sleep duration	204.966	1	204.966	3.645	.065
Caffeine/No Caffeine	19.172	1	19.172	.341	.563
Error	1855.756	33	56.235		
Total	2068.750	35			

The predicted main effect of caffeine consumption was not significant, $F(1, 33) = 0.341$, $p > 0.05$. The interaction between caffeine and sleep duration was also not significant, $F(1, 33) = 3.645$, $p > 0.05$. Thus, it can be concluded that there was no significant effect of caffeine consumption on attention level, after controlling sleep duration, for FP UAJ class of 2016.

4. Discussion & Conclusion

Discussion. This research aims to see if there was any influence of consumption of low doses of caffeine on the attention of first-year students of the Department of Psychology, Atma Jaya Catholic University in Indonesia (FP UAJ) who participated in this research in which a Stroop Test was used to measure attention. The researchers wanted to see if there was any effect of a certain dose of caffeine

consumption on attention. Taking into account the possibility that the duration of sleep may affect attention, it was hence hypothesized that there might be a significant effect of caffeine consumption on the level of attention after controlling sleep time. Based on the results of the experiment, the researchers found no effect of caffeine consumption on attention, even after controlling sleep duration. This might have happened due to the time interval between caffeine administration and the timing of the test, which was approximately 20 minutes. Past research indicated a significant increase in the score of Stroop Effect Test in a group that consumed 40 mg of caffeine daily, but only when participants initially refrained from consuming caffeine for seven consecutive days and were then given certain doses of caffeine once for seven consecutive days (Rahardian & Scovani, 2014).

Another limitation that may have affected the results of the Stroop Effect Test is the participants' diet (Rahardian & Scovani, 2014). With the unregulated diet of participants, the researchers did not know whether participants took caffeine on a regular basis or whether they consumed caffeine at all. This could have affected the process and the research results due to lack of uniformity among participants. Another factor that may have also affected the final score of the Stroop Effect Test was the participants' physical condition during the experiment. There were participants who were not feeling well during the experiment, possibly affecting the final score of the Stroop Effect Test they obtained.

In addition, the researchers found that two participants who indicated not having color blindness on their demographic data, could not distinguish purple from blue and brown from black when doing the Stroop Effect Test. Therefore, the participants faced difficulty in answering the Stroop Test and the results of the Stroop Effect Test were not optimal. The researchers later removed data from the participants who were sick and unable to distinguish certain colors to prevent it from interfering with the rest of the data. Based on past literature, the researchers assumed the participants may have been experiencing unintentional blindness. This can lead to priming, in which speed per slide results in participants identifying items presented afterward (Mack & Rock in Reisberg, 2013). This effect is related to subliminal perception, in which participants fail to consciously capture what is presented rapidly because during the process they do not have enough time to absorb all

the sensory stimuli around them. Although not consciously felt by the participants, under certain conditions and with given stimuli, priming could take place. Such an effect is very likely to occur in the two participants who could not distinguish some colors.

This research has several advantages and disadvantages. The advantages include the administration of Stroop Effect Test that was conducted one-on-one, so that researchers were able to note each participant's responding pace and the accuracy of answers. The pilot study also became one of the study's advantages, because during its implementation, the researchers obtained feedback from students who had been or were in the midst of taking an Experimental Psychology course, thus allowing the researchers to get more input on procedures and how to deliver instructions. The Pilot Study also made the execution of the study more focused and prepared the researchers to face the actual research. Prior to the execution of the research, the research team always made sure to explain the contents of the informed consent to the participants so that they were clearly made aware of the physical or psychological impacts they might experience after the experiment. The researchers also ensured that the experiments run consistently according to the SOP that had been made by maintaining the same conditions and controlling secondary variables.

Yet there remained several things in the study that could be improved further. Firstly, the demographic data form contained numerous and diverse questions, thus the duration needed to complete the form turned out to be fairly long. In fact, the researchers did this purposely to ensure the participants were neutral and unaware of the true purpose of the experiment. In the future, researchers should give the participants an exact duration to complete the demographic data so that the experiment goes according to the rundown. Moreover, in the debriefing session, the researchers did not inform the participants about the real purpose of making them watch cartoon, which was to wait for the caffeine to work. In addition, related to the answer sheet of the Stroop Effect Test, the researchers experienced some difficulty in keeping records of the participants' answers, as at the same time the researchers also had to turn the answer sheet.

One suggestion that can be considered for further research is the Stroop Test's validity and reliability. The Stroop Test that is often used to measure attention has several types of interpretation used in practice, but there is no test of reliability and validity for orally administered Stroop Test, which was used in the present study.

Based on the considerations stated above, the researchers are open to the possibility that a similar research can be developed with a larger sample size and a wider range of population, with a side note that the caffeine intake should be controlled in advance. Caffeine consumption itself is not limited to FP UAJ 2016 students, but also widely found among students all over Indonesia, and even around the world. Researchers can also consider measuring the intelligence of participants to see whether intelligence has a part in one's performance during Stroop Effect Test. It is also possible for subsequent research to use more diverse methods of Stroop Effect Test, which can be adapted to match the field conditions.

Conclusions. There was no significant effect of consumption of 113.5 mg caffeine on attention after controlling for sleep duration in students from the class of 2016, Faculty of Psychology, Atma Jaya Catholic University in Indonesia.

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