JOURNAL OF ENGINEERING AND MANAGEMENT IN INDUSTRIAL SYSTEM VOL. 11 NO. 2 YEAR 2023

e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

THE EFFECT OF AGE, SLEEP DURATION, AND LEARNING DURATION ON SHORT-TERM MEMORY

Huki Chandra[1*)], Silvi Istiqomah[1)], Adhitya Rinda Wahyu Purnama[1)], Sasotya Rigan Rafsanjana[1)], Ahmad Nur Rosyid[1)]

Program Studi Teknik Industri, Fakultas Teknologi Elektro dan Industri Cerdas,
Institut Teknologi Telkom Surabaya[1)]

Abstract In the reality of life, learning requires a process of remembering. In the process of teaching and learning, memory is crucial. Sleep deprivation affects the process of remembering in learning. Memory is one of the important aspects that affect student performance in learning. In addition to sleep duration, the age factor can also affect short-term memory. This study wants to find out if age, sleep duration, and learning duration have an impact on short-term memory. This study incorporates elements of cognitive ergonomics because it measures short-term memory performance to assess how people process information and how they maintain it in their memory. Based on the results of multiple linear regression tests, the R Square value was 0.328 and the Adjusted R Square was 0.272. The age variable has a significance value of 0.001. The coefficient value on the age variable is 0.303 and is positive. This positive value indicates that increasing student age will increase the value of short-term memory. This shows that the higher the age of the student, the higher the ability in short-term memory. The sleep duration variable has no significant effect on short-term memory. The learning duration variable has no significant effect on short-term memory.

Keywords: short-term memory; age; sleep duration; learning duration; cognitive ergonomics

1. Introduction

Students are particularly vulnerable to sleep deprivation. The ability to store information is very important for students. Poor sleep quality will interfere with the ability to remember [1]. The lack of sleep duration of students is because of the many tasks they have to complete the tasks and the activities outside of academic life. It can cause the ability to remember will decrease [2].The decrease in the ability to remember something will affect the students' memory [2]. The low level of students' memory can interrupt learning activities, especially for subjects that require a high level of short-term memory and a high level of concentration [2].

There is a significant relationship between sleep quality and short-term memory [3]. Good sleep patterns can improve memory performance [4]. Memory is one of the important aspects that affect student performance in learning. There is a relationship between sleep and cognitive function. Sleep is an important factor in the process of remembering. Lack of sleep besides causing fatigue and drowsiness can also reduce cognitive performance.

In general, sleep duration affects students' grades [5]. Sleep duration is one of the variables that can determine the level of cognition of students. Sleep deprivation will make the students feel tired and have to sleep immediately. These factors can decrease the ability to retrieve information from the course materials. Consequently, poor duration of sleep contributes to a low level of short-term memory. The academic performance of students drops significantly when they have poor short-term memory. Students' grades in academic life can be impacted if their academic performance decreases. Sleep duration must be considered because it affects cognitive function [6]. There is a positive correlation between short-term memory and sleep duration. In addition, this evidence is very significant for workers or students [7].

Lack of sleep duration can cause a decrease in memory and cognitive ability [8]. There is a significant effect between sleep duration and memory [9]. In college students, there is a statistical relationship between sleep and memory [10]. Sleep duration has an influence on cognitive function, especially on short-term

*Corresponding author. Email: hukichandra@ittelkom-sby.ac.id
Published online at http://Jemis.ub.ac.id

Cite this Article As Chandra, Huki et al (2023). The Effect Of Age, Sleep Duration, And Learning Duration On Short-Term Memory. Journal of Engineering and Management in Industrial System, 11(2), p97-104
Paper Submitted : June, 27th 2023
Paper Published : December, 31th 2023

e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

memory [11]. Sleep duration is a crucial factor for students. Students who have sleep deprivation usually experience hard to concentrate, even when they fall asleep in class. That condition makes the students miss the course materials and fail to follow and comprehend the lectures. Therefore, it makes the students fail to get remarkable grades. But interestingly, other studies have shown no significant effect between sleep quality and short-term memory [2].

There is no significant relationship between sleep quality and short-term memory in students or subjects aged 18-22 years [12]. The duration of habitual sleep does not affect memory [13]. This shows that several of these studies, do not reach the same conclusion. Some studies say sleep duration affects short-term memory significantly, while other studies show no significant effect. Due to disagreements between the results of past studies, the purpose of this study is to investigate whether there is a relationship between sleep duration and short-term memory.

Apart from sleep duration, based on previous studies, the age factor also influences short-term memory. There is a significant relationship between short-term and long-term memory performance in age range [14]. Short-term memory is affected by age as a result of slowing down the process of receiving and sending information to long-term memory [15]. There is a relationship between age differences in the accuracy of short and long-term memory [16]. The influence of age significantly affects the performance of short-term memory [17]. Where short-term memory performance can decrease with age [18]. The higher the age, the cognitive ability will decrease significantly [19]. Based on these studies, shows that age will affect short-term memory and accuracy. However, other studies explain that there is no significant effect between age and a person's cognitive level. The age factor has no significant relationship with the decline of the level of cognition [20]. There is no significant relationship between age and cognitive abilities in adults [21]. This shows that these studies have different conclusions.

Several studies explain that age affects short-term memory, while other studies do not show a significant effect. This study explores whether there is an impact of age on short-term memory due to contradictions in the findings of earlier studies. This study explores additional factors concerning the short-term memory of students, including study duration and caffeine consumption. Notably, it encompasses variables such as age, sleep duration, study duration, and coffee consumption, expanding upon prior research that considered a more comprehensive set of factors. The inclusion of study duration as a variable is motivated by the desire to investigate whether students who regularly engage in studying exhibit superior memory capabilities, as well as to determine any potential influence of coffee on students' short-term memory. Consuming coffee is associated with heightened alertness and focus, prompting this study to evaluate whether coffee consumption enhances memory retention among respondents.

Previous research has indicated a significant improvement in short-term memory recall among young adults exposed to caffeine in an experimental setting [22]. Additionally, providing participants with caffeinated beverages resulted in a notable performance boost, specifically in the experimental group, without affecting the overall performance of the control group. These findings underscore the efficacy of these conditions [22]. The rationale behind caffeine's potential memory-enhancing effects lies in its ability to promote wakefulness and enhance cognitive performance. Thus, the primary objective of this study was to examine the impact of caffeine on short-term memory [23]. The research findings unequivocally support the positive impact of caffeine on students' short-term memory [23]. Consequently, this study incorporated this factor to assess whether there exists a substantial disparity in short-term memory between individuals who consume coffee and those who do not.

This study is focused on determining if age, sleep duration, learning duration, and coffee drinking have an impact on short-term memory. Learning duration was included in the analysis because this study wanted to see whether there was an effect of learning duration on students who were determined and tenacious in learning on short-term memory abilities. This study incorporates elements of cognitive ergonomics because it measures short-term memory performance to assess how people process information and how they maintain it in their memory. Analysis using appropriate and suitable statistical methods. The independent variables in this study were age, sleep duration, and learning duration. The dependent variable in this study is

e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

short-term memory. Multiple linear regression was used because the independent variable used in this study was more than one, and after the data was collected and analyzed, it was found that the data met the requirements of multiple linear regression tests such as normality tests and linearity tests.

2. Methods

This section describes the methods, variables, subjects, data collection and analysis techniques, and the steps in this study. Data was collected experimentally to measure short-term memory, where respondents had to remember the digits that appeared on the screen. Then, a questionnaire was used to obtain the respondent's profile such as age, sleep duration, and study duration. Table 1 shows the variables used in this study. This study was initiated by commencing a comprehensive review of existing literature in the field. A literature review was conducted to obtain research developments on short-term memory. By conducting a literature review, the factors that influence short-term memory can be identified.

In the initial phase of this investigation, the first step involves identifying and specifying the target participants. The target respondents in this study were college students aged between 18-22 years. This target respondent was chosen because short-term memory can affect cognitive abilities in students. The total number of respondents in this study was as many as 40 respondents. The subsequent step entails the formulation of an experimental plan. In preparing the experiment plan, this study created a respondent profile questionnaire which contained information about the respondent's age, the respondent's sleep duration before filling out the questionnaire, the average learning duration per day, and whether the participants consumed coffee or abstained from it just before the assessment of short-term memory.

Subsequently, gather data in accordance with the devised experimental design. Data retrieval is done by showing several digits. The number of digits that appear on the screen increases as the respondent's level increases. Short-term memory is measured by the high level achieved when remembering the digits of that number. Analysis using appropriate and suitable statistical methods. The independent variables in this study were age, sleep duration, and learning duration. The dependent variable in this study is short-term memory. In this study, the data were normally distributed and there was linearity, so a statistical test was performed using multiple linear regression.

Finally, the research culminates in the process of drawing conclusions. Based on data processing findings it proves whether or not the independent variable has an impact on the dependent variable, and this study's conclusions can be drawn. Figure 1 illustrates the methodology employed for quantifying short-term memory performance. The assessment involved measuring the respondent's ability to recall a specific number of digits. With each incremental test level, the number of digits that the respondent was required to remember increased by one. For instance, if the respondent made an incorrect response at level 7, this indicated an inability to remember the 7-digit number. As a result, the respondent's score for short-term memory was recorded as 6, reflecting their capacity to recall 6-digit numbers.

Sleep duration is the number of hours the respondent slept the previous day. The study duration is the average study time (in hours) per day. The respondent's age is the age (in years) when the measurement or data is taken. Short-term memory is measured based on the number of digits successfully memorized without failing a single digit. The higher the level of short-term memory, the more digits the respondent has to remember. If the respondent is wrong in recalling digits, then the short-term memory value obtained by the respondent is at that level.

To determine if the independent variables and the dependent variable have a causal relationship, multiple linear regression analysis was used. More than one independent variable is included in multiple linear regression. In carrying out multiple linear regression, it is necessary to test the assumptions. The data in this study were 40 respondents.

In the event that the research plans to undertake a multivariate analysis, such as correlation or multiple regression, it is essential that the sample size consists of a minimum of ten times the number of variables under examination, as advised by previous research [24]. Given that there are three independent variables of interest, the research necessitates a minimum of 30 respondents to ensure an adequate sample size. Hence, adhering to this principle and considering the demonstrated normal distribution of the data, it can be affirmed

e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

that the dataset is adequately sized for the analysis.

Respondents in this study were students aged 18-22 years. A summary of the profiles of respondents in this study is shown in Table 2. The average short-term memory score obtained by the respondents was 5,813. This shows that the average respondent is only able to remember 5-6 digits correctly. The average learning duration is 2,738 hours. The average duration of sleep is 6.075 hours and the average age is 19.75 years. The shortest duration of sleep is 3 hours and the longest duration of sleep is 8 hours. The shortest learning duration is 1 hour and the longest learning duration is 5 hours. The lowest short-term memory score was 4 and the highest short-term memory score was 7.

The sampling approach employed in this study was purposive sampling. The study targeted individuals within the age range of 18-22 years, specifically focusing on students, as many learning activities in this age group heavily rely on short-term memory. Additionally, the choice of students as respondents was also influenced by the convenience of data collection. To assess the potential impact of age, sleep duration, and study duration on short-term memory, the statistical method utilized was multiple linear regression. This method was chosen due to its conformity with assumptions such as normality, lack of multicollinearity, linearity, homoscedasticity, and variance inflation factor values. Meanwhile, the analysis to investigate whether there exists a discrepancy in short-term memory based on coffee consumption involved the application of a t-test. This test was employed to determine if there was a significant difference in the average number of digits remembered by respondents who consumed coffee prior to the test in comparison to the control group, consisting of respondents who refrained from drinking coffee.

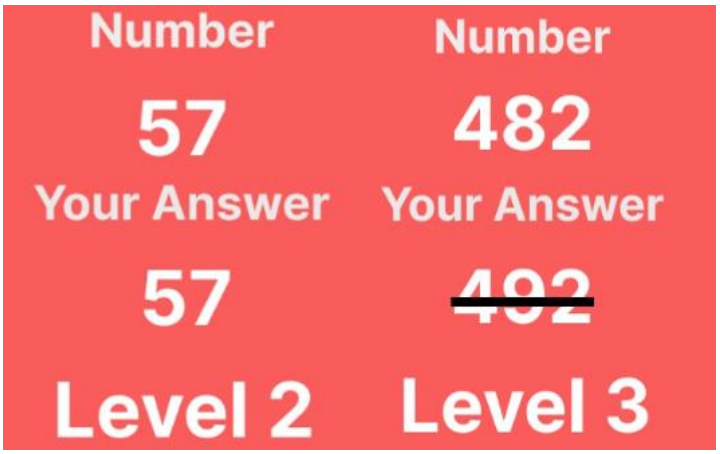

Fig. 1 Short-Term Memory Measurement

Table 1. List of Variables and Description

Variable	Description	References
X_1 (Age)	Independent Variable	[1]–[13]
X_2 (Duration of Sleep)	Independent Variable	[14]–[21]
X_3 (Learning Duration)	Independent Variable	[4]
Y (Short-Term Memory)	Dependent Variable	[1], [2], [11]–[20], [3], [21], [23], [4]–[10]

Table 2. Profiles of Respondents

Variable	Min	Average	Max
X_1 (Age) in years	18	19.75	22
X_2 (Duration of Sleep) in hours	3	6.075	8
X_3 (Learning Duration) in hours	1	2.738	5
Y (Short-Tern Memory) in digits	4	5.813	7

e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

3. Results

3.1. Assumption Test for Linear Regression

Based on the results of the normality test, a significance value of 0.117 is obtained. Because the significant value in this study was above 0.05, the data in this study were normally distributed. The results of the deviation from linearity are shown in Table 3. This test is used to see whether the model is linear. A good correlation must have a linear relationship between the independent and dependent variables, thus why the linearity test is used. Next, the Variance Inflation Factor and Tolerance tests were carried out.

In this study, the multicollinearity test is used to determine if the independent variables are correlated with one another. There should be no multicollinearity in a regression model, which means there should be no correlation between the independent variables. The results of the Variance Inflation Factor and Tolerance tests are shown in Table 4. Another test that was performed was the heteroscedastic test. Table 5 shows the results of the heteroscedastic test. Heteroscedastic test to make sure there are no heteroscedastic indications or that the variance of the residual value varies equally from one observation to another [22].

Table 3. Deviation from Linearity

Variable	F	Sig.
X_1 (Age)	2.842	0.052
X_2 (Duration of Sleep)	1.096	0.374
X_3 (Learning Duration)	0.405	0.804

Table 4. Variance Inflation Factor and Tolerance

Variable	VIF	Tolerance
X_1 (Age)	1.171	0.854
X_2 (Duration of Sleep)	1.196	0.836
X_3 (Learning Duration)	1.036	0.966

Table 5. Heteroscedastic Test

Variable	t	Sig.
X_1 (Age)	-1.250	0.219
X_2 (Duration of Sleep)	0.999	0.324
X_3 (Learning Duration)	-1.872	0.069

Table 6. Multiple Linear Regression Results on Short-Term Memory

Variable	Coefficients	Sig.
Constant	-0.507	0.744
X_1 (Age)	0.303	0.001
X_2 (Duration of Sleep)	0.032	0.706
X_3 (Learning Duration)	0.050	0.578

For the age variable, the significance score for the deviation from linearity is 0.052. The sleep duration variable's deviation from linearity had a significance value of 0.374. The significance value of the deviation from linearity for the learning duration variable is 0.804. All significant values for deviation from linearity have values above 0.05, so there is a significant linear relationship between these variables and short-term memory.

The value of the variance inflation factor in the age variable is 1.171. The tolerance value for the age variable is 0.854. The value of the variance inflation factor in the sleep duration variable is 1.196. The tolerance value for the sleep duration variable is 0.836. The value of the variance inflation factor in the learning duration variable is 1.036. The tolerance value on the learning duration variable is 0.966. All values of the variance inflation factor in each variable are less than 10. All collinearity tolerance values are above 0.10 so it can be concluded that there is no multicollinearity.

In the heteroscedastic test, the significance value for the age variable is 0.219. In the heteroscedastic test, the significance value for the sleep duration variable was 0.324. In the heteroscedastic test, the significance value of the learning duration variable is 0.069. All significance values in the heteroscedastic test were above 0.05, so it can be concluded that there were no signs of heteroscedasticity.

3.2. Effect of Age, Sleep Duration, Study Duration, and Coffee Consumption on Short-Term Memory

Multiple linear regression tests can be carried out because they meet the assumptions of multiple linear regression tests. Table 6 shows

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e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

the results of the regression test to see if there is an effect of age, sleep duration, and learning duration on short-term memory.

The equation $Y = 0.303\ X_1 + 0.0032\ X_2 + 0.05\ X_3 - 0.507 + \text{error}$ is produced based on the multiple linear regression test. Each increase in X1 (Age) will increase the value of Y (Short-Term Memory) by 0.303. Each increase in X2 (Duration of Sleep) will increase the value of Y (Short-Term Memory) by 0.0032. Each increase in X3 (Learning Duration) will increase the value of Y (Short-Term Memory) by 0.05.

Based on Table 5, the age variable has a significance value of 0.001. The sleep duration variable has a significance value of 0.706. The learning duration variable has a value of 0.578. The age variable has a significance value below 0.05. Other variables, namely sleep duration and learning duration have a significance value above 0.05. This shows that only the age variable has a significant effect on short-term memory. Variable sleep duration and learning duration have no significant effect on short-term memory. This result is supported by previous studies. There is no significant relationship between sleep quality and short-term memory in students or subjects aged 18-22 years [12]. The duration of habitual sleep does not affect memory [13].

The coefficient value on the age variable is 0.303 and is positive. This positive value indicates that increasing student age will increase the value of short-term memory. The higher the age of the student, the better the ability to remember digit numbers. Thus, students in their senior year tend to have better short-term memory. Senior students have better short-term memory because as they get older, they have taken many courses that require a high level of short-term memory. Therefore, older students have better short-term memory abilities.

To assess whether disparities exist in short-term memory performance between individuals who consume coffee and those who abstain, a preliminary normality test was conducted. The significance value of this normality test was found to be 0.179, which is greater than 0.05, indicating that the data follows a normal distribution. Consequently, the appropriate statistical test to employ is the t-test. Levene's test yielded a significance value of 0.504, signifying uniform data variance between the groups of respondents. The results of the subsequent t-test revealed a highly significant p-value of 0.0001. This outcome allows us to conclude that there is a substantial distinction in short-term memory between respondents who consumed coffee on the test day and those who refrained. Specifically, the average performance of coffee consumers stood at 9.05 in terms of digit recall, while non-coffee consumers averaged 5.75. This discrepancy underscores that respondents who consumed coffee exhibited markedly superior cognitive performance compared to their counterparts who did not partake in coffee consumption.

4. Discussion

The findings of this study reveal a degree of congruence with prior research outcomes. Specifically, this investigation indicates that there is no statistically significant correlation between sleep duration and short-term memory, aligning with the results reported in earlier studies. Nonetheless, it is noteworthy that some researchers have reported a significant association between sleep duration and short-term memory, potentially attributed to differences in the characteristics of the study population. In this study, the respondents primarily comprised students, a demographic that often experiences insufficient sleep.

As for the impact of age on short-term memory, the conventional belief that advancing age leads to a decline in memory is contradicted by the results of this research. Contrarily, the study demonstrates that older participants exhibit improved short-term memory, which can be attributed to the relatively narrow age range of the student respondents, where the distinctions are more reflective of variations in learning experiences within the context of memory-intensive courses. Seniors, who tend to be older, have adapted to the demands of memorization during their academic journey, consequently yielding higher short-term memory scores.

Regarding the influence of coffee on short-term memory, this study's findings indicate a substantial positive effect on memory capacity. This phenomenon is explained by the enhanced focus and alertness experienced by students after coffee consumption, mitigating drowsiness and improving concentration. Consequently, students who consume coffee demonstrate notably higher and more significant short-term memory scores, consistent with previous research outcomes as observed in the previous study [23]. Evidently, the consumption of coffee

e-ISSN 2477-6025
https://doi.org/10.21776/ub.jemis.2023.011.02.2

is conducive to memory enhancement.

The students should improve their performance by managing the key factors that affect the human information process, especially memory retention. Coffee drinking, sleep duration, learning time spent, and age are the factors observed in this study. This research offers a cognitive ergonomics approach to improve performance in humans. In terms of student characteristics, the junior-year students who have a lower age compared to their seniors in this study tend to have low performance. As the implication of this study, junior year students can enhance their memory by practicing more so they can store it in their mental model to get better memory retention. Drinking coffee is encouraged for students to improve their cognitive performance in memory retrieval since this research found it significantly improves their short-term memory.

4. Conclusion

Based on the results of multiple linear regression analysis, the variable that has a significant effect on short-term memory is the age of the student and has a positive coefficient. This shows that the higher the age of the student, the higher the ability in short-term memory. This is because senior students are used to dealing with subjects that require a high level of short-term memory. So that senior students have to enhance their short-term memory since it requires them a high level of short-term memory to get good grades in their subjects, especially in senior year. The sleep duration variable has no significant effect on short-term memory. The learning duration variable has no significant effect on short-term memory. The short-term memory performance of students who consume coffee is notably superior and statistically more significant compared to students who do not partake in coffee consumption. Hence, the consumption of coffee can be deemed beneficial for enhancing students' short-term memory abilities.

5. Acknowledgment

For sponsoring and funding this study, LPPM Institut Teknologi Telkom Surabaya is acknowledged by the authors. The reviewers who enhanced the quality of this study are also thanked by the author.

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