

A Pilot Study: The Effect of Sunnah Bedtime Routines on The Memorizing and Problem-Solving Skills of University Students

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Abstract: Quality sleep is essential to maintain normal levels of cognitive skills. During sleep, electroencephalogram (EEG) is used to study brain activity to detect disorders. However, the effect of Sunnah bedtime routines on the brain cognitive performance is rarely studied. Therefore, this study was conducted to compare the effect of Sunnah bedtime routines on cognitive performance of ten male college students using cortical information pathway. The students were divided into Group 1 (Control) and Group 2 (Sunnah bedtime routines). Members of Group 2 performed Sunnah bedtime routines for six weeks whereas members of Group 1 were not assigned to any particular routine. The participants' memorizing and problem-solving abilities were assessed in the first and final week of the experiment. The subjects' brain signals were recorded using EEG and Partial Directed Coherence (PDC) was applied to extract the cortical information pathway. The cortical connectivity and test scores between the two groups were compared. Members of Group 2 were found to perform better than in both abilities, and EEG analysis showed that the two groups were utilizing different parts of the brain region. Statistically, Group 2 has improved their memorizing skills by 18% in average, higher than Group 1 with only 4% in average. Also, Group 2 showed cortical activity in frontal and temporal regions and sensory integration area as compared to Group 1 that mostly utilized the pre-frontal area. In conclusion, this study highlighted the probable impact of Sunnah bedtime routines on the two cognitive skills, which are memorizing and problem solving.

Keywords: Cognitive performance, brain region, brain performance, EEG, Sunnah bedtime routines.

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1. INTRODUCTION

Sleep is the condition where the bodies usually are quiescence and eyes are closed. Sometimes there are unusual cases of sleep such as sleepwalking, teeth grinding and sleep-talking [1, 2]. Proper sleep is measured by the amount of sleeping time. Appropriate sleep is generally between 7-9 hours/night while having sleep less than 7 hours/night is categorized as having sleep deprivation [3, 4].

Quality sleep is complex and difficult to define objectively. In a quality sleep study, by Harvey et al. [5] of twenty-five insomnias and twenty-eight normal sleepers, the parameters to determine quality sleep parameters are total sleep time, difficulty to fall asleep, and numbers of unintentional waking up and not being able to go back to sleep again. The post sleep parameters studied are state of coordination and balance, ease or difficulty of staying awake, and alertness and clear-headedness to concentrate on tasks at work.

In another study Rangtell [6], the finding has indicated that quality sleep has been affected by pain and illness, age, stress and noise. The study has found out that quality sleep

can be maximized by setting clear-headedness and busyness during the day, reasonable reflections on one's problem, and proper management of emotion and stress.

From the study of 52 young adults while using EEG, Zhua et al. [7] have shown that high self-perceived exercise exertion before bedtime improves sleep patterns of the participants, and thus increase their quality sleep.

Quality sleep is proven to be an important element in attaining good mental and physical health. It is also crucial in developing great memorizing, problem solving, and critical skills especially in early ages and adolescence [8, 9, 10, 11, 12]. When one is deprived of sleep, his brain cannot function properly, his ability to concentrate and learn new things may be interfered, his decision-making process may be hindered, and his creativity may be suppressed. Sleep deprivation usually occurs among college students and adolescences group and this has been linked to their lifestyle [13].

Even though quality sleep is essential for mental and physical health, quality sleep, often, has been overlooked especially among college students.

'Sunnah', in its simplest term, refers to actions and

sayings by Prophet Muhammad p.b.u.h. Sunnah is a model for Muslim conduct as well as a primary source of Islamic law after the holy Qur'an. In this sense, Sunnah bedtime routines simply refer to bedtime routines taught and practiced by Prophet Muhammad p.b.u.h. such, among many, as performing ablution (wudu'), dusting the bed, wearing loose clothes, turning off the lights, and reciting prayers (du'a) [14].

Some of the components of this Sunnah bedtime routines have been scientifically researched on and its benefits in modern science have been published [15, 16]. Yet, no published literature was found comparing the effect of the Sunnah bedtime routine on cognitive performance. Thus, this paper aims to establish, if any, effect of Sunnah bedtime routines on cortical information pathway in memorizing and problem-solving tasks.

2. METHODOLOGY

Ten male college students were chosen to be the subjects of the study. The participants were 22 to 23 years old, pursuing Bachelor of Electrical Engineering at Universiti Teknologi Malaysia, Skudai. Initially, all subjects performed about the same bedtime routines. The subjects were then divided into two groups. Five of them were randomly selected to follow Sunnah bedtime routines (Group 2) for 6 weeks while those in Group 1 were not assigned to any particular routine. Six weeks were chosen because it approximately equals to 40 days; a symbol of completing development process of embryo into fetus, where the brain cells are rapidly grown and developed within this phase [17]. Hence, six weeks were seen to be enough for the participants to adapt to the bedtime routines.

Table 1 lists the 11 Sunnah bedtime routines that were followed by the members of Group 2 throughout the experiment. The subjects were encouraged to sleep early in the night (as early as 11 pm) so that they could wake up fresh early in the morning (around 5 am). To improve alertness and performance for 2.5 – 4 hours in the evening and night, a short mid-day nap or known as Qailullah [14] was recommended. By having Qailullah, the body is refreshed for the evening activities [15] and vigilance, cognitive function, as well as memory consolidation could be improved [18].

Members of Group 2 were asked to perform ablution before sleep because washing motor and sensory organs using cool water is best for deep sleep [15]. To reduce body temperature and have good effect on blood circulation, loose clothes were recommended [15]. Dusting the bed could protect the body from bedbugs [15]. Sleeping in darkness is vital as light can interfere with one's internal body clock (circadian rhythm). Furthermore, darkness promotes the production of the naturally occurring hormone, melatonin, which is a powerful antioxidant hormone that is useful in preventing diseases, sleep disorders, and chronic fatigue.

Subjects were asked to lay on the right side of the body. The benefit of this sleeping position was discovered by the modern scientist; the cardiac vagal activity is the greatest when the subjects are in the right lateral decubitus position [19]. Last but not least, du'as were recited as engaging in

spiritual activity could bring one peace and clarity of mind.

A cap with 19 electrodes was used to acquire the brain signals. The cap was connected to EEG machine NeuroFax 9000, Nihon Kohden. Figure 1 shows the equipment used for data acquisition. The equipment was set up in a special room to avoid electromagnetics interruption, such as interference from mobile phones and computer networks.

The experiments were conducted in Week 1 and Week 6. There were 3 different parts in each experiment: relaxed condition, memorizing, and problem solving. The order of the experiments is shown in Figure 2. For the first task, the subjects were asked to be in a relaxed condition while the EEG signal is being captured. The subject was seated on a chair and was asked to look at the white screen in a relax manner with no specific activity or task. The brain signal was captured for 30 seconds. This signal was used as the control signal (baseline). PDC was applied to the extracted EEG signals to determine the active brain regions that can be considered as the source of the information.

Table 1. List of selected Sunnah bedtime routines

No.	Parameters
1	Sleep early
2	Qailullah (short nap in the afternoon)
3	Perform ablution (wudu') before sleep
4	Wear loose clothes before sleep
5	Dusting the bed before sleep
6	Lights off, close door and windows
7	Lay on the right side of the body (sleep position)
8	Perform du'a before sleep
9	Intend to Qiamullail (Midnight pray)
10	Perform Qiamullail (Midnight pray)
11	Wake up early

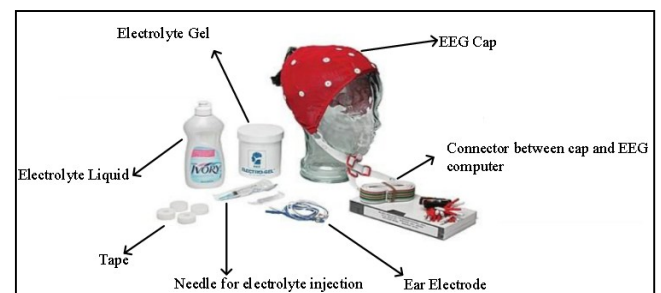


Figure 1. EEG instrument set

Memorizing Task was performed after the control signal was acquired from the subject. In this task, the subjects were given 30 seconds to memorize 15 numbers ranged from 1- 3 digits presented in 3x5 matrix. Then, the

subjects were given another 30 seconds to correctly recall the numbers by writing the numbers in a blank 3x5 matrix. Different set of numbers were given in Week 1 and Week 6. Two brain signals (during memorizing and recalling process) were captured from each subject.

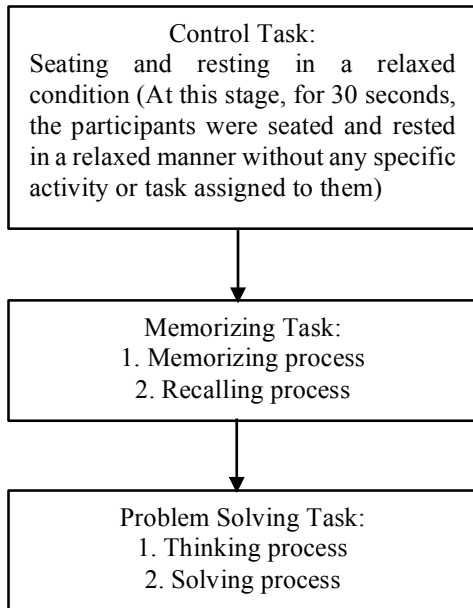


Figure 2. The experimental procedure

Problem Solving Task was performed immediately after the Memorizing Task. For Problem Solving Task in Week 1 and Week 6, different set of puzzles were given to the participants. The presented puzzles in Week 1 were different from Week 6. After a short briefing about the puzzles, the subjects were given 30 seconds to figure out how to solve the problem (thinking process). Then, the subjects were given 60 seconds to solve the problem (solving process). Brain signals during both thinking and solving process were captured from each subject.

The recorded data were then saved in Microsoft Excel for offline processing. Partial Directed Coherence (PDC) was applied to the EEG data to extract the cortical information pathway. The cortical connectivity and test scores for both memorizing and problem-solving abilities between the two groups were compared.

3. RESULT

3.1 Control Task

Table 2 tabulates the findings from the Control Task. For Week 1 assessment, it was observed that nine out of ten subjects had used the prefrontal cortex (F_p) as the source of the information during resting state. This highly developed part of the brain is responsible for the execution of cognitive tasks such as focusing (F_{p1} region) [17] and making judgment (F_{p2} region) [18]. The results showed that for both groups, the brains were not totally “blank” or “rested” even-though the subjects were asked to be in relaxed manner as some area of the brain still remains active.

In Week 6, four out of five members of Group 2 did not show any major activity in the brain region during Control Task. In contrast, none of the Group 1 members managed

to completely calm themselves; 80% of them were still coordinating their mental traffic (F_{p2} region).

3.2 Memorizing Task

Memorizing Task was divided into two sections: remembering and recalling. Remembering involves encoding and storing information in the brain; while recalling involves re-accessing the stored information [22]. Table 3 compares Memorizing Task scores between Week 1 and Week 6.

Table 2. Source of information from the brain regions during Control Task

Group	Subjects	Week 1	Week 6
1 (Non-Sunnah)	A	F_{p2}, F_z	F_{p2}
	B	P_z	F_8
	C	F_{p2}	F_{p2}
	D	F_{p2}	F_{p2}
	E	F_{p2}	F_{p2}
2 (Sunnah)	F	F_{p2}	-
	G	F_{p2}	-
	H	F_{p2}	F_7, F_8, T_3
	I	F_{p2}	-
	J	F_{p1}	-

In Table 3, the percent improvement of the scores on Memorizing Task was derived from the number of the correct answers obtained by each of the participant during the recalling process. There were 15 numbers, of 1 to 3 digits presented in 3x5 rectangular matrix, the participant had to recall after he had been given 30 second to memorize. This number of correct answers during the test, in Week 1 and Week 6, were compared to determine the performance of the participants on Memorizing Task. Majority of the subjects (80%) showed improvement in the Memorizing Task with members of Group 2 obtained better scores than members of Group 1. In addition, 2 out of 5 members of Group 1 were recorded as no improvement.

Referring to Table 3, Student’s t-test was used to statistically analyze the differences of the score obtained between Group 1 and Group 2 during Week 1 and Week 6.

It was found that for Group 1, there were no significant differences ($p > 0.05$) between the Memorizing Task score obtained during Week 1 and Week 6. Whereas for Group 2, there were significant differences ($p \leq 0.05$) between the Memorizing Task score obtained during Week 1 and Week 6, with the score obtained on Week 6 being higher.

Furthermore, it was found that the Memorizing Task score obtained by both groups during Week 1 did not show any significant differences ($p > 0.05$). On the other hand, the score obtained by both groups during Week 6 showed significant difference ($p \leq 0.05$), with Group 2 having the higher score.

From this, it can be deduced that the group that practices Sunnah bedding routine have managed to increase the ability to memorize over the course of 6 weeks.

Table 4 highlights the brain regions that represented the source of information during Memorizing Task. For Week 1 assessment, the use of prefrontal cortex (F_{p2}) was observed in 80% of the subjects. The finding is expected because this part of the brain is normally used to develop short term memory.

Table 3. Memorizing Task scores in percentage (%)

Group	Subjects	Week 1	Week 6	Improvement
1	A	F_{p2}, F_z	F_{p2}	11
	B	P_z	F_8	0
	C	F_{p2}	F_{p2}	10
	D	F_{p2}	F_{p2}	7
	E	F_{p2}	F_{p2}	-7
	Average	-	-	4
2	F	F_{p2}	-	20
	G	F_{p2}	-	14
	H	F_{p2}	F_7, F_8, T_3	14
	I	F_{p2}	-	33
	J	F_{p1}	-	7
	Average	-	-	18

In Week 6, it is observed that members of Group 2 were no longer utilizing F_{p2} region. Instead, it is noted that each participant in this group were utilizing different region of the brain. Three out of 5 members (60%) of Group 2 had been utilizing frontal (F_3, F_4, F_7, F_8, F_z) regions while executing the task. The main functions of these regions are memorizing and planning. The frontal lobe is important for cognitive functions and control of voluntary activity [23]. It is also used to process short- term memory and retain long-term memory. Subject F had integrated sensory motor (C_3 region) to process his motor planning (F_3 and F_4 regions) in order to consciously remember the numbers. On the other hand, subject G and I had integrated verbal expression (F_7) or emotional expression (F_8) with data retrieval from verbal memory (T_3) and emotional memory (T_4). Subject H was the only person who processed visual information to memorize the numbers. Subject J integrated (P_z region) sensory information (C_z region) to perform the task. However, he also used working memory (F_z region) for temporary storage and manipulation of information. Yet, working memory comes with limitations especially when it comes to retaining numbers; the acceptable number of digits that can be memorized by a normal adult human is seven [24]. This may explain why subject J got the lowest score among members of Group 2.

Table 4 shows the origin of the information in the brain

during recalling process. In Week 1 assessment, 70% of the subjects showed the use of F_{p2} region. In Week 6, all members of Group 1 were still found coordinating their mental traffic (F_{p2} region) while recalling the numbers. Only one of them processed emotional memory (T_4) to perform the task. On the other hand, 80% of the Group 2 members processed verbal memory (T_3), emotional memory (T_4), and verbal understanding (T_5) to recall the numbers. One member of Group 2 performed motor planning and sensorimotor integration ($F_3, F_4,$ and C_3) to complete the task.

Table 4. Source of information from the brain regions during Memorizing Task

Group	Subjects	Memorizing Process		Recalling Process	
		Week 1	Week 6	Week 1	Week 6
1	A	F_{p2}	F_{p2}, T_6	F_{p2}, T_4	F_{p2}
	B	T_5	F_{p2}	F_8, T_3	F_{p2}
	C	F_{p2}	F_8	F_{p2}, T_6	F_{p2}
	D	F_{p2}	F_{p2}, T_3	O_2	F_{p2}
	E	F_{p2}	F_{p2}	F_{p2}	F_{p2}, T_4
2	F	F_{p2}	F_3, F_4, C_3	F_{p2}, T_3, T_4	F_3, F_4, C_3
	G	F_{p2}	F_8, T_3, T_4	F_{p2}	T_3, T_4
	H	F_{p2}	O_2	F_{p2}, F_7	T_3
	I	F_{p2}	T_3, F_7	F_{p2}	T_3
	J	T_3, T_4	F_z, C_z, P_z	T_5	T_5

Overall, results from Memorizing Task showed that after practicing Sunnah bedtime routines, members of Group 2 were able to utilize frontal and temporal lobes to help them remember numbers.

3.3 Problem-Solving Task

Problem Solving Task was divided into two parts: thinking and solving. The results for this task were recorded as either ‘Passed’ or ‘Failed’ as tabulated in Table 5. During the assessment in Week 1, only two of the subjects managed to solve the puzzle within the specified time and both of them were members of Group 2. All Group 2 members were able to solve the puzzle whereas only one member from Group 1 managed to complete the task in Week 6.

Referring to Table 5, Fisher Exact Test was used to statistically analyze the differences in outcome between Group 1 and Group 2 obtained on Week 1 and Week 6.

For the assessment in Week 6, 80% of the subjects in the Group 1 were still using prefrontal cortex (F_{p2} region).

The only one member of Group 1 who passed the test used F_z (working memory), C_z (sensorimotor integration) and P_z (cognitive processing) to complete the task. Different performance was observed in Group 2. 80% of the group members used frontal lobe and temporal lobe.

Table 5. Achievements in Problem Solving Tasks

Group	Subjects	Week 1	Week 6
1	A	Fail	Pass
	B	Fail	Fail
	C	Fail	Fail
	D	Fail	Fail
	E	Fail	Fail
2	F	Pass	Pass
	G	Fail	Pass
	H	Fail	Pass
	I	Fail	Pass
	J	Pass	Pass

The sense of familiarity of task might activate the usage of temporal lobe as it has the abilities to retrieve past information. When a person is familiar with the task, they might have different or more creative approach to solve the problem, which might lead to critical thinking in solving the problem.

Temporal lobe also processes information into meaningful units and frontal lobe controls the decision making. Two members of Group 2 used motor planning (F_4 region) during thinking process where one of them integrate it with sensorimotor (C_3 region). Subject I processed signals (P_z region) from T_5 region (verbal understanding) to interpret the problem whereas subject J only used verbal understanding (T_5 region) to understand the problem.

Surprisingly, result showed that Subject H has no obvious brain activity during the thinking process as if he did not need to put much thinking to solve the given problem.

Table 6 indicates the brain regions that operated as the source of information during Problem Solving Task in Week 1 and Week 6. For Week 1 assessment, 80% of the subjects used F_{p2} region. Use of verbal memory (T_3) and emotional memory (T_4) were observed in 40% of the subjects. Only one subject utilized visual processing (O_2) to solve the problem.

For Week 6 assessment, all members of Group 1 were still coordinating their mental traffic (F_{p2} region) while solving the problem. While in judgment state, only one subject from this group was able to process emotional memory (T_4) to solve the problem. On the other hand, two out of five members of Group 2 processed verbal memory (T_3) and emotional understanding (T_6) to solve the problem. One subject paid attention (F_{p1} region) for decision making while another subject integrated

sensorimotor (C_z) to complete the task.

In summary, thinking processes are supported by the frontal lobes. Activity in these lobes, mainly, will involve in executive functions such as working memory, cognitive flexibility, and inhibitory control. This group of three skills will allow people to pay attention, make reasoning, organizing choices and make plans, take action, and solve problems. Prefrontal cortex (F_p) possesses the ability to access information and memories which makes the frontal lobes responsible for allowing people to think things thoroughly and make decision. The temporal lobe, on the other hand, involves in many reasoning skills. Temporal lobe is connected closely with medial temporal lobe which consist limbic system. This plays a major role in processing memories, integrating them with sensations of taste, sound, sight and touch to help form long-term memory. As movement is crucial for each brain function including remembering and learning, sensory motor integration may also be used to integrate these activities.

Table 6. Source of information from the brain regions during Problem Solving Task

Group	Subjects	Thinking Process		Solving Process	
		Week 1	Week 6	Week 1	Week 6
1	A	F_{p2}	F_z, C_z, P_z	F_{p2}	F_{p2}
	B	O_2	F_{p2}	O_2, T_3	F_{p2}
	C	F_{p2}, T_4	F_{p2}	F_{p2}, T_4	F_{p2}
	D	F_{p2}, T_6	F_{p2}	F_{p2}, T_3, T_4	F_{p2}
	E	F_{p2}	F_{p2}	F_{p2}	F_{p2}, T_4
2	F	F_{p2}	F_4, C_3	F_{p2}	T_6
	G	F_{p2}	F_4	F_{p2}	F_{p1}
	H	F_{p2}	-	F_{p2}	T_3
	I	F_{p2}	T_5, P_z	F_{p2}	C_z
	J	T_3, T_4	T_5	T_4	-

The human brain has great capacity to reason out complex issues. Several parts of the brain work together in a sophisticated manner to integrate information and develop thoughts. However, this cognitive performance may be impaired by poor sleep quality [25, 26]. Quality of sleep and cognitive development has shown important associations with bedtime routines [27]. Prior research on bedtime routines heavily focused on quality of sleep. Therefore, this study had focused on the effect of Sunnah bedtime routines on cognitive performance. Subjects following Sunnah bedtime routines showed better cognitive performance on tests of memorizing and

problem solving.

From assessment in Week 1, it was found out that 80% of the subjects initially possessed the ability to access information and memories (F_{p2} region). After following the assigned bedtime routines for 6 weeks, majority members of Group 1 did not show any improvement in terms of optimizing different regions of the brain. However, the use of frontal regions, temporal regions, and sensory motor integration were observed in members of Group 2.

4. CONCLUSION

The results of this study have shown beneficial effects of Sunnah bedtime routines to a good sleep quality that contributes to better memorizing performance and problem-solving ability. Within a period of six weeks, Sunnah bedtime routines have been shown, statistically, to be able to improve the scores of Memorizing Task and Problem-Solving Task for the participants in Group 2. For Memorizing Task, the subjects in Group 1, who were not assigned any sleep routine; statistics has shown no significance difference of their memorizing performance in Week 1 and Week 6. Subjects in Group 2, on the other hand, have shown statistically significance difference score of the memorizing ability in Week 6 compared to Week 1. For Problem Solving Task, only one subject in Group 1 has passed the tests both in Week 1 and Week 6. On the other hand, the subjects who passed the test in Group 2 have increased to five persons in Week 6, compared to two persons in Week 1.

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