



Faculty of Cognitive Sciences and Human Development

**Effect Of Time Of The Day (Morning & Evening) On Short – Term
Memory Performance**

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Bachelor in Psychology (Honours)

2024

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This project is submitted
in partial fulfilment of the requirements for a
Bachelor in Psychology with Honours

Faculty of Cognitive Sciences and Human Development
UNIVERSITI MALAYSIA SARAWAK
(2024)

The project entitled Effect Of Time Of The Day (Morning & Evening) On Short – Term Memory Performance was prepared by Pani Malar A/P Nedung Chalian (82087) and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfillment of the requirements for a Bachelor in Psychology with Honours

Received for examination by:



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Date:

Grade

A

ACKNOWLEDGEMENT

Finishing this Final Year Project and writing this acknowledgment bring back a lot of memories to me. There wasn't a moment that I didn't doubt myself throughout this journey. Although the journey was a hard one, having a good support system that always made me believe in myself was what made me go through this journey. Thus, I would like to take this opportunity to thank each and every one of them here.

There is a saying in Tamil known as "Matha, Pitha, Guru, Theivam", this literally translates to "Mother, Father, Educator, God". People told me these are flow of people that I should always show respect to without fail. Although "Guru" is in the third place in this flow, I would still like to say thank you to my Supervisor Dr Kartini Abdul Ghani first. Without her I wouldn't have been able to finish this FYP. I'm really very grateful and happy that I got to finish this FYP under her support and guidance.

Secondly, I would like to thank my Parents, Mr. Nedung Chalian and Mrs. Saraswathy together with my brother Kovarasan for their unconditional love, prayers and never-ending encouragement that gave me the strength to keep going whenever I feel like giving up. Furthermore, I would like to thank my two dear best friends, Shavita Padmanathan and Cernelsha Anne for always motivating me whenever I'm in a slump and keeping me company whenever I'm lonely and was struggling to complete this project.

Lastly, I would also like to extend my sincerest thanks to my university friends and my participants who was involved in completing this FYP. A very big thanks to everyone that has directly or indirectly helped me in completing my FYP. The completion of this project and the precious memories that I have collected while doing this project would not have been possible without you all.

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ABSTRACT

This study aimed to investigate the effect of time of day on short-term memory performance, focusing on both verbal and visual memory. Conducted with 20 undergraduate students from the Faculty of Cognitive Sciences and Human Development at UNIMAS, the research employs an experimental approach utilizing within-group design to measure performance at different times of day. Morning sessions were conducted between 8 a.m. and 10 a.m., while evening sessions took place between 4 p.m. and 6 p.m. Participants were subjected to tasks assessing verbal memory through word recall and visual memory through shape recognition. The study aims to identify potential differences in memory performance attributable to circadian rhythms, contributing to a broader understanding of cognitive functions influenced by time of day. The findings are expected to offer insights that could impact daily routines and various professional sectors, particularly those requiring optimal cognitive performance at specific times.

Keywords: Time of the day, Verbal Short – term memory performance, Visual Short – Term Memory Performance

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Chapter 1 includes background of study, problem statement, research objectives, research questions, research hypothesis, conceptual framework, significance of study, definition of terms and a summary of the whole chapter.

1.1 Background of Study

The impact of time of day on the functioning of short-term memory has garnered significant attention within the realms of psychology and neuroscience over the course of numerous decades. Numerous studies have consistently demonstrated that cognitive performance, including memory, can be significantly influenced by the time of day. For example, a study conducted by Smith et al. (2015) found that participants performed better on memory tasks in the afternoon compared to the morning, suggesting that cognitive performance may vary throughout the day. Additionally, research has shown that individuals who are "morning people" tend to have better memory function in the morning, while "night owls" perform better in the evening (Jones et al., 2018). These findings highlight the importance of considering individual differences and circadian rhythms when examining the relationship between time of day and memory function. In this research the, this effect of time of the day will be explored furthermore in verbal and visual short – term memory.

According to Lindsay et al. (2010) verbal memory refers to material presented in the verbal form while visual memory denotes material presented without words or verbal

mediation. It should also be noted that verbal memory strongly is associated with temporal lobe while occipital lobe is associated with visual memory. This both domains of short term memory is being tested in this research.

One study published in the Quarterly Journal of Experimental Psychology, “Memory and time of the day” (Baddeley et al., 1970) found that memory performance on the immediate memory task was better in the morning than in the afternoon. However, the repeated item was recalled more accurately than non-repeated items. Another study published in the Behavioural Brain Research part of Elsevier journal (Barner et al., 2019), found that time-of-day effects in three out of four prospective memory tasks, with participants performing better in the evening than in the morning showing that there are different studies contradicting each other’s.

Despite these claims, majority believes that the time of day can have a significant impact on short-term memory performance. Much research suggests that memory performance is better in the morning compared to the evening. This is because the brain’s ability to consolidate memories is higher in the morning and declines as the day progresses (Baddeley et al., 1970).

One study found that the peak memory performance time is around 10am, with memory abilities declining gradually throughout the day (Facer-Childs et al., 2018). Another study found that the evening is associated with worse memory performance, possibly due to the natural decline in cognitive function that occurs as the day progresses (Baddeley et al., 1970).

Thus, it is significant that the effect of time of the day on memory performance should be studied in order to understand how cognitive processes may vary throughout the day. Additionally, investigating the impact of time of day on memory performance can

provide valuable insights for optimizing learning and memory strategies based on individuals' peak cognitive periods.

1.2 Problem Statement

The purpose of this investigation is to determine whether the performance of individuals' short-term memory is affected by the time of day, more specifically between morning and evening. Daily tasks including problem-solving, learning, and decision-making rely heavily on the critical cognitive function of short-term memory. Contemporary research indicates that cognitive functions might experience changes during the day in response to circadian rhythms within the body. However, there remains a significant literary gap on how it affects them in regards with visual and verbal short-term memory.

This investigation seeks to address this gap by conducting a systematic exploration of verbal and visual short-term memory performance during morning and evening hours. This study endeavours to discern whether there are difference in short-term memory capabilities depending on the time of day. The outcomes of this research could offer valuable insights into the optimal timing for engaging in tasks that heavily rely on short-term memory, thereby potentially influencing educational practices, workplace scheduling, and individual cognitive well-being.

Besides that, it is also notable that the literature available so far lacks comparative studies on the effects of time of the day on both visual and verbal short-term memory, hindering our understanding of potential interaction between these two domains. By conducting such comparative studies, researchers can gain insights into whether the time of day has a differential impact on visual and verbal short-term memory. This

knowledge would contribute to a more comprehensive understanding of cognitive processes and potentially inform strategies for optimizing memory performance based on the time of day.

Aside from that studies on the effects of time on visual and verbal short-term memory are inconsistent due to the methodological variation and lack of standardized methodologies highlighting a methodological gap. Addressing this methodological gap is crucial for obtaining reliable and valid results in future studies. Implementing standardized methodologies across different research settings would allow for better comparisons and generalizability of findings, ultimately leading to a more robust understanding of the effects of time on visual and verbal short-term memory.

Understanding the temporal nuances of short-term memory performance is particularly relevant in the context of cognitive health optimization. If time-dependent variations are identified, this research could inform tailored approaches to task scheduling and time management, ultimately enhancing cognitive efficiency and contributing to the broader fields of education, occupational psychology, and healthcare.

1.3 Research Objectives

1.3.1 General Objective

To investigate the effect of time of day (morning and evening) on short-term memory performance of FCSHD undergraduate students.

1.3.2 Specific Objectives

- I. To assess the effect of time of day (morning and evening) on verbal short - term memory performance of FCSHD undergraduate students.
- II. To investigate the effect of time of the day (morning and evening) on visual short – term memory performance of FCSHD undergraduate students.

1.4 Research Questions

- I. Does the time of day (morning vs evening) have a significant effect on verbal short-term memory performance of FCSHD undergraduate students?
- II. Does the time of day (morning vs evening) have a significant effect on visual short-term memory performance of FCSHD undergraduate students?

1.5 Research Hypotheses

Hypothesis 1

H₀: There is no significant difference of time of the day (morning and evening) on verbal short-term memory.

H₁: There is significant effect of time of the day (morning and evening) on verbal short-term memory.

Hypothesis 2

H₀: There is no significant difference of time of the day (morning and evening) on visual short-term memory.

H₁: There is significant effect of time of the day (morning and evening) on visual short-term memory.

1.6 Conceptual Framework

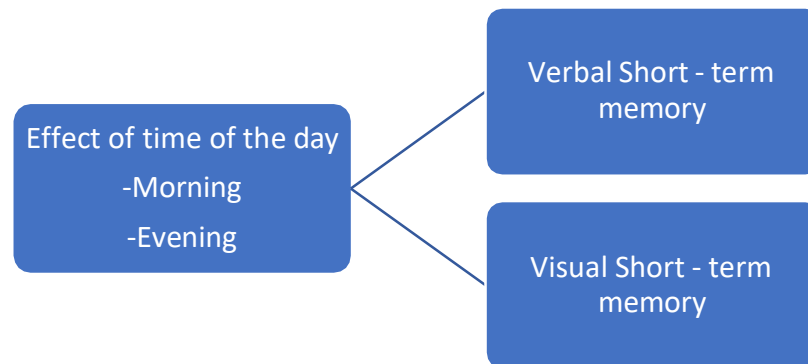


Figure 1: Conceptual Framework

1.7 Significance of Study

The importance of researching the effect of time of day on verbal and visual short-term memory ability cannot be underestimated. Understanding how time of day influences cognitive skills such as memory has practical consequences in a variety of sectors. For example, in education, this research can provide insights regarding the best times to learn and take tests. It can help employers make decisions regarding scheduling jobs that need a high level of concentration and memory retention. Furthermore, understanding the impact of time of day on memory in healthcare could be critical for designing strategies to improve cognitive function in patients with memory-related disorders such as dementia. Furthermore, this research can help to advance our understanding of human circadian rhythms and their impact on cognitive capacities, offering light on how our internal body clock influences brain processes. Overall,

studying the effect of time of day on short-term memory performance has the potential to improve learning, productivity, and overall well-being.

1.8 Definition of Terms

1.8.1 Morning

Conceptual Definition: In the context of the study "Memory and Time of Day" by Baddeley et al. (1970), the morning testing sessions were conducted between 9 and 11 a.m.

Operational Definition: In my research the, morning time period where the research will take place is from 8am to 10am.

1.8.2 Evening

Conceptual Definition: In the context of the research "Memory and Time of Day" by Baddeley et al. (1970), the evening testing sessions were conducted between 4 and 6 p.m.

Operational Definition: In my research, the evening time period will be from 4pm to 6pm.

1.8.3 Verbal (short – term) memory

Conceptual Definition: Verbal memory refers to the ability to encode, store, and retrieve information that is presented in a verbal or auditory format, such as words, sentences, or stories (Baddeley et al., 1970).

Operational Definition: The study will assess the verbal memory of FCSHD undergraduates by administering a test consisting of ten different words associated with

a specific theme (e.g., animals). Participants will be tasked with recording in writing the ten words that they are able to recall.

1.8.4 visual (short – term) memory

Conceptual Definition: The term "visual memory" describes our ability to recall visual stimuli such as words, symbols, numbers, patterns, or other visual stimuli. One of the keyways that we learn and remember information is through our visual memory (Henry, 2023).

Operational Definition: The participants' visual memory is tested by presenting them with a limited number of images to examine, followed by a subsequent selection of a few images from the set of images that were previously displayed. Following that, involved participants are required to select the image they observed earlier.

1.9 Summary

The objective of this study is to examine the influence of morning and evening time periods on verbal and visual short-term memory. The present study aims to examine potential disparities in verbal and visual short-term memory capabilities during morning and evening time periods. Through the analysis of the impact of time of day on cognitive processes, numerous daily routines and various sectors can be comprehensively investigated. In the present chapter, the fundamental details of the investigation have been presented, encompassing the conceptual and operational definitions of morning and evening hours, as well as the significance of comprehending their influence on cognitive processes.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter includes further related research that has been carried regarding the main variables. These studies concentrate on three important topics, short-term memory, factors affecting them, and theory related to memory and time of the day.

2.1 Short-Term Memory

The definition of short-term memory is a separate short-term storage component that is not part of working memory. It refers to passive storage mechanisms that hold a limited amount of post sensory, typically categorically encoded information (Cowan, 2017). It is crucial for various cognitive processes and plays a vital role in daily functioning, such as learning, problem-solving, and decision-making. Short-term memory allows us to temporarily hold and manipulate information, helping us to make sense of our surroundings and engage in complex mental tasks. It has a limited capacity and duration, typically retaining information for 20 to 30 seconds without rehearsal.

An extensive variety of cognitive activities, including as immediate processing, language comprehension, learning, problem-solving, attention, executive functions, and decision-making, are supported by short-term memory, which is an essential cognitive resource. Its importance highlights the pivotal role it plays in human cognition and affects numerous aspects of daily life, education, and cognitive performance.

2.1.1 Verbal Short-Term Memory & Visual Short-Term Memory

Verbal and visual short-term memory play vital roles in our cognitive functioning. Verbal short-term memory refers to our ability to temporarily hold and manipulate verbal information, such as words or numbers, in our minds. This type of memory is often assessed through tasks such as digit span, where individuals are asked to repeat back a sequence of numbers in the order they were presented. Research has shown that verbal short-term memory capacity varies across individuals, with some people able to hold more information in their working memory than others (Chiang & Atkinson, 1976). Visual short-term memory, on the other hand, involves the temporary storage and manipulation of visual information. This can include things like remembering the location of objects in a scene or recalling the details of a visual image.

Studies have found that verbal and visual short-term memory are closely related but can also function independently, indicating that they may rely on separate cognitive processes (Baddeley & Hitch, 1974). Furthermore, research has shown that both verbal and visual short-term memory are crucial for various everyday tasks. For example, verbal short-term memory is essential for language comprehension and production. Additionally, visual short-term memory is important for tasks such as navigation, object recognition, and visual problem-solving.

The literature on verbal short-term memory suggests that it is supported by a phonological component, which involves the retention and manipulation of verbal material. This component is often associated with the phonological loop model proposed by Baddeley and Hitch, which suggests that verbal information is temporarily stored in a phonological loop, where it is rehearsed and maintained through subvocalized speech. In contrast, the literature on visual short-term memory proposes

different mechanisms and models. One prominent model is the visual-spatial sketchpad, which suggests that visual information is temporarily stored and manipulated in a visuospatial buffer. This buffer allows individuals to mentally represent and manipulate visual images and spatial information. These models of verbal and visual short-term memory provide valuable insights into the underlying processes involved in the temporary storage and manipulation of different types of information. In summary, both verbal and visual short-term memory are crucial for various cognitive tasks.

2.1.2 Theory Related: Multi-Store Memory Model

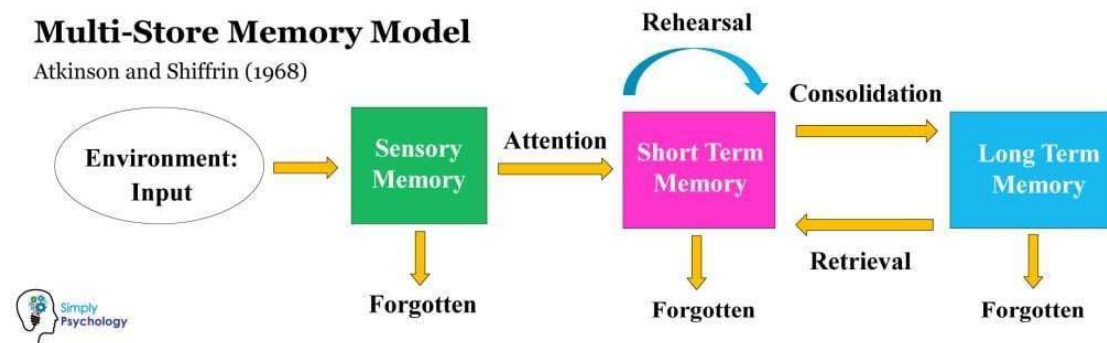


Figure 2: Multi-Store Memory Model (McLeod, 2023)

The Multi-Store Memory Model is a theoretical framework that explains human memory. It divides memory into three components: the sensory register, the short-term store, and the long-term store. Information enters the sensory register through the five senses, then is processed in the short-term store before being stored in the long-term store. The information in the long-term store is relatively permanent (Mulyono et al., 2023). This model also shows the process by which a short-term memory is formed. The formation of a short-term memory involves the encoding of information from the sensory register, which is then transferred to the short-term store for temporary storage

and processing (Hong et al., 2015). This model suggests that through rehearsal and consolidation, information can be transferred from the short-term store to the long-term store, where it can be stored for an extended period of time. This multi-store memory model, which describes how short-term memory is produced, is directly connected to the subject of the research. The experimenter provides the verbal and visual sensory stimuli that will be displayed during the study. The memory will be placed in short-term storage through the participant's attention; it will be retrieved when the participant writes the memory back for the verbal short-term memory test and numbers it down for the visual short-term memory test.

2.2 Previous Findings on the Effect of Time of the Day and Short-Term Memory

The concept of time of day refers to the specific period during which an activity or event takes place. It can be divided into different segments such as morning, afternoon, and evening. The effect of time of day on short-term memory performance has been a topic of interest in research studies (Marx et al., 2017). These studies have shown that short-term memory performance tends to be better in the morning and declines as the day progresses (McKinney & Coyle, 2004). This decline in performance could be attributed to various factors, such as fatigue, decreased alertness, or a build-up of cognitive load throughout the day (Marx et al., 2017).

Several studies have investigated the effect of time of day on short-term memory performance, and the results have been mixed. Some studies have reported that short-term memory performance is better in the morning, while others have found no significant differences between different times of the day. A study examined the influence of time of day on short-term memory performance using a digit-span task

(Baddeley et al., 1970). Participants were asked to listen to a sequence of digits and recall them in the same order. The researchers found that individuals performed better in the morning compared to the afternoon, suggesting that short-term memory performance may be influenced by circadian rhythms. This pattern of improved short-term memory performance in the morning may be attributed to factors such as increased alertness and cognitive functioning after a period of restful sleep, as well as lower levels of fatigue and distraction compared to later in the day.

Another study examined the effect of time of day on short-term memory performance in a visual recognition task. Participants were shown a series of images and were later asked to identify if they had seen the image before or if it was new. The researchers found that short-term memory performance was better in the afternoon compared to the morning, indicating that there may be individual differences in the effect of time of day on short-term memory performance (Ceglarek et al., 2021). Additionally, it has been suggested that the time of day can also influence memory consolidation (Folkard, 1979).

All in all, studies regularly demonstrate that short-term memory function can change throughout the day. In a visual short-term memory exercise, Ceglarek (2021) discovered that evening types performed better, putting in more effort in the evening and having slower reaction times in the morning. According to Folkard (1979), people could rely more on elaborative processing in the evening and more on maintenance processing in the morning, which might have an effect on short-term memory function. Additionally, Millar (1980) observed that retrieval from long-term memory performed better in the evening, possibly as a result of increased physiological arousal. Nonetheless, Baddeley (1970) discovered that mornings were superior for quick recall

of digit sequences, pointing to a complicated link between short-term memory function and the time of day. These findings suggest that the relationship between time of day and short-term memory performance is complex and can vary depending on the nature of the task.

2.2.1 Previous Findings on Other Factors effecting Short-Term Memory That Relates to Time of the Day

Chronotype

Several factors have been identified that can influence the relationship between time of day and memory performance. One of the factors is individual differences in chronotype. Individuals have different internal biological clocks, known as chronotypes, which determine their natural preference for sleep and wakefulness during different times of the day. This can be categorized as morning, evening, or intermediate chronotypes (Kivelä et al., 2018). Research has shown that morning chronotypes, who prefer to wake up early and find it difficult to stay awake past their usual bedtime, tend to have better memory performance in the morning compared to evening chronotypes (Schmidt et al., 2015).

Age

Additionally, age has also been found to play a role in the relationship between time of day and memory performance. Adolescents, who are known to have a later chronotype and often struggle with early school start times, may experience a mismatch between their internal biological clocks and the timing of school activities (Goldstein et al., 2007). As a result, their memory performance may be negatively affected in the morning when they are expected to learn and recall information (Goldstein et al., 2007).

These factors highlight the importance of considering individual differences and developmental factors when studying the effect of time of day on short-term memory performance.

Stress And Arousal Level

Stress and arousal levels represent another set of potential factors that effects short-term memory performance (Schönfeld et al., 2014). Both acute and chronic stress have been linked to impairments in cognitive function, including memory processes. Furthermore, arousal levels fluctuate throughout the day, peaking at certain times and declining at others. These fluctuations can impact cognitive performance, potentially confounding the relationship between time of day and short-term memory.

Fatigue

Fatigue can have a significant impact on memory performance throughout the day. As individuals experience mental and physical fatigue, their cognitive functions, including memory, may be affected. Research has shown that fatigue can impair cognitive functioning and memory processes, leading to decreased short-term memory performance. The relationship between fatigue and memory performance is complex and multifaceted. When individuals experience higher levels of fatigue later in the day, their alertness and cognitive functioning may decrease, contributing to a decline in short-term memory performance. Furthermore, the accumulation of cognitive load from various tasks and activities throughout the day can hinder an individual's ability to maintain and recall information in short-term memory, further impacting memory performance (Borragán et al., 2016).

2.2.2 Theory Related: Circadian Rhythm Theory

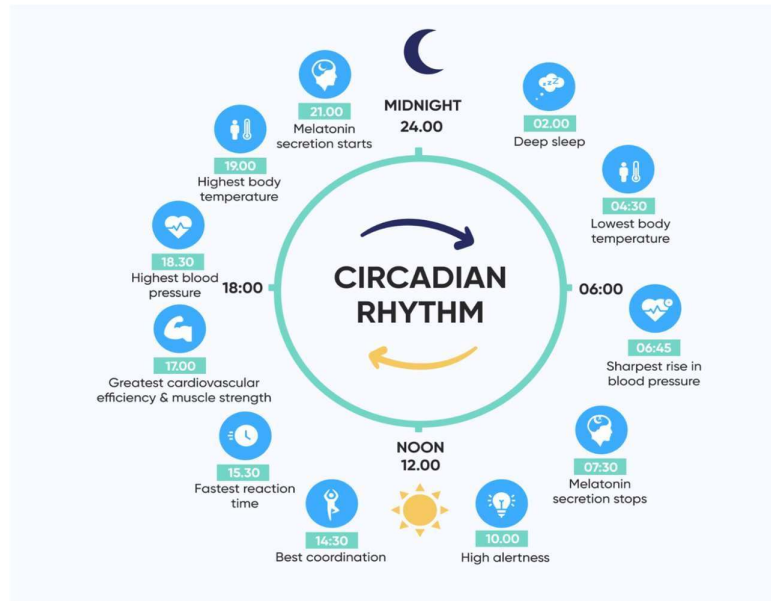


Figure 3: Circadian Rhythm (Waters, 2021)

The circadian rhythm theory suggests that our biological processes and behaviors are regulated by an internal clock that operates on a roughly 24-hour cycle. This internal clock, known as the circadian rhythm, influences various physiological functions, such as sleep-wake cycles, hormone production, body temperature regulation, and metabolism. One area of research that has been particularly interested in the effect of circadian rhythm is short-term memory performance. Research has shown that short-term memory performance can be influenced by the time of day and how it aligns with an individual's circadian rhythm (Mou, 2016). For example, several studies have found that memory performance tends to be better during individuals' peak circadian times, which is usually in the late morning or early afternoon. These findings suggest that there is a relationship between circadian rhythm and short-term memory performance.

This relationship can be attributed to several factors. First, during our peak circadian times, our cognitive abilities tend to be at their highest. Our alertness, attention, and focus are typically at their peak during these times, which can positively impact our memory performance. Additionally, our body temperature tends to be higher during our peak circadian times, which has been linked to enhanced cognitive function and memory consolidation (Johnson et al., 1992). Another factor that may contribute to the relationship between circadian rhythm and short-term memory performance is the release of certain hormones, such as cortisol and melatonin. These hormones play a role in regulating our sleep-wake cycles and can also affect our cognitive function and memory. Furthermore, research has shown that disruptions to the circadian rhythm, such as jet lag or shift work, can negatively impact short-term memory performance (Valdez et al., 2012). Overall, the effect of the time of day on short-term memory performance is influenced by an individual's circadian rhythm.

2.3 Summary

In chapter 2, I have highlighted the key findings of previous studies, theory related to the main variables and their definitions. This chapter will be able to give a basic understanding of the research topic.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This quantitative study investigates the effect of time of the day (morning and evening) on short – term memory performance. It measures both verbal and visual short – term memory performance of the FCSHD undergraduate students. Chapter 3 outlines the research design, population and sample, instruments, procedure, pilot study and data analysis of the study.

3.1 Research Design

The researcher uses an experimental approach for this study. The experimental method ensures objectivity in quantitative research by providing a higher degree of control in the experiment and producing a higher degree of validity. This allows researchers to systematically collect and analyze quantitative data using mathematical models, which helps to eliminate bias and subjective interpretations (Williams, 2007). Thus, a quantitative methodology will be employed in this study. With this approach, the researcher might be able to collect data in a more accurate manner on the words and images that could be recalled in both the morning and evening. Additionally, this study uses convenient sampling and research is carried out in FCSHD, UNIMAS, in order to get the necessary data since it is easier to conduct them in person with all of the students physically present. The researcher will design specific tasks and surveys to gather quantitative data, such as word recall tests and image recognition tasks. By conducting the study in person at FCSHD, UNIMAS, the researcher can ensure a controlled environment and minimize external factors that could affect the results. Moreover,

direct interaction with the students will allow for better monitoring and clarification of any doubts or questions they may have during the study.

In this study, the researcher utilized the within-group design as it is preferable to select a within-group design in studies examining how the morning and evening hours affect short-term memory since it gives each participant more control. This design reduces variability among the groups, which helps to minimize individual differences and boost the study's statistical power. Results are more accurate and dependable since individuals are exposed to both morning and evening circumstances, which controls for any potential confounding variables relating to individual variations (Anthony G, 1976). Furthermore, because within-group designs use fewer participants, they are more effective for researching the precise impact of daytime on short-term memory.

3.2 Participants of the Study

The sample for this research involves 20 UNIMAS undergraduate students enrolled in the Faculty of Cognitive Sciences and Human Development (FCSHD). Convenient sampling is utilized based on the premise that only students who are willing to participate and don't have any cognitive disabilities are chosen for the study. The participants are expected to complete a series of tasks that test their verbal and visual short-term memory.

3.3 Instruments

The research employs a cognitive instrument tailored for the evaluation of short-term memory performance. Verbal memory tasks are facilitated through the utilization of linguistic stimuli, while visual memory tasks incorporate pictorial stimuli. The selection

of cognitive tasks is meticulous, with a deliberate focus on distinct facets of short-term memory, encompassing both verbal and visual domains.

3.3.1 Instrument Structure

I. Verbal Short – Term Memory Assessment

The method employed to evaluate participants' short-term memory performance involves the utilization of the word-list recall paradigm (Baddeley et al., 1975). Within this evaluative framework, individuals are presented with a list of words and subsequently tasked with recalling as many words as possible immediately following the presentation. As posited by Baddeley et al. (1975), the act of recalling provided words is intricately linked to short-term memory performance, given the influential role played by the capacity of the articulatory rehearsal loop—an integral component of the working memory system—in determining memory span.

II. Visual Short – Term Memory Assessment

Shape Memory Tasks (Vlach, 2016) (adapted & modified) are used to test participants visual short-term memory. "The shape memory task specifically tests a participant's visual short-term memory by presenting them with a memory display containing shapes, followed by a retention interval, and then a full-probe display. The participant's task is to number the shapes in display according to the sequence that was shown to them. This task assesses the participant's ability to retain and recall the shapes they saw in the memory display, which is a measure of their visual short-term memory capacity for shapes." (Logie et al., 2010) (Olson & Jiang, 2004).

3.4 Procedures

3.4.1 Recruitment Procedure

- I. Using Google Forms, participants were recruited and made aware of the purpose of the study.
- II. Google Forms included informed consent forms, where participants were asked to sign to confirm their willingness to participate.
- III. The experiment's goal, general methods, and procedures were explained to the participants.

3.4.2 Verbal Memory Test Procedure

- I. Full instructions were provided for the experiment.
- II. Ten words was shown one after the other in the laptop screen.
- III. The participant was instructed to focus on the screen and closely examine the words shown (3 seconds were allotted to each word).
- IV. The researcher gave participant paper and pens after the word presentation.
- V. The participant was asked to record as many terms from the list as they could recall in writing.
- VI. Participant was given 1 minute to recall and write back the words.
- VII. After finishing the recall task, participants raised their hands to indicate they were done.
- VIII. This task was done 4 times to collect the average result. The result is counted through the accurate number of words recalled.
- IX. The experimenter gathered participant's written answers.

- X. Following data collection, participants received a briefing about the experiment's aim and had the chance to ask questions.

3.4.3 Visual Memory Task Procedure

- I. The test began by explaining the purpose of the task and providing clear instructions to the participant.
- II. Participants were shown a series of different shapes, such as squares, circles, triangles, and stars, for a brief period (3 seconds for each shape).
- III. After the initial presentation, the participants were given laminated paper containing different shapes.
- IV. The participants were asked to recall and number the shapes that they saw, participants are instructed to recall as many shapes as they can remember in the order they were presented.
- V. Participant's responses were recorded accurately, noting both correct and incorrect recalls.
- VI. This test started from level 3 (recall 3 shapes) until level 10 (recall 10 shapes).
- VII. The [participant's score was based on the level that they could reach.'
- VIII. Following data collection, participants received a briefing about the experiment's aim and had the chance to ask questions.
- IX. The debriefing included any questions or misunderstandings about the experiment.

3.5 Pilot Study

A pilot study is important for research because it allows researchers to assess the feasibility of their study and identify any logistical issues before conducting the main study. It can also be used to refine research instruments, collect preliminary data, and develop the research plan. Conducting a pilot study increases the likelihood of success for the main study and helps to avoid potential problems (Thabane et al., 2010). However, it is important to note that a pilot study is not meant for hypothesis testing, but rather for assessing feasibility and refining the approach for the main study.

Hence, to conduct a preliminary study, the researcher selected a group of 3 participants for the study, as the intended total number for the main research is 20. All 3 participants followed the exact methodology outlined in the research plan. The pilot study's goal is to identify any potential challenges or issues in the methodology and make necessary adjustments before carrying out the full-scale research. By closely observing the participants' experiences and gathering feedback, the researcher gained valuable insights to refine the methodology used for the research.

Once the data is collected, it was analyzed to assess participants' ability to complete both verbal and visual short-term memory tests. The results were also interpreted in light of participants' feedback to determine if the research objectives were met. Consequently, the researcher identified areas that required improvements and made necessary changes.

3.6 Data Analysis Procedures

The process of data analysis in research is integral to the investigative endeavor, involving a systematic and rigorous examination of data to unveil discernible patterns,

relationships, and insights. This multifaceted undertaking employs a spectrum of methodologies and techniques, encompassing considerations such as autocorrelation, mean and mean squares, probability density, and assessments of nonstationary. As elucidated by Bendat and Piersol (2010), data analysis serves as a pivotal tool, empowering researchers to draw substantiated conclusions, formulate predictions, and rigorously evaluate hypotheses based on the comprehensive scrutiny of the collected data. This analytical process constitutes a fundamental aspect of the research methodology, providing a nuanced understanding of the empirical landscape under investigation.

Statistics from the Statistical Package for the Social Sciences (SPSS) were utilized in this research. Software called SPSS is frequently used in social science research for statistical analysis. It offers a variety of instruments and methods for proficient data analysis and interpretation for researchers. Researchers may create descriptive statistics, run many statistical tests, and illustrate data using graphs and charts by using SPSS. The study's use of SPSS guarantees reliable and precise information analysis, which enhances the overall validity and reliability of the study's conclusions.

3.6.1 Descriptive Data Analysis

The process of summarizing and characterizing the gathered data using statistical measures like mean, median, mode, and standard deviation is known as descriptive data analysis in quantitative research psychology. According to Hanson et al. (2005), it entails arranging and displaying the data so as to provide a clear comprehension of the traits and patterns contained in the data set. Descriptive data analysis allows researchers to identify trends, patterns, and relationships within the data, which can then be used to

draw meaningful conclusions. Additionally, it helps in detecting outliers or unusual observations that may require further investigation.

In this study, the demography will be recorded through a Google Form, analyzed, and exhibited under descriptive data analysis. The findings from the analysis will provide valuable insights into the demographic characteristics of the study population. The average score for both the verbal and visual test was analysed in this section.

3.6.2 Inferential Data Analysis

Inferential data analysis refers to the process of making inferences or drawing conclusions about a population based on sample data. It involves using statistical techniques to analyze the sample data and make generalizations or predictions about the larger population from which the sample was drawn (Simpson, 2015).

Since this research analyzes the effect of time of day (morning and evening) on both verbal and visual short-term memory, the researcher uses Paired sample T-test. This statistical technique allows the researcher to find the difference in morning and evening in both verbal and short-term memory separately.

3.7 Summary

The general method of research is presented in Chapter 3. I stated about the quantitative research that examined how short-term memory (verbal and visual) performance was affected by the time of day, namely the morning and evening. The tests utilized in the study include the verbal and visual short-term memory assessments. The researcher can view the results as a consequence of the chosen SPSS approach.

CHAPTER 4

FINDINGS

4.0 Introduction

This chapter includes demographic information of the participants and findings from the experiment done for this study. To identify the effect of time of the day on Short – Term memory performance, Paired Sample T-Test has been performed using Statistical Package for the Social Sciences (SPSS).

4.1 Demographic Information

Gender	N	Percentage
Female	16	80.0%
Male	4	20.0%

Table 1 Gender

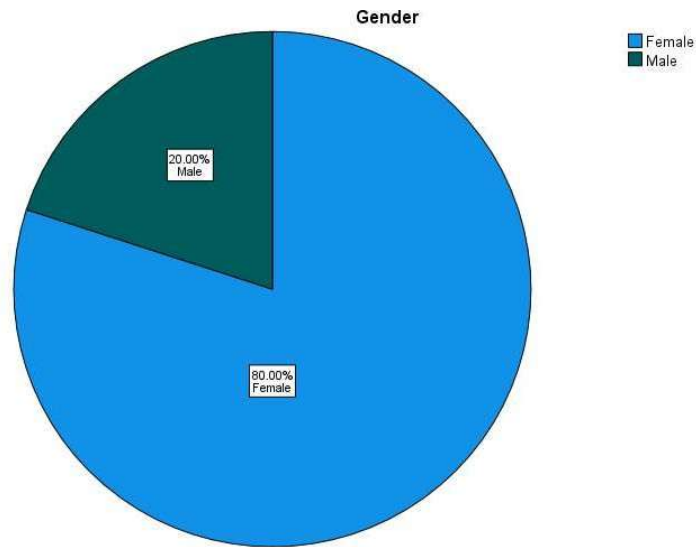


Figure 4: Gender pie chart

The demographic table provides an overview of the gender distribution among the 20 participants in the study on the effect of time of day on short-term memory performance. Out of the total participants, 16 are female, representing 80.0% of the sample, and 4 are male, making up the remaining 20.0%. This indicates a significant majority of female participants in the study.

Age

Age (Years Old)	N	Percentage
24 and above	1	5.0%
20	1	5.0%
21	2	10.0%
22	5	25.0%
23	11	55.0%

Table 2: Age

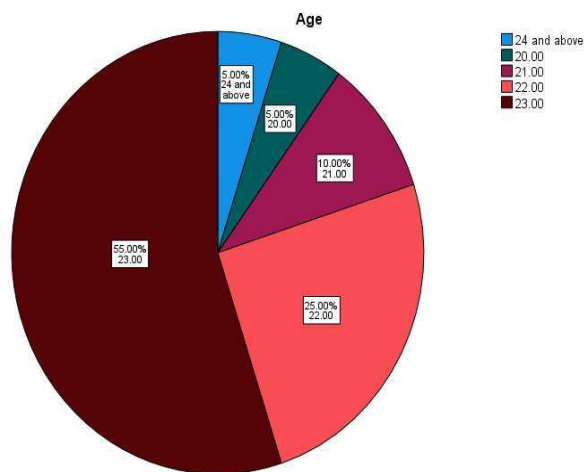


Figure 5: Age pie chart

The age demographic table outlines the distribution of ages among the 20 participants in the study examining the effect of time of day on short-term memory performance. The participants' ages are predominantly clustered in their early twenties. Specifically,

11 participants, accounting for 55.0% of the sample, are 23 years old. Five participants, or 25.0%, are 22 years old. Two participants, representing 10.0%, are 21 years old. The remaining participants are more diverse in age, with one participant each at 24 years old (5.0%) and 20 years old (5.0%). This age distribution indicates that the majority of the study's participants are between 22 and 23 years old, providing a relatively narrow age range that may influence the generalizability of the findings to broader age groups.

Programme

Programme	N	Percentage
Psychology	11	55.0%
Cognitive Science	7	35.0%
Human Resource Development	2	10.0%

Table 3: Programme

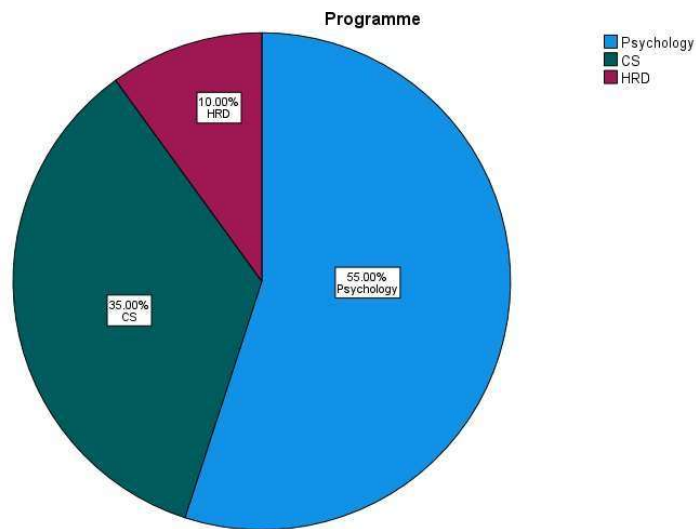


Figure 6: Programme pie chart

The programme demographic table provides an overview of the academic disciplines of the 20 participants involved in the study on the effect of time of day on short-term memory performance. The majority of participants, 11 students, are enrolled in the Psychology programme, constituting 55.0% of the sample. Seven participants,

representing 35.0%, are from the Cognitive Science (CS) programme. The remaining two participants, making up 10.0% of the sample, are enrolled in the Human Resource Development (HRD) programme. This distribution indicates that over half of the participants are studying psychology, which may be relevant given that their academic background could influence their performance on memory tasks. The presence of students from diverse academic programmes adds some variability to the sample, which can be beneficial for the robustness of the study's findings.

Year of Study

Year of Study	N	Percentage
1 st Year	2	10.0%
2 nd Year	1	5.0%
3 rd Year	17	85.0%

Table 4: Year of Study

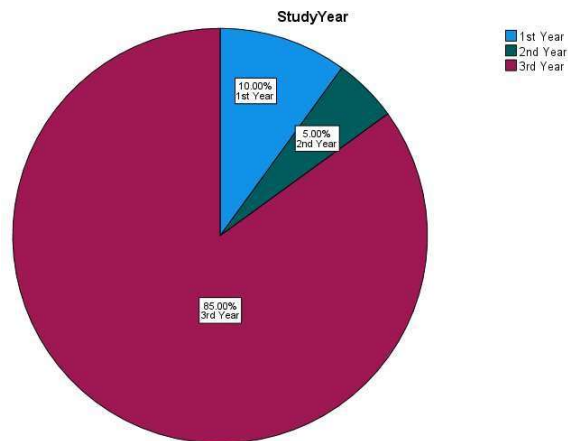


Figure 7: Year of Study pie chart

Table 4 and figure 7 indicates the number of participants and their corresponding year of study. The total number of participants is 20, with 2 participants being in their first year of study, which accounts for 10% of the total number of participants. 1 participant is in their second year of study, which accounts for 5% of the total number of participants. 17 participants are in their third year of study, which accounts for 85% of the total number of participants.

4.2 Effect of Time of The Day (Morning and Evening) On Verbal Short-Term Memory

	Mean	Std. Deviation	Std. Error Mean
Verbal Morning	8.3125	0.82667	0.18485
Verbal Evening	7.8875	1.26302	0.28242

Table 5: Mean score of Verbal Short – Term Memory Performance

	Mean	Std.Deviation	Std.Error Mean	95% Confidence Interval		t	df	Sig. (2- tailed)
				Lower	Upper			
Verbal Test(M&E)	0.42500	0.99704	0.22294	-.04163	.89163	1.906	19	0.72

Table 6: Paired sample T-test of Verbal Short – Term Memory Performance

The tables above present the results of paired sample t-tests that compare the verbal short-term memory performance of 20 students tested in the morning and evening.

Table 6 shows the mean difference between the morning and evening scores is 0.425, with a standard deviation of 0.99704 and a standard error of 0.22994. The 95% confidence interval for the mean difference ranges from -0.04163 to 0.89163. The calculated t-value is 1.906 with 19 degrees of freedom, resulting in a p-value of 0.072. When the mean score of both morning and evening compared as shown in Table 5 it suggests that, on average, students performed slightly better in the morning compared to the evening for verbal memory, but this difference is not statistically significant at the 0.05 level.

4.3 Effect of Time of The Day (Morning and Evening) On Visual Short-Term Memory

	Mean	Std. Deviation	Std. Error Mean
Visual Morning	4.95	1.820	0.407
Visual Evening	4.80	1.576	0.352

Table 7: Mean score of Visual Short – Term Memory Performance

	Mean	Std.Deviation	Std.Error Mean	95% Confidence Interval		t	df	Sig. (2 - tailed)
				Lower	Upper			
Visual Test(M&E)	0.150	2.033	0.455	-0.802	1.102	0.330	19	0.745

Table 8: Paired sample T-test of Visual Short – Term Memory Performance

The tables above present the results of paired sample t-tests that compare the visual short-term memory performance of 20 students tested in the morning and evening. Table 8 shows that the mean difference between the morning and evening scores is 0.150, with a standard deviation of 2.033 and a standard error of 0.455. The 95% confidence interval for the mean difference ranges from -0.802 to 1.102. The t-value is

0.330 with 19 degrees of freedom, and the corresponding p-value is 0.745. This indicates a very small improvement in visual memory scores in the morning compared to the evening, but this difference is also not statistically significant. But a slight difference in the average score is still visible as shown in table 7.

In summary, the results show slight differences in both verbal and visual short-term memory performance between morning and evening sessions, with a marginally better performance in the morning. However, neither of these differences is statistically significant, indicating that the time of day does not have a meaningful impact on the short-term memory performance of the students in this sample.

Chapter 5

DISCUSSIONS

5.1 Discussion

The aim of this research was to investigate whether Time of the day have and effect on Verbal and Visual Short – Term memory performance as the relationship between time of day and memory processes is a topic of research and debate for a long time. The results of my study examining the effect of time of day on visual and verbal short-term memory (STM) performance in 20 students from Faculty of Cognitive Sciences and Human Development (FCSHD) did not show statistically significant differences between morning and evening performance, despite a slight trend towards better STM in the morning.

The findings of this research contrast with previous research that has reported significant time-of-day effects on STM. For example, a study by Barner et al. (2019) found better prospective memory performance in the evening compared to the morning in young adults, regardless of their chronotype. Similarly, the study by Ceglarek et al. (2021) reported that evening types outperformed morning types on visual STM tasks, with time-of-day effects observed on both objective and subjective measures.

The lack of statistically significant results in this study may be due to factors such as the sample size. The sample size of 20 students may have been underpowered to detect the relatively small differences in STM performance between morning and evening. Because through the mean score of both morning and evening STM performance it evident that memory performance in morning is better. Thus, it can be said that larger sample sizes are required to reliably identify time-of-day effects, which can be subtle.

Additionally, individual differences in circadian rhythms and chronotype may have influenced the results as well, but this study did not assess or control for these factors.

Although the results of this study weren't able to replicate past studies, through the completion of this study it was identified past studies and recent studies have shown a clear distinction in the memory performance as previous research done by Baddeley et al., (1970) shows that participants had better memory in the morning however recent research shows time-of-day effects on STM, with evening types outperforming morning types in both objective and subjective measures, as seen in Barner et al.'s (2019) study and Ceglarek et al.'s (2021) study. The inconsistencies in the literature highlight the need for further research with larger sample sizes and more robust methodologies to better understand the relationship between time of day and STM performance.

Despite the non-significant findings, this study contributes to the growing body of research on the influence of time of day on cognitive performance. The slight trend towards better STM in the morning observed in the data is worth further investigation, as it may suggest that certain individuals or tasks are more sensitive to circadian rhythms than others.

5.2 Limitation and Recommendations

One of the main limitations of the study is the small and uneven sample size. The output of the research suggests that the majority of the participants are in their third year of study, which could affect the generalizability of the results. It is important to consider whether the sample is representative of the population of interest. If the sample is not representative, the results may not be applicable to the entire population. Furthermore,

the small number of participants in the first and second year of study could limit the statistical power of the study. To address this limitations of the current research, future studies could aim to recruit a more representative sample of participants, with a more balanced distribution of participants across different years of study. Additionally, increasing the sample size would improve the statistical power of the study and enable the detection of smaller but meaningful differences in short term memory performance between the morning and evening time of day.

Furthermore, the representativeness of the sample size is also a limitation of the study. Since the participants are all from the same age group, the result of this study is not able apply its finding on other people with different age group. As a recommendation future research should definitely recruit participants from a more diverse age group as the could be a potential discovery where people from different generation perform better at different time of the as the way of living between these generations are becoming more and more different.

Besides that, the lack of chronotype assessment and control for individual differences in circadian rhythms, may also be seen as a limitation as different people have different chronotype and circadian rhythm and this might also affect their STM performance. Thus, it is advisable for future research to assess the chronotype of the participants, divide them based on their chronotype and carry out the research to see if the chronotype play a role in the STM performance.

Last but not least, the potential confounding variables is another limitation of the study. As study was carried out in a short amount of time with limited resources, the confounding variable of the study was not properly addressed. It would be beneficial to control for potential confounding variables, such as sleep patterns, caffeine intake, and

time of last meal, which could affect short term memory performance. Controlling for these variables would help to isolate the effect of time of day on short term memory performance. By addressing these limitations and expanding the research in this area, future research can contribute to a better understanding of the complex relationship between time of day and short-term memory performance.

5.3 Conclusion

To conclude, the study aiming to identify the effect of time of the day on both verbal and visual short – term memory performance resulted in no significant difference. The result may have been affected by the small sample size used in conducting the research. It is without a doubt that this study can provide a significant understanding on whether the time of the day effects the short – term memory performance or not. However, there many limitations present in this study that could hardly be avoided by the researcher due to the limited amount of time and resources. If the future researchers planned to undertake research similar to this then following the recommendations provided in this research would give them a more statistically significant result.

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