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The Influence of Music on Working Memory Performance

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THE INFLUENCE OF MUSIC ON WORKING MEMORY PERFORMANCE

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ABSTRACT

This study aimed to investigate the influence of music on working memory performances based on total correct recalled. Several past research have shown that different types of music have different influence on verbal and visual working memory. 45 participants from the undergraduates' students of Universiti Malaysia Sarawak (UNIMAS) have participated in the study and performed Reading Span Task and Matrix Span Task to assess verbal and visual working memory performance. One-way ANOVA and Kruskal-Wallis H Test were used to test the hypothesis. The result of this study showed that there is a significant difference between the music groups in verbal working memory performance based on total correct recalled while there is no significant difference between the music groups in visual working memory performance based on total correct recalled. Several limitations were found in this study. The main implication of this study is that vocal music might have its potential utility in tasks involving verbal working memory.

Keywords: verbal working memory performance, visual working memory performance, vocal music, instrumental music

ABSTRAK

Kajian ini bertujuan untuk mengkaji pengaruh muzik terhadap prestasi ingatan kerja berdasarkan jumlah ingatan yang betul. Beberapa kajian lepas telah menunjukkan bahawa jenis muzik mempunyai pengaruh yang berbeza terhadap ingatan kerja lisan dan visual. Seramai 45 pelajar prasiswazah Universiti Malaysia Sarawak (UNIMAS) telah mengambil bahagian dalam kajian ini dan melaksanakan *Reading Span Task* dan *Matrix Span Task* untuk menilai prestasi ingatan kerja lisan dan visual. *One-way ANOVA* dan *Kruskal-Wallis H Test* telah digunakan untuk menguji hipotesis. Hasil kajian ini menunjukkan bahawa terdapat perbezaan yang signifikan antara kumpulan muzik dalam prestasi ingatan kerja lisan berdasarkan jumlah ingatan yang betul manakala tiada perbezaan yang signifikan antara kumpulan muzik dalam prestasi ingatan kerja visual berdasarkan jumlah ingatan yang betul. Beberapa keterbatasan telah dikenal pasti dalam kajian ini. Implikasi utama kajian ini ialah muzik vokal mungkin mempunyai potensi kegunaan dalam tugas-tugas yang melibatkan ingatan kerja verbal.

Kata kunci: ingatan kerja lisan, ingatan kerja visual, muzik vokal, muzik instrumental

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter discussed the details of this research which includes the background of study, problem statement, research objectives, research questions, research hypotheses, conceptual framework, significance of study and definitions of terms.

1.1 Background of Study

Baddeley (2001) defined that working memory is a complicated cognitive process that combines data from several subsystems to enable people to carry out a variety of complicated cognitive activities. It enables a person to store a limited quantity of information in their short-term memory for instantaneous mental application. Working memory is fundamental for cognitive abilities such as problem solving and learning and is frequently used in daily life. Combining multiple concepts in mind and holding a number in mind are examples of working memory. The subtype of working memory includes verbal working memory and visual working memory. According to van Ede et al. (2019), visual working memory accesses both sensory attributes and motor responses concurrently, enabling quick and accurate memory-guided behaviour, while Schwering and MacDonald (2020) state that with comprehension processes handling encoding and production processes handling serial order and recall, verbal working memory is an emerging model supported by a rich, dispersed long-term memory for language.

Several research has demonstrated the exposure of working memory to different factors such as age-related effects (Rhodes & Katz, 2017), sleep deprivation (Santisteban et al., 2019), and motivation (Krawczyk & D'Esposito, 2011), including environmental stimuli like music.

Some research has proven that music has effect on working memory performance such as research by Zanto et al. (2022) and Derks-Dijkman et al. (2022). According to Zanto et al. (2022), training in music can improve one's working memory for facial cues. Meanwhile, Derks-Dijkman et al. (2022) found out that pitch and melodic cues have a negative impact on older people's working memory performance. Through these research we can say that music have different impact towards working memory performances.

Music is commonly believed to be universal to humans, having evolved as an evolutionary adaptation unique to the sound of music or as a byproduct of adaptations related to impact, language, motor control, and auditory perception (Mehr et al., 2019). It helps to improve memory, mental illness treatment, have effects on mood, boost exercise performance and more (Stanborough, 2020). According to Gómez Gallego and Gómez García (2017), music therapy was used to improve some psychological, cognitive, and behavioural alternations in Alzheimer's Disease patients.

Research examining the connection between music and cognition has revealed that music affects a few cognitive processes, such as information processing, memory, and attention. Nevertheless, research and discussion on the specific mechanisms that underlies music's influence on working memory performance are continuing. In research done by Ferreri and Verga (2016), One way to think about music as a stimulus is as something that can affect both external and interior elements. External aspects include the content to be learnt, the encoding setting, or the experimental instructions. Internal elements include motivation, techniques, or past knowledge. In memory studies, music has frequently been used as a cognitive stimulation to improve learning and memory or to change mood. According to Lange (2002), melody and rhythm are not processed independently in musical working memory; rather, both verbal-auditory and visuospatial subsystems are used.

Therefore, the main purpose of this study is to identify how will music influence working memory performance verbally and visually. The researcher also wants to investigate different effect of different elements of music towards correct recall of working memory.

1.2 Problem Statement

The exact impact of music on working memory performance is still poorly understood, especially on the interaction between musical aspects and cognitive functioning. Although certain research has shown that music can have a beneficial impact on working memory performances (Johndro et al., 2019), especially among the musicians (Pallesen et al., 2010), other studies have expressed concerns over the possible distractions and cognitive strain that music may impose during complex cognitive tasks (Lehmann & Seufert, 2017; Küssner, 2017). Some researchers suggest that no significant influence on working memory performance with different background music (Singh et al., 2019). Therefore, the researcher wants to thoroughly study the impact of music towards working memory performance in this study.

Besides that, many of the research that are now available may concentrate on specific elements, such as the effect of music genre or tempo on working memory performances. According to Schweppe and Knigge (2020), music tempo changes have an extra negative impact on working memory performance. Recall was significantly worse under irrelevant sound settings than it was under silent control. However, other elements of music were less discussed such as comparison of vocal music and instrumental music. Therefore, a comprehensive theoretical framework that incorporates these elements and offers a more comprehensive understanding is necessary.

Lastly, different experimental designs and procedures may be used in different studies during research. In research done by Anwar et al. (2019), the researchers used observational method to understand the average response time for tactile and visual cues among different gender. Meanwhile, in research done by Lehmann and Seufert (2017), the researchers did experiment and collect data based on paper-and-pen results from the participants. In this study, the researcher will conduct experiments using two online tests: Reading Span Task (Loboda, 2012) as verbal memory test, and Matrix Span Task (Stone & Towse, 2015) as visual memory test to collect data.

1.3 Research Objectives

1.3.1 General Objective

- To investigate the influence of music on working memory performances.

1.3.2 Specific Objectives

- To investigate the difference between music groups (vocal music, instrumental music, no music) on verbal working memory performance based on total correct recall.
- To investigate the difference between music groups (vocal music, instrumental music, no music) on visual working memory performance based on total correct recall.

1.4 Research Questions

1. Is there any significant difference between music groups (vocal music, instrumental music, no music) on verbal working memory performance based on total correct recall?

2. Is there any significant difference between music groups (vocal music, instrumental music, no music) on visual working memory performance based on total correct recall?

1.5 Research Hypotheses

H1: There is significant difference between music groups (vocal music, instrumental music, no music) on verbal working memory performance based on total correct recall.

H2: There is significant difference between music groups (vocal music, instrumental music, no music) on visual working memory performance based on total correct recall.

1.6 Conceptual Framework

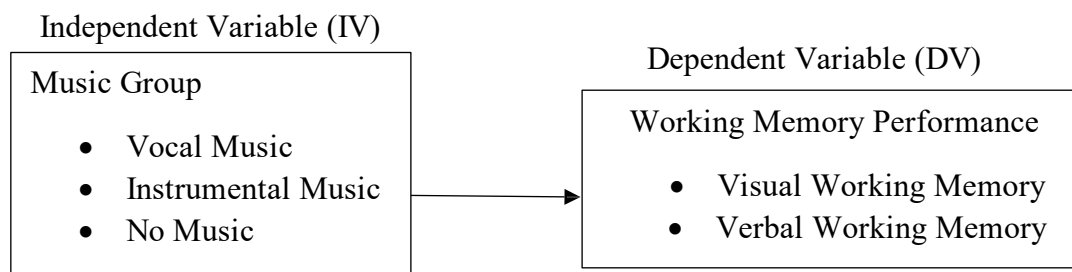


Figure 1.6.1 Conceptual Framework on the Influence Between Music and Working Memory Performance

A thorough analysis of relevant research has been used to construct the conceptual framework shown in Figure 1, which shows the significance of music groups in examining the influence of music on working memory performances. It helps to identify and analyse topics that need more investigation and provides a basic framework for arranging and expanding current research. This framework also provides a theoretical basis for the hypotheses being tested in the study. The independent variable (IV) in this study is music groups, which includes vocal music, instrumental music, and no music. The dependent variable (DV) is working

memory performance, which is measured in terms of verbal and visual working memory performance.

1.7 Significance of Study

This study aims to investigate how music influences working memory performance. The topic's investigation has significant implications on the impact of music to human's cognitive abilities, which can benefit future researchers on this topic. The result of this study may give a different perspective of Malaysian on this topic for future studies. Besides that, this study focuses on elements of music (vocal music and instrumental music) which is less discussed in previous studies to improve our understanding of how different music groups affect working memory performance. This study also helps in resolving the difference between earlier research findings, which indicated that although some studies demonstrated that music negatively affects working memory ability, others provided proof of the opposite effect. Numerous studies have also shown inconsistent results and conclusions. Finally, by investigating working memory performance due to different music groups, this current study's researcher may identify important areas in understanding the influence of music that past researchers may not have been able to find out. This will encourage further researchers to study musical components outside of vocal or instrumental music. It could also inspire more investigation into other factors that could influence the performance of working memory in the future. As a result, this study is important for society, for next researchers, and for the researcher of this study.

1.8 Definition of Terms

There are two important terms discussed in this study, which is “music” and “working memory performance”. The conceptual definition and operational definition of both terms are stated as below:

1.8.1 Music

Conceptual Definition: The artistic expression of sound and rhythm that uses harmonious sounds to describe events, phenomena, and situations in a beautiful framework (Kabataş, 2020).

Operational Definition: The types of music (vocal music, instrumental music, no music) played to the participants while doing the visual and verbal memory test in the experiment.

1.8.2 Working Memory Performance

Conceptual Definition: The execution of cognitive tasks of small amount of information that can be held in mind (Cowan, 2014).

Operational Definition: The total correct recall accessed through Reading Span Task (Loboda, 2012) as verbal memory test, and Matrix Span Task (Stone & Towse, 2015) as visual memory test while listening to the music played, either it is vocal music, instrumental music or no music played.

1.9 Summary

The current research's initial understanding is derived from the prior research on the relationship between working memory performance and music. Additionally, the precise influence of music on working memory performance remains a poorly studied subject, particularly regarding the relationship between musical elements and cognitive functioning, which helps to establish and justify the purpose of the study. The prediction of research

outcomes is shaped by the research's objectives and hypotheses in relation to the research questions. In the meanwhile, the significance of study clarifies how this research might help others and future studies. Last but not least, the operational and conceptual definitions for each term enable a deeper comprehension of the variables under study.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

A summary of earlier studies on the relationship between working memory function and music is given in this chapter. The intention of this chapter is to provide an understanding of the variables of the research. The independent variables are vocal music, instrumental music, and no music condition. Meanwhile, the dependent variables are the visual and verbal working memory performance based on total correct recalled. The review started with a brief introduction of music psychology, music and its classification and characteristics, working memory and theory related to it, followed by past findings related to the research variables.

2.1 Music Psychology

Music psychology, also known as psychology of music, was initially proposed in 1897 by Carl Emil Seashore of the University of Iowa (Yao & Wu, 2023). Therefore, later scholars called him and considered him the most as “the father of music psychology” (Yao & Wu, 2023; Hodges, 2003). The origin of music psychology can be traced back to 6th century B.C. by Pythagoras (Hodges, 2003), later by Helmholtz (1863; as cited in Hodges, 2003) and the others. Following almost a century of growth and advancement, music psychology is currently the primary field of study for music-related degrees in developed countries in Europe and America (Yao & Wu, 2023).

There are several definitions for music psychology. According to Espinosa (1956), music psychology is a branch of psychology that studies how the mind perceives, reacts to, directs, and evaluates musical performance. Zhang (2023) defines it as an analysis of human’s

psychology in music activities that include psychological states, psychological activities, and psychological traits.

Hodges (2003) defines music psychology as a multidisciplinary study including the explorations of anthropology, sociology, biology, physics, philosophy, and psychology of music, and interdisciplinary study of the phenomenon of music which includes psychoacoustics, psychobiology, or social psychology. The field of music psychology has seen unity as a result of the rapid growth of specialised venues for interdisciplinary study in the 1980s and 1990s. These venues connected researchers globally and established a community of practitioners who shared common theories and methodologies (Graziano, 2009).

2.2 Music

Music is nearly unavoidable in human nature and plays a crucial part in our life. It is beneficial and used in various aspects such as tourism (Lashua et al., 2014) and advertising (Dunbar, 1990). In the field of psychology, music has psychological benefits that include regulating mood, interpersonal connections, and self-identity in daily life (Hargreaves & North, 1999).

People listen to music for different purposes such as for relaxation, entertainment, or social interaction. The findings of the study by Schäfer et al. (2013) which measures three distinct dimensions of music listening shows that arousal and mood regulation is the most important dimension followed by self-awareness, and lastly social relatedness is relatively less important than the other two dimensions. The purpose of music listening also varies in different settings. According to Boal-Palheiros and Hargreaves (2001), home listening is

associated with enjoyment, emotional state, and social interactions, whereas school music encourages participation and learning.

2.2.1 Music Classification and Characteristics

Music classification is a way of categorising and organising music based on shared characteristics. These characteristics can include elements such as rhythm, melody, harmony, instrumentation, and cultural context. Music can be classified to several aspects such as western and non-western, tonal, atonal, and modal music, or folk and popular music (Schmidt-Jones, 2017). These classifications include different genre, tempo, instruments, and other characteristics, forming the world of music.

Despite the general effect of music on working memory performance, a variety of music characteristics also influence working memory differently. Numerous research studies have investigated the effects of different musical characteristics on the working memory-related cognitive processes (Maghsoudipour et al., 2017; Wang et al., 2020; Mitta et al., 2019). The types of music may have an impact on individual difference in working memory performance (Borella et al., 2014). These studies have investigated elements including genre, tempo, and emotional content to clarify how they specifically affect working memory performance. For example, some research has examined the possible effects of music tempo, which is commonly measured in beats per minute (BPM), on arousal and cognitive load. Meanwhile, it has been investigated if the emotional content present in different genres might affect mood states, which in turn affects attentional and memory functions. The combined results of these studies provide an improved understanding of the ways in which certain musical characteristics significantly influence working memory performance.

2.3 Working Memory

Memory is a psychological process of encoding, storing and retrieving information. It acts as a storage for our previous experiences, forming our current perspective of the world and directing our future behaviour. Declarative (explicit) memory, working memory, and nondeclarative (implicit) memory are among the several forms of memory that are maintained by different brain systems, with links amongst these systems (Squire & Dede, 2015). The three major classifications of memory defined by the scientific community are sensory memory, short term-memory, and long-term memory (Camina & Güell, 2017). Working memory is a subtype of short-term memory associated with the prefrontal cortex, providing a framework for comprehending the neurological mechanisms of memory (Funahashi & Kubota, 1994).

The three subcomponents that make up working memory are the phonological loop, the visuospatial sketch pad, and the central executive (Baddeley & Hitch, 1974). These subcomponents interact to carry out complex cognitive functions including learning, reasoning, and comprehension of language. Some examples of working memory in daily life are combining multiple concepts in mind, recalling pronunciation of an unfamiliar word, and carrying a conversation. According to Oberauer and Hein (2012), about four informational components may be stored in working memory at once, and one chunk can be chosen at a time. Meanwhile, based on research results, human working memory capacity in a large radial maze is similar to rats', suggesting a capacity close to the magical number 7 ± 2 (Glassman et al., 1994).

2.3.1 Theory Related to Working Memory

The working memory model was proposed by Baddeley and Hitch (1974). It is a very prominent theory of memory that explains how humans temporarily change and store information while doing activities involving thought and reasoning. The model enables us to

understand how memory processes are used in routine, familiar tasks as well as more difficult ones that call for more concentration and new ideas.

There are three components in the model: a central executive, a phonological loop, and a visuospatial sketchpad (Baddeley & Hitch, 1974; Baddeley, 2003). Central executive is the system to control attention, which is the most important component. It takes place to make sure that working memory resources are allocated and used effectively in order to meet the predetermined goals. The phonological loop holds verbal information, and the visuospatial sketchpad holds visual information. Later, the fourth component, episodic buffer, was added into the model, improving the ability of the model for capturing complex aspects of information integration and executive control (Baddeley, 2000).

Neuroimaging studies, such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET), have contributed greatly to our understanding of the brain correlates of working memory. It can effectively observe brain regions engaged in memory functions (Poeppel & Krause, 2008). According to Baddeley (2003), it has been demonstrated by neuropsychology and neuroimaging that the components of working memory are localised. The left temporoparietal region is linked to the phonological loop, whereas the right hemisphere's corresponding regions are linked to visuospatial working memory. The frontal lobes are most likely connected to the central executive.

2.4 Previous Findings

In recent years, there has been an increasing number of research and studies on connections between working memory and music. Sections below further discussed the research and studies on several aspects.

2.4.1 Studies Related to Music and Working Memory Performance

One important area where music has an influence is visual working memory, perceived as an online system that temporarily stores and modifies visual information (Baddeley & Hitch, 1974; Cowan, 2008; Ma, Husain, & Bays, 2014; Vogel, Woodman, & Luck, 2006; as cited in Schurgin, 2018). At the same time, music also crucially influence verbal working memory.

Music can affect one's working memory performance positively or negatively. In the research of Rajendran et al. (2021), Backward Wechsler Digit Span test for digits from 3 to 7 was performed by the participants in two conditions: with-music and no-music. The results measured through behavioural parameters (typing duration and accuracy) and electroencephalography (EEG) shows that the accuracy of correct recall decreases in the presence of music as the size of digit sequences increased. The increasing spectral power of theta band of EEG when music is played also shows that music overloads working memory and hinders task performances. The findings of this study appear to be negative towards the influence of music on working memory.

In contrast to research above, a positive effect of music was shown in the research done by Ken-ichi Tabei et al. (2023). An online version of physical exercise program with music was conducted through online conferencing system, with 114 healthy older adults with mean age of 70.7 years as participants. The participants were divided into treatment group (physical exercise with music group) and control group. N-back task was tested after the program, showing a significant greater improvement in treatment group ($p=0.008$). The finds suggest that online version of physical exercise with music program can improve working memory.

Research of Wang et al. (2013) exhibits that working memory performance of healthy older adults can be improved temporarily by listening to music. The findings showed that

among healthy, older adults, both positive and negative music enhanced auditory verbal working memory ability, proved through the improved performance in Wechsler Digit Span Test (positive music: $t(62) = 2.68$, $p = .01$; negative music: $t(62) = 2.54$, $p = .01$). However, the result on spatial span is not significant.

Music training may show positive effect on different individuals. According to Degé and Kerkovius (2018), older females with a mean age of 77 years old and 3 months who are musically trained on drumming and singing for 15 weeks were able to remember more words from a word list and more symbol sequences correctly than the control groups (literature trained group and untrained group), showing an effect of musical training on verbal and visual memory in elderly.

In a study by Jakobson et al. (2008), musicians demonstrated better visual and verbal working memory performance than non-musicians. The results of Rey Visual Design Learning Test (RVDLT) shows musicians scored significantly higher in delayed free recall ($F(1, 34) = 6.77$, $p < .02$), and delayed recognition ($F(1, 34) = 5.59$, $p < .03$). In California Verbal Learning Test-II (CVLT-II), musicians also perform better in short delay cued recall ($F(1, 34) = 6.30$, $p < .02$), long delay free recall ($F(1, 34) = 8.83$, $p < .005$), and long delay cued recall ($F(1, 34) = 6.20$, $p < .02$), showing significant difference in contrast with non-musicians. Long-term music training improves auditory and visual memory in highly trained musicians and is linked to better verbal and visual memory abilities.

Musically trained people, especially musicians, show significant positive effects in verbal working memory performances. In the research of Franklin et al. (2008), training in music enhances verbal working memory and long-term memory of, which is probably because musicians have better verbal rehearsal mechanisms. Based on the research result by Fennell et

al. (2020), a relationship between stronger verbal working memory capacity and musicianship has been supported by the fact that musicians performed more accurately on the working memory tests, especially for the musical and verbal working memory stimuli. Other than musicians, it is also shown in older adults. According to Galloway and Strong (2021), the findings of their research imply that instrumental or vocal music training may improve older persons' verbal and working memory.

A negative effect is also determined by some researchers. According to Mohammadzadeh (2016), verbal working memory performance is negatively impacted by the orientation of auditory attention and the presence of competing music, which includes both positive and null music, and this could be caused by music's intervention with the brain's processing of verbal information. However, the effect of music on verbal working memory differs for every individual. People with higher working memory performs better in verbal task with the presence of music, while people with lower working memory has a worse performance in verbal task. This is supported by the research of Ong and Chan (2022).

2.4.2 Studies Related to Different Music Characteristics affecting Working Memory

2.4.2.1 Classical Music

Classical music usually brought several effects to our brain and our body such as increase the accuracy of experts in laparoscopic surgery (Conrad et al., 2009), improve sleep quality in depressed patients (Deshmukh et al., 2009), and improved trait anxiety and psychological well-being significantly (OSMANOĞLU & YILMAZ, 2019). Furthermore, it is proven that classical music can affects working memory performance.

According to Taheri et al. (2022), background music (classical instrumental music) enhances working memory and accelerates skill performance. However, this result is argued

by Ying et al. (2019), showing that classical music reduces the correct response rates (86%, five percent lower than no-music condition) and increases response times (761ms, 33ms higher than no-music condition) of the subjects. In recent study, Rahmi et al. (2023)'s research has shown that there is no significance difference on correct recall between the experimental group (Mozart's Sonata for Two Pianos K448 in D-Major 2nd Movement is played) and control group (no music played). Research above have shown that more study needs to be done on identifying the influence of classical music on working memory.

Music of famous classical musician such as Vivaldi and Mozart have brought different effects to individuals. According to Mammarella et al. (2007), compared to white noise and silence, listening to Vivaldi's "Four Seasons: Spring" significantly improves older adults' working memory performance. Meanwhile, in another similar research conducted by Thompson et al. (2005) proves that both healthy older adults and Alzheimer's disease patients' category fluency improves when they listen to Vivaldi's Four Seasons, suggesting that music helps attentional processes. Exposure to this so-called Vivaldi effect has improve the working memory performance.

The "Mozart effect" describes the theory that listening to Mozart's music improves an individual's results on tests of spatial abilities (Thompson et al., 2001). According to research done by Maghsoudipour et al. (2017), there is an improvement in working memory in medical students when listening to classical music (Mozart's music), compared to pop music, traditional music and no music played. After playing music, the classical group had a significantly higher mean Wechsler test score (22.88 ± 2.42) than the control group (20.94 ± 3.20), pop group (20.36 ± 4.21), and traditional group (19.87 ± 4.90). Furthermore, the comparison on mean words remembered before (20.29 ± 3.20) and after listening to Mozart's music (22.88 ± 2.42) has a

significant difference ($P < 0.01$), which concludes that Mozart's music helps in improving working memory and concentration.

2.4.2.2 Tempo of Music

The speed at which a piece of music is played determines its overall pace and rhythm, which is known as the tempo of music. It is a key component that significantly affects a musical composition's energy, mood, and emotional effect. Beats per minute (BPM), which expresses the quantity of beats or pulses in a minute, is commonly used to measure tempo. When a music has a beats per minute (BPM) of 120, it is considered as fast tempo. On the other hand, music with a range of 40-108 BPM is considered slow tempo. The tempo can affect one's working memory performance differently which may lead to a positive or negative effect.

Fast tempo music helps in improving working memory performance. According to the result of research done by Nichols et al. (2018), jazz musicians have better recall of auditory pitches and the piano, which conclude that jazz musician have better working memory spans than classical musicians, years of expertise performing the genre is favorably associated with these improvements. However, the fast tempo music played (instrumental version of "Auf uns" by Andreas Bourani and "Nur ein Wort" by Wir sind Helden) in research shows no significant effect on recall performance, but suggesting an individual with high working memory capacity can learn better with the presence of background music (Lehmann & Seufert, 2017).

Slow tempo music also has some effect on working memory performance. In comparison to the no-music condition, slower musical tempo results in poorer performance in all three tests and slower cognitive processing speed; yet it exhibits the highest accuracy in the linguistic processing task (Lin et al., 2023).

2.4.2.3 Vocal Music

Vocal music is music which focuses on singing by one or more singers, with or without instrumental accompaniment. When a vocalist sings the melody on the track, they often sing lead. Lead vocals frequently accompany harmony vocals. They could play subordinate roles to the melody. Vocal music can be performed in several ways, which includes opera, acapella, beatboxing, pop, and Gregorian chant. It has brought a certain influence to working memory performance.

According to Iwanaga and Ito (2002), when it comes to memory tasks, vocal music is the most disruptive; both vocal and instrumental music can produce disruptions in verbal memory tasks. This is also supported by the research of Waters (2013), which the result shows that the performance was the worst under vocal music condition with an average of 9.64 words recalled correctly in contrast to instrumental music condition (10.31 words recalled correctly) and silent condition (10.83 words recalled correctly). Together with it, Oliver et al. (2020) shows that adults' cognitive function is negatively impacted by lyrics in music, which emphasizes the need to avoid listening to such music when performing busy activities through their research studies. As for consumers with lesser working memory capacity, vocal background music has a detrimental impact on cognitive performance and attitudinal outcomes; however, this negative effect is somewhat mitigated by short-term habituation (Kang & Lakshmanan, 2017).

Research by Silverman and Schwartzberg (2014) shows a comparison on different vocal music conditions towards working memory performance. When the female voice was used with guitar accompaniment, the participants' memory was least accurate, and when the male voice was used with piano and no accompaniment, it was most accurate. This research

proves that the difference in vocal music conditions brings significant effect to working memory performance.

2.4.2.4 Instrumental Music

Music without lyrics or singers is referred to as instrumental music. Simple sounds produced by one or more instruments are represented in instrumental music. Some common types of instrumental music are instrumental jazz, instrumental hip hop, instrumental rock, marching band, and classical music. Several research has proven that instrumental music has an impact in working memory performance of an individual.

According to Guo et al. (2018), children's working memory was significantly improved by a 6-week instrumental music training program, which focused on playing the keyboard harmonica in particular. Besides that, when it comes to the phonological loop and central executive subtests of working memory function, children who get instrumental music training demonstrate a better developmental course than those who do not (Roden et al., 2014). These studies have shown the positive impact of instrumental music on children's working memory.

In another research by Guo et al. (2020), the results shows that inexperienced older persons who participate in 4-month keyboard harmonica training program report improvements in verbal memory based on the significant improvement ($F(1, 51) = 5.582, p = 0.022$) of intervention group in Wechsler Memory Scale- Logical Memory II (WMS-LM II) and brain efficiency, which may lead to an improvement in cognitive function. Positive impact is also significant among the elderly.

2.5 Summary

In summary, the expanding corpus of prior research offers insight into previous research and facilitates the recognition of patterns in related studies. From the literature review, music psychology and music classification and characteristics were discussed alongside the inconclusive evidence of working memory performance in vocal music, instrumental music, and no music condition.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter explains on the research design, population and sample, instrument's structure, procedures, pilot study, data collection procedures, and data analysis of this study. A summary of this chapter is done at the last section of this chapter.

3.1 Research Design

This research used quantitative approach. It is the systematic investigation of phenomena through the collecting of numerical data and the use of statistical, mathematical, or computational techniques (Adedoyin, 2020). The research design of this study is between-subjects experimental design, which each participant experienced only one condition, and the group differences between participants in various conditions were compared (Bhandari, 2022). This design examined the effects of different types of music played (no music, vocal music, and instrumental music) on the participants' working memory performance based on the total correct recall of "Reading Span Task" for verbal memory test and "Matrix Span Task" for visual memory test.

3.2 Population and Sample

In this experimental research, the population consists of undergraduate students and the sample comprises the undergraduate students from Universiti Malaysia Sarawak (UNIMAS). This sample is reachable and within the researcher's reach. The sample size of this study is 45

participants, 15 participants for each condition. The chosen sampling method for this study is convenience sampling, which is a form of non-probability sampling method that involves selecting sample units based on their accessibility to the researcher (Nikolopoulou, 2022).

3.3 Instruments

3.3.1 Instrument Structure

There were five instruments used in this research: informed consent form, Google Form, Reading Span Task, Matrix Span Task, and music. Each instrument's structure is further explained below.

3.3.1.1. Informed Consent Form

A person must know the important information regarding a study, including any possible risks and benefits, in order to provide their informed consent and make an informed decision about whether or not to participate in the research (Noble et al., 2009; as cited in Nnebue, 2010). An informed consent form was created and agreed by the participants to ensure all of them knows every risk and cost involved in this experimental research. It was created in a Google Form and agreed by participants before they register for participation in this study. All procedures of the research and rules and regulations were included in this form.

3.3.1.2 Google Form

To recruit participants and ease the registration to join this experimental research, an online form was created by using Google Form. This participation form included the participants' demographic such as matrix number, age, gender, year of study, faculty, e-mail, and contact number.

3.3.1.3 Reading Span Task

The reading span task is a computerised-based verbal memory test designed by Loboda T.D. (2012). There are two tasks, A and B, were done at the same time. Task A focuses on retaining a series of letter in memory for later recall. When the recall prompt is presented, the participants chose the letters following the sequence of the letters shown. The participant can reset answer and start over with the recall prompt. Task B focuses on judging if English language sentences make sense. A sentence is presented to the participants at a time, and they chose between “correct” and “incorrect”. In this test, task A and task B were interleaved. The participants were forced out by the system when they took too much time to complete on task B. The number of letters and sentences presented within a single trial vary from 2 to 7. The order was random. There were 18 trials in this test. There was no time limit for task A. The result was generated by the system and shown on the website.

3.3.1.4 Matrix Span Task

The visual working memory performance is measured using a computerised-based test called the Matrix Span Task (Stone & Towse, 2015). There are two stages in this test: presentation phase and recall phase. For presentation phase, a 4x4 grid was used, with each random grid location lighting up in response to the span load at intervals of one second on the screen. Participants were required to click the grid areas in the correct sequence during the recall phase and there was no time limit for it. Six span loads were presented (n=2, 3, 4, 5, 6, 7). There were 3 trials per span load, and 18 trials in total. The participant only scores one mark when the grid locations were selected in correct sequences. If the participants only clicked on one wrong grid spot, they will not receive a mark if they recall the sequence incorrectly. Total score was recorded, and data analysis was done.

3.3.1.5 Music

Four songs were chosen and played throughout the tests, including two instrumental music and two vocal music. The instrumental music was played in the instrumental music group and the vocal music was played in vocal music group. Both songs for each group were played repeatedly. The instrumental songs played were “Die for You (Instrumental)” by The Weeknd and “River Flows in You” (piano) by Yiruma. The vocal songs played were “See You Again” by Wiz Khalifa feat. Charlie Puth and “All of Me” by John Legend. These songs were chosen due to their worldwide popularity. The vocal songs chosen are all sung in English language, and the genre is pop music. All these music shares a common characteristic which is slow-tempo music.

3.4 Procedures

Convenience sampling was employed to recruit the participants for the research. This method was used as the population drawn was close to hand of the researcher. A Google Form link was spread out through WhatsApp to recruit participants, including the requirements for this research. The participants were required to agree with the informed consent and to fill in the demographic information in the Google Form. The participants have also chosen their time slot available for the test in that Google Form. After that, the researcher contacted the participants and informed the confirmed time, date, and location for the tests.

The participants were randomly assigned to one of the groups by picking a paper with number written on from a box. Number “1” represents vocal music group; number “2” represents instrumental music group; number “3” represents no music group. A short briefing on the procedures of the tests was done by the researcher to the participants. Next, the

participants started to do the tests. Reading Span Task was conducted first, followed by Matrix Span Task. Counterbalance was applied in this research to control order effect and eased the researcher to control the nuisance variables effect.

3.5 Pilot Study

Six participants have taken part in a pilot test designed to verify the validity and reliability of the research. Two participants each were allocated to the three condition which are no music condition, vocal music played condition and instrumental music played condition. The pilot test used the same set of tasks under same musical conditions and conduct in a way consistent with the real methodology. After the test, a feedback form was filled in by the participants. All six participants did not give a lot of comment on the tests and agreed that the whole experiment has no problem and no improvement need to be done.

3.6 Data Collection Procedures

The data for visual and verbal working memory performance were collected through the usage of computerised-based assessment software: Matrix Span Task and Reading Span Task. For Reading Span Task, the results were shown at the website after completing the task, while an excel showing the data was extracted from the software of Matrix Span Task. completion time for both tasks varied for each person, from 25 minutes to 45 minutes to complete both tasks.

3.7 Data Analysis Procedures

Statistical Package for Social Science (SPSS) program 26.0 was used to calculate the result of the experiment. Both descriptive and inferential data analysis were performed on the collected data. Descriptive statistics, which is the first step of analysis that is used to characterise and summarise data (Sarmiento & Costa, 2017), were used for better understanding on the participants' demographic variables. On the other hand, inferential tests were done, and all tests were set at 0.05 alpha levels of significance.

3.7.1 Descriptive Data Analysis

Frequency and percentage were used to analyse the demographic information of the participants including age, gender, year of study, faculty, and their preference of listening to music while studying.

3.7.2 Inferential Data Analysis

Inferential data analysis is utilised to examine a hypothesis's effects, assumptions, and probability (Hassan, 2023). One-way Analysis of Variance (ANOVA) is a statistical test that analyses the means of more than two groups using a single independent variable (Bevans, 2020). In this research, one-way ANOVA was used to determine the effect of different music conditions on verbal working memory, with α level of 0.05. Meanwhile, Kruskal-Wallis H test was used to determine the effect of different music conditions on visual working memory. Table below shows the tests that were used for each hypothesis.

Table 3.7.2.1: *Test for Each Hypothesis*

Hypothesis	Statistical Test
H1: There is significant difference between music groups (vocal music, instrumental music, no music)	One-way ANOVA

on verbal working memory performance based on total correct recall.	
H2: There is significant difference between music groups (vocal music, instrumental music, no music) on visual working memory performance based on total correct recall.	Kruskal-Wallis H

3.8 Summary

Generally, this research used a between-subjects experimental design. The data collected had shown the influence of different music conditions on verbal and visual working memory performance. One-way ANOVA and Kruskal-Wallis H test were used.

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.0 INTRODUCTION

This chapter includes the findings and discussion of the study. The demographic data (gender, age, year of study, faculty of the participants), normality of the test, and inferential data were described in this chapter. A conclusion was done to summarize the whole chapter.

4.1 DEMOGRAPHIC DATA

A Google Form was filled by the participants, including the informed consent and demographic data of the participants. The participants are the undergraduates' students from University Malaysia Sarawak (UNIMAS). The demographic data such as gender, year of study, age, faculty, and preference of listening to music while studying were displayed below.

4.1.1 Gender

Table 4.1.1: *Frequency and Percentage of Participants' Gender*

Gender	<i>n</i>	%
Male	16	35.56
Female	29	64.44
Total	45	100.00

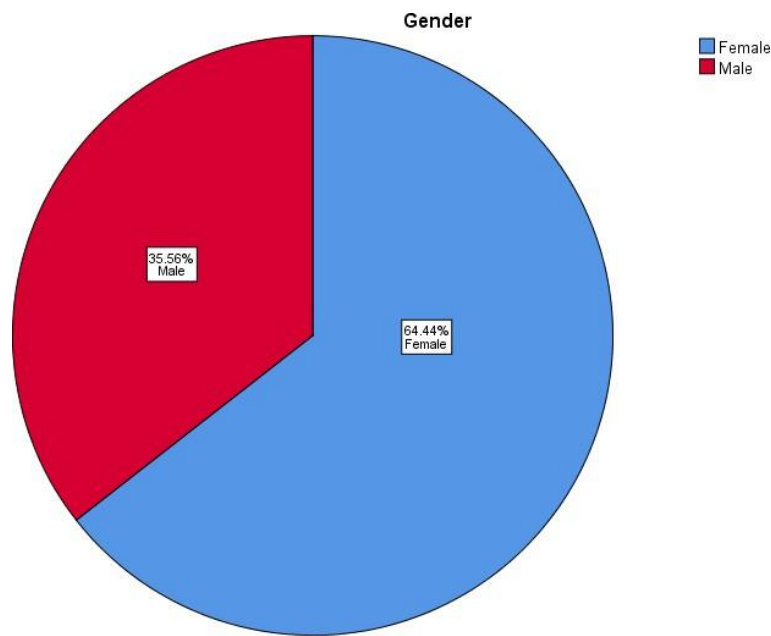


Figure 4.1.1 Pie Chart of Participants' Gender

Table 4.1.1 and *Figure 4.1.1* shows the frequency and percentage of the gender of participants. Female participants (n=29) make up the majority, with a percentage of 64.44%. Meanwhile, the rest of the participants were male (n=16), taking 35.56% from the total number of participants (n=45). This shows that the female participants are more than male participants.

4.1.2 Year of Study

Table 4.1.2: Frequency and Percentage of Participants' Year of Study

Year of Study	<i>n</i>	%
1	7	15.56
2	19	20.00
3	26	57.78
4	3	6.67
Total	45	100.00

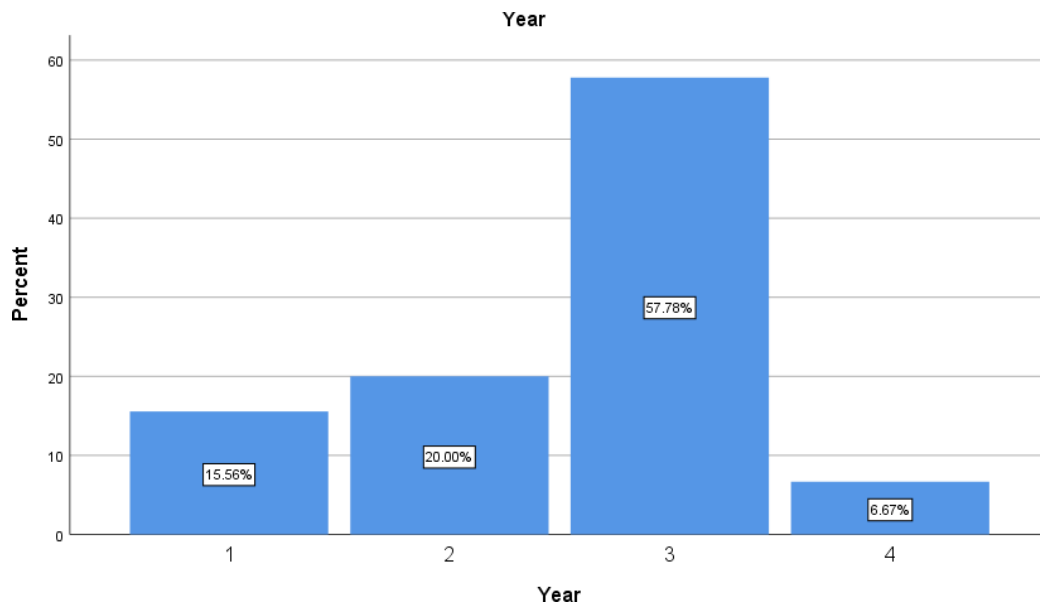


Figure 4.1.2 Bar Chart of Participants' Year of Study

Table 4.1.2 and *Figure 4.1.2* shows the frequency and percentage of the year of study of the participants. 45 participants are made up from year 1, year 2, year 3 and year 4 students from UNIMAS. Among the participants, 15.56% are from year 1 ($n=7$), and 20.00% are from year 2 ($n=9$). Year 3 students take most of the participants ($n=26$), consisting of 57.78% from the total number of participants. Meanwhile, only 6.67% of participants are from year 4 ($n=3$).

4.1.3 Age

Table 4.1.3: Frequency and Percentage of Participants' Age

Age	<i>n</i>	%
19	1	2.22
20	2	4.44
21	8	17.78
22	13	28.89
23	19	42.22

24	2	4.44
Total	45	100.00

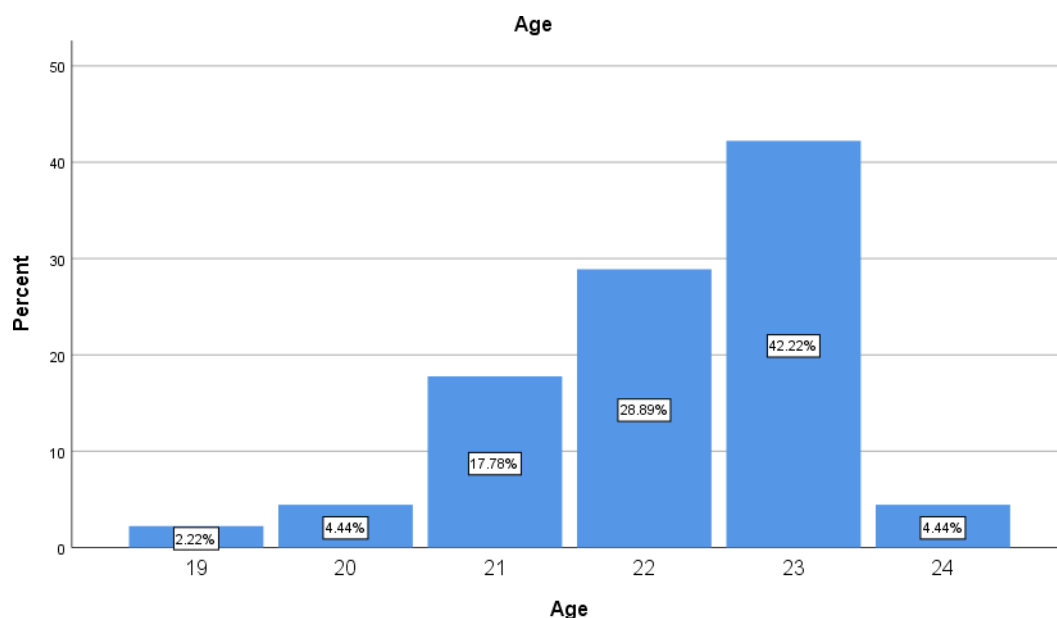


Figure 4.1.3 Bar Chart of Participants' Age

The age distribution of the participants is shown in Table 4.1.3 and *Figure 4.1.3*. Most participants are 23 years old ($n=19$), occupied 42.22% of the total number of participants, followed by 22 years old ($n=13$), with a percentage of 28.89%. 17.78% of the participants are 21 years old ($n=8$), while 4.44% each from 20 and 24 years old ($n=2$). Only one participant is 19 years old, with a percentage of 2.22%.

4.1.4 Faculty of the Participants

Table 4.1.4: *Frequency and Percentage of Participants' Faculty*

Faculty	<i>n</i>	%
Faculty of Applied and Creative Arts	2	4.44
Faculty of Built Environment	1	2.22

Faculty of Cognitive Sciences and Human Development	20	44.44
Faculty of Computer Science and Information Technology	3	6.67
Faculty of Economics and Business	8	17.78
Faculty of Education, Language and Communication	5	11.11
Faculty of Engineering	2	4.44
Faculty of Medicine and Health Sciences	1	2.22
Faculty of Resource Science and Technology	1	2.22
Faculty of Social Sciences and Humanities	2	4.44
Total	45	100.00

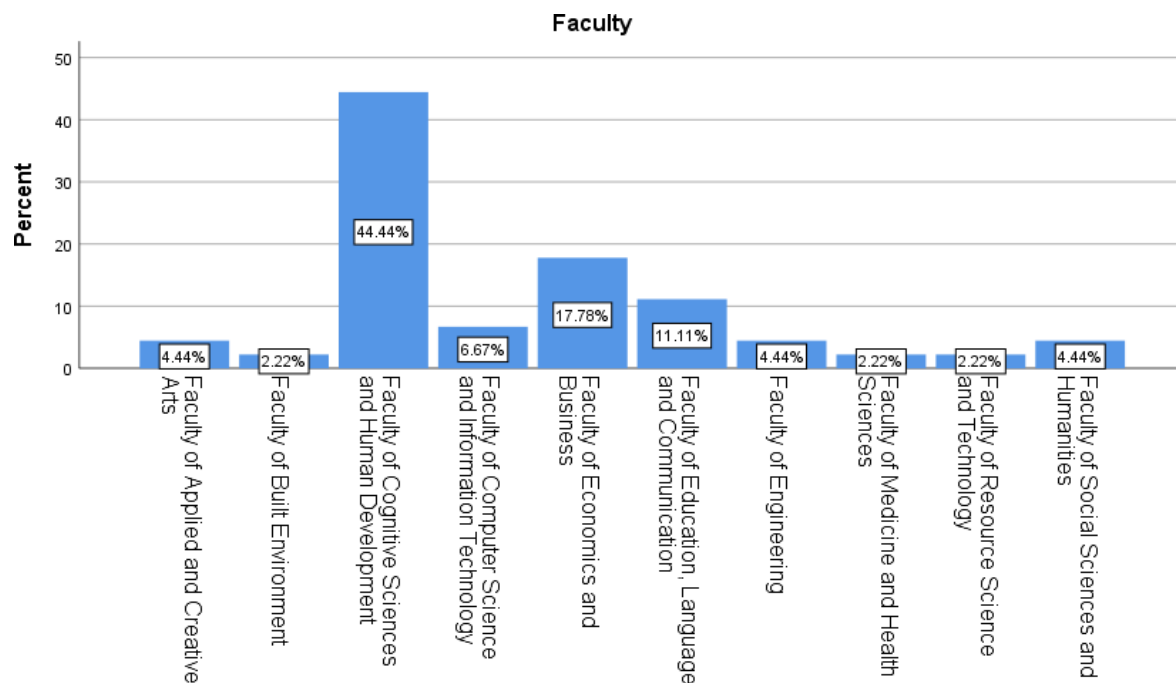


Figure 4.1.4 Bar Chart of Participants' Faculty

Table 4.1.4 and *Figure 4.1.4* demonstrated the faculty of the participants. The majority of the participants came from the Faculty of Cognitive Sciences and Human Development (n=20), occupied 44.44% of the total. Faculty of Economics and Business (n=8) has the second most participants which takes 17.78%, followed by Faculty of Education, Language and Communication (n=5) with a percentage of 11.11%. 6.67% of participants came from the Faculty of Computer Science and Information Technology (n=3). Faculty of Applied and Creative Arts, Faculty of Engineering, and Faculty of Social Sciences and Humanities have 2 participants each, which took up 4.44% for each faculty. Lastly, the participants from Faculty of Built Environment, Faculty of Medicine and Health Sciences, and Faculty of Resource Science and Technology take up 2.22% each (n=1).

4.1.5 Preference of Listening to Music While Studying

Table 4.1.5: *Frequency and Percentage of Participants' Preference of Listening to Music While Studying*

Listening to Music	Frequency	Percentage (%)
Totally no	8	17.78
Rarely	4	8.89
Sometimes	9	20.00
Often	13	28.89
Always	11	24.44
Total	45	100.00

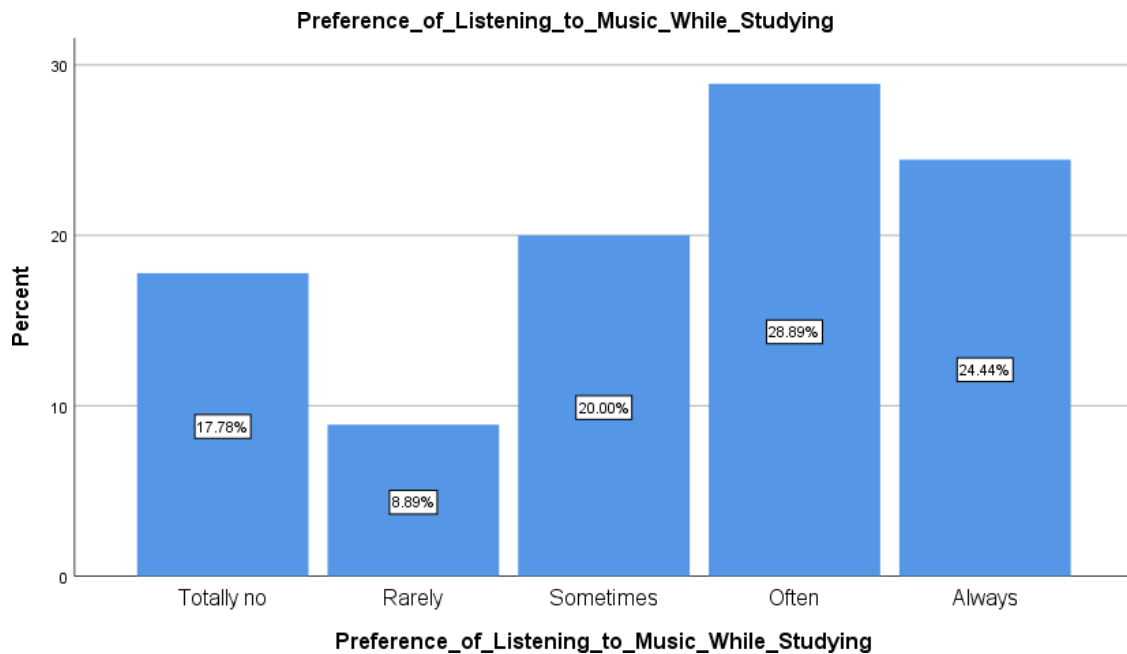


Figure 4.1.5 Bar Chart of Participants' Preference of Listening to Music While Studying

Table 4.1.5 and *Figure 4.1.5* demonstrated the participants' preference of listening to music while studying. 28.89% of participants (n=13) often listen to music while studying, accumulating the majority. 24.44% of participants (n=11) always listen to music while studying, followed by 20.00% (n=9) sometimes listen to music while studying. There are 8 participants (17.78%) who totally do not listen to music while studying and only 4 of them (8.89%) rarely listen to music while studying.

4.2 NORMALITY OF THE TESTS

Table 4.2.1: *Descriptive Statistics on Verbal Working Memory Performance and Visual*

Working Memory Performance

	Mean	Skewness	Kurtosis
VerbalResults	.5907	-.404	.175

VisualResults	.6544	-.150	-1.013
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Table 4.2.2: *Normality Tests on Verbal Working Memory Performance and Visual Working Memory Performance*

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
VerbalResults	.092	45	.200*	.971	45	.309
VisualResults	.124	45	.082	.942	45	.025

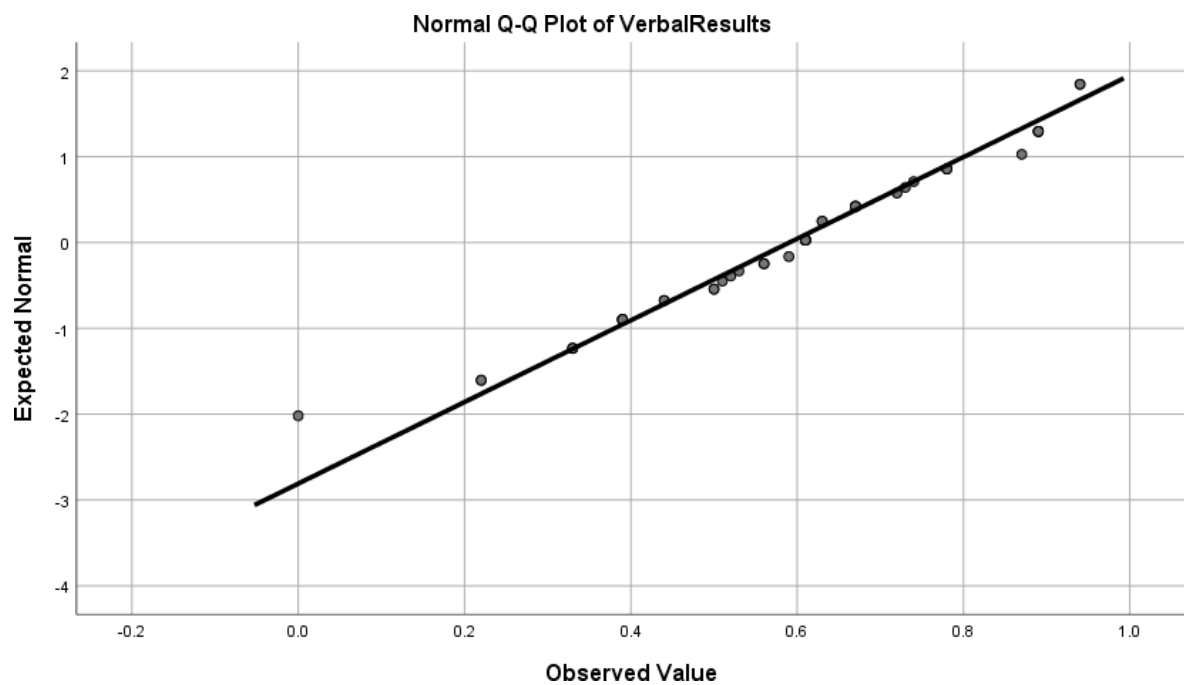


Figure 4.2.1 *Normal Q-Q Plot of Verbal Working Memory Performance*

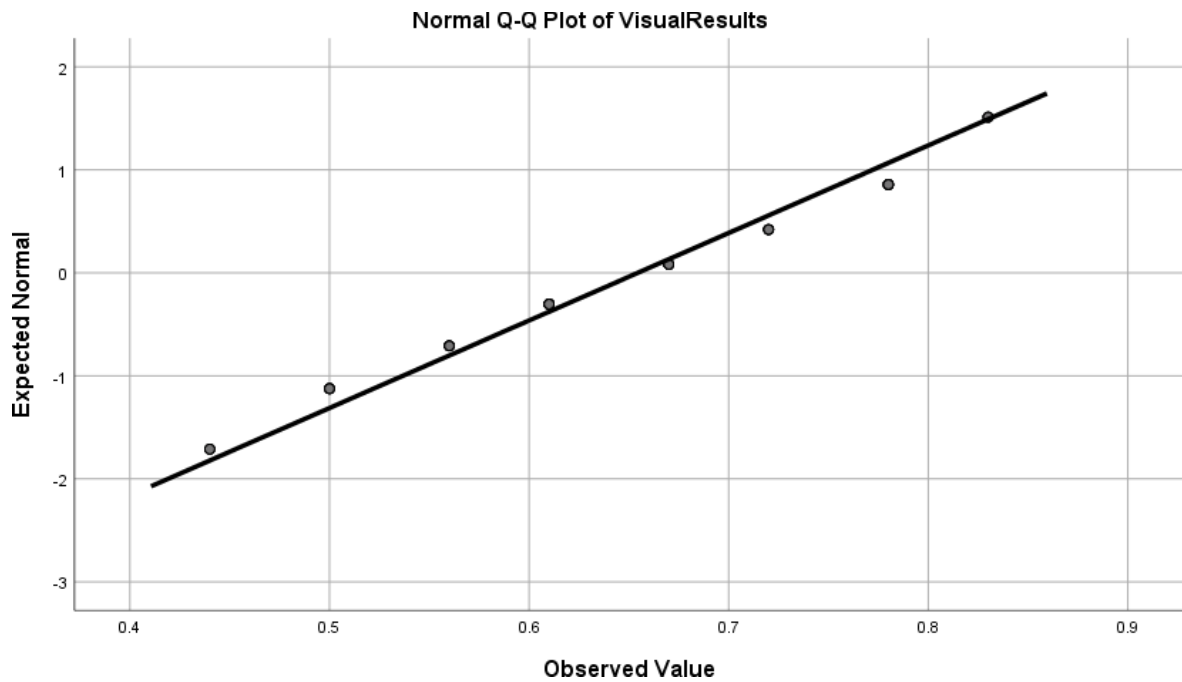


Figure 4.2.2 Normal Q-Q Plot of Visual Working Memory Performance

The variable name “VerbalResults” indicates the total correct recall of Reading Span Task as verbal working memory performance of the participants while “VisualResults” indicates the total correct recall of Matrix Span Task as verbal working memory performance. Table 4.2.1 shows the descriptive statistics for both variables. The mean value of VerbalResults, 0.59 (SD=0.21) indicates the proportion of items for which all the elements were recalled correctly. The data shows a skewness of -.404 and a kurtosis of .175, which means that the distribution is relatively close to a normal distribution, with a slight left skew. The Kolmogorov-Smirnov test shows $p=0.200$ while Shapiro-Wilk test shows $p=0.309$, both $p>0.05$, showing normality is not violated. The results of both tests indicate that there is no significant deviation from normality in the distribution. Furthermore, the Q-Q plot in *Figure 4.2.1* shows a close alignment of observed quantiles with expected quantiles for a normal distribution, reinforcing the claim that it is normally distributed.

The mean value of VisualResults is 0.65 (SD=0.12), indicating the proportion of total correct recalled items. The distribution is approximately symmetric with a small negative skew, and it is relatively flat when compared to a normal distribution, as indicated by its skewness of -.150 and kurtosis of 1.013. The Kolmogorov-Smirnov test has a p-value of 0.082, $p>0.05$, showing normality is not violated; the Shapiro-Wilk test shows $p=0.025$, $p<0.05$, showing it deviates from a normal distribution. The Shapiro-Wilk test shows a deviation from normality, whereas the Kolmogorov-Smirnov test shows normality. Meanwhile, the Q-Q plot in *Figure 4.2.2* shows a slight S-shape, indicating consistent deviation. With above results, the distribution is not normal.

4.3 INFERENTIAL DATA (MAIN FINDINGS)

The inferential data was collected from both working memory performances. The verbal working memory performance data was collected through reading span task while the visual working memory performance data was collected through matric span task. To determine the acceptability of the hypothesis, analysis of data was performed. One-way ANOVA was used for first hypothesis, “There is significant difference between music groups (vocal music, instrumental music, no music) on verbal working memory performance based on total correct recall”. Kruskal-Wallis H Test was used for the second hypothesis, “There is significant difference between music groups (vocal music, instrumental music, no music) on visual working memory performance based on total correct recall.” The results were presented as tables below.

4.3.1 Verbal Working Memory Performance in Different Music Groups Based on Total Correct Recall

H1: There is significant difference between music groups (vocal music, instrumental music, no music) on verbal working memory performance based on total correct recall.

Table 4.3.1.1: *Mean and Standard Deviation of Verbal Working Memory Performance for Each Music Group*

Condition	N	Mean	Std. Deviation
Vocal Music	15	.7127	.17236
Instrumental Music	15	.5707	.19159
No Music	15	.4887	.21203
Total	45	.5907	.21022

Table 4.3.1.2: *One-Way ANOVA Results between Music Groups (Vocal Music, Instrumental Music, No Music) on Verbal Working Memory Performance Based on Total Correct Recalled*

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.385	2	.193	5.190	.010
Within Groups	1.559	42	.037		
Total	1.944	44			

Table 4.3.1.3: *Post Hoc Test (Tukey HSD Test) between Music Groups (Vocal Music, Instrumental Music, No Music) on Verbal Working Memory Performance Based on Total Correct Recalled*

(I)	(J)	Mean			95% Confidence Interval	
		Difference			Lower	Upper
Condition	Condition	(I-J)	Std. Error	Sig.	Bound	Bound
Vocal Music	Instrumenta	.14200	.07035	.120	-.0289	.3129
	1 Music					
	No Music	.22400*	.07035	.008	.0531	.3949
Instrumenta	Vocal	-.14200	.07035	.120	-.3129	.0289
	1 Music					
	No Music	.08200	.07035	.480	-.0889	.2529
No Music	Vocal	-.22400*	.07035	.008	-.3949	-.0531
	Music					
	Instrumenta	-.08200	.07035	.480	-.2529	.0889
	1 Music					

*. The mean difference is significant at the 0.05 level.

Table 4.3.1.1 shows the mean and standard deviation of the verbal working memory performance based on total correct recalled by vocal music group, instrumental music group and no music group. The results show that the vocal music group ($M=0.71$, $SD=0.17$) performed the best, followed by instrumental music group ($M=0.57$, $SD=0.19$), and lastly, no music group ($M=0.49$, $SD=0.21$).

In Table 4.3.1.2, the one-way ANOVA shows a result of $F(2,42)=5.190$, $p=0.010$. The p-value is smaller than 0.05, thus we reject the null hypothesis. There is a significant difference between the music groups in verbal working memory performance based on total correct recalled.

A post-hoc test (Tukey HSD test) was conducted to determine which specific groups differ from each other. As shown in Table 4.3.1.3, it is found that the mean value of verbal working memory performance was significantly different between vocal music group and no music group ($p = 0.008$, 95% C.I. = [0.0531,0.3949]). There was no statistically significant difference between vocal music group and instrumental music group ($p=0.120$) and between instrumental music group and no music group ($p=0.480$).

4.3.1.1 Discussion

The results show that there is a significant difference between vocal music group, instrumental music group, and no music group on verbal working memory performance based on total correct recalled as tabulated in Table 4.3.1.2. The performance is measured through the proportion of items (several complete cycles of sentence judgment followed by the presentation of element and recall of a sequence of elements, $n=18$) for which all elements (alphabets) were recalled correctly. According to the results displayed in Table 4.3.1.1, vocal music group can recall the most with a mean proportion of 0.71 element recalled correctly within items. The instrumental music group can recall lesser than vocal music group, having a mean proportion of 0.57 element recalled correctly within items, while the no music group has the least mean proportion of element recalled correctly within items, which is 0.49.

Several past research has supported current research's findings that music has significant differences in verbal working memory performance. Wang et al. (2013) have done research by letting two groups of adults, one listen to positive musical clips and another listen to negative musical clips, and then complete a digit span test. The result indicates that listening to positive affect music can temporarily improve working memory performance in healthy older adults, despite expected declines in this area with age. On the other hand, vocal music has more significant influence on verbal working memory performance (Cheah et al., 2022;

Alley & Greene, 2008; Iwanaga & Ito, 2002). The systematic review done by Cheah et al. (2022) has shown that background music with lyrics, which is vocal music, has significant detrimental effects on memory and language-related tasks. Iwanaga & Ito (2002) research findings also shown that vocal music causes the highest disturbance in memory tasks, with disturbances observed in verbal memory tasks under both vocal and instrumental music conditions. Similarly, positive and neutral competitive music has a detrimental impact on verbal working memory performance, probably because it interferes with the brain's processing of verbal information (Mohammadzadeh, 2016).

Based on existing research, the influence of music on verbal working memory performance was not conclusive. The research by Peng (2023) shows that music with lyrics does not significantly reduce verbal memory performance compared to music without lyrics among high school students. When comparing musically trained individuals and non-musically trained individuals on verbal working memory performance, there is no significant differences although musicians had higher scores compared to non-musicians (Kim et al., 2021). These research shows an opposite result with current research, indicating not significant difference between music and verbal working memory performance.

4.3.2 Visual Working Memory Performance in Different Music Groups Based on Total Correct Recall

H2: There is significant difference between music groups (vocal music, instrumental music, no music) on visual working memory performance based on total correct recall.

Table 4.3.2.1: *Mean and Standard Deviation of Visual Working Memory Performance for Each Music Group*

Condition	N	Mean	Std. Deviation
Vocal Music	15	.6600	.11753
Instrumental Music	15	.6667	.10841
No Music	15	.6367	.13200
Total	45	.6544	.11768

Table 4.3.2.2(a): *Mean Rank between Music Groups (Vocal Music, Instrumental Music, No Music) on Visual Working Memory Performance Based on Total Correct Recall*

Condition	N	Mean Rank
Vocal Music	15	23.30
Instrumental Music	15	24.20
No Music	15	21.50
Total	45	

Table 4.3.2.2(b): *Kruskal-Wallis H Test Results between Music Groups (Vocal Music, Instrumental Music, No Music) on Visual Working Memory Performance Based on Total Correct Recall*

	VisualResults
Kruskal-Wallis H	.335
df	2
Asymp. Sig.	.846

Table 4.3.2.1 shows the mean and standard deviation of the visual working memory performance based on total correct recalled by vocal music group, instrumental music group

and no music group. The results show that there is not much difference between the three groups. The instrumental music group ($M=0.67$, $SD=0.11$) performed slightly better than vocal music group ($M=0.66$, $SD=0.18$), followed by the no music group ($M=0.64$, $SD=0.13$).

A Kruskal-Wallis H Test indicated that there was no significant difference in visual working memory performance across the three music groups, $\chi^2(2, N = 45) = 0.335$, $p = 0.846$. The mean rank of visual working memory scores was 23.30 for vocal music, 24.20 for instrumental music, and 21.50 for no music, as shown in Table 4.3.2.2(a).

4.3.2.1 Discussion

The results for visual working memory performance shows that there is no significant difference between vocal music group, instrumental music group, and no music group based on total correct recalled. The performance is measured through the proportion of total correct recalled grids in sequence in Matrix Span Task ($n=18$). According to the results displayed in Table 4.3.2.1, the three groups have relatively similar mean proportion of grids recalled correctly in sequence. Vocal music group has a mean proportion of 0.66 grids recalled correctly in sequence. The instrumental music group can recall the most, having a mean proportion of 0.67 grids recalled correctly in sequence, while the no music group has the least mean proportion of grids recalled correctly in sequence, which is 0.64.

Several past research found that music training does not significantly enhance visual working memory performance. Studies have shown that although musicians could possess better reaction times, their accuracy in visual memory tasks is not more precise to non-musicians (Rodrigues et al., 2014; Roden et al., 2012). Different types of music may have varying effects on working memory training outcomes, suggesting that the specific characteristics of the music might influence cognitive benefits. According to Borella et al.

(2017), when compared to Mozart's music, listening to Albinoni's music produced greater short-term improvements in older people's visuospatial abilities. While in the study of Souza and Leal (2023), music with lyrics hinders visual memory, while instrumental music does not credibly hinder or improve performance. Regardless of the intricacy or lyrical content of the background music, the current study extends the understanding by showing that visual working memory seems to be resilient to its impact.

The differential processing pathways for visual information in the brain could explain the findings of this study on visual working memory performance. While visual working memory is primarily based on the visuospatial sketchpad, which processes and stores visual and spatial information (Baddeley, 2003; Logie, 1995), verbal working memory is primarily based on the phonological loop, which is vulnerable to auditory interference, especially from lyrics in music (Baddeley, 2003). The lack of significant differences in visual working memory performance across music conditions suggests that visual tasks may be insulated from the type of auditory stimuli used in this study.

4.4 Conclusion

This chapter concludes the findings of this study based on data collected. The demographic data was analysed using descriptive analysis approach, presented in frequency and percentage tables. Normality tests were run for both verbal and visual working memory test results, showing normality for verbal but not normally distributed for visual working memory test results. One-Way ANOVA was used for analysing verbal working memory test results and Kruskal-Wallis H Test was used to analyse visual working memory test results.

The One-Way ANOVA results indicate that there is a significant difference between the music groups in verbal working memory performance based on total correct recalled. Meanwhile, the Kruskal-Wallis H Test found that there was no significant difference in visual working memory performance across the three music groups based on total correct recalled. It is crucial to acknowledge that past research has conflicting findings as the results of current study is consistent with some previous research, which also found no significant difference in verbal and visual working memory performance between music groups. These contradictory findings demonstrate the complex nature of the interaction between music and cognitive processes, indicating that the influence on working memory may depend critically on a variety of factors, including individual difference, task features, and music characteristics. To get a deeper understanding of the circumstances in which music might either improve or impair cognitive function, future studies must carry out further investigation into these aspects.

CHAPTER 5

LIMITATION, IMPLICATION, RECOMMENDATION AND CONCLUSION

5.0 Introduction

This chapter will discuss about the limitations found in this study and the implications of this study. Besides that, some recommendations will be discussed for future research improvements. Lastly, this study was wrapped up in the conclusion, reviewing the whole study.

5.1 Limitations of Study

Several limitations were founded in this study. The sample size in this study is relatively small, with only 45 participants divided into three groups, each group only contain 15 participants. The participants are the undergraduates' students in UNIMAS, which came from a very big population. Nearly half of the participants are from the same faculty, and only a few participants are from the others faculty. The unbalanced proportion of participants' faculty may have an impact in the research findings, limits the generalizability of the results to broader populations. However, convenience sampling has allowed practical and feasible recruitment within the available timeframe and resources. The findings were carefully interpreted, providing valuable insights and considered exploratory and indicative rather than definitive.

The second limitation is the participants variability. The individual differences include factors such as musical training, familiarity with music, working memory capacity, and personal preferences for background music or silence. Participants who are musically trained may have different cognitive response to background music played while doing the experiment compared to participants who are not musically trained. Similarly, since the music chosen to

have high popularity, participants who are familiar with the music may enhance cognitive performance or causing distraction. These factors also depend on the participants' personal preferences. Participants who always preferred listening to music while doing tasks may have a significant difference in performance compared to those who do not prefer to listen to music while doing tasks. Furthermore, an individual's working memory capacity may affect their working memory performance. It may skew results if it is not distributed evenly across all the music groups. The working memory performance under conditions is also affected under personal preference of background music or silence. Some might find background music is distracting while some might not. Thus, the information of participants personal preferences of music while studying were collected to allow the researcher to control the variables in analysis.

The third limitation is the difficulty of the task. Participants with lower level of English proficiency may find the sentence in Reding Span Task is difficult to understand, thus could not make their decision correctly. This could result in low correct recall for verbal working memory performance as they tend to focus more on sentence judgement rather than memorising the alphabet shown after each sentence judgement. However, requirement on English understanding was required while recruiting participants and no timer set when doing the tests, providing them enough time to complete the task.

The last limitation is the generalizability of research. The data was collected from specific population which is undergraduates' students from UNIMAS. Thus, the data could not be generalisable to other populations, such as different nationality, different age groups, cultural backgrounds, or other settings. However, this study included different age group of university undergraduates' students from the age 19 to 24, and students from year 1 to year 4 from different faculty for the sample. This study would suggest future study to include a larger and more diverse sample for better results.

5.2 Implication

The current study is aligned with the findings of past results, indicating significant difference between music groups in terms of verbal working memory performance. However, this study offers a distinctive viewpoint, showing that vocal music led to the best performance in verbal working memory, followed by instrumental music, with no music condition resulting in lowest performance. This goes against the findings of previous studies that showed vocal music would be less beneficial for verbal memory-related cognitive tasks because it is more distracting. These findings show that previous studies may have undervalued the cognitive advantages of music, especially vocal music, and that music might help create a more stimulating atmosphere that improves specific types of cognitive function.

Besides that, the findings that vocal music enhance verbal working memory performance might be beneficial in education or workplace settings. Vocal music can be incorporated into learning environments which needs verbal memory such as language learning and memorizing verbal information. The employers can consider letting the employees to listen to music while working on tasks involving verbal working memory. In these context, vocal music might improve students and employee's performance. However, the effects depend on personal preferences, working memory capacity, and attention focus while doing tasks. Music genre and characteristics of vocal music may also affect the verbal working memory performance.

Furthermore, current research findings provide insight into cognitive rehabilitation, suggesting vocal music could offers an effective strategy to enhance verbal working memory performance in individuals with memory impairments. Using the Arousal-Mood-Cognition framework, music therapists can utilise certain vocal music genres to elevate arousal and mood

states, which may enhance verbal memory retrieval and retention during therapy sessions. Instrumental music can also be used to enhance visual working memory performance, but the effect remains to be seen.

Lastly, the results of this research suggest that additional investigation is needed to determine why vocal music affects verbal working memory more strongly, and why do the individuals perform the least under no music condition. Investigating the underlying brain mechanisms or psychological processes that support this impact may be one way to do this. The results of this study could be verified and its generalizability to other age groups, cultural backgrounds, and cognitive capacities might be ascertained by doing a bigger and more varied sample replication.

5.3 Recommendations

The current research is limited to a small sample of undergraduates' students in UNIMAS, which is still not very generalizable to prove that music has significant influence in verbal working memory performance or no significant difference in visual working memory performance. A larger and more diverse sample should be involved in future research to make sure the results are applicable to a wide range of demographics including different ages, cultural backgrounds, and cognitive abilities. This strategy will assist in identifying any possible differences in the ways different demographics respond to instrumental and vocal music, strengthen the external validity of the results and encourage the development of more widely applicable recommendations for using music in educational and occupational settings.

Furthermore, future research should delve into how different genre and characteristics can influence working memory performance to figure out the best types of music for cognitive

improvement. It is also critical to explore how individual differences, for example, baseline working memory capacity, attention spans, and musical preferences, affect the moderating effects of music on working memory. Knowing these subtle differences will make it easier to determine if some music types have advantages for everyone or if individuals respond differently to other types of music. For example, music with fast tempo and complicated lyrics may be motivating to some people while doing tasks involving working memory, but it may also be distracting to others. Future researchers may provide more individualised and effective suggestions for using music as a cognitive aid in both educational and occupational settings by looking at both music characteristics and personal preferences.

Additionally, longitudinal studies can be implemented in future studies to understand the long-term effect of music on working memory performance. This allows future researchers to determine whether cognitive benefits are maintained or decreased over time from exposure to different types of music. The interaction between the changes in individual factors and music exposure influencing the working memory performance can be explored. As a result, the researchers can identify the effective application of music on working memory tasks, contributing new knowledge and address research gaps.

Lastly, it is also advised that future researchers use a variety of working memory tasks. It is also important to consider the other types of working memory tasks beyond verbal and visual working memory. By doing this, it helps researchers to conduct a thorough study, delve deeper into the real effect of music on different working memory performance, and promote a deeper knowledge within this field of study.

5.4 Conclusion

This study has explored the influence of music on verbal and visual working memory performance based on total correct recalled, revealing that vocal music enhances the verbal working memory significantly, while no significant differences were found for visual working memory across different music conditions. Several limitations were highlighted, emphasising the need for larger and more varied samples in future studies. These included individual difference and personal preferences, difficulty of the tasks, small and homogeneous sample sizes, and limited generalizability. The findings have implications for the use of vocal music in education, workplace, and therapy for improving verbal working memory function. Future research is recommended to increase sample size, explore various music types and characteristics on working memory, implementation of longitudinal studies, and use variety working memory tasks to obtain a better understanding in this field.

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APPENDIX A

RAW SPSS OUTPUTS

A. Demographic Data

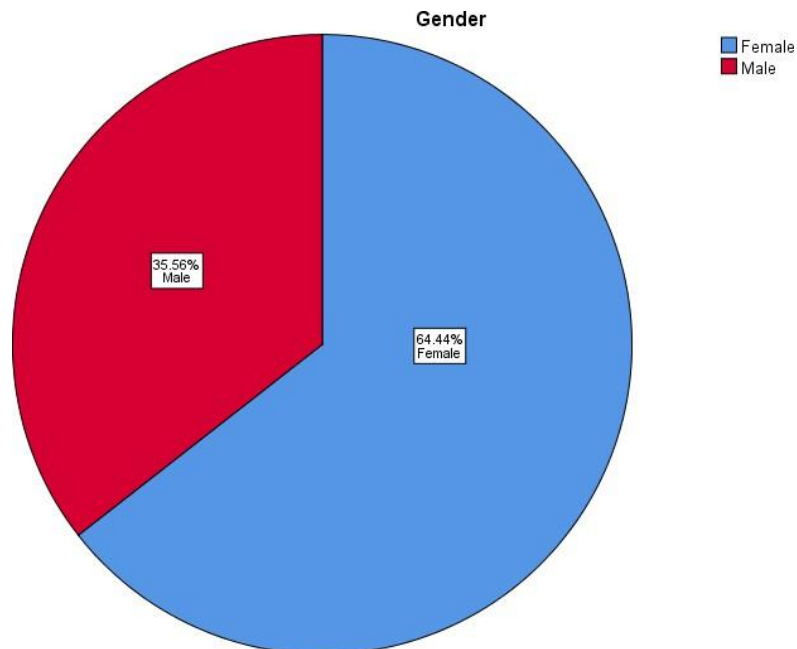
Statistics

		Gender	Year	Age	Faculty
N	Valid	45	45	45	45
	Missing	0	0	0	0

1. Gender (Frequency Table and Pie Chart)

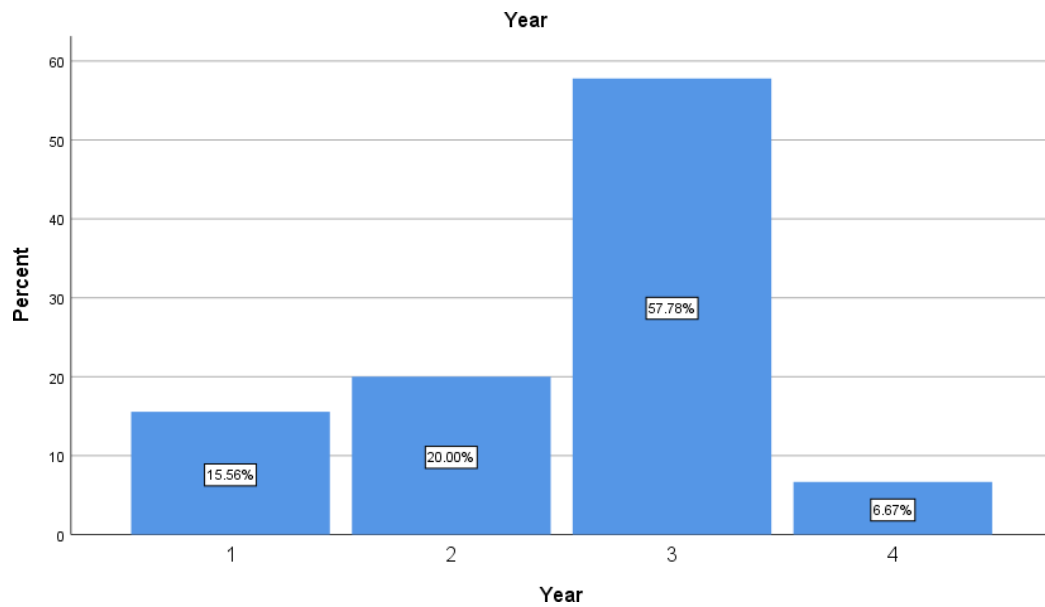
Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	29	64.44	64.44	64.44
	Male	16	35.56	35.56	100.00
	Total	45	100.00	100.00	



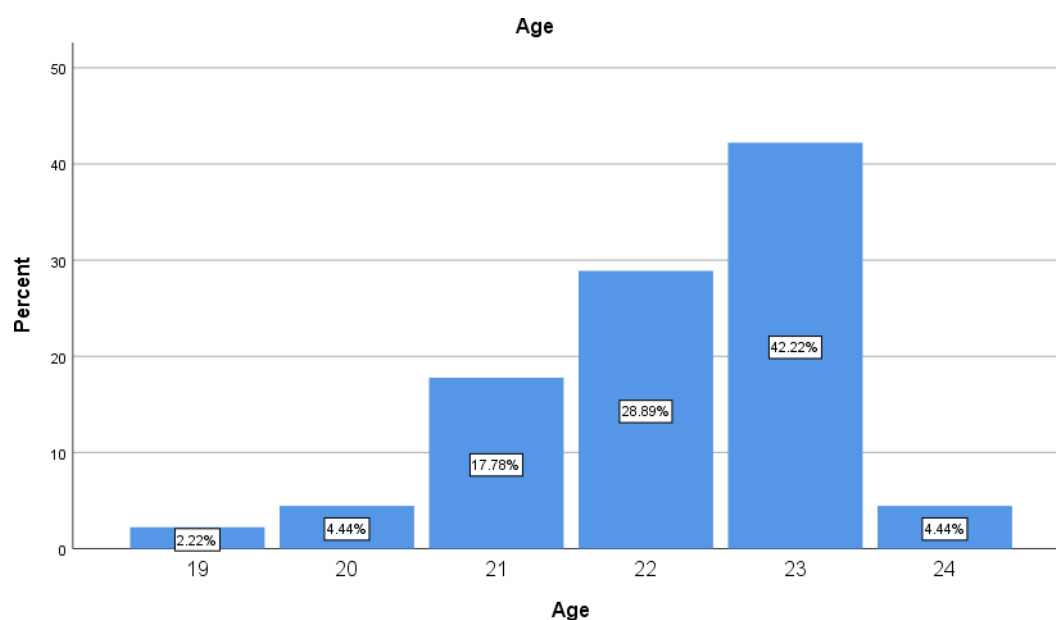
2. Year of Study (Frequency Table and Bar Chart)

<i>Year</i>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	7	15.56	15.56	15.56
	2	9	20.00	20.00	35.56
	3	26	57.78	57.78	93.33
	4	3	6.67	6.67	100.00
	Total	45	100.00	100.00	



3. Age (Frequency Table and Bar Chart)

<i>Age</i>					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19	1	2.22	2.22	2.22
	20	2	4.44	4.44	6.67
	21	8	17.78	17.78	24.44
	22	13	28.89	28.89	53.33
	23	19	42.22	42.22	95.56
	24	2	4.44	4.44	100.00
Total		45	100.00	100.00	

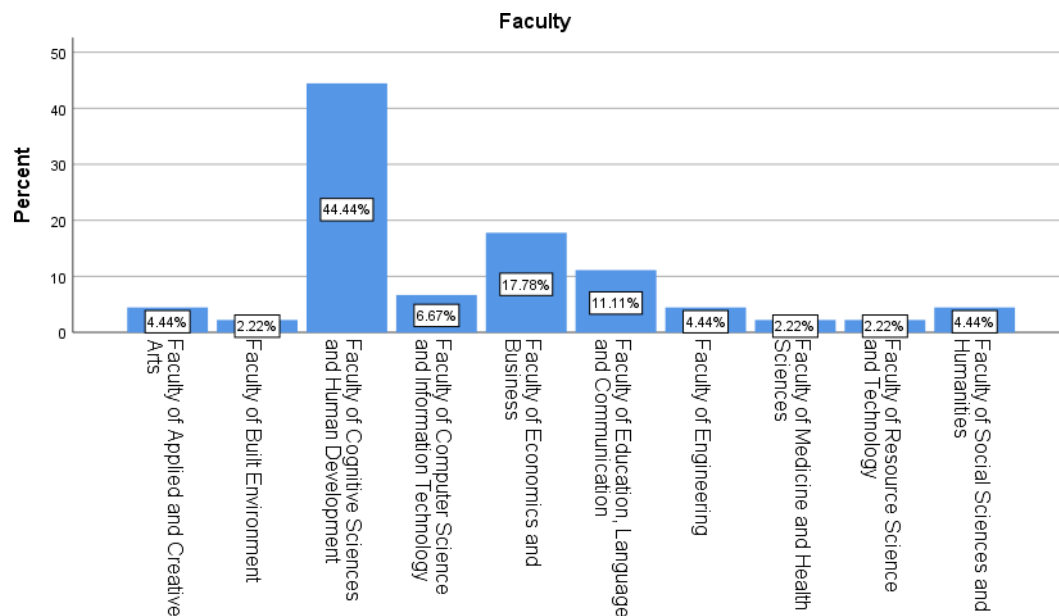


4. Faculty (Frequency Table and Bar Chart)

Faculty

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Faculty of Applied and Creative Arts	2	4.44	4.44	4.44
	Faculty of Built Environment	1	2.22	2.22	6.67
	Faculty of Cognitive Sciences and Human Development	20	44.44	44.44	51.11
	Faculty of Computer Science and Information Technology	3	6.67	6.67	57.78
	Faculty of Economics and Business	8	17.78	17.78	75.56
	Faculty of Education, Language and Communication	5	11.11	11.11	86.67
	Faculty of Engineering	2	4.44	4.44	91.11
	Faculty of Medicine and Health Sciences	1	2.22	2.22	93.33

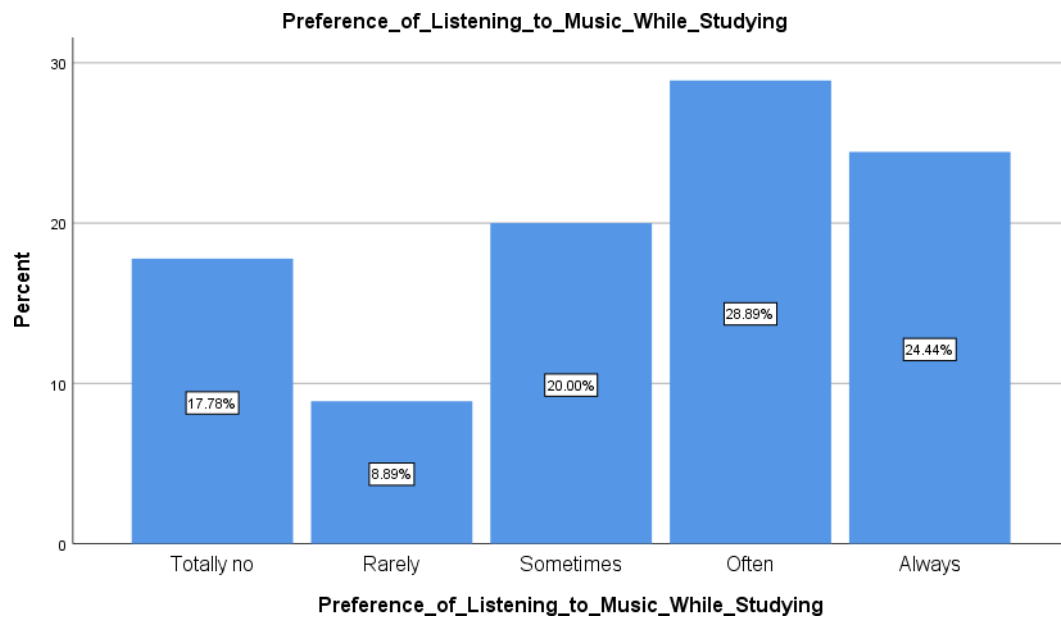
Faculty of Resource Science and Technology	1	2.22	2.22	95.56
Faculty of Social Sciences and Humanities	2	4.44	4.44	100.00
Total	45	100.00	100.00	



5. Participants' Preference of Listening to Music While Studying (Frequency Table and Bar Chart)

Preference of Listening to Music While Studying

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Totally no	8	17.78	17.78	17.78
	Rarely	4	8.89	8.89	26.67
	Sometimes	9	20.00	20.00	46.67
	Often	13	28.89	28.89	75.56
	Always	11	24.44	24.44	100.00
	Total	45	100.00	100.00	



B. Normality Test (Descriptive Data, Test of Normality, Normal Q-Q Plot)

Descriptives

			Statistic	Std. Error
VerbalResults	Mean		.5907	.03134
	95% Confidence Interval for Mean	Lower Bound	.5275	
		Upper Bound	.6538	
	5% Trimmed Mean		.5976	
	Median		.6100	
	Variance		.044	
	Std. Deviation		.21022	
	Minimum		.00	
	Maximum		.94	
	Range		.94	
	Interquartile Range		.30	
	Skewness		-.404	.354
	Kurtosis		.175	.695
VisualResults	Mean		.6544	.01754
	95% Confidence Interval for Mean	Lower Bound	.6191	
		Upper Bound	.6898	
	5% Trimmed Mean		.6566	
	Median		.6700	
	Variance		.014	
	Std. Deviation		.11768	
	Minimum		.44	

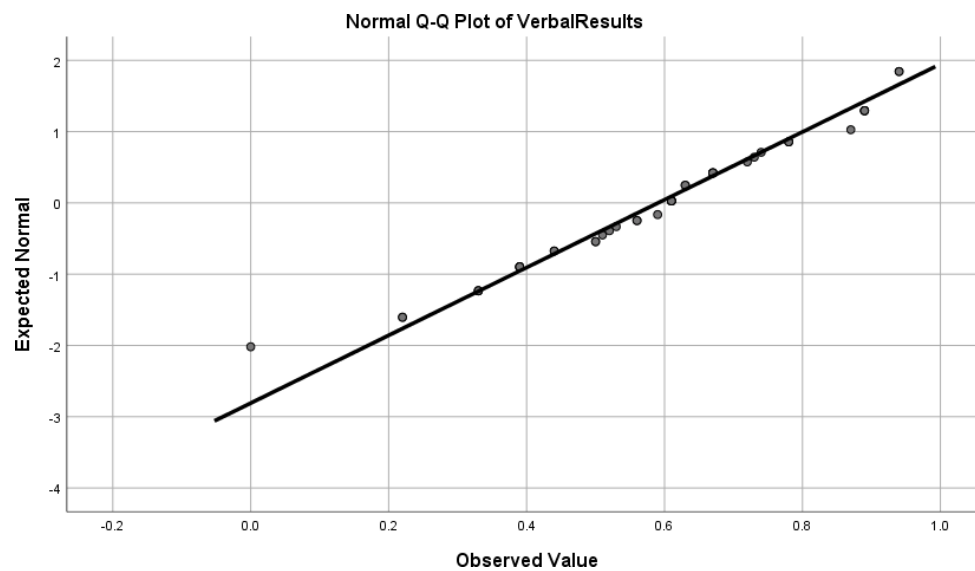
Maximum	.83	
Range	.39	
Interquartile Range	.22	
Skewness	-.150	.354
Kurtosis	-1.013	.695

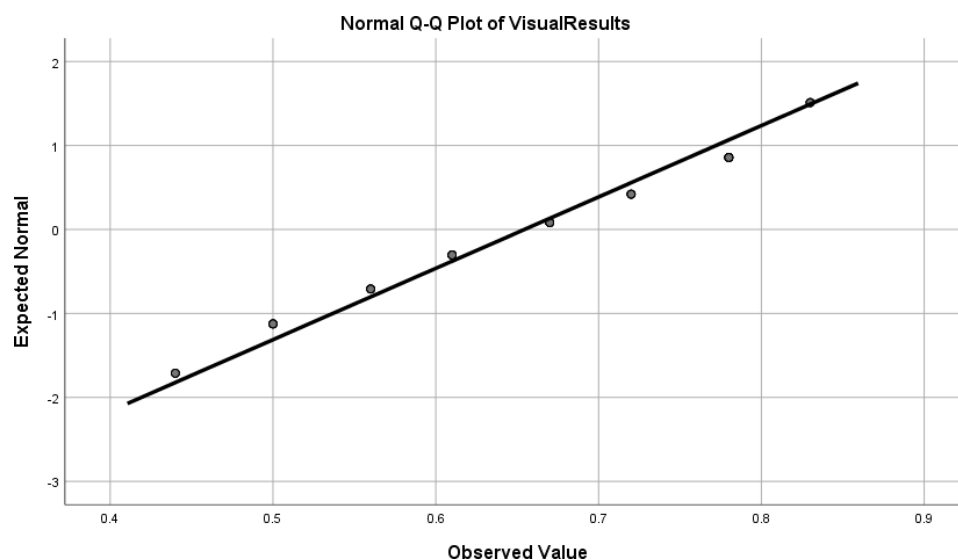
Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
VerbalResults	.092	45	.200*	.971	45	.309
VisualResults	.124	45	.082	.942	45	.025

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction





C. Inferential Data

1. One-way ANOVA (Mean & Standard Deviation, One-Way ANOVA, Post Hoc)

Report

VerbalResults

<u>Condition</u>	<u>N</u>	<u>Mean</u>	<u>Std. Deviation</u>
Vocal Music	15	.7127	.17236
Instrumental Music	15	.5707	.19159
No Music	15	.4887	.21203
Total	45	.5907	.21022

ANOVA

VerbalResults

	<u>Sum of Squares</u>	<u>df</u>	<u>Mean Square</u>	<u>F</u>	<u>Sig.</u>
Between Groups	.385	2	.193	5.190	.010
Within Groups	1.559	42	.037		
Total	1.944	44			

Multiple Comparisons

Dependent Variable: VerbalResults

Tukey HSD

					95% Confidence Interval	
(I) Condition	(J) Condition	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Vocal Music	Instrumental Music	.14200	.07035	.120	-.0289	.3129
	No Music	.22400*	.07035	.008	.0531	.3949
Instrumental Music	Vocal Music	-.14200	.07035	.120	-.3129	.0289
	No Music	.08200	.07035	.480	-.0889	.2529
No Music	Vocal Music	-.22400*	.07035	.008	-.3949	-.0531
	Instrumental Music	-.08200	.07035	.480	-.2529	.0889

*. The mean difference is significant at the 0.05 level.

2. Kruskal-Wallis H Test (Mean & Standard Deviation, Mean Rank, Kruskal-Wallis H)

Report

VisualResults

Condition	N	Mean	Std. Deviation
Vocal Music	15	.6600	.11753
Instrumental Music	15	.6667	.10841
No Music	15	.6367	.13200
Total	45	.6544	.11768

Ranks

	Condition	N	Mean Rank
VisualResults	Vocal Music	15	23.30
	Instrumental Music	15	24.20
	No Music	15	21.50
	Total	45	

Test Statistics^{a,b}

<u>VisualResults</u>	
Kruskal-Wallis H	.335

df	2
<u>Asymp. Sig.</u>	<u>.846</u>

a. Kruskal Wallis Test

b. Grouping Variable: Condition

APPENDIX B

MATERIALS/INSTRUMENT

1. Informed Consent Form and Google Form

Participants Recruitment for Final Year Project (FYP)

Greetings to all! I am Kelly Lee Ying Ying (79753), a 3rd year undergraduate student from Bachelor of Psychology (Honours) program in Universiti Malaysia Sarawak (UNIMAS). I am recruiting participants for my final year project titled "**The Influence of Music on Working Memory Performance**". This study is under the supervision of Enck Mohamad Azhari Bin Abu Bakar.

The Purpose of the Study
To investigate the difference between **music groups** (vocal music, instrumental music, no music) on **verbal and visual working memory performance** based on total correct recall.

Participants Needed
45 undergraduate students from UNIMAS

What are involved in this study?

- You are required to complete 2 tests: Reading Span Task and Matrix Span Task.
- You will be randomly assigned to control group (no music played while completing the tests) or one of the treatments groups (vocal music/ instrumental music played while completing the tests).
- The whole session will be approximately 25-35 minutes.

Confidentiality
All personal details collected in this research will be kept confidential. While information gained in this study may be used in a conference presentation, and may also be published in a journal article, you will not be identified.

Voluntary Participation
Your participation in this study is voluntary. It is up to you to decide whether to take part in this study. If you decide to take part in this study, you will be asked to agree to a consent form. After you agree the consent, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

For more inquiries or further information, you may contact:
Email: 79753@siswa.unimas.my
Phone Number: 016-8662910

[Sign in to Google](#) to save your progress. [Learn more](#)

* Indicates required question

Email *

Your email

Consent *

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I voluntarily agree to take part in this study. I understand that study investigators, qualified monitors and auditors, the sponsor or its affiliates, and governmental or regulatory authorities may have access to my records to ensure the study's integrity and data accuracy. All personal information will be treated as STRICTLY CONFIDENTIAL.

☐ Yes, I agree

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Participants Recruitment for Final Year Project (FYP)

kelly.jyy0505@gmail.com [Switch account](#)



* Indicates required question

Demographic Information

Matric Number *

Your answer

Gender *

- ☐ Male
☐ Female

Year *

- ☐ 1
☐ 2
☐ 3
☐ 4
☐ 5

Age *

- ☐ 18
☐ 19
☐ 20
☐ 21
☐ 22
☐ 23
☐ 24
☐ 25
☐ Other:

Faculty *

- ☐ Faculty of Cognitive Sciences and Human Development
☐ Faculty of Computer Science and Information Technology
☐ Faculty of Economics and Business
☐ Faculty of Engineering
☐ Faculty of Applied and Creative Arts
☐ Faculty of Medicine and Health Sciences
☐ Faculty of Resource Science and Technology
☐ Faculty of Social Sciences and Humanities
☐ Faculty of Built Environment
☐ Faculty of Education, Language and Communication

Music and Preference

Please choose the scale that best describes your situation.

5 - Always
4 - Often
3 - Sometimes
2 - Rarely
1 - Totally no

Do you listen to music while studying? *

- | | 1 | 2 | 3 | 4 | 5 |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Totally no | ☐ | ☐ | ☐ | ☐ | ☐ |
| Always | | | | | |

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kelly.lyy0505@gmail.com [Switch account](#)



* Indicates required question

Time Slot Selection

Location: PeTARY Discussion Room (The researcher will inform the exact room number to you through WhatsApp an hour before your slot)

Day and Time: Please select the time slot available (You may choose more than one. The exact day and time will be informed later based on your selection.)

Contact Number *

Your answer

Time Slot (You may choose more than one) *

- ☐ Monday 9am - 12 noon
- ☐ Monday 1pm - 5 pm
- ☐ Tuesday 1pm - 5 pm
- ☐ Wednesday 9am - 12 noon
- ☐ Wednesday 1pm - 5 pm
- ☐ Thursday 9am - 12 noon
- ☐ Thursday 1pm - 5 pm

Thank You!

A copy of your responses will be emailed to the address you provided.

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[Submit](#)

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Google Forms

2. Reading Span Task



Welcome and thank you for your participation!

This part of the experiment consist of doing two tasks, A and B, at the same time. Good performance on both is important. Before the real test starts, you will have a chance to first practice both of the tasks separately, then both of them at the same time. On-screen instruction will tell you what to do.

All instructions will be presented in blue while stimuli will be presented in black.

Please read all instructions carefully and if at any point you have questions, please ask the experimenter.

Continue



Task A focuses on retaining a series of letters in memory for later recall. When the recall prompt is presented, choose letters in the order in which they were presented. If you forgot a particular letter, hit the blank box. The recall prompt will also allow you to reset your answer and start over. After you provide the answer you will be presented with the results (green = correct, red = incorrect).

Continue



Task B focuses on judging if English language sentences makes sense. You will be presented with one sentence at a time and be able to choose between "Correct" and "Incorrect." Below are examples of correct and incorrect sentences.

John was asked to sit on a chair. (correct)
John was asked to sit on a marmalade. (incorrect)

Your overall accuracy will be displayed in red in the top-right corner of the recall prompt screen. It is imperative that you answer as QUICKLY and ACCURATELY as possible. For our purposes we will not be able to use data with accuracy below 85%. Please try not to fall below that threshold.

Continue





The new government decided to stone all criminals that committed socks.

Incorrect Correct



Y



F L P

0%

F	H	J	K
L	N	P	Q
R	S	T	Y

Start over Backspace Ok





F L P



3. Matrix Span Task

Matrix Span

Instructions

Presentation Phase

This is the **matrix span** task. This task is a simple visuo-spatial memory task. You will be shown a 4x4 matrix in the center of the screen. A number of the grids in this matrix will **turn blue** one at a time (between 2 and 7 grids in any one trial). Image one shows an example of what the matrix looks like while one of the grids is coloured.

TRIAL
1

PRESENTED

USER
finalTester

You need to remember the grids that you are presented with in the **correct order** that they were presented.

Recall Phase

After you have been shown the grids to remember you will be presented with an empty grid that you can use to input your response. Simply **click the grids in the order** you remember seeing them light up.

▶ Next

You need to remember the grids that you are presented with in the **correct order** that they were presented.

Recall Phase

After you have been shown the grids to remember you will be presented with an empty grid that you can use to input your response. Simply **click the grids in the order** you remember seeing them light up. Once you click a grid it will change colour to indicate you have selected it. Image two shows an example of what the task looks like while somebody is midway through inputting their response.

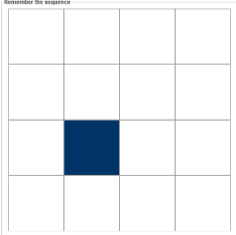
TRIAL
1

PRESENTED

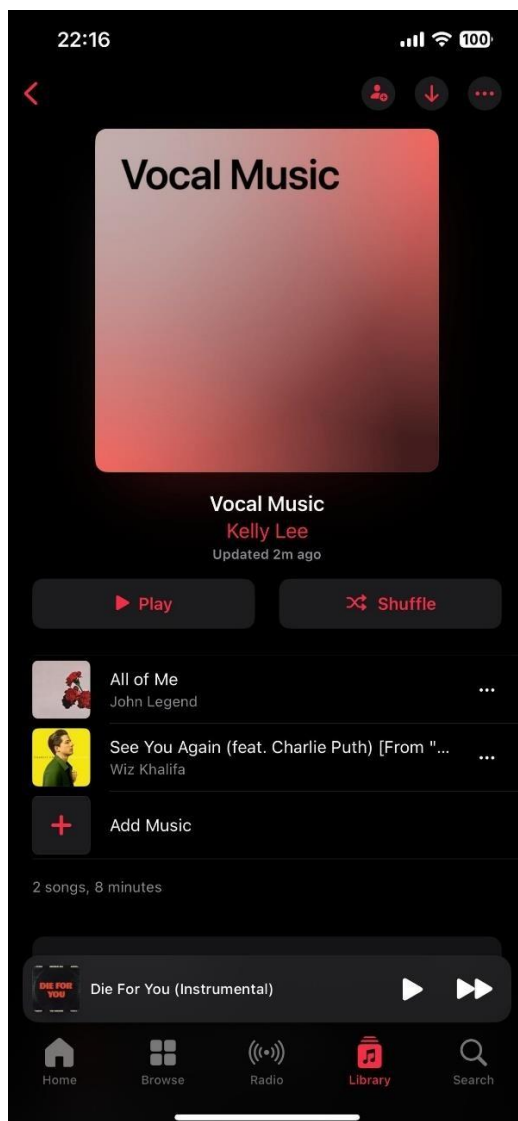
USER
finalTester

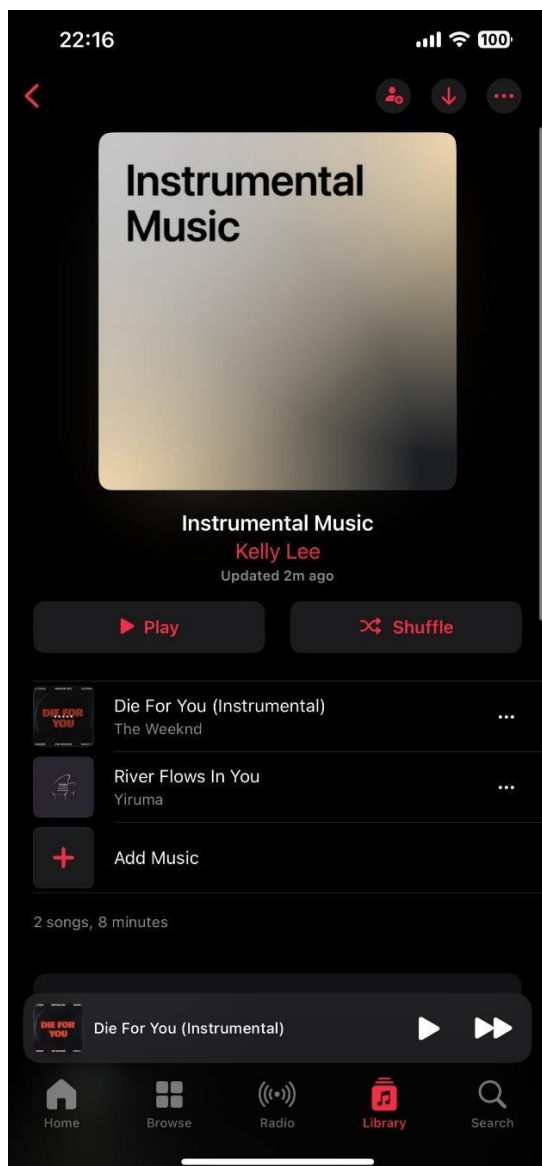
Press the **right arrow key** on your keyboard to start the task.

▶ Next

TRIAL 1	FEEDBACK	User Kelly
Remember the sequence Remember the sequence 		

4. Vocal Music and Instrumental Music





APPENDIX C

TURNITIN SIMILARITY INDEX

The screenshot displays the Turnitin Feedback Studio interface. The main document area shows an abstract with several sentences highlighted in red, indicating matches with sources. The similarity index is 19%. The right sidebar shows a list of matched sources with their respective similarity percentages.

ABSTRACT

This study aimed to investigate the influence of music on working memory performances based on total correct recalled. Several past research have shown that different types of music have different influence on verbal and visual working memory. 45 participants from the undergraduates' students of Universiti Malaysia Sarawak (UNIMAS) have participated in the study and performed Reading Span Task and Matrix Span Task to assess verbal and visual working memory performance. One-way ANOVA and Kruskal-Wallis H Test were used to test the hypothesis. The result of this study showed that there is a significant difference between the music groups in verbal working memory performance based on total correct recalled while there is no

Match Overview

19%

Rank	Source	Similarity
1	ir.unimas.my Internet Source	5%
2	Susan Hallam, Evangel... Publication	1%
3	gitlab.pavlovvia.org Internet Source	<1%
4	"Proceedings of the 21... Publication	<1%
5	eprints.utar.edu.my Internet Source	<1%
6	arizona.openrepository... Internet Source	<1%
7	Jiayi Hao, Yuhuan Zho... Publication	<1%
8	Submitted to University... Student Paper	<1%

Page: 1 of 54 Word Count: 11337 Text-Only Report High Resolution On