THE EFFECT OF RHYTHMIC PATTERN ON SHORT TERM MEMORY OF 10 DIGIT RECALL BETWEEN MUSIC AND NON-MUSIC UNDERGRADUATE STUDENTS

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ABSTRACT

Contentious issues on the perception of musical elements such as melody as a mnemonic device on verbal memory has been widely discussed particularly in the field of education and clinical used. However, research focused on the effect of rhythm, notably on the various type of rhythmic patterns have not fully discovered yet, hence this research attempts to fill the gap in the literature, by testing rhythmic patterns on verbal memory of the recall of ten digit numbers and whether there is a difference between music and non-music major undergraduate students. Methodology included a recall test with 6 sets of 10 digit number and two attempts were given for each rhythmic pattern: no rhythmic pattern, dotted rhythm, inverted dotted rhythm, long short rhythm, short long rhythm and triplets rhythm. Sixty undergraduate students were recruited for this study; thirty musicians from music faculty and thirty non-musicians from non-music faculty. Meanwhile, data were analyzed using SPANOVA. Results revealed that there was a significant difference in 10 digit number recall when the digit is presented with dotted rhythm on 1st attempt [F (df = 1, 118) = 104.47, p < .05)] and 2nd attempt [F (df = 1, 118) = 127.27, p < .05)], inverted dotted rhythm on 1st attempt [F (df = 1, 118) = 19.66, p < .05)] and 2nd attempt [F (df = 1, 118) = 75.73, p < .05)], long short rhythm on 1st attempt [F (df = 1, 118 p < .05) = 34.04] and 2nd attempt [F (df = 1, 118) = 56.13, p < .05)], short long rhythm on 1st attempt [F (df = 1, 118) = 21.98, p < .05)] and 2nd attempt [F (df = 1, 118) = 55.81, p < .05)], triplet rhythm on 1st attempt [F (df = 1, 118) = 9.63 p < .05)] and 2nd attempt [F (df = 1, 118) = 16.54, p < .05)]. Furthermore, There was a significant difference in 10 digit numbers recall between musicians and non-musicians on their short term memory with the aid of different rhythmic patterns on 1st attempt [F (df = 3.6, 206.92) = 5.68, p < .05)] and 2nd attempt [F (df = 1, 58,) = 2.78, p < .05]. Finally, research question 2 was answered using the ANOVA test and result

indicated there was a significant contrast of different rhythmic patterns on 10 digit numbers recall on 1st attempt [(df = 4, 295) = 17.809, p < .05)] and 2nd attempt [(df = 4, 295) = 10.507, p < .05]. The finding implied that rhythmic patterns aid in digit recalling and the process of rehearsal enhances verbal working memory on both musicians and non-musicians, however musicians scored better as compared to non-musicians according to the result.

ABSTRAK

Perbalahan untuk isu-isu pada persepsi elemen muzik seperti melodi sebagai peranti mnemonik dalam memori lisan telah dibincangkan secara luas terutamanya di bidang pendidikan dan klinikal. Walau bagaimanapun, penyelidikan yang memberi tumpuan kepada kesan irama, terutamanya pelbagai jenis corak irama belum ditemui sepenuhnya lagi. Oleh itu, kajian ini cuba untuk mengisi jurang dalam kesusasteraan, dengan menguji corak irama pada memori lisan tentang mengingat kembali sepuluh nombor digit dan ingin mencari perbezaan antara pelajar sarjana muda muzik dan bukan muzik. Metodologi hanya termasuk ujian peringatan kembali dengan 6 set 10 nombor digit dan dua percubaan diberi untuk setiap corak irama: irama tiada rentak, irama bertitik, irama bertitik terbalik, irama panjang pendek, irama panjang pendek dan irama tiga serangkai. Enam Puluh pelajar sarjana muda terpilih sebagai responden dalam penyelidikan ini:- tiga puluh pemuzik dari fakulti muzik dan tiga puluh bukan pemuzik dari fakulti bukan muzik. Sementara itu, data dianalisis dengan menggunakan SPANOVA bagi persoalan kajian 1 dan 3. Hasil kajian menunjukkan bahawa terdapat perbezaan yang ketara dalam 10 nombor digit mengingat kembali apabila nombor digit telah dibentangkan dengan irama bertitik pada kali yang pertama [$F (df = 1, 118) = 104.47, p < .05$)] dan kali yang kedua [$F (df = 1, 118) = 127.27, p < .05$)], irama bertitik terbalik pada kali yang pertama [$F (df = 1, 118) = 19.66, p < .05$)] dan kali yang kedua [$F (df = 1, 118) = 75.73, p < .05$)], irama pendek dan panjang pada kali yang pertama [$F (df = 1, 118\ p < .05) = 34.04$] dan kali yang kedua [$F (df = 1, 118) = 56.13, p < .05$)], irama pendek dan panjang terbalik pada pertama kali [$F (df = 1, 118) = 21.98, p < .05$)] dan kali yang kedua [$F (df = 1, 118) = 55.81, p < .05$)], irama triplet pada kali yang pertama [$F (df = 1, 118) = 9.63\ p < .05$)] dan kali yang kedua [$F (df = 1, 118) = 16.54, p < .05$)]. Selain itu, terdapat perbezaan yang ketara dalam 10 nombor digit mengingat kembali antara

pemuzik dan bukan pemuzik dalam memori jangka pendek mereka dengan bantuan corak irama berbeza pada percubaan pertama [F (df = 3.6, 206.92) = 5.68, p < .05)] dan percubaan kedua [F (df = 1, 58,) = 2.78, p < .05]. Tambahan lagi, persoalan kajian 2 telah menjawab dengan menggunakan ujian ANOVA dan keputusan menunjukkan terdapat perbezaan yang ketara bagi corak irama yang berbeza pada 10 nombor digit mengingat kembali pada percubaan pertama [(df = 4, 295) = 17.809, p < .05)] dan percubaan kedua [(df = 4, 295) = 10.507, p < .05]. Akhirnya, kajian ini menentukan bahawa rentak membantu dalam mengingat angka dan proses latihan meningkatkan memori antara pemuzik dan bukan ahli muzik, tetapi kajian menunjukkan bahawa pemuzik mempunyai keputusan yang lebih baik berbanding dengan bukan ahli muzik.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

Despite music having a remarkable capacity to enhance a person's sensory memory in remembering information due to its elements such as rhythm and melody where those elements are able to shape and organize as well as chunk information into meaningful phrases and patterns verbally (Dowling, 1973; Wallace, 1994), the idea of using musical elements to improve verbal memory seems to remain unpopular. Yet, mnemonic device is still the preferred choice in dealing with memory training programme.

An experiment solely involved short term memory is performs to clarify the nature of rhythmic pattern. The objective of this study was to test the effect of different rhythmic patterns upon verbal memory. Five types of different rhythmic patterns: dotted rhythm, inverted dotted rhythm, triplets, long short rhythm, short long rhythm and non-rhythmic series were used as experimental variables. Selected rhythmic patterns were designed using binary tone sequence in 3 bars for each rhythmic pattern. The material consisted only a set of 10 digits numbers formed from the digit from 0- 9 excluding "7" arranged horizontally, for example, 196852342. Pairing numbers in sequence was restricted as it is easier to recall and it may affect the final results. Language used is also being considered; English is adopted as it is commonly used in Malaysia, besides being a universal language.

Rhythmic pattern was manipulated as an independent measure and dependent variable was short term memory, a total of 60 respondents consisting of 30 musicians and 30 non-musicians. Gender ratio would not be addressed in this study. In the study phase, participants were instructed to write down as many numbers as they could remember after listening to each set of number. A period of 15-30 seconds was given to

write down as to fulfil the laws of short term memory and the entire experiment would require approximately 20 minutes.

Three null hypotheses presented in this research were discussed. Firstly, there will be no significant difference with or without the existence of rhythm. Secondly, there will be no significant difference in the recall of phone number when the number is presented using different rhythmic patterns in undergraduate students. Lastly, there will be no significant difference of musicianship on phone number recall in undergraduate students. A further detailed background on memory process, rhythm and mnemonic device would be elucidated in background of study.

1.2 Background of Study

Short term memory (STM) has a short lifespan, according to Atkinson and Shiffrin (1968), between 15-30 seconds, limited capacity or space in storing information as well as the length of retention (Baddeley, 1986; Gazzaniga, et al, 2009). The capacity of human's brain can only store approximately 7 items, plus or minus 2 in hippo campus at once in short term memory are then given a name as the magic number 7 (Miller, 1956). Information would decay unconsciously after the limited time length given in short term memory although it could be kept under a process of named rehearsal by the technique of repetition (Gazzaniga et al., 2009). Cowan (1995) stated that not all information stored in short term memory are active knowledge as short term memory's storage is very fragile.

Short-term memory is usually stored and retrieved sequentially such as phone number, addresses, names, dates, direction (McLeod, 2007). Information transfer from short term memory (STM) to long-term memory (LTM) is a routine in daily life (Martin & Lesch, 1998; Burgess & Hitch, 1999). Therefore, long-term memory (LTM) relies on short-term memory, once short term memory is affected, long-term memory would be altered as well (Lewis-Smith, 1975). Baddeley and Hitch (1974) stated working

memory includes in short term memory as a subcomponent which comprised of the phonological loop; phonological store as an inner ear and articulatory control process as an inner voice, visuospatial sketchpad as an inner eye as well as central executive. Phonological loop is believed to function with spoken and written material. The items in first component called the "phonological short-term store" would decay unconsciously in auditory memory however the second component, called the "articulatory control process," is able to maintain items in auditory memory through active rehearsal. According to Baddeley, Henson, Hartley, Burgess, Hitch, & Flude, once information enter phonological store, items would be stored in a correct sequence and transfer to articulatory process acting as an "inner voice". Information is repeated in this process in order to decompose (as cited in Grahn & Schuit, 2012, p. 105-106).

An array of literature review showed the effect of musical elements on verbal memory (Sloboda, 1985; Yalch, 1991; Wolfe & Horn, 1993; Wallace, 1994; Snyder, 2001; Smith & Phillips, 2001; Rainey & Larsen, 2002; Oakes & North, 2006; Thaut, et al., 2008; Curtis & Bharucha, 2009; Silverman, 2010) the role of rhythm in education (Wallace, 1994; Fitch & Rosenfeld, 2007; Farrell 2008; Hayes, 2009) where rhythm is believed to group a large amount of information into smaller units by chunking information (Dowling, 1973; Wallace, 1994; Davis, et al., 2008) and its advantage in clinical populations (Vink, et al., 2003; Kim, 2010; Moussard, et al., 2014). As a result, the effect of rhythmic patterns on short term verbal memory shows an area of interest that has yet to be discussed in music-related literature. Future research should be done to support if optimal result are able to confirm later.

Furthermore, issues on the 'problem of serial order' (Lashley, 1951) such as how to recall the correct order or sequence of numbers, letters, alphabetical orders, sentences in novel are successfully deal with the three main basic theories in serial order: chaining,

ordinal and positional theories. Pros and cons of each theory will be discussed in chapter 2.

In context of musical training, studies have shown some evidence in support of this theory with positive impacts (Chan, et al., 1998; Kilgour, et al., 2000; Brandler and Rammsayer, 2003; Ho et al., 2003; Helmbold et al., 2005; Franklin et al., 2008; Cabanac et al., 2013; Nutley et al., 2013). Researchers found out that musicians have a greater left hemispheric activation compared to non-musicians (Bever and Chiarello, 1974; Besson et al., 1994; Ohnishi et al. 2001). The left PT dealing with language and perception of music is located within Wernicke's area. In other words, verbal memory process also takes place in that similar area (Baddeley, Gathercole, & Papagno, 1998; Ohnishi et al., 2001).

In conclusion, minimal research exists regarding the combine effect of rhythm as a mnemonic and musical training on verbal memory. This research provided evidence that may support the effect of different rhythmic patterns between musicians and non-musicians on verbal memory in recalling digits.

1.3 Definition of terms

In this study, a few terminologies should first be defined such as verbal short term memory, rhythm, mnemonic device, musician, which are the keywords used. Short term memory is a general label where further enquiry in terms of verbal short term memory and working memory pertaining to this study is explained in the following section.

Musician

Rhythm – Number – Working memory (Short term memory)

Non-musician

1.3.1 Verbal short term memory (AVSTM)

In this study, the term digit recall is used to reflect verbal short term memory that deals with the subcomponent of working memory named as phonological loop shown in the working memory model by Baddeley and Hitch (1974). The phonological loop functions with spoken and written material which comprises two components; phonological store and articulatory control process. The phonological store acts as an inner ear holds spoken material such as phone number for 1-2 seconds. Rhythmic sequence passes through articulatory control process termed as the inner voice from the phonological store where it is rehearse and store however it would be decay automatically if failed to enter the process.

1.3.2 Rhythm in terms of musical elements

Rhythm is one of the most essential elements in music, as if the pulse rate in human body. Nandi (1989) urged that without rhythm, music would not be alive. Some scholars describe the value of rhythm by giving examples that relate with natural phenomena like sun and wind and basic activities in human's life (Nash, 1974).

In music, scholars presented the same idea that rhythm is the main design of time in music (Meyer & Cooper, 1960; Taylor, 1989; Nandi, 1989; Kamien, 1996) though McAuley (2010) stated rhythm could be described in two ways; sound pattern or the perception of that pattern. As regards to the sound pattern, rhythm is the core element in controlling the flow of time apart from the existence of tempo. With respect of perception, rhythm has a natural feeling of movement in time (Fraisse, 1963; Lerdahl & Jackendoff, 1983; McAuley, 2010).

More precisely, rhythm is one or more groups of unaccented beats in relation to an accented (Meyer & Cooper, 1960). It also occurs within the structure of meter by recurring patterns of strong and weak beat; hence meter was moulded by the regular

groups of beats. There are several types of meter; duple, triple, quadruple, sextuple, quintuple and septuple meter. Each name was given according to the beats in a measure such as duple meter will be groups of 2 beats and so on.

Rhythmic patterns can be divided into few types; dotted rhythm, long short rhythm, triplets, syncopation and etc. In this research, dotted rhythm, long short rhythm and triplets are defined in turn for readers. Generally, dotted rhythm is formed by two parts. The first beat would be a dotted note, follow by an extra note to complete the rhythm in every measure. Dotted note is designed by adding a dot next to the note head and it changes the duration of a note by adding half the value of the note. The accent occurs on the dotted note in every measure; however it is then in reverse when comes to an inverted dotted rhythm. Accent would fall on the first note and follow by tenuto played on the second note. Triplet is shaped within a curved line with the numeral 3 and formed by 3 even notes. The value of triplets only last by the first two equal notes and accent normally falls on the first note of three. However, beats made up by long and short beats in a measure are given the name long-short rhythm and same goes with the rhythm of short long rhythm.

1.3.3 Mnemonic device

Forgetting seems to be an inevitable behaviour in the human's brain. To overcome this matter, several studies have been done since 20th century as to boost the human's natural ability by creating beneficial methods or techniques used. There are some general skills for improving memory apart from using mnemonic device.

The process of memory posits 3 levels; encode, store and recall. Terms and conditions in the process of encoding were listed by Higbee (2007) and Mastropieri & Scruggs (1998). First, enhance attention by using strategies such as make use of interesting activities as an aid to reinforce attention. Secondly, organization is required in such promote external memory by writing down in notebook or keeping text in cell

phone as to refer when necessary. Thirdly, identify main point so as to reduce interference to produce a direct and prompt recall. Furthermore, transforms meaningfulness information into significant idea and turn it into part of experience in life is essential. The use of pictures, music or draw chart as an aid to recall via the method of visualization as well as promote active manipulation by experience it yourself in specific events or story by given the term association or most commonly known as the loci method. Brown (2006) shown the best example by elucidates Shakespeare's plays using the idea of walking through the Globe theatre.

Apart from the few categorizes as mentioned earlier, Mastropieri & Scruggs (1998) added, repetition does an important role in memory as well. Back to the 1500s, "practice makes perfect" a famous quote by John Adams indicated the more practice you do, the more perfect you are, same goes to memory. However when comes to memorize new facts, active reason is needed rather than repeating though rote learning does helps in memory process.

Mnemonic, used as a teaching aid especially in subjects such as history, science and foreign language (Mastropieri & Scruggs, 1991) split into 3 types; letter strategy, keyword and pegword (Kleinheksel & Summy 2003; Roediger, 1980). The letter name strategy consists of acronyms such as 'NBA' represents National Basketball and acrostics; 'HOMES' usually used in an order to indicate the five great lakes of North America: Huron, Ontario, Michigan, Erie and Superior. Keyword method is most widely used mnemonic devise among all. Mastropieri & Scruggs (2000) classified this method into 3 steps; first is to transform new terms into physical objects auditory, pick out keyword from new terms and relate it with a collaborative picture, lastly recall according to specific pictures. This method is prominent in language teaching as well as subjects with science contents.

As regard to recall information specifically for numbering, pegword and chunking are preferred. Number in pegword method is associated with interactive picture such as bun refers to the number of one, two will be shoe and three closely link with tree (Mastropieri & Scruggs, 1991). According to Schumaker et al. (1998), there are 4 steps to go through in creating pegword. Firstly, list out numbers and place in an order, connect with certain pictures and select the necessary items to be retrieved in an accurate order. Link each item with the list prepared earlier and combine the pictures one by one. Higbee (2007, p. 172) added, linking numbers with consonant alphabetical usually could be used as well. This method calls the 'phonetic mnemonic'.

The other common way when recalling numbers will be chunking method. This method reduces numbers from a group of sixteen digits to a few subgroups, each subgroup contain 4 digit numbers (Brower, 1993, p. 22). As stated earlier, short term memory is merely able to hold 5 to 9 numbers at once, in order to make it more effective during the memory process; chunking method is used here as to reduce the large amount of numbers holding at once.

1.3.4 Musicians

In the study, musicians need to fulfil the following requirements: individuals began learning an instrument since young, currently taking formal instrumental or vocal lessons in university, majoring in music at the university level (Franklin et al., 2008) and must perform once in a formal occasion before.

1.3.5 Non-musicians

As for non-musicians, they may not have little to any musical experience or been engaged in less than two years of self-taught instruction (Jakobson et al., 2008).

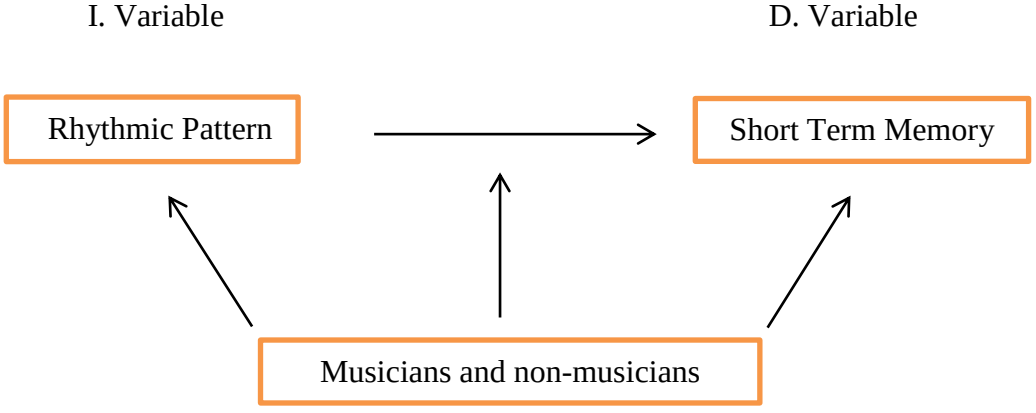
1.4 Problem Statement

This research came with a few problem statements arising from the available literature. There was an absence of research testing the effect of digit recalls using rhythmic pattern as an aid. Subsequently, there was no information as to whether different rhythmic pattern may deliver different result when it was used as an aid for digit recall.

1. No information on the effect of rhythmic pattern applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians.
2. No information on the effect among five different rhythmic patterns applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians.
3. No information between the combinations of rhythmic mnemonic and musicianship on sequential 10 digit numbers recall performance.

Hence, this research also challenged the question of whether there was a difference between music-major and non-music major students when a test for digit recall based on using rhythmic pattern as an aid for memory was carried out. It provides new evidence in this field of musical and psychological studies, and fills the gap in the body of language regarding the relationship between rhythmic pattern and short term memory.

Figure 1.1 shows that conceptual framework of this study.



Types of respondents

Figure 1.1: Conceptual framework of the study

The independent variable was formed by 6 different types of rhythmic patterns which are long short rhythm, short long rhythm, triplets, dotted rhythm, inverted dotted rhythm and no rhythmic pattern. Short term memory was chosen as dependent variable in this experiment and meanwhile respondents were undergraduates with a mixture of musicians and non-musicians in which they were divided into two group in this experiment; treatment group vs. control group. According to the chart above, short term memory performed as dependent variable gave an impact on the level of memory of respondents and the rhythmic pattern may influence respondents on memory as well. Moreover, there is a significant relationship between independent and dependent variable meanwhile musicians and non-musicians played a role as types of respondents are expected to have differences in their short term memory aside from rhythmic patterns. In addition, the type of respondents possibly would influence the relationship between rhythmic pattern and short term memory of the respondents.

1.5 Research Objectives

This study looked into the application of rhythmic pattern in the announcement of a 10-digit number, and tested on the effect rhythmic pattern in improving short term memory on the recall of numbers. This research also investigated whether there are any differences between musicians, who have knowledge in music and non-musicians, who have no background and training in music. In addition, whether there are any differences in the effect of short term memory in different rhythmic patterns. The following research objectives are the aims of this study:

1. To study the effect of rhythmic pattern applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians
2. To examine the differences among five different rhythmic patterns applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians.
3. To investigate if there is a significant effect between the combinations of rhythmic mnemonic and musicianship on sequential 10 digit numbers recall performance.

1.6 Research Questions and null hypothesis

This research addressed the following questions and hypotheses in relation to rhythmic pattern used in working memory.

1. Is there a significant difference of rhythmic pattern on working memory between musicians and non-musicians?

H_o: There will be no significant difference of rhythmic pattern on working memory between musicians and non-musicians.

2. Are there any significant differences among the five different rhythmic patterns on working memory between musicians and non-musicians?

H_o: There will be no significant differences among the five different rhythmic patterns on working memory between musicians and non-musicians.

3. Is there any significant effect of the combinations of rhythmic mnemonic and musicianship on recall performance?

H_o: There will be no significant effect between of the combination of rhythmic mnemonic and musicianship on recall performance.

1.7 Significant of study

This study provided certain relevance in several aspects. The purpose of this study was to find out the effect of rhythmic patterns on memorization and recall of phone

number between musicians and non-musicians in undergraduate students. If recall is easier following a rhythmic aid, this study will show that rhythmic pattern can be effective recall or remember device for young adults and rhythmic mnemonic might be a beneficial tool in academic field in memorizing numbers for exams especially subjects involving numbering such as science and maths at a college level as well as the different level of education in Malaysia.

Moreover, this study provided positive effect in advertisement field either advertisement play on radio or television. If rhythmic pattern has certain effect on memory span, advertisers may add in rhythmic elements when composing particular tune or song used in interpreting phone number as to ease the process of remembering or recalling for radio listener. Despite pictorial memory is more crucial than auditory memory for television viewers, rhythmic patterns may give a support to pictorial memory if the result show rhythmic pattern can be effective in auditory memory.

Furthermore if the outcome shown in this study proven that musicians achieved greater recall of numbers than non-musicians, the effect of musicianship on auditory memory will be supported. This finding may eventually support the importance of music education in Malaysia. Individuals who attended music classes since young or have strong music background might have better auditory memory abilities as to compare with individuals who did not receive proper musical training. Therefore, this study may provide evidence on the importance of music education in Malaysia.

In addition, this research may arouse the effect of musical training on clinical populations with memory deficits such as children with learning disabilities and adult suffer from Alzheimer's disease. If healthy participants could perform better than healthy non-musicians in verbal memory, the idea of using musical elements as a mnemonic device during learning process is strongly recommended to be used in clinical populations as well. Furthermore, if result shows there is a significant

relationship between musical training and musical mnemonics on verbal memory, this study might be able to help children with learning disabilities in their daily life activities. Lastly, the collaboration between music therapist and music education may create a positive effect in both educational and clinical field.

In conclusion, this study provided baseline information for further research in music-related literature, which was the combined effect of musical training and rhythmic pattern on auditory memory. A further support on the combination effect of rhythmic pattern and musicianship on verbal memory in typical and clinical population were needed if the outcome shows optimal effect.

1.8 Limitation of Study

Due to the limitation of time, the present study was limited to a total of 60 undergraduate music students from cultural centre and non-music students from University Malaya. The perimeter of this study merely based on the area of Kuala Lumpur, Malaysia and the university comprises of predominantly Malaysian. This study solely focuses on the correlation of a few rhythmic patterns in short term involving auditory memory. Visual or pictorial memories were excluded in the research. Furthermore, this study did not explore the effect of melodic contour and texture in short term memory. 10 digit dialling number was shaped by number 0 to 9 except the omitted number of 7 as it consists of two syllabus.

1.9 Organization of Study

The present study has five chapters. The first chapter formed the foundation of the study by providing an elementary outline of the entire research, included a brief background of study with explanation for each vital term. Problem statements were clearly stated as why research is done, research questions to be answered, limitation of research and the 5 main objectives were listed as well.

The second chapter reviewed the combination of different sources from internet and books. Literature review includes journal, books and articles regarding topics on music psychology, the effect of musical elements on verbal memory, the problem of serial order and the importance of musical training.

Chapter 3 provided a detailed demographic profile regarding the participants involved in this research, method used in employment and suitable criteria. Experiment design and variables were shown in this chapter as well as materials and measures used to evaluate demographic questionnaire and numbers recall. Research mainly based on quantitative approach, supported by an empirical experiment which procedures were further elucidate and how data were collected and analysed within one year.

In chapter 4, data analyses were done using SPSS (Statistical Package for the Social Sciences) software. SPANOVA and One-way ANOVA tests were selected in order to answer research question 1-3. Each research question was further discussed in details.

Lastly, chapter 5 discussed each research questions in details. Based on the result collected, conclusion was made and suggestions on further research were discussed as well.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This study examined the rhythmic patterns used as an aid to remember or recall 10 digit numbers in short term memory. Theories from music psychology, music education, and music perception were used and literature review particularly looked into music elements such as melody and rhythm as a mnemonic aid in verbal memory. The first section in literature review discussed the development of music psychology connected with human brain in recent years. The following section discussed the basic process of human memory and structure of auditory verbal short term memory between musician and non-musicians. In order to support the effect of rhythm used in memory, musical elements were studied as well. Lastly, the problem of serial recall and the effect of musical elements as mnemonic device used in clinical population were further discussed in details.

2.2 Music Psychology

The psychology of music or known as music psychology has been discovered since Pythagoras in the 6th century B.C (Hodges, 2003; Deutsch, 2013). However, it only became an academic discipline with its own identity in the 1980s (Graziano, 2009). Sloboda stated the existence of musical structure triggered thinking, research and theory that shaped music psychology as an independent field (as cited in Graziano, 2009, p. 159).

During 1980-1990s, the field came to a turning point; a sudden rapid growth of interdisciplinary research was recognized. Focus on empirical research in psychoacoustics and music perception was carried out in Europe (Helmholtz, 1863; Wundt, 1874; Fechner, 1876, as cited in Boer, 2009, p. 3) and United State of America (Downey, 1897; Gilman, 1892, as cited in Boer, 2009, p. 3). In 20th century, music

cognition, music perception, music and brain were strongly interacting and the name "father of modern music psychology" was given as an honour to Carl Seashore (1919, 1938 & 1947), an American psychologist (as cited in Hodges, 2003, p. 32). Currently, music psychology receives growing recognition (Hodges, 2003; North & Hargreaves, 2008; Hallam, Cross, & Thaut, 2009).

A myriad definition has come up with the term "music psychology". Gjerdingen (2002) stated music psychology is a subfield of psychology that relates mind in reacts to imagines, controls and evaluates music. It is a new science and the form of discipline features between psychology and music (Seashore, 1967; Deutsch, 2013).

To be more specific., Hargreaves (1986) & Hodges (2003) defined music psychology as a multidisciplinary study which includes anthropology, sociology, biology, physics, philosophy and psychology of music likewise interdisciplinary study of music in the human experience which includes integrating neurology, philosophy, psychology, and comparative musicology. Conversely, Richard Wallaschek, a prominent Austrian musicologist made an early contributor in the late 19th century to the field of music psychology who merely emphasized interdisciplinary approach (Graziano & Johnson, 2006).

2.3 Memory Process

Human memory could be classified into three different stages in memory process which involves the procedure of encoding, storage and recall (Gazzaniga, Ivry & Mangun, 2009). Each phase is essentially crucial from the very beginning stage of grouping information to recall or retrieve information either in short or long term memory by avoiding overloaded information occurred. Generally, new memory is created in the stage of encoding; it has a role to convert information into an idea that could probably be stored and could be formed in 4 types; acoustic encoding, visual encoding, tactile encoding and semantic encoding. In short term memory, acoustic

encoding is exposing. This encoding process requires hearing by repeating or decorating information into song and rhythm which certainly meet the purpose of this research (Mastin, 2010).

Once information is received, obtained information spreading everywhere throughout several parts of the brain earlier is retained and constructed when this process performs. After passing through the process of encoding and storage, information is then transferred to the consolidation process, giving the explanation of stabilizing memory and solely exists in long term memory.

Recalling is the last process to enter by splitting into two groups; recognition and recall. Recognition is an unconscious process; it involves the recalling of facts, event or objects like known faces and special event whereas the process of recall contains 3 types; free recall, cued recall and serial recall. Free recall has the advantage of recall freely in any order; cued recall however is guided by giving cues while serial recall performs as a whole rather than an incomplete item (Mastin, 2010) which will be tested in this research.

2.3.1 Short Term Memory (STM)

Memory has formed in an incomplete system (Vallar, 2006). The first modal of memory was discovered by Waugh and Norman in 1965. This modal was structured in a simple form with two components: primary and secondary memory (Vallar, 2006). Later in 1968, the second modal of memory by Richard Atkinson and Richard Shiffrin, eventually named as Atkinson-Shiffrin model or more commonly known as the multi-store. This model has been widely used and debated by many scholars. For instance, McLeod (2007), Gazzaniga, Ivry & Mangun, (2009) supported Atkinson and Shiffrin (1968) indicating memory could be possibly divided into three major stages; sensory memory, short-term memory and long term memory.

Sensory memory is a subconscious process with very short life span. Sensory information could be received in three different ways; somatosensory stimuli, auditory known as echoic memory and visual referred as iconic memory (Pindale, 2013). Once information detected by sensory memory, it enters automatically within half second (Sams, et al., 1993), it is then transferred to short-term memory, meanwhile short term memory would pass to long term memory automatically after a duration of 30 seconds.

Short term memory has three limitations; limited capacity, limited duration and encoding (McLeod, 2009). All information needed to be transferred to sound including visual information in order to enter short term memory. It has minimum storage of 15-30 seconds and only allows 7 items to be stored at once. Miller (1956) stated "Magic number 7 (plus or minus 2 items)" by supporting Jacobs's (1887) research providing people intend to recall numbers more easily with the average span of 9.3 score than letter with 7.3 score. However, chunking information would help store more information in short term memory (McLeod, 2009; Pindale, 2013). Furthermore, McLeod (2007) made a comparison in the perspective of memory retrieval later and explained that short-term memory is usually stored and retrieved sequentially such as phone number, addresses, names, dates, direction however long-term memory are able to be stored and retrieved non-sequentially.

Meanwhile, there are few studies partially agreed with Atkinson-Shiffrin model and expanded the original model into more details (Baddeley & Hitch, 1974; Baddeley, 1986, 1992, 2012; Cowan, 2008). They clarified the structure of Atkinson-shiffrin modal was way too simple as short term memory (STM) does include a subcomponent named as working memory, formed by different parts in which each part dealing with specific materials. Kane, Conway, Hambrick, and Engle (2007) described working memory as an interaction between short-term memory and attention. Both play the same basic process but perform differently in certain circumstances (Unsworth and Engle,

2007). The main storage system leads by short term memory and working memory allocate tasks related with storage and attention resources (Baddeley & Logie, 1999; Duff & Logie, 2001).

The structure of working memory comprises a few components. Central executive act as a control system in working memory and supported by two subsidiary parts; visuospatial sketchpad storing information in visual and spatial form (Baddeley, 2002, 2012; McLeod, 2008) and phonological loop that deals with spoken materials and written words undergo articulatory control process by converting and stored information in speech based form from the phonological store, a component holds verbal information within 1-2 seconds (Baddeley & Hitch, 1974; Baddeley, 1986; Saito, 2001). Furthermore, articulatory control process functions in rehearsing information from the phonological store by retaining information for longer duration (Burgess & Hitch, 1992; McLeod, 2008). Later, short term memory had been modernized by Baddeley in the year of 2000, forming a new model called multicomponent model with a forth component named episodic buffer functions in chunking information such as phone numbers (McLeod, 2008) and recalling text (Baddeley, 2002).

As a whole, working memory not only provides specific role in language such as reading and counting (Logie & Baddeley, 1987; Daneman & Merikle, 1996; Saito, 2001), it is believed to deal with musical information as well. In 1995, Berz proposed a theoretical model of working memory based on Baddeley's previous model by adding music memory loop as this is supported by Salame and Baddeley (1989) stating there must be acoustic storage presumably additional deals with musical information if we ~~are~~ allow hearing and remembering sounds differ from speech. Somehow, the existence of music memory loop was not clearly elucidated in the past as the loop could be attached or separated from phonological loop (Berz, 1995 & Gardner, 2011).

2.4 Serial order

Recall or retrieve information happens in our daily life, a process in remembering facts provided or learnt in the past. In our brain, information is scattered around without organization and hence during the process of memory encoding, memory retrieval is required to re-visiting the nerve pathways (Mastin, 2010).

The three main types of recalls as mentioned earlier- serial recall, free recall and cued recall will not be discussed as this study only focus on serial recall, a type of recall with ability to recall items with its' correct sequence and order where originally placed. In short term memory, it is commonly known as a series of unattached item rather than as a whole in long term memory (Mastin, 2010).

A series of general issues in serial recall are listed. For instance, more time is required during the process of retrieval when the number or sequence increased (Robinson & Darrow, 1924; Mastin, 2010). Mastin (2010) also stated it would be easy to remember the sequence when events happened at a recent time however, if no immediate recall trial is taken, there's a high chance of interruption occur on delayed-recall (Wang, Thomas, & Ouellette, 1992). Furthermore, there's a possibility to recall the correct information but in a different order and once error is detected, it is then amended immediately. On the other hand, information is likely to be recalled at its last position rather than its original spot as well. Those issues mentioned earlier had eventually evoked an idea given by Karl Lashley called the 'problem of serial order' (Lashley, 1951).

The term of serial order basically means ordering a series of numbers where three main basic theories were proposed in order to overcome the problem of serial order (Henson, 1996). Each theory has its own function and weakness. The oldest and perhaps most intuitive theory falls on chaining, a theory using the "chain" method forming elements sequentially. The difference between simple and compound chaining model

are obviously seen as simple chain involving stimulus-response theory, where each response are related and stimulate with each other (Lashley, 1951). Sharing of same cue with repeated elements leads to an inefficiency of final recall as overall recall may be affected once an error has been made (Henson, 1996). Compound chaining model somehow resolve the above matter with the addition of elements preceding the repeated elements. However, chaining theory is not the most sufficient theory to be used after all (Lee and Estes, 1977; Henson, 1996)

Positional theory aroused from the word "position", uses position-item associations (Henson, 1996). Items retrieved according to its original position individually, hence there are no issues on repeated items. Despite people do select this method, positional theory does involve interference problem. For example, the orders of letter in rat, art, tar. The last theory in serial order is ordinal theory. According to Henson (1996), it stores as a single element where order can be recalled freely along the dimension without any connection from the previous info. Furthermore, issues on interference will not occur with the existed of unique node. Hence, ordinal theory could be the most effective theory as compared to chaining and positional theories.

As a result, chaining theory requires connection but positional and ordinal theories share a common function-recall independently. Somehow there's a difference between these theories such as positional theory is able to retrieve middle elements promptly however ordinal theory is in need of its predecessors.

2.5 Musical elements as mnemonic device

Prior reviews discussed music as a mnemonic device widely used for years in verbal working memory and recall information especially in the field of education (Sloboda, 1985; Wolfe & Horn, 1993). Music listening making an attempt in emotions: (1) brain stem responses, (2) estimating conditioning, (3) emotional influences, (4) visual imagery, (5) episodic memory and (6) musical expectation (Juslin, n.d). Musical

elements (Snyder, 2001) such as melody; harmony and rhythm play as a transfer method to convey information and assist the process of recall and retention of words and actions (Horn & Wolfe, 1993) in verbal memory as well as auditory memory (Wallace, 1994; Thaut, Mertel & Leins, 2008). Jellison stated pitch or frequency may help to deliver a greater written recall as compared to spoken presentation (as cited in Horn & Wolfe, 1993, p. 102) as well as others musical characteristic such as patterns, scales, and tonal resolution shown an effect on memory recall (Curtis & Bharucha, 2009). Furthermore, the aspect of familiarity of music may affect the ability in recalling information as familiar melodies rather than unfamiliar tune could improve memory verbally as they are likely to expect patterns that serve as a recall cue (Rainey & Larsen, 2002; Silverman, 2010; Chazin & Neuschatz 1990). For example, children used the melody of "twinkle-twinkle little star" as their alphabetical song.

Research using music as mnemonic in word recall was done by Wallace who conducted four experiments using familiar melody as a mnemonic. In Wallace (1994) first experiment, results showed participants are able to recall text in the sung condition significantly more accurately as compared to the spoken condition. In contrast, unfamiliar melody may not provide an efficient outcome. Wallace (1994) also urged the combination of rhythm and melody able to create a greater outcome than spoken rhythmically in his following experiment. Music does provide sequential information as a guideline during encoding and recalling in order declining the possibility of misplacing a portion of the text (Wallace, 1994). Meanwhile, Rainey and Larsen (2002) studies showed more effectiveness in long term memory when recall of unconnected text with familiar melody compared to prose learning. Therefore, advertisers make use of music as a mnemonic device in recalling particular product or brand (Smith & Phillips, 2001; Oakes & North, 2006; Yalch, 1991).

Apart from showing successful example in recalling text, several researches did reveal the effect of musical elements in recalling digits. In 1993, Wolfe & Horn published an article regarding the use of familiar and unfamiliar music as a tool in recalling telephone number. Followed by Silverman (2010), the author measured digit recall on working memory by working along with the combination of unfamiliar and familiar melodies, pitch, and rhythm. Nonetheless, there's a difficulty to determine the role of rhythm as an aid in memorization when verbal information is performed in the context of song as interaction going on between rhythmic and tonal elements (Medina, 1994).

2.5.1 Musical mnemonics used in clinical applications

The effect of music does exist in clinical populations in the past. Research have focused on clinical populations whom suffered from learning disabilities (Gfeller, 1983; Claussen & Thaut, 1997), Alzheimer's disease (Simmons-Stern, Budson, & Ally, 2010; Simmons-Stern et al., 2012; Moussard, et al., 2014), dementia (Vink, et al., 2003) and language dysphasia (Kim, 2010).

In 1983, Gfeller conducted two experiments with learning disabilities. The first experiment was to find out the musical repetition and short term effect of spoken on verbal memory. Result showed healthy respondents performed better than those who suffered from learning disabilities indicating verbal memory deficit was implanted among children with learning disabilities. However, musical rehearsal failed to show significant result as compared to spoken rehearsal as overall. The used of unfamiliar melody may cause the failure of using musical elements as mnemonic during the learning process due to the overloaded of cognitive and hence reflected a poor effect of musical mnemonics on short-term verbal memory.

The second experiment from Gfeller tested the effect of rehearsal on teaching method. The same memory task was chosen as the first experiment with an addition of repetition.

Result shown that both groups of respondents with or without learning disabilities could recall more words with the aid of repetition. The findings indicated that respondents with or without learning disabilities could performed well with the combination of repetition and musical elements used as a learning tool on verbal memory.

Later in 1997, there were few reasons stated by Claussen and Thaut where music ease the process of learning verbal information in short term memory by connected it with musical tunes or melody. Furthermore, musical mnemonic may be favourably as it was different as compared to pegword, chunking and linking methods that were commonly chosen. Thirdly, the temporal structure of musical elements such as rhythm is believed to have the ability to chunk information into smaller units that enable the process of learning to be more efficient. In addition, the repetition of melodic and rhythmic parts has the ability to chunk and recall verbal information easily.

As for patients whom suffered from Alzheimer's disease, chunking method was introduced to support or improve spatial working memory (Huntley et al., 2011). Healthy participants and Alzheimer's patient were involved in this research where digit recall test was given. Result successfully implied the method of chunking was useful in recalling information and able to improve verbal memory. Indeed, scholars from musical aspects have given the same conclusion where musical elements could also improve verbal memory on Alzheimer's patient.

Simmons-Stern, Budson, and Ally (2010) had the similar idea of testing the same respondents as Huntley et al., (2011) by examined the effect of musical elements on familiarity of new information such as lyric. It shown there was a significant difference on recognition of lyric where respondents with Alzheimer's disease could performed better on sung lyric more accurately as compared to spoken lyrics. Conversely, healthy respondents showed no significant difference in recognition either of sung or spoken lyrics.

A few reasons were suggested by the author where musical elements may be effective in recalling lyrical information by stimulating more area of the brain. Furthermore, music enhances timing and helps in the development of neuron where the process of encoding and retrieval were able to progress well (Thaut et al., 2005; Simmons-Stern et al., 2010).

2.5.2 Gestalt laws of perception

The law of Gestalt plays a significant role in sensation of music. The state where auditory information passes through apart from the process of perception, and cognition. Sensation is the collaboration occurs between living things and the environment; however perception is the process where information is being selected and filter for further processing. The final steps will be cognition where storage and recall of information takes place (Lipscomb, 1996).

The law of gestalt has the ability to group musical information upon the arrangements of musical patterns and elements (Tan, Pfordresher, & Harré, 2010). Musical components such as rhythm are able to provide sequential cues and melody can provide repetitive motif where both elements are able to produce suitable arrangement for chunking. In addition, Koffka (1935) introduced the law of Pragnatz; a subfield of the gestalt law of grouping stated humans naturally recognize information in grouping or chunking condition.

A few scholars have agreed that there is a connection between musical elements and gestalt law of grouping (Werner, 1919; Koffka, 1935; Fraisse, 1975). Few types of Gestalt laws of grouping that are used in music include similarity, proximity, good continuation and common fate (Lipscomb, 1996).

Musical components such as melody, rhythm, pitch, dynamics and tonality are grouped together creating music. This formation can be named as similarity where music was created when the combination of common features occurred. Similarity

occurs whenever repetitive motif, theme or phrases are repeated (Lerdahl & Jackendoff, 1983). In addition, the law of proximity attempts to shorten the gap between two elements where smaller units are seen as a whole. For example, a melodic phrase form by ascending or descending scale is more easily observed as a single part where the melody is easily predicted. Furthermore, some scholars have given example using two pitches that are link together forming an interval that tends to be seen as one group (Tenney, 1964; Tenney & Polansky, 1980; Deutsch, 1999; Tan et al., 2010).

Common fate is commonly linked with melodic and harmonic purpose. According to Tan et al., (2010), common fate has a trend of motion where music is assumed as a whole by closing the gap automatically. For example, cadences or melodic sequence as such leading note perform as a cue, resolute to the tonic note at the end of music (Snyder, 2000; Pindale, 2013). On the other hand, good continuation indicating items follows the similar pattern or path. As Deutsch (1999) stated, musical elements that connect each other is a same way are expected to be grouped together, therefore descending and ascending scales or arpeggios with the same patterns can easily grouped.

As a result, the law of Gestalt is essentially related in grouping of musical elements such as melody and rhythm (Snyder, 2000). Information is more accurately perceived and grouped into meaning units with the aid of musical elements.

2.5.3 The effect of rhythm on working memory

Working memory for musical rhythmic pattern from the viewpoint of rhythm and memory is needed to be done with the intention of giving an idea or mnemonic device as an aid in recalling 10 digit numbers as most research stated the more easily is it observed, the more easily it is to be memorized. In the review of literature, attention is given to memorization with the advantage of rhythm. Concentration merely falls on the

variable of rhythm without musical tonality in order to examine the effect of rhythm in details.

London (2012) stated rhythm and meter involves our insight and cognition of the temporal stimuli. Gjerdingen (1989) added rhythm is to what we listen while meter is a mode of presence. Rhythm gives an effect on memory and music perception (Krumhansl, 1991). The impact of melody to learning the text comprises more than simply providing a rhythmical framework presented by speech patterns and accents making words and sentences able to chunk into more meaningful units (Wallace, 1994). Three basic R's: Rhyme, Rhythm, and Repetition making nonsensical words and phrases as well as numbers easy to remember (Maute, 1987; Gromko, et al., 2009). Therefore, a specific rhythmic sound is believed to help in learning and could retain a longer memory in verbal material (Yalch, 1991). However, the more syncopated rhythm used may delay the effectiveness in recall and reproduce (Wallace, 1994; Fitch & Rosenfeld, 2007).

There is an argument between scholars regarding the role of rhythm in long term memory and working memory. Studies by Medina (1994) literally showed there is an impact of rhythm in both short and long term memory of semantically unrelated and related verbal information. However, Toukhsati & Rickard (2001) stated there is a potential to enhance long term memory consolidation in an avian species whenever the existence of exposure to rhythmic stimulus. Milman (1974) supported the statement above using metronome as a tool among a group of slow learners, giving an interesting idea where time tables are learnt rhythmically following to the sound of the metronome.

Nonetheless, Farrell (2008) disagreed and stated in working memory, rhythm is a sort of material readily to be handled well and stored (Ross & Houtsma, 1994; Collier & Logan, 2000). Staples (1968) agreed rhythm is able to assist in recalling unrelated items among mentally retard children on working memory. Meanwhile, looking more into

linguistic approach, scholars found positive impact on sentence rhythm in working memory as result shown the aspect of intonation and rhythm facilitated working memory in a group of normal intelligence children (Weener, 1971; Shepard and Ascher, 1973).

As a result, rhythm does make a difference in either long term or working memory but there's no evidence shown on the effect of each rhythmic pattern. Therefore, the aim of this thesis is to investigate the existence of rhythm as to support previous research and to find out the role of each rhythmic pattern between musicians and non-musicians in working memory.

2.6 Musical training on verbal memory

Studies have shown a vast impact of musical training on verbal memory (Brandler and Rammsayer, 2003; Ho et al., 2003; Helmbold et al., 2005; Franklin et al., 2008; Cabanac et al., 2013; Nutley et al., 2013). Back in late 90's, Chan et al., (1998) conducted a recall experiment where participants have to retrieve words as many as possible after each of the word read out three times. Result showed musicians have a better recall as compared to non-musicians.

In 2003, Jakobsen et al conducted a different experiment in order to prove the statement earlier. Specifically, adults with different level of musical training were chosen in this task. Participants were required to recall the sequence of syllables and as expected, a huge impact was found between years of musical training. The authors carried out another experiment in the year of 2008, an experiment comparing visual and verbal memory on well-trained musicians and non-musicians with less than one or two years of music lesson. Result stated musicians' performance was way better in verbal memory tasks than non-musicians as musicians encode verbal or semantic information (Pindale, 2013).

Franklin et al. (2008) conducted another similar experiment in the same year. Two tasks were performed by the same group of respondents. First tasks supported the statement where musicians retrieved more words in immediate and delayed-recall tasks significantly than non-musicians. Nonetheless, result showed no differences between musicians and non-musicians with the addition of articulatory suppression, a condition where verbal information is repeated and transferred to memory (Pindale, 2013).

Ho et al., (2003) conducted an experiment showed musically trained children performed better in verbal memory as compared to visual memory. Furthermore, children with prolong musical training displayed huge prospect in improvement on verbal memory, however the opposition failed. Roden et al., (2012) further investigate into this. The authors carried out a research among primary school children in order to examine the effects of instrumental training program upon verbal and visual memory skills. 3 different groups of subjects were chosen; natural science group, music and non-music group. Result showed musically trained children obtained highest score among the groups in verbal learning, verbal delayed recall test and verbal recognition test but not in visual memory.

The human brain is made up of cerebellum (controls breathing), brain stem (balance and motor control) and cerebrum, also known as forebrain. The cerebrum is protected by cerebral cortex, controlling memory, attention, thought and language. It is also divided into 4 parts; frontal lobe, parietal lobe, temporal lobe and occipital lobe. The temporal lobe deals with senses of smell and sound.

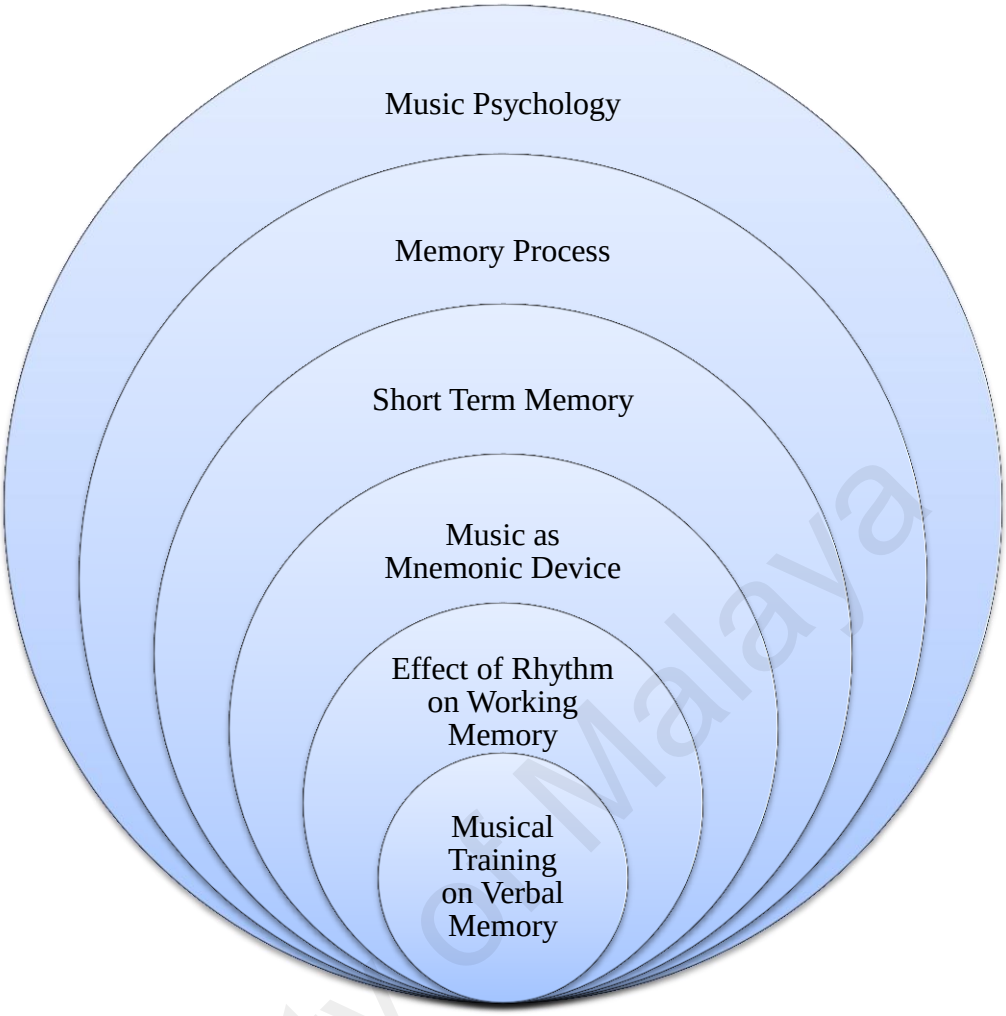
Specifically, researches came up with presumption about the impact of musical training on verbal memory (Chan et al., 1998; Ho et al., 2003; Jakobson et al., 2003; Franklin et al., 2008; Roden et al., 2012). Various scientific methods used for recording neuronal activity showed evidences in supporting the statement above. Firstly, Ohnishi et al. (2001) suggested using functional magnetic resonance imaging (fMRI) to

determine the effect of cortical activation between musicians and non-musicians. Studies found musicians have larger part of the planum temporale (PT) on left-sided asymmetry than non-musicians. Thus, musicians would have better verbal memory as visual memory is mediated by the right temporal lobe and verbal by the left (Chan et al., 1998). A few scholars used electroencephalogram (EEG) to detect electrical activity in human brain shown musicians perform greater left-hemisphere lateralization (Bever & Chiarello, 1974; Besson et al., 1994).

Overall, studies had been done to clarify the differences between musicians and non-musicians. Precisely, scholars intended to verify the importance of musical training on verbal memory. Yet, musicians definitely have a better recall ability on verbal but not visual memory due to the greater left planum temporale (PT).

2.7 Conclusion

The above literatures cover literatures concerning the study into music psychology to its sub-division of study into memory process and the relationship or effect between the use of music in memory processes.



This literature helps to form a foundation for the present study, and delineate that musical elements especially rhythm has an effect in recalling information on verbal memory. Most studies focused on melody, pitch, patterns, scales, and tonal resolution as an aid to recall information. Therefore, the issues of varied rhythmic pattern used in an experiment could be highlighted as this is absent in current literature. Furthermore, there was a lack of attention towards the effect of rhythm between musicians and non-musicians on verbal memory and the aspect of rhythmic patterns used as a recalling tool with the importance of musical training in recalling digit.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Scientifically, research methods are often divided into two main types; quantitative and qualitative method. Quantitative study is a method to quantify information and it is deductive (Rasinger, 2013). Hughes (n.d.) added quantitative research as an empirical research where the data are in the form of numbers.

According to Mujis (2010), quantitative view is defined as 'positivist'. He further explained that this method requires researcher to maximize objective rather than focusing on involvement and it fits the research's aim which is to investigate the impact of rhythmic patterns in short term memory using numbering as a tool therefore the most suitable method to carry out this research will be quantitative method. Quantitative-deductive approach involves several steps. Hypothesis needed to be done before methodology is first generated and data will be collected once experiment is done. The following step will be analysing data and final step is to prove or disprove hypothesis based on the given result (Rasinger, 2013; Newman & Benz, 1998).

Quantitative approach is an indispensable method in this study and the following reason would be clearly explained that this method was employed in this research. As mentioned earlier, quantitative approach involves the method of survey in order to collect data to be analysed and the most effective way revealing the target variable among a particular population is using the method of survey as the result would be more precise. For example, the status of variable would be cast in numerical form rather than verbal expressions like majority, many and etc (Thomas, 2003; Mujis, 2010).

Subsequently, Mujis (2010) uttered that quantitative approach is chosen when specific research question could merely be answered quantitatively or wanting to

explain certain phenomena. Moreover, the most critical reason of selecting this method is to test whether hypothesis is accepted or rejected and it is the best method for looking the effect in a research. Due to the approach of selecting averages in an entire population, quantitative research fails to describe the uniqueness of each individual in the population, it forbidden researcher to explore more deeply in future. In addition, quantitative approach fits well in testing hypothesis; however it is not suitable in developing hypothesis.

As discussed in Chapter 1, experimental approach was selected in this research. The purpose of an experiment is to reveal a truth condition where the entire design is under controlled and the importance of input from the experimental result (Thomas, 2003; Mujis, 2010). In the meantime, Mujis (2010) added that quantitative research basically involved two research designs; experimental design and non-experimental design.

On the contrary, this research requires measurements in psychology as well. Three main units: overt non-verbal behaviour, verbal behaviour and convert non-verbal behaviour are included in this measurement. Basically, overt non-verbal behaviour is also known as Non-Verbal Communication which implies facial expressions and gestures. Language recordings normally take place in verbal behaviour while psychology response such as heart rate and memory response which cannot be observed directly are known as convert non-verbal behaviour (Clark-Carter, 1997). Consequently, convert non-verbal behaviour would be tested as part of the result.

Secondary resources will be concentrated on relevant books, journals, articles, encyclopaedias during the pre-fieldwork.

3.2 Participants

This study included 60 healthy subjects with normal hearing who were recruited and divided into music and non-music undergraduate students of University Malaya, between 18 and 26 years old. For this experiment, participants were thoroughly

interviewed before the experiment with regard to their musical background. During the experiment, participants were not allowed to drink, eat or use cell phone as these actions would affect the result.

3.2.1 Inclusion criteria

All participants were matched in terms of age, socioeconomic characteristics and raised in English-speaking culture with same education background and hence English numerals are being familiar to those subjects. Students who were enrolled at the University of Malaya were included in this study in order to maintain a constant age and level of education via a demographic survey as follows, participants were divided into musicians and non-musicians:

1. Any background in formal music training:
   - ☐ No (Please go to Part B)
   - ☐ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☐

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☐

Can you play a basic piece of music? Yes ☐ No ☐

Do you attend any music classes before? Yes ☐ No ☐

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☐

Please list your major instrument _____ (GRADE:_____)

Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? _____ years old.

Music Examination Board Attended: ☐ Trinity, ☐ ABRSM, other: please specify_____

3.2.2 Musicians

Participants were selected as musicians with the following criteria. Individuals began learning an instrument since young, individuals currently taking formal instrumental or vocal lessons in university, majoring in music at the University of Malaya. The majority of music students are keyboard player with a few string players and vocalist.

3.2.3 Non-musicians

Participants were selected randomly as non-musicians with no musical experience or had been engaged in less than two years of self-taught instruction (Jakobson et al., 2008).

3.2.4 Exclusion criteria

Only Malaysians involved in this task and international students were not recruited. Non-music students from psychology department were not selected as they could be familiar with short term memory concepts.

3.3 Research Design and variable

SPANOVA and One-way ANOVA were implemented in this study to examine the relationship between the independent variables;- rhythmic pattern and respondents between musicians and non-musicians and the dependent variable; numbers recall. Numbers recall was measured by a recall task, which was given throughout 12 trials with each rhythmic patterns repeated once.

3.3.1 Measure

Demographic information was designed into a few parts. Part I obtained information with respects to age, gender, race, and language used (see appendix A). All information was needed to be reviewed before completing the task in order to obtain a better outcome. Part II acquired the level of music background for musicians and non-musicians. This part was acquired to distinguish between musicians and non-musicians.

Part III was planned for number recall (see appendix B). Respondents were requested to listen recorded presentation of 6 different sets of numbers and asked to recall and write down as many numbers according to accurate sequence as they could remember on the form provided. Numbers would be repeated twice and scores will be given according to the correct number of digit written down by each respondent. Each correct digit recalled in the correct order would receive one point; total score would be calculated in percentage.

3.3.2 Materials

All participants were required to write down the recalled numbers in a recall form. There were 10 spaces for each set of numbers and every set of numbers was administered for 2 attempts. Numbers from 0-9 were chosen except number '7' was omitted in the experiment as this number is composed by two syllables: se and ven compared to the others which are only formed by a syllable. Numbers in this experiment were designed with a set of 10 digit phone numbers with one repeated number to fill up all 10 spaces. In addition, this research involved cell phone numbers that were used in daily life as well as phone numbers used in advertisement field. Therefore, the first digit used would not start with "0" as other numbers would be taken care as well. On the other hand, the method of chunk would be eliminated as it is proven to be effective as an aid in memorizing numbers (Brower, 1993). As for rhythmic pattern used in this experiment, syncopated rhythm is restricted as it has an effect in the process of memory (Fitch & Rosenfeld 2007), consequently merely 6 different rhythmic patterns were chosen to be examined. The lists of 10 digit numbers used were:

a) 1208523694

b) 2830693145

c) 3048962145

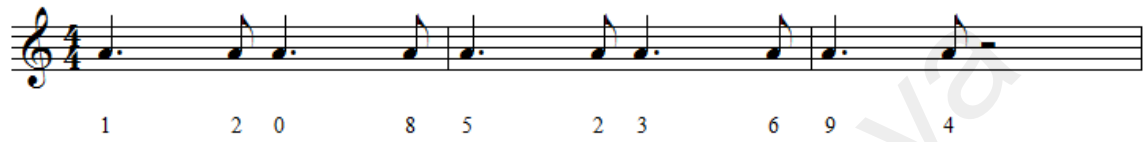
d) 3698041256

e) 1453698520

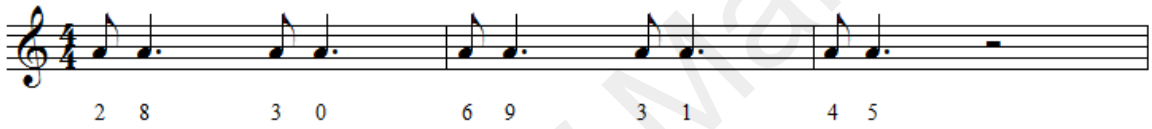
f) 9815683204

These sets of digits were then affixed to a set of rhythmic pattern as follows:

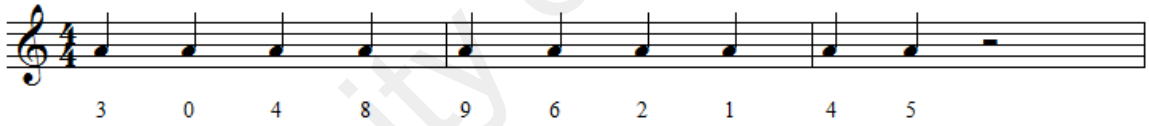
a) Dotted rhythm



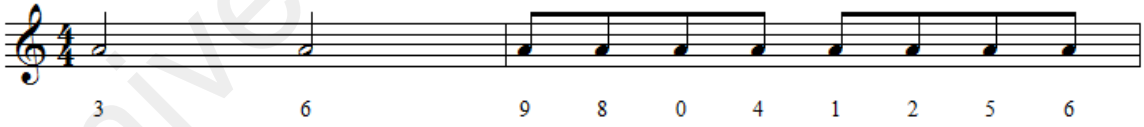
b) Inverted dotted rhythm



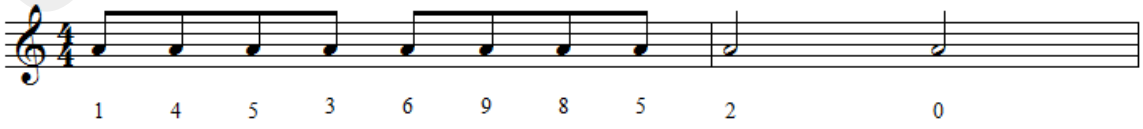
c) No rhythmic pattern



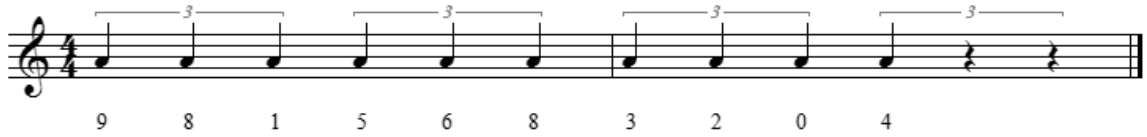
d) Long short rhythm



e) Short long rhythm



f) Triplets



Dependent measurements were performed in the memory task and visual or haptic test would not be included in this research as it will be merely carried out by auditory test. The tempo of each rhythmic pattern was set to 90bpm except for triplet which was set 70bmp. The audio equipment used to record numbers is called Garage Band© through an Apple MacBook Pro©. As for sound producing system, IPhone 4s audio player attached with speaker was utilized. An audible volume was played during the task to ensure that respondents were able to hear each set of numbers clearer.

Equipment used in research:

3.3.3 Pilot Study

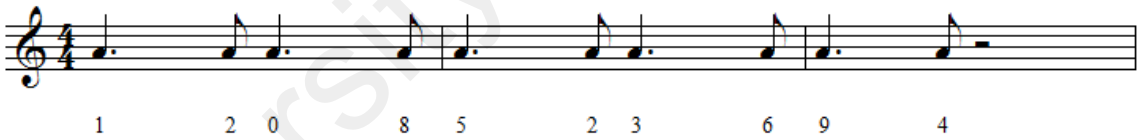
A pilot test was carried out before the real task to make adjustment for experimental parameters and only 5 participants were tested. The Reliability Statistics test was analysed using Cronbach's alpha.

3.4 Procedure

Musicians were selected as the treatment group and non-musicians were chosen as the control group in this experiment therefore, respondents were being tested separately into equal size during the experiment in order to produce a solid result. Respondents were organized in an unaware condition without knowing the main purpose of this experiment in turn to construct a neutral outcome.

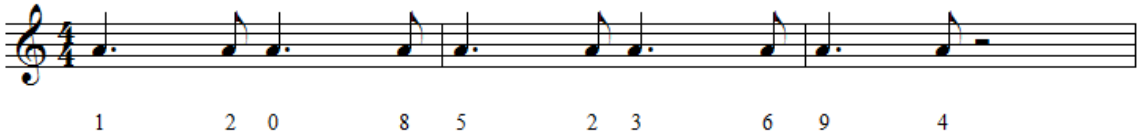
A total of 60 subjects were used, 30 musicians and 30 non musicians being placed in 2 groups. Each group was consisted with 30 respondents. The Subjects were placed in a comfortable room with the most suitable listening level through loudspeakers. Studies only included auditory memory, hence each subject was told to involve in a test by listening pre-recorded tape. Participants were instructed to listen each set of phone number one by one and write down each set of numbers between 15-30 seconds. For example, the following shows how the first set of digit was affixed to the designated set of rhythmic pattern – dotted rhythm, a play back recording took place and the participants were asked to fill in the column as many of the digit they could recall:

1208523694



15 -30 seconds

1ST ATTEMPT



15 -30 seconds

2nd ATTEMPT

There were 6 groups of numbers to be recalled. The 1st group of numbers was without rhythmic patterns, 2nd group involved in numbers with dotted rhythm, 3rd group will be tested in numbers of inverted dotted rhythm, followed by long short rhythm and the last group was the triplets' session. After the set of numbers was played, subjects were required to write down the whole complete set of digit numbers after 15 seconds and were required to stop writing at 30 seconds. The recall task lasted about 10 minutes for six groups of numbers; 10 minutes to complete demographic questionnaire and the entire session lasted 20 minutes.

The results were recorded in the usual way and calculated in the form of percentage of the total amount recall. A credit of 10 percent was awarded if the number was answered in the correct position. There were two trials for each set of 10 digits numbers.

In Trial One, the participants:

1) Listened to the recording one time
2) Recalled and wrote down as many numbers as possible between 15-30 seconds.

In Trial Two, the participants:

1) Listened to the recording second time
2) Recalled and wrote down as many numbers as possible between 15-30 seconds.

3.5 Data collection

Each recall was collected and respondents were given one point for each correct number in correct order. Each point is equivalent to 10% therefore the total score for each set of numbers would be 100%. The scoring test would determine the different rhythmic patterns used for number recall between musicians and non-musicians. Recall trials would probably examined the following questions in details:

1) Number recall between musicians and non-musicians.
2) The effect of rhythmic patterns on number recall in musicians compared to non-musicians.
3) The different level of verbal memory in number recall between musicians and non-musicians.

3.6 Data analysis

Data were analysed using a mixed two way analysis of variance (ANOVA) to investigate the effect of rhythmic pattern on percentage in musicians and non-musicians. The dependent variable was the number recall and two factors included musicians and non-musicians as well as 6 different types of rhythmic pattern were examined collaboratively as to answer research question 2. Furthermore, effects included the background music training on musicians as compare to non-musicians and rhythmic pattern as a mnemonic device will solve the research question 1 and 3 in turn using SPANOVA test.

3.7 Pilot test result

A pilot test was carried out to test if the survey questionnaires and experimental design procedure is clear to the participants.

3.7.1 Profile of respondents

Table 3.1: Frequency of respondents demographic based on their age

Age	Frequency	Percent
20	3	60%
21	2	40%

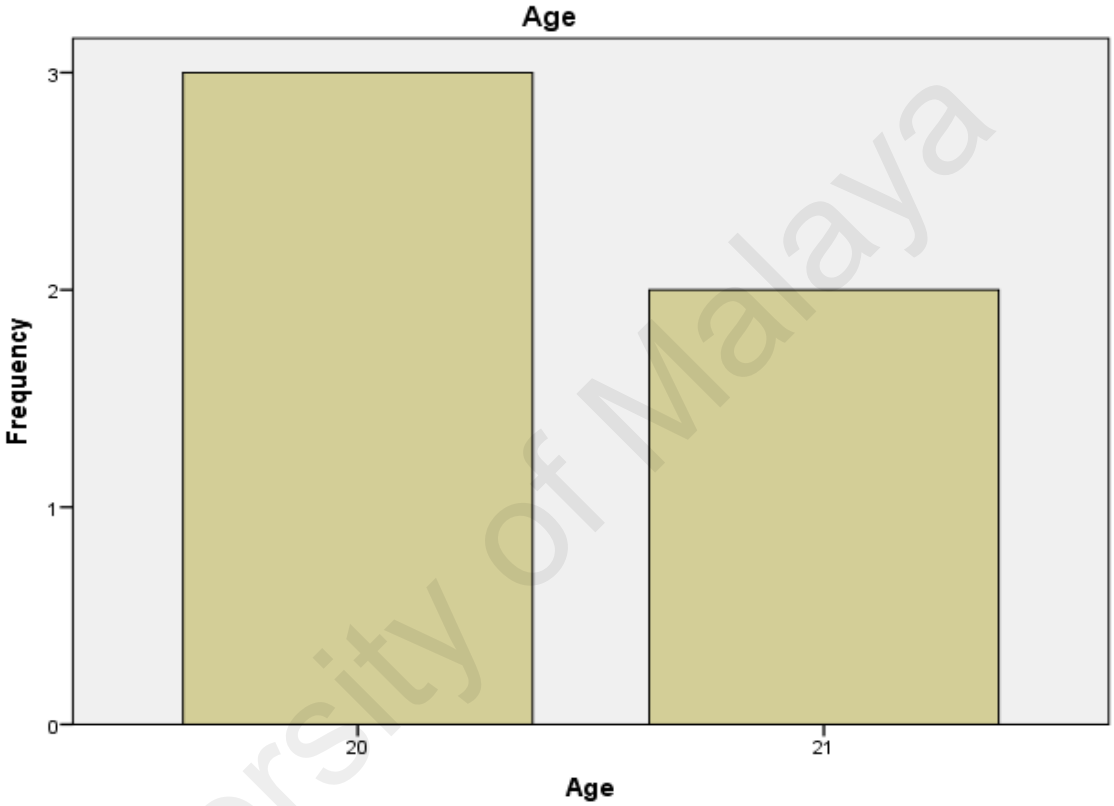


Figure 3.1: Frequency of respondents demographic based on their age

Table 3.1 and figure 3.1 showed the age of 5 respondents fall in the range of 20 and 21 years old. Respondents with the age of 20 (60%) and 21 (40%) years old were selected in the pilot test.

Table 3.2: Frequency of respondents demographic based on their gender

Gender	Frequency	Percent
Male	2	40%
Female	3	60%

Figure 3.2: Frequency of respondents demographic based on their gender

Table 3.2 and figure 3.2 showed the frequency of gender of respondents. Among 5 respondents, female (60%) has a higher frequency than male (40%).

Table 3.3: Frequency of respondents demographic based on formal music training

Formal music training	Frequency	Percent
Musicians	2	40%
Non-musicians	3	60%

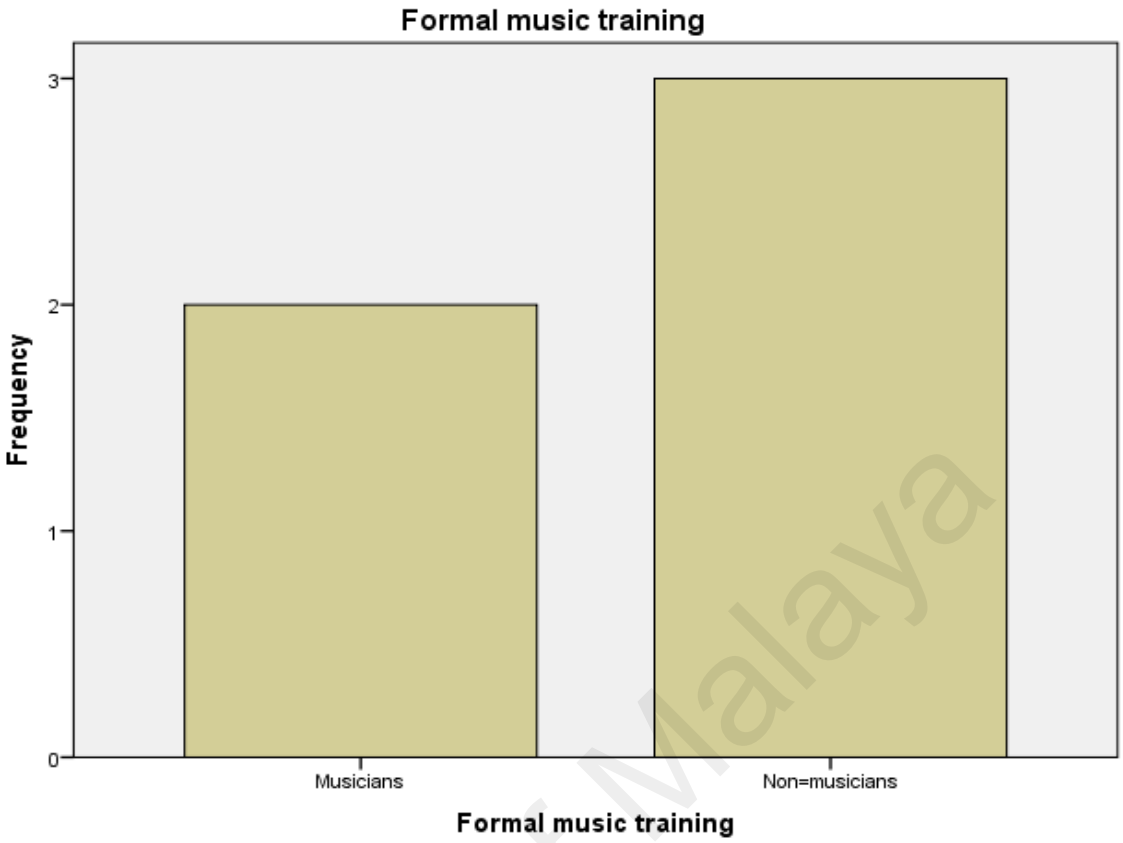


Figure 3.3: Frequency of respondents' demographic based on formal music training

Table 3.3 and figure 3.3 showed the background of respondents. Out of 5 respondents, 2 were musicians and 3 were non-musicians.

3.7.2 Reliability test

Table 3.4 Reliability Statistics

Cronbach's Alpha	N of Items
.743	6

Table 3.4 and table 3.5 shown for this research instrument, the correlation (correlated item-total correlations) are above .30 and the Cronbach's alpha is > .70, therefore internal consistency reliability is achieved for the instrument. The researcher reported that this research instrument is satisfactory. Hence, the instrument now contains 6

rhythmic patterns, which are dotted rhythm, inverted dotted rhythm, long short rhythm, short long rhythm, triplet rhythm and no rhythmic pattern.

Table 3.5 item-Total Statistics

Rhythmic pattern	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Dotted rhythm	24.60	10.800	.667	.648
Inverted dotted rhythm	27.20	8.700	.674	.647
Long short rhythm	27.60	12.800	.357	.742
Short long rhythm	28.40	14.300	.374	.734
Triplet rhythm	27.80	13.700	.347	.739
No rhythmic pattern	31.40	13.300	.582	.695

CHAPTER 4: DATA ANALYSIS AND FINDINGS

4.1 Overview

This chapter presented the profile of respondents; the results of data analysis on SPANOVA and one-way ANOVA indicated whether the independent variables of musicianship and rhythmic mnemonic would have an effect on the dependent variable of number recall. The independent variable of musicianship consisted of two groups: Musicians vs. Non-musicians and 6 different types of rhythmic mnemonic. The dependent variable of number recall was measured by scoring each correct word with one point which equal to 10%. The total possible score is 100%.

The result was showed in two ways; descriptive analyses and inferential statistics. Demographic information included descriptive results and mean scores of all two trials between the two groups. The results were based on null hypotheses. There was no significant difference in the recall of phone number when the number was presented using different rhythmic patterns in undergraduate students was the first hypotheses. Secondly, there was no significant difference of musicianship on phone number recall in undergraduate students. Lastly, there was no significant difference of interaction effect on rhythmic mnemonic and numbers recall between musicians and non-musicians in short term memory. The duration of entire experiments lasted about 20 minutes, in which recall was measured across two trials.

The inferential results were presented with a Split-plot Analysis of Variance (SPANOVA) and One-way Analysis of Variance (One-way ANOVA) was chosen to analyse the auditory recall, which had given a precise result on the two trials of measurement between musicians and non-musicians following a rhythmic mnemonic.

4.2 Descriptive Results

Participants' information included age, gender; faculty and musical training of musicians were reported via demographic questionnaires. Additionally, the participants' auditory recall scores in each trial are provided between groups (musicians and non-musicians) and within groups (rhythmic mnemonic).

4.3 Profile of respondents

Table 4.1: Frequency of respondents demographic based on their age

Age	Frequency	Percent
19 years old	3	30%
20 years old	21	21%
21 years old	24	24%
22 years old	8	8%
23 years old	3	3%
24 years old	1	1%

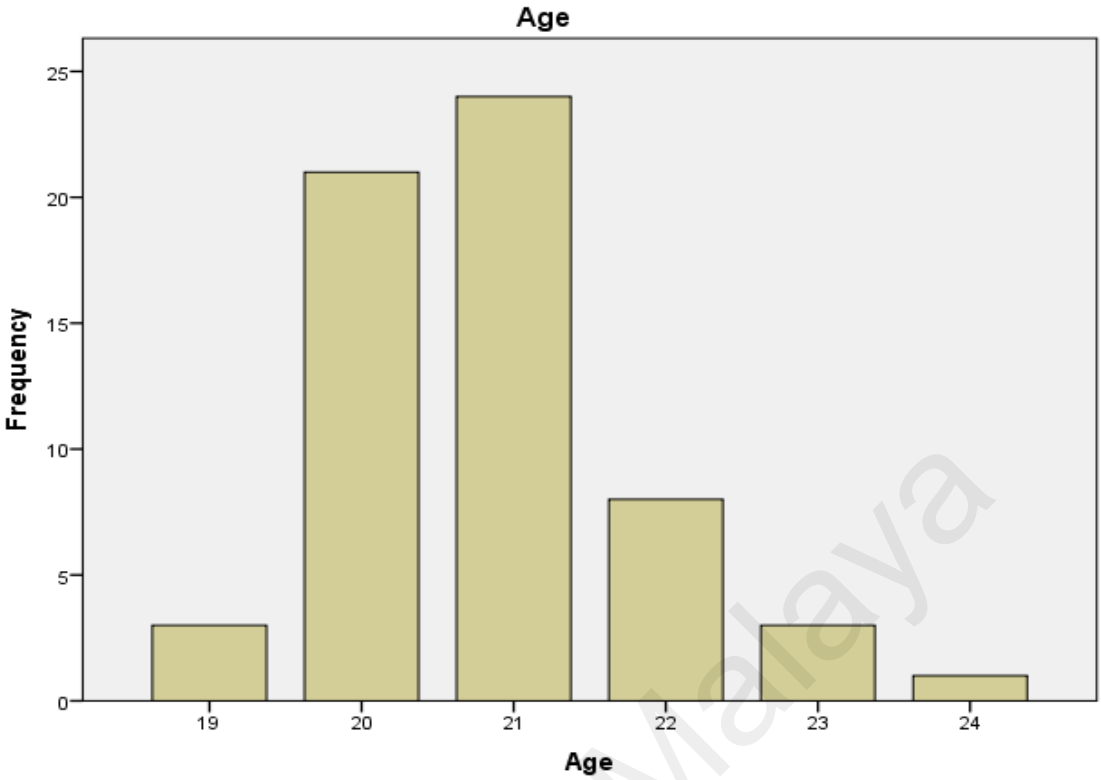


Figure 4.1: Frequency of respondents demographic based on their age

Table 4.1 and figure 4.1 showed the age of 60 respondents fall in the range between 19-24 years old. Respondents with the age of 20 (21%) and 21 (24%) years old have a high frequency as compared to others.

Table 4.2: Frequency of respondents demographic based on their gender

Gender	Frequency	Percent
Male	20	20%
Female	40	40%

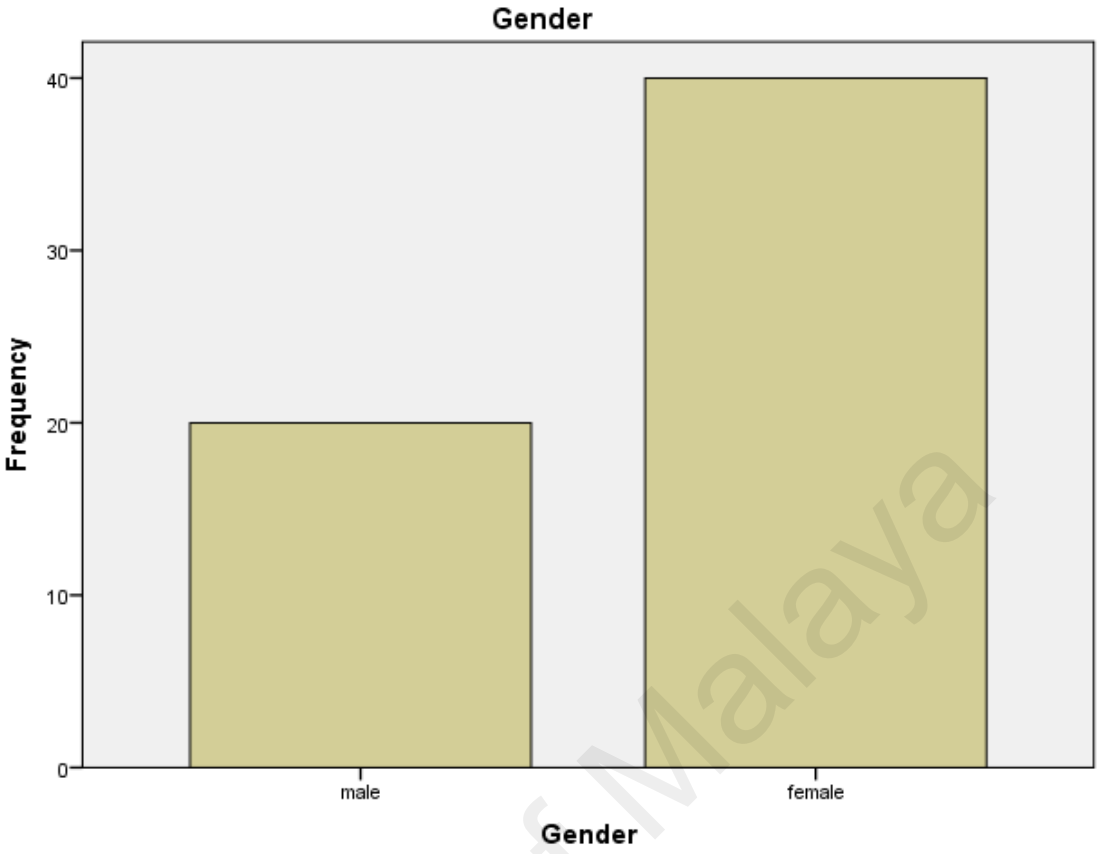


Figure 4.2: Frequency of respondents demographic based on their gender

Table 4.2 and figure 4.2 showed the frequency of gender between musicians and non-musicians. Among 60 respondents, female (40%) has a higher frequency than male (20%).

Table 4.3: Frequency of respondents demographic based on formal music training

Formal music training	Frequency	Percent
Non-musicians	30	50%
Musicians	30	50%

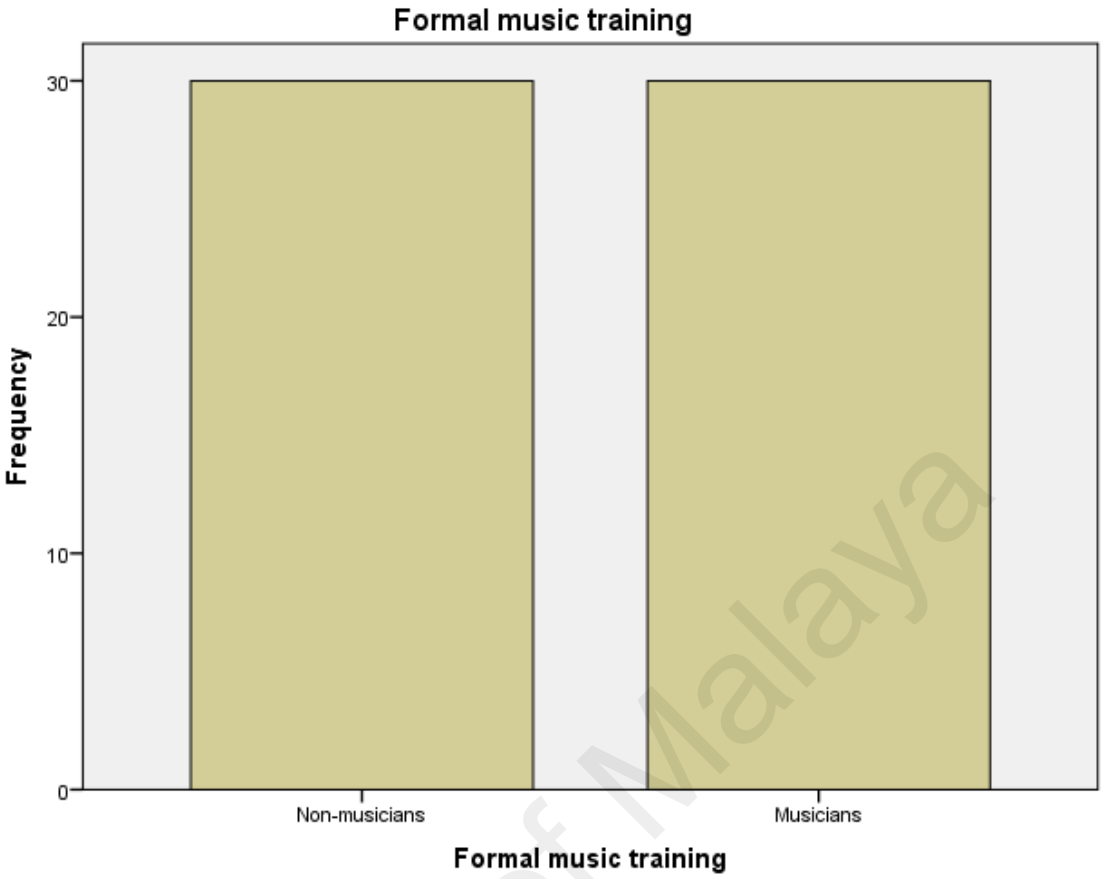


Figure 4.3: Frequency of respondents' demographic based on formal music training

Table 4.3 and figure 4.3 showed the background of 60 respondents. 30 respondents have attended formal music training and the remaining has not attended any formal music training.

Table 4.4: Frequency, Mean and Standard Deviations of musicians' musical training

Major instrument	Frequency	Mean	Std. Deviation
Piano	24	N/A	N/A
Violin	2		
Vocal	3		
Flute	1		
Total instrument play		1.37	0.67

one	22		
two	5		
three	3		
Age begin playing music(in years)		6.67	2.82
3-5	12		
6-8	11		
9-11	5		
12-14	1		
15-17	1		

Table 4.4 elucidated a further detail on musicians' responses regarding musical training. Among 30 musicians, 24 played piano, 2 played string instruments (violin), 1 played woodwind instrument and 3 were vocalist. Furthermore, 22 musicians played one instrument, 5 musicians played two instruments and 3 musicians played 3 instruments including major instruments. The mean number of total instrument play was 1.37 (*SD* = 0.67).

The age of starting playing instrument was reported as 12 musicians started playing music at the age of 3-5 years old, 11 musicians started at the age of 6-8 years old, 5 musicians started at the age of 9-11 years old, 1 musician at the age of 12-14 and 1 musician at the age of 15-17 years old. The mean of age begin playing music was 6.67 (*SD* = 2.82).

4.4 Inferential Analysis Results

Inferential analyses were presented based on 3 research questions as following.

4.4.1 Difference in number recall when the digit is presented with or without rhythm

Research question 1:

Is there a significant effect of rhythmic pattern on working memory between musicians and non-musicians?

Tables 4.5 depicted the mean value and mean differences for each rhythmic pattern against no rhythmic pattern on 1st attempt. Dotted rhythm had a higher mean value (M = 6.58, SD = 2.51) as compare to no rhythmic pattern (M = 2.73, SD = 1.48), followed by inverted dotted rhythm (M = 4.42, SD = 2.54), long short rhythm (M = 5.32, SD = 2.65), short long rhythm (M = 4.92, SD = 2.43) and triplet rhythm (M = 3.12, SD = 1.45). The negative value of mean difference (I-J) indicated no rhythmic pattern has a weaker effect as compare to each rhythmic patterns.

On the 2nd attempt (see Table 4.7), result shown rhythmic pattern has a higher mean where dotted rhythm (M = 8.35, SD = 2.11), inverted dotted rhythm (M = 7.32, SD = 2.08), long short rhythm (M = 7.22, SD = 2.60), short long rhythm (M = 6.93, SD = 2.27) and triplet rhythm (5.73, SD = 2.62) as compare to no rhythmic pattern (M = 3.95, SD = 2.16). The negative value of mean difference (I-J) indicated no rhythmic pattern had a weaker effect as compared to each rhythmic pattern.

The ANOVA test result (see Table 4.6) shown significant on dotted rhythm [F (df = 1, 118 $p < .05$) = 104.47], inverted dotted rhythm [F (df = 1, 118) = 19.66, $p < .05$], long short rhythm [F (df = 1, 118 $p < .05$) = 34.04], short long rhythm [F (df = 1, 118) = 21.98, $p < .05$] and triplet rhythm [F (df = 1, 118) = 9.63, $p < .05$] on 1st attempt.

Furthermore, ANOVA test result (see Table 4.8) indicated dotted rhythm [F (df = 1, 118) =127.27, $p < .05$], inverted dotted rhythm [F (df = 1, 118) = 75.73, $p < .05$], long short rhythm [F (df = 1, 118) = 56.13, $p < .05$], short long rhythm [F (df = 1, 118) = 55.81, $p < .05$] and triplet rhythm [F (df = 1, 118) = 16.54, $p < .05$] is significant on 2nd attempt as well.

Table 4.5: Descriptive statistics for recall test on 1st attempt

Attempt	Rhythmic patterns	Mean	Mean difference (I-J)	Std. Deviation
1st	Dotted rhythm (I)	6.58	3.85*	2.51
	No rhythmic pattern (J)	2.73	-3.85*	1.48
	Inverted dotted rhythm (I)	4.42	1.68*	2.54
	No rhythmic pattern (J)	2.73	-1.68*	1.48
	Long short rhythm (I)	5.32	2.58*	2.65
	No rhythmic pattern (J)	2.73	-2.58*	1.48
	Short long rhythm (I)	4.92	2.22*	2.43
	No rhythmic pattern (J)	2.73	-2.22*	1.48
	Triplet rhythm (I)	3.07	.38*	1.45
	No rhythmic pattern (J)	2.73	-.38*	1.48

Table 4.6: ANOVA test for rhythmic patterns against no rhythmic pattern on 1st attempt

Attempt	Rhythmic pattern	Recall test score	Df	F	Sig.
1st	Dotted rhythm	Between Groups	1	104.46	.000
		Within Groups	118		
	Inverted dotted rhythm	Between Groups	1	19.66	.000
		Within Groups	118		
	Long short rhythm	Between Groups	1	34.04	.000
		Within Groups	118		
	Short long rhythm	Between Groups	1	21.98	.000
		Within Groups	118		
	Triplet rhythm	Between Groups	1	9.63	.002
		Within Groups	118		

Table 4.7: Descriptive statistics for recall test on 2nd attempt

Attempt	Rhythmic patterns	Mean	Mean difference (I-J)	Std. Deviation
2nd	Dotted rhythm (I)	8.35	4.40*	2.11
	No rhythmic pattern (J)	3.95	-4.40*	2.16
	Inverted dotted rhythm (I)	7.32	3.37*	2.08
	No rhythmic pattern (J)	3.95	-3.37*	2.16
	Long short rhythm (I)	7.22	3.27*	2.60
	No rhythmic pattern (J)	3.95	-3.27*	2.16
	Short long rhythm (I)	6.93	2.98*	2.27
	No rhythmic pattern (J)	3.95	-2.98*	2.16
	Triplet rhythm (I)	5.73	1.78*	2.62
	No rhythmic pattern (J)	3.95	-1.78*	2.16

Table 4.8: ANOVA test for rhythmic patterns against no rhythmic pattern on 2nd attempt

Attempt	Rhythmic pattern	Recall test score	Df	F	Sig.
2nd	Dotted rhythm	Between Groups	1	127.27	.000
		Within Groups	118		
	Inverted dotted rhythm	Between Groups	1	75.73	.000
		Within Groups	118		
	Long short rhythm	Between Groups	1	56.13	.000
		Within Groups	118		
	Short long rhythm	Between Groups	1	55.81	.000
		Within Groups	118		
	Triplet rhythm	Between Groups	1	16.54	.002

On 1st attempt, figure shown dotted rhythm (figure 4.4), inverted dotted rhythm (figure 4.6), long short rhythm (figure 4.8), short long rhythm (figure 4.10) and triplet rhythm (figure 4.11) scored higher mean as compare to no rhythmic pattern. Furthermore, figure shown no rhythmic pattern has lower mean score as compare to dotted rhythm (figure 4.5), inverted dotted rhythm (figure 4.7), long short rhythm (figure 4.9), short long rhythm (figure 4.11) and triplet rhythm (figure 4.13) on 2nd attempt. Hence, rhythmic pattern performed better in recalling 10 digit numbers on short term memory. Figure 4.4 to 4.13 show the means plot of recall score against rhythmic pattern.

Means plots of recall score against rhythmic pattern

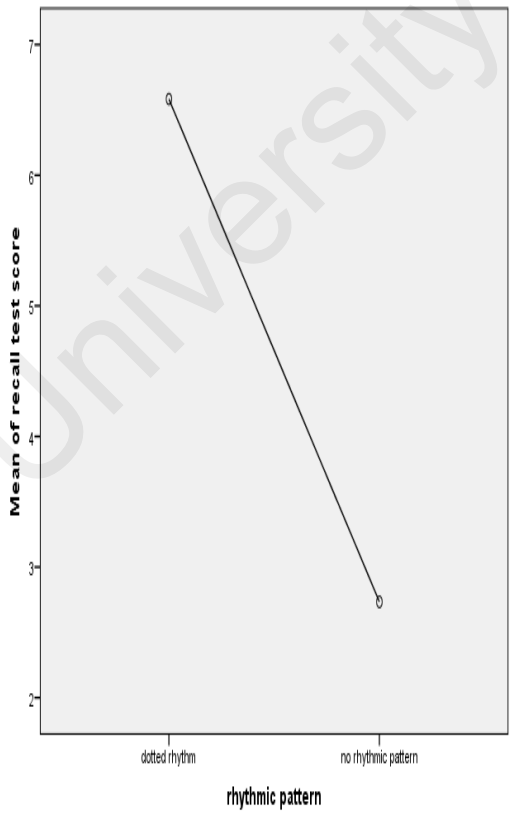


Figure 4.4: 1st attempt

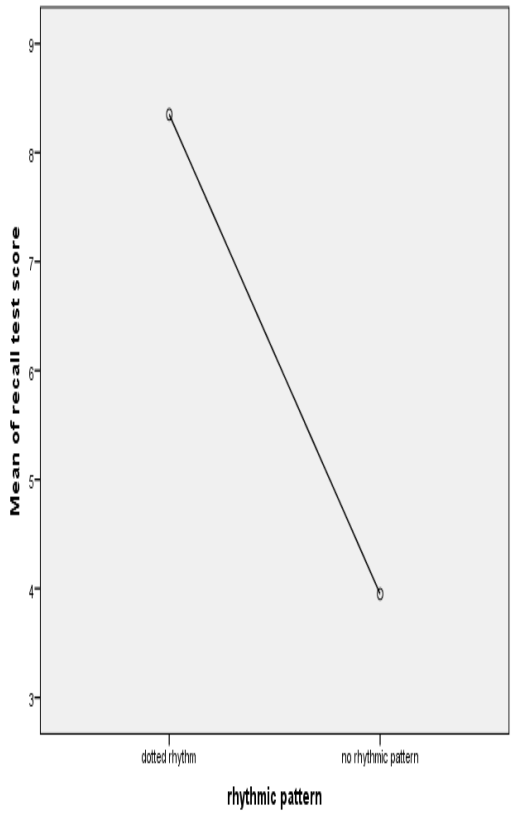


Figure 4.5: 2nd attempt

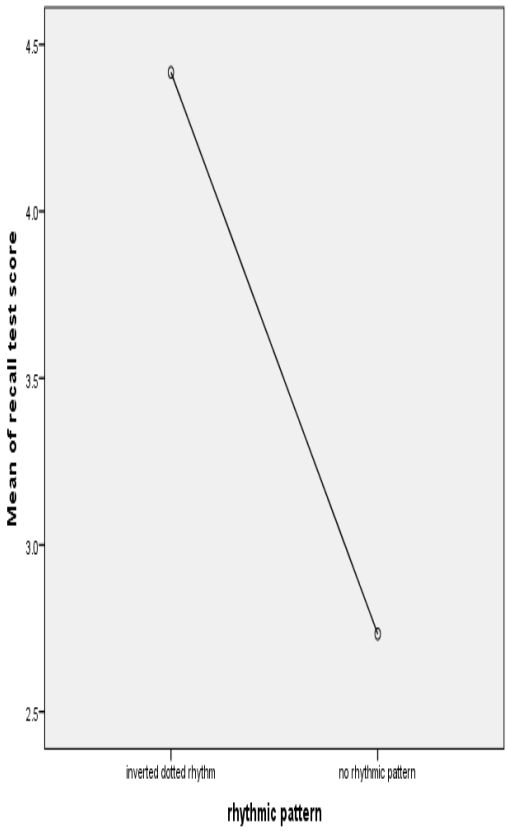


Figure 4.6: 1st attempt

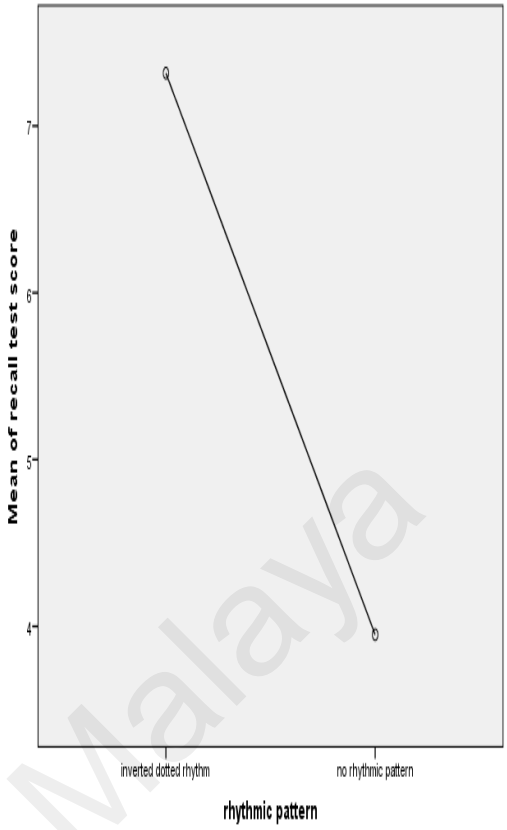


Figure 4.7: 2nd attempt

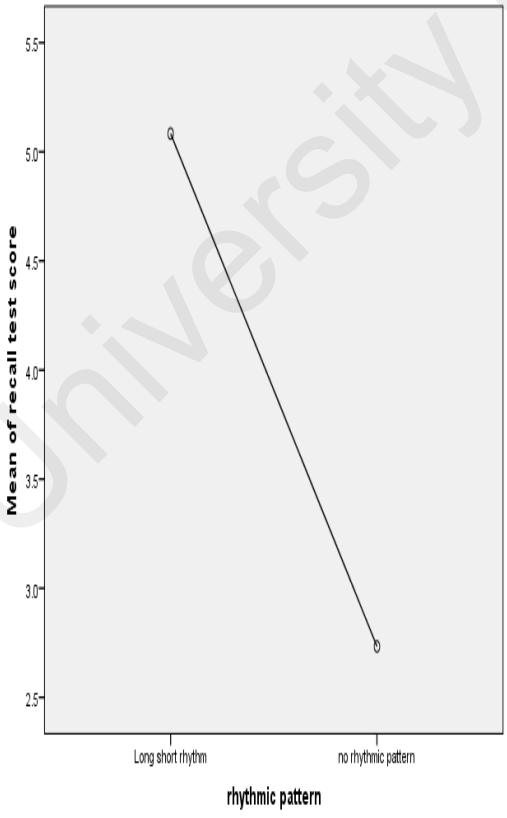


Figure 4.8: 1st attempt

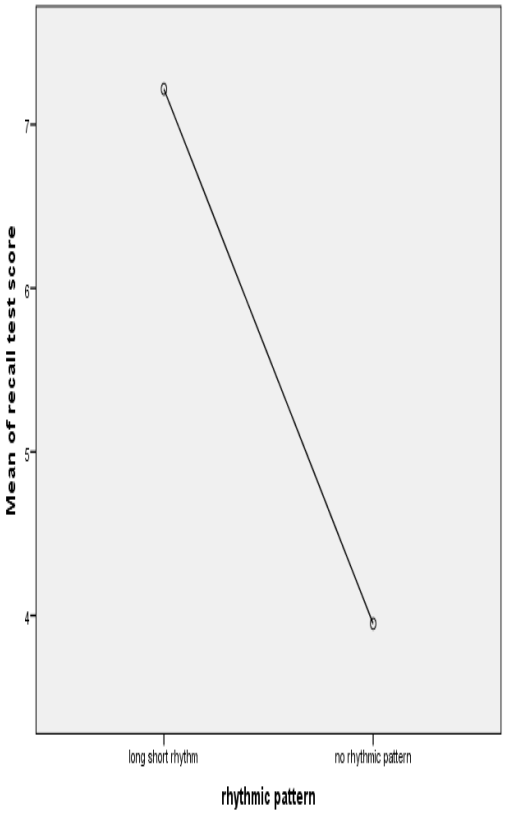


Figure 4.9: 2nd attempt

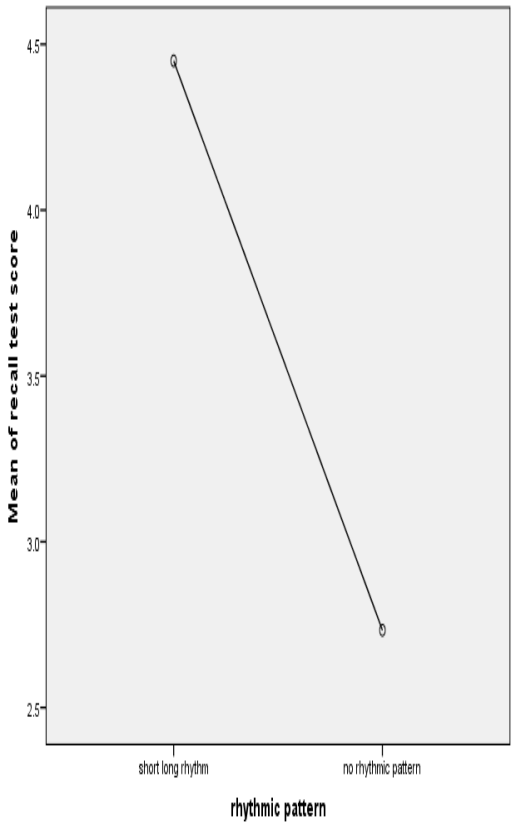


Figure 4.10: 1st attempt

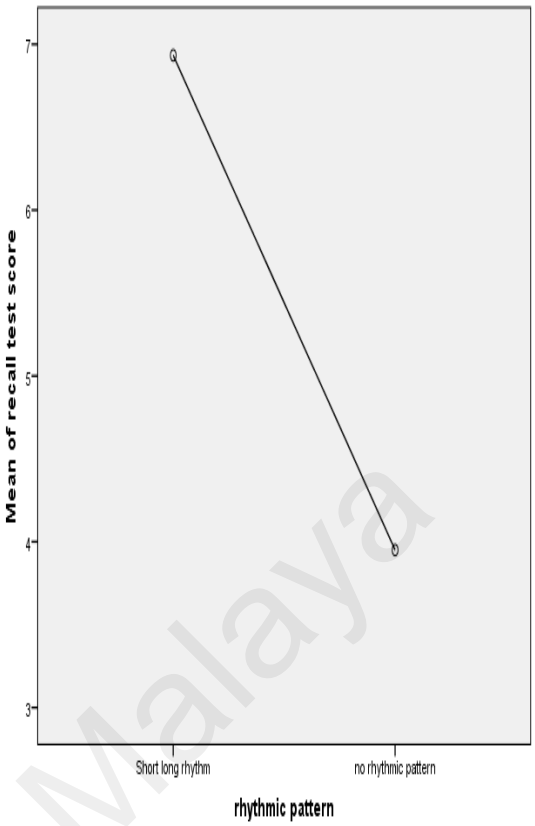


Figure 4.11: 2nd attempt

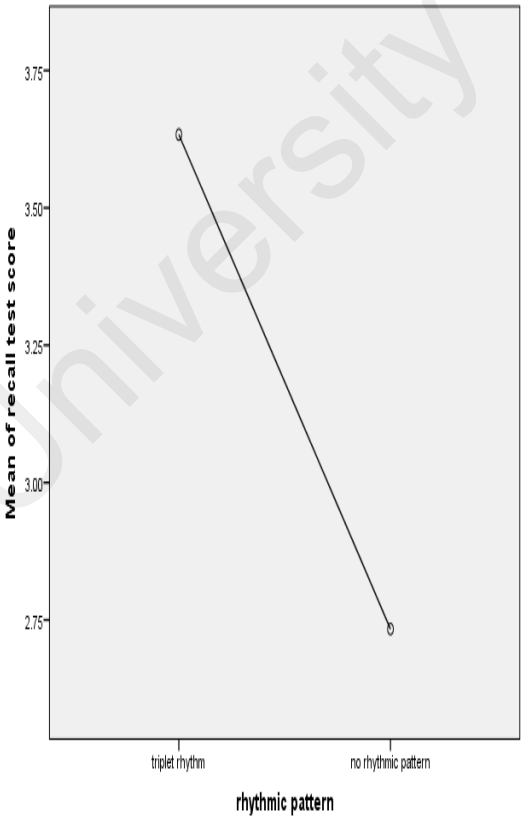


Figure 4.12: 1st attempt

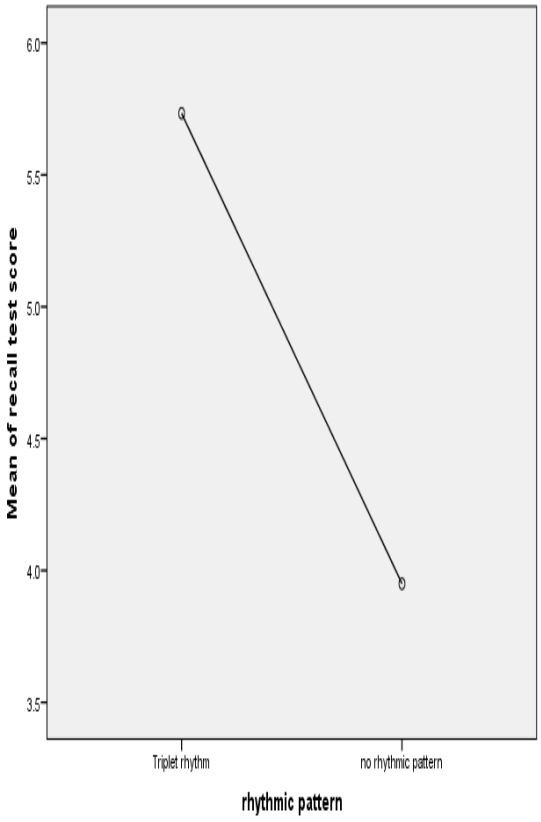


Figure 4.13: 2nd attempt

4.4.2 Different rhythmic patterns on digit recalls

Research Question 2:

Are there any significant differences among the five different rhythmic patterns on working memory between musicians and non-musicians?

The mean score for the six groups of different rhythmic patterns are shown on the 1st and 2nd attempt. It is observed that the triplet rhythm has the lowest mean score for both attempts. On the 1st attempt, triplet rhythm has the lowest mean score (M = 3.07, SD = 3.07) and (M = 5.63, SD = 2.61) on 2nd attempt. However, dotted rhythm has the highest mean score on 1st attempt (M = 6.58, SD = 2.51) and 2nd attempt (M = 8.35, SD = 2.11). Meanwhile, Long short rhythm has the 2nd highest mean score (M = 5.32, SD = 2.65) followed by short long rhythm (M = 4.92, SD = 2.43) and inverted dotted rhythm (M = 4.42, SD = 2.54) on 1st attempt. Conversely, Inverted dotted rhythm has the 2nd highest mean score (M = 7.32, SD = 2.08) followed by Long short rhythm (M = 7.22, SD = 2.60) and Short long rhythm (M = 6.92, SD = 2.20) on 2nd attempt (see table 4.9).

Table 4.10 depicts the one way ANOVA test result shown where the value of F (df = 4, 295, $p < .05$) = 17.809 is significant on 1st on the 2nd attempt (df = 4, 295, $p < .05$) = 10.507. Thus, there is a significant difference in the effectiveness of the five rhythmic patterns in recall digits for both attempts.

The Turkey HSD hoc test results have shown a significant difference between the mean score of each rhythmic pattern. On the 1st attempt, (see table 4.11) the negative sign of means difference (I-J) in triplet rhythm against dotted rhythm (I-J = -3.517, $p < 0.5$), inverted dotted rhythm (I-J = -1.350, $p < 0.5$), long short rhythm (I-J = -2.250, $p < 0.5$) and short long rhythm (I-J = -1.850, $p < 0.5$) indicated triplet rhythm has the lowest mean score. On the 2nd attempt (see table 4.12), triplet rhythm has the lowest mean score as well. The negative sign of means difference (I-J) in triplet rhythm against

dotted rhythm (I-J = -2.717, p < 0.5), inverted dotted rhythm (I-J = -1.683, p < 0.5), long short rhythm (I-J = -1.583, p < 0.5) and short long rhythm (I-J = -1.283, p < 0.5) shown significant. Hence, triplets rhythm used in recalling digits is not as effective as dotted rhythm, inverted dotted rhythm, long short rhythm and short long rhythm on 1st and 2nd attempt.

Table 4.9: Descriptive statistic for different rhythmic patterns on 1st and 2nd attempt

Attempt	Recall test score	Mean	Std. Deviation
1st	Dotted rhythm	6.58	2.51
	Inverted dotted rhythm	4.42	2.54
	Long short rhythm	5.32	2.65
	Short long rhythm	4.92	2.43
	Triplet rhythm	3.07	1.45
2nd	Dotted rhythm	8.35	2.11
	Inverted dotted rhythm	7.32	2.08
	Long short rhythm	7.22	2.60
	Short long rhythm	6.92	2.20
	Triplet rhythm	5.63	2.61

Table 4.10: ANOVA test for different rhythmic patterns on 1st and 2nd attempt

Attempt	Recall test score	df	Mean Square	F	Sig.
1st	Between Groups	4	98.913	17.809	.000
	Within Groups	295	5.554		
2nd	Between Groups	4	57.103	10.507	.000
	Within Groups	295	5.435		

Table 4.11: ANOVA Multiple Comparisons Test of Rhythmic Pattern on 1st Attempt

(I) Rhythmic pattern	(J) Rhythmic pattern	Mean Difference (I-J)	Sig.
Dotted rhythm	Inverted dotted rhythm	2.167*	.000
	Long short rhythm	1.267*	.029
	Short long rhythm	1.667*	.001
	Triplet rhythm	3.517*	.000
Inverted dotted rhythm	Dotted rhythm	-2.167*	.000
	Long short rhythm	-.900	.226
	Short long rhythm	-.500	.773
	Triplet rhythm	1.350*	.016
Long short rhythm	Dotted rhythm	-1.267*	.029
	Inverted dotted rhythm	.900	.226
	Short long rhythm	.400	.885
	Triplet rhythm	2.250*	.000
Short long rhythm	Dotted rhythm	-1.667*	.001
	Inverted dotted rhythm	.500	.773
	Long short rhythm	-.400	.885
	Triplet rhythm	1.850*	.000
Triplet rhythm	Dotted rhythm	-3.517*	.000
	Inverted dotted rhythm	-1.350*	.016
	Long short rhythm	-2.250*	.000
	Short long rhythm	-1.850*	.000

Table 4.12: ANOVA Multiple Comparisons Test of Rhythmic Pattern on 2nd Attempt

(I) Rhythmic pattern	(J) Rhythmic pattern	Mean Difference (I-J)	Sig.
Dotted rhythm	Inverted dotted rhythm	1.033	.111
	Long short rhythm	1.133	.062
	Short long rhythm	1.433*	.008
	Triplet rhythm	2.717*	.000
Inverted dotted rhythm	Dotted rhythm	-1.033	.111
	Long short rhythm	.100	.999
	Short long rhythm	.400	.881
	Triplet rhythm	1.683*	.001
Long short rhythm	Dotted rhythm	-1.133	.062
	Inverted dotted rhythm	-.100	.999
	Short long rhythm	.300	.955
	Triplet rhythm	1.583*	.002
Short long rhythm	Dotted rhythm	-1.433*	.008
	Inverted dotted rhythm	-.400	.881
	Long short rhythm	-.300	.955
	Triplet rhythm	1.283*	.023
Triplet rhythm	Dotted rhythm	-2.717*	.000
	Inverted dotted rhythm	-1.683*	.001
	Long short rhythm	-1.583*	.002
	Short long rhythm	-1.283*	.023

The means plot clearly indicated that triplet rhythm yields the lowest recall score and dotted rhythm has the highest mean score for both attempts as compared to other rhythmic patterns. Figure 4.15 shown inverted dotted rhythms has slightly rise on 2nd attempt however long short and short long rhythm remain no changes.

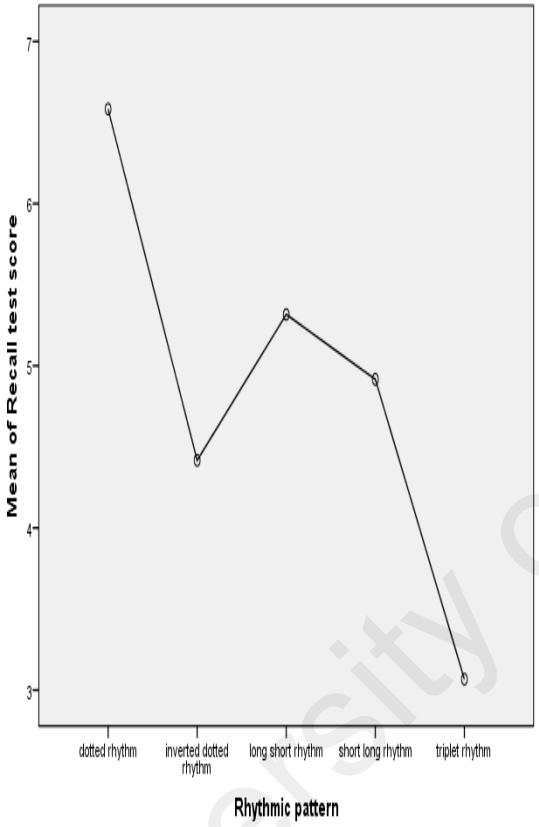


Figure 4.14:1st attempt

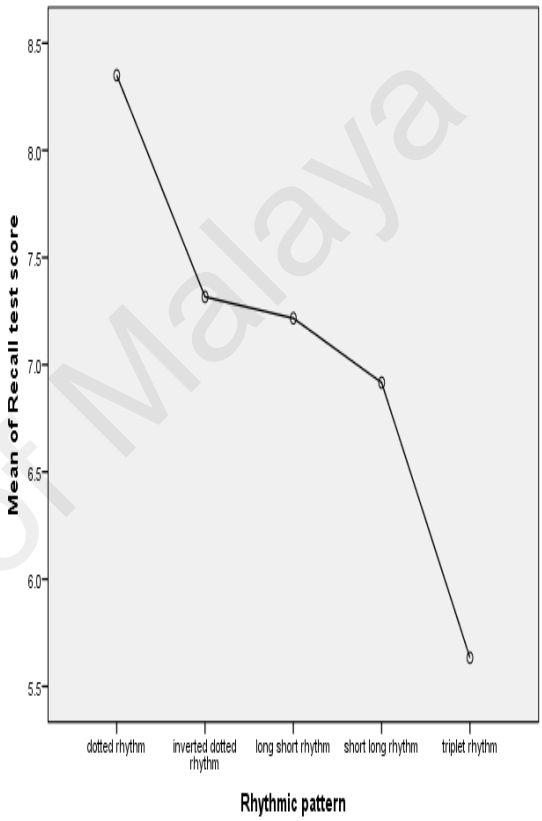


Figure 4.15: 2nd attempt

Mean of recall test score on 1st attempt

4.4.3 Difference in digits recall between musicians and non-musicians on their short term memory with the aid of different rhythmic patterns

Research Question 3:

Is there any significant effect of the combinations of rhythmic mnemonic and musicianship on recall performance?

Table 4.13 shown mean score of musicians and non-musicians against each rhythmic pattern.

Table 4.13: Descriptive statistics for rhythmic pattern against formal music training

Formal music training	Attempt	Rhythmic pattern	Mean	Standard Deviation
Musicians	1st	Dotted rhythm	6.63	2.46
		Inverted dotted rhythm	5.67	2.54
		Long short rhythm	7.00	2.07
		Short long rhythm	5.73	2.24
		Triplet rhythm	4.10	1.37
	2nd	Dotted rhythm	9.07	1.76
		Inverted dotted rhythm	7.80	2.11
		Long short rhythm	8.57	1.85
		Short long rhythm	7.17	2.25
		Triplet rhythm	6.83	2.49
Non-musicians	1st	Dotted rhythm	6.53	2.61
		Inverted dotted rhythm	3.17	1.86
		Long short rhythm	3.63	2.03
		Short long rhythm	4.17	2.42
		Triplet rhythm	2.13	.68
	2nd	Dotted rhythm	7.63	2.22
		Inverted dotted rhythm	6.83	1.97
		Long short rhythm	5.87	2.56
		Short long rhythm	6.70	2.20

	Triplet rhythm	4.63	2.30

Result shown musicians scored a higher mean score for each rhythmic pattern on both attempts. On 1st attempt, musicians' mean score are higher on dotted rhythm (M = 6.63, SD = 2.46), inverted dotted rhythm (M = 5.67, SD = 2.54), long short rhythm (M = 7.00, SD = 2.07), short long rhythm (M = 5.73, SD = 2.24) and triplet rhythm (M = 4.10, SD = 1.37) as compare to non-musicians' mean score on dotted rhythm (M = 6.53, SD = 2.61), inverted dotted rhythm (M = 3.17, SD = 1.86), long short rhythm (M = 3.63, SD = 2.03), short long rhythm (M = 4.17, SD = 2.42) and triplet rhythm (M = 2.13, SD = .68).

For 2nd attempt (see table 4.13), musicians hold higher mean scores as 1st attempt. Rhythmic patterns such as dotted rhythm (M = 9.07, SD = 1.76), inverted dotted rhythm (M = 7.80, SD = 2.11), long short rhythm (M = 8.57, SD = 1.85), short long rhythm (M = 7.17, SD = 2.25) and triplet rhythm (M = 6.83, SD = 2.49) have better effects with musicians as compare to non-musicians. The mean scores of non-musicians shown in table 4.13 are slightly lower on dotted rhythm (M = 7.63, SD = 2.22), inverted dotted rhythm (M = 6.83, SD = 1.97), long short rhythm (M = 5.87, SD = 2.56), short long rhythm (M = 6.70, SD = 2.20) and triplet rhythm (M = 4.63, SD = 2.30).

Table 4.14 shown Mauchly's Test of Sphericity for 1st attempt is significant where $p < .05$ therefore result will be based on Huyng-Feldt (refer Table 4.15). For 2nd attempt, result will be based on multivariate tests as table 4.14 shown Mauchly's Test of Sphericity is not significant, $p > .05$ (refer Table 4.16).

Value of Huyng-Feldt (see Table 4.15) shown the main effect for rhythmic pattern [$F(3.6, 206.92) = 24.85$, $p < .05$] and the interaction effect of rhythmic pattern and musical background [$F(3.6, 206.92) = 5.68$, $P < .05$] are significant. Test result indicated rhythmic pattern influence recall test individually. Furthermore, interaction

effect between rhythmic patterns and formal music training gives an impact on recall test as well.

Table 4.14: SPANOVA Mauchly's Test of Sphericity for 1st and 2nd attempt

Attempt	Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]	
						Greenhouse-Geisser	Huynh-Feldt
1st	Rhythmic pattern	.566	32.133	9	.000	.822	.892
2nd		.868	7.973	9	.537	.929	1.000

On 2nd attempt, Multivariate Tests shown in table 4.16 indicated the effect of rhythmic patterns on short term memory [F (4, 55) = 10.41, $p < .05$] is significant. Furthermore, the interaction effect between rhythmic patterns and musical background on short term memory is significant [F (1, 58) = 2.78, $p < .05$]. In other word, when rhythmic pattern and musical background are putting together, there's significant effect on short term memory.

Table 4.15 shown there is a significant difference between musicians and non-musicians in short term memory on 1st attempt [F (1.58) = 40.55, $p < .05$] and 2nd attempt [F (1.58) =30.73, $p < .05$]. As a result, musicians performs better on 1st attempt (Mean: musicians = 5.83; non-musicians = 3.93) and 2nd attempt (Mean: musicians = 7.89; non-musicians = 6.33) as compare to non-musicians in short term memory.

Table 4.15: SPANOVA Tests of Within subjects effects on 1st attempt

	Source	Df	F	Sig.
Rhythmic pattern	Sphericity Assumed	4	24.85	.000
	Greenhouse-Geisser	3.29	24.85	.000
	Huynh-Feldt	3.57	24.85	.000
	Lower-bound	1.00	24.85	.000
Rhythmic pattern *	Sphericity Assumed	4.00	5.68	.000

formal music training	Greenhouse-Geisser	3.29	5.68	.001
	Huynh-Feldt	3.57	5.68	.000
	Lower-bound	1.00	5.68	.020
Error(rhythmic pattern)	Sphericity Assumed	232.00		
	Greenhouse-Geisser	190.62		
	Huynh-Feldt	206.92		
	Lower-bound	58.00		

Figure 4.16 (1st attempt) and 4.17 (2nd attempt) showed the mean plot of rhythmic pattern against musicians and non-musicians. For both attempt, musicians scored higher on each rhythmic patterns as compare to non-musicians. However, non-musician showed an improvement in inverted dotted rhythm on 2nd attempt.

Table 4.16: SPANOVA Multivariate Tests on 2nd attempt

Effect		Value	F	Hypothesis df	Error df	Sig.
Rhythmic pattern	Pillai's Trace	.431	10.410[b]	4.000	55.000	.000
	Wilks' Lambda	.569	10.410[b]	4.000	55.000	.000
	Hotelling's Trace	.757	10.410[b]	4.000	55.000	.000
	Roy's Largest Root	.757	10.410[b]	4.000	55.000	.000
Rhythmic pattern * formal music training	Pillai's Trace	.185	3.121[b]	4.000	55.000	.022
	Wilks' Lambda	.815	3.121[b]	4.000	55.000	.022
	Hotelling's Trace	.227	3.121[b]	4.000	55.000	.022
	Roy's Largest Root	.227	3.121[b]	4.000	55.000	.022

Table 4.17: SPANOVA Test of Between-Subjects on 1st and 2nd attempt

Attempt	Source	df	F	Sig.
1st	Background	1	40.55	.000
	Error	58		
2nd	Background	1	30.73	.000
	Error	58		

Means plot of rhythmic patterns against musicians and non-musicians

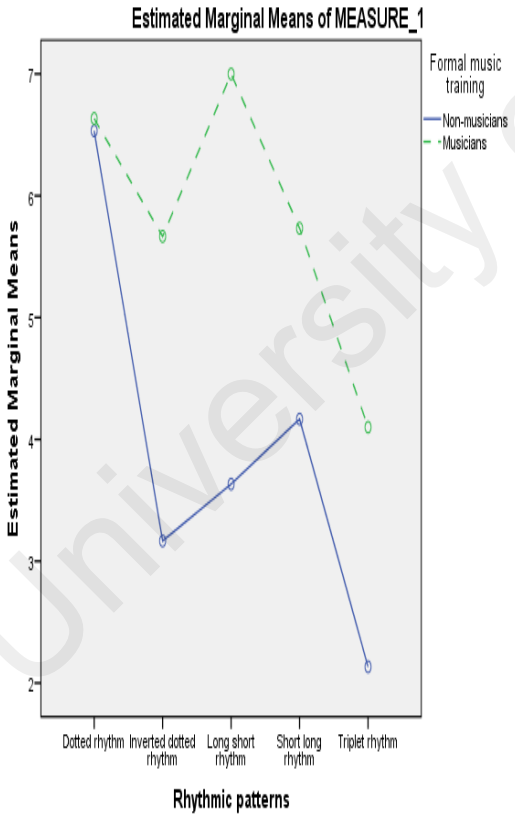


Figure 4.16: 1st attempt

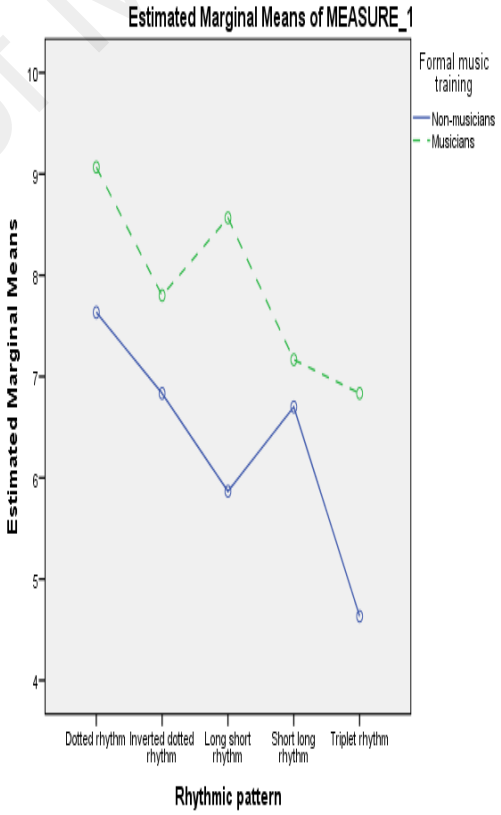


Figure 4.17: 2nd attempt

4.5 Summary of findings

Summary of findings are presented based on research questions and hypotheses.

Research Question 1: Is there a significant effect of rhythmic pattern applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians?

Null Hypothesis 1. There will be no significant effect of rhythmic pattern applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians. The null hypothesis is rejected on both attempts. SPANOVA indicated that there is a significant difference in number recall when the digit is presented with dotted rhythm [F (df = 1, 118 $p < .05$) = 104.47], inverted dotted rhythm [F (df = 1, 118 $p < .05$) = 19.66], long short rhythm [F (df = 1, 118 $p < .05$) = 34.04], short long rhythm [F (df = 1, 118 $p < .05$) = 21.98] and triplet rhythm [F (df = 1, 118 $p < .05$) = 9.63] on 1st attempt. Furthermore, result show significant difference on 2nd attempt when digit is presented with dotted rhythm [F (df = 1, 118 $p < .05$) =127.27], inverted dotted rhythm [F (df = 1, 118 $p < .05$) = 75.73], long short rhythm [F (df = 1, 118 $p < .05$) = 56.13], short long rhythm [F (df = 1, 118 $p < .05$) = 55.81] and triplet rhythm [F (df = 1, 118 $p < .05$) = 16.54]. Hence, no rhythmic pattern showed ineffective as compare to rhythmic pattern in recalling 10 digit numbers on short term memory.

Research Question 2: Is there a significant differences among five different rhythmic patterns applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians?

Null Hypothesis 2. There will be no significant differences among five different rhythmic patterns applied to 10 digit numbers recall by testing on working memory between musicians and non-musicians. The null hypothesis is rejected on both attempts. One-way ANOVA test result shown there is a significant contrast between 5 rhythmic patterns where the value of F is significant [F (df = 4, 295, $p < .05$) = 17.809] on 1st

attempt and [F (df = 4, 295, p < .05) = 10.507] on 2nd attempt. Therefore, there is a significant effectiveness between 5 rhythmic patterns; dotted rhythm, inverted dotted rhythm, long short rhythm, short long rhythm and triplet rhythm.

Research Question 3: Is there any significant effect between the combination of rhythmic mnemonic and musicianship on sequential 10 digit numbers recall performance?

Null Hypothesis 3. There will be no significant effect between the combination of rhythmic mnemonic and musicianship on sequential 10 digit numbers recall performance. Researcher rejected the null hypothesis on both attempts. On 1st attempt, result based on value of Huyng-Feldt showed there is a significant difference between the interaction effect of rhythmic pattern and musical background [F (df = 3.6, 206.92, p < .05) = 5.68]. In addition, the interaction effect between rhythmic patterns and musical background on 2nd attempt showed significant [F (df = 1, 58, p < .05) = 2.78]. In other words, formal music training influenced the result of digit recalls on short term memory.

4.5.1 Additional findings

Researchers found a main effect of trials using SPANOVA which showed significant differences between 1st and 2nd attempts. Table 4.18 showed negative value in mean difference (MD = -9.073) when comparing 1st attempt with 2nd attempt. Significant result indicated respondents performed better in 2nd attempt. Despite Value of Huynh-Feldt (refer table 4.19) showed significant on trials [F (df = 1, 58, p < .05) =131.98], it failed to show significant on the interaction between formal music training and trials [F (df = 1, 58, p > .05) =1.48]. Furthermore, figure 4.18 showed the mean plot between 1st and 2nd attempt where 2nd attempt clearly showed a higher mean as compare to 1st attempt. Hence, there's a main effect of trials in recalling 10 digit numbers among

respondents on short term memory independently, however formal music training has shown no impact on recalling test.

Table 4.18: Pairwise Comparisons between attempts

Attempt		Mean Difference (I-J)	Std. Error	Sig.[b]
I	J			
1st	2nd	-9.073*	.790	.000
2nd	1st	9.073*	.790	.000

*. The mean difference is significant at the .05 level.

Table 4.19: Tests of Within-Subjects Effects

Source		df	F	Sig.
Attempt	Sphericity Assumed	1	131.981	.000
	Greenhouse-Geisser	1.000	131.981	.000
	Huynh-Feldt	1.000	131.981	.000
	Lower-bound	1.000	131.981	.000
Attempt * formal music training	Sphericity Assumed	1	1.477	.229
	Greenhouse-Geisser	1.000	1.477	.229
	Huynh-Feldt	1.000	1.477	.229
	Lower-bound	1.000	1.477	.229
Error(factor1)	Sphericity Assumed	58		
	Greenhouse-Geisser	58.000		
	Huynh-Feldt	58.000		
	Lower-bound	58.000		

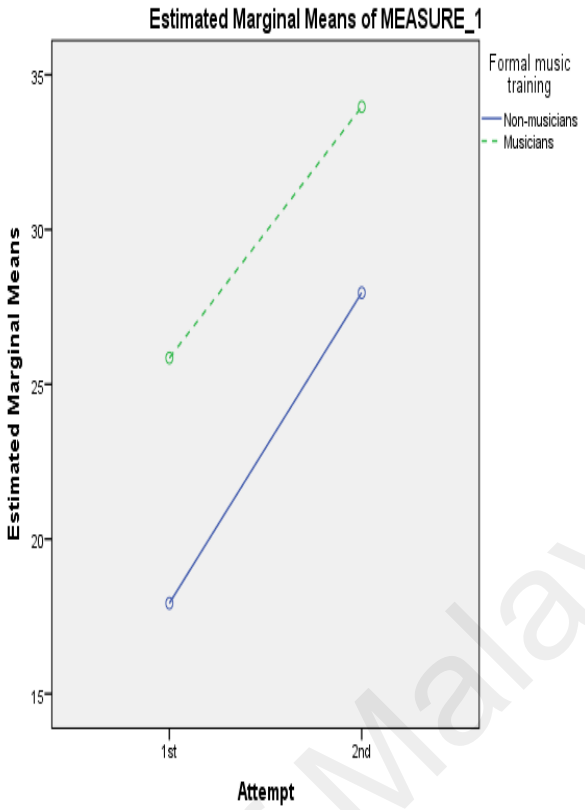


Figure 4.18: Means plot of musical background against attempts

4.6 Discussion

This section provided a discussion of the results theoretically and practically as a whole, followed by limitations of study and suggestion for future research. The objectives as stated earlier in this study were to examine the effect of rhythmic pattern and musical training in recalling 10 digit numbers on short term memory. Therefore, respondents were chosen between musicians and non-musicians as to find out the impact of musicianship.

Formal musicianship (musicians and non-musicians) and mnemonic modality (rhythmic pattern) served as independent variable and 10 digit numbers recall (short term memory) as dependent variable. Respondents were gathered for digit recall test and were examined throughout two trials. Each attempt was analysed separately as to obtain a precise result and 10% of score was given by the correct number of digit recalled in the correct order. Hence, a total of possible score was 100%.

Prior research verified musical elements such as melody served as a mnemonics device in recalling words (Horn & Wolfe, 1993; Wallace, 1994; Thaut, Mertel & Leins, 2008; Curtis & Bharucha, 2009; Pindale, 2013) and digit numbers (Wolfe & Horn, 1993; Silverman 2010) with the effect of formal musical training on verbal recall (Brandler and Rammsayer, 2003; Ho et al., 2003; Helmbold et al., 2005; Franklin et al., 2008; Cabanac et al., 2013; Nutley et al., 2013).

However, there was a deficiency of attention underlining the role of rhythmic pattern independently on 10 digit numbers recall, meanwhile some researches failed to reveal significant result on the impact of musical training due to insufficient sample size. Therefore, this study ought to be carried out as to define the interaction effect of musical training and rhythmic pattern on verbal recall in undergraduate students.

4.6.1 Discussion of the Research Questions

The purpose of this research was to identity the effect of rhythm and without rhythm on digit recalls. Data analysis result of the first research question showed that there was a significant difference on the effect of rhythm where rhythmic patterns; dotted rhythm, inverted dotted rhythm, long short rhythm, short long rhythm and triplet rhythm were able to assist in recalling number more effectively as compared to non-rhythmic pattern. Thus, there was a main effect of rhythmic patterns in recalling 10 digit numbers on verbal memory.

A few researches had agreed with the findings of this study. Wallace (1994) added that information is being chunk into relevant idea whenever rhythm is presented. Later, Pindale (2013) stated that rhythm has the hidden ability to provide retrieve cues during the process of recall. As a result, rhythm served as a mnemonic device may have an effect in resulting digit recall score.

The second research question investigated the effect of different rhythmic patterns on 10 digit numbers recall. Result of the present research showed that there was a

significant difference in digit recall between 5 rhythmic patterns on both attempts and hence indicating there was a main effect for different rhythmic patterns. Among those 5 rhythmic patterns were tested, descriptive result showed that respondents performed the best on dotted rhythm for 1st and 2nd attempt.

Prior studies had shown the effect of syncopated rhythm in verbal memory. According to Wallace (1994) & Fitch & Rosenfeld (2007), there was a cause of delay in recall when syncopated rhythm was used. However, dotted rhythm, inverted dotted rhythm, long short rhythm, short long rhythm and triplet rhythm had not completely examined. Therefore this research needed to be carried out to find out the effect of each rhythmic pattern on digit numbers recall.

The last research question examined the effect of musical training on digit numbers recall. Result indicated that there was a significant difference between musicians and non-musicians on digit numbers recall with the aid of different rhythmic patterns. According to the descriptive result, it showed that musicians performed better than non-musicians on each trial. Therefore, there was a main effect of musicianship on digit numbers recall.

Previous researches had shown the significance of musicianship on verbal memory (Chan et al., 1998; Brandler and Rammsayer, 2003; Ho et al., 2003; Helmbold et al., 2005; Franklin et al., 2008; Cabanac et al., 2013; Nutley et al., 2013). A few studies where authors focused on word recall showed that musicians recalled more words than non-musicians (Chan et al., 1998; Ho et al., 2003; Jakobson et al. 2008; Franklin et al., 2008). Scholars stated that musicians may have better verbal recall on short term memory than non-musicians due to the larger part of left planum temporale (PT) where verbal memory takes place (Bever and Chiarello, 1974; Besson et al., 1994; Ohnishi et al., 2001). In spite of musical training may perhaps influence the result of digit recall scores, the significance of musicianship on digit recall has not been found yet.

4.6.2 Discussion of Additional Findings

An additional result of this study showed that respondent's mean scores in recall test were significantly different in both attempts. There was an obvious changed on 2nd attempt where result showed that the percentage of recall score increased from the 1st attempt to 2nd attempt. In other words, the importance of rehearsal or repetition has revealed during verbal learning in order to achieve a better outcome. However, result showed both musicians and non-musicians have higher scores on 2nd attempt as compared to 1st attempt. Therefore, the role of musicianship did not showed a significant difference when the habit of repetition was applied.

The participants of this research were given a chance to rehearse the verbal materials;- 6 sets of rhythmic patterns by listening twice for each sets of 10 digit numbers. The result showed an increase of scores throughout the two attempts. Hence, these findings showed the significance of repetition on verbal short term memory. Several researches debated and supported the theory of articulatory rehearsal system where repetition of verbal materials has the ability to keep or store and recover from verbal short term memory to long term memory (Vallar, 2006; Baddeley, 2012). As stated earlier by Gfeller (1983), the combination of repetition and musical elements create better outcome in verbal memory upon children with learning disabilities.

4.7 Conclusion

As a result, Chapter 4 presented findings of data analysis and discussion based on each research questions of the present study. Via this experiment, it is found that rhythmic patterns have a positive effect on recalling information where each rhythmic pattern functioned as mnemonic device in recalling digit numbers on verbal short term memory. Specifically, dotted rhythm performed the best in recalling digit numbers as compared to inverted dotted rhythm, short long rhythm, long short rhythm and triplet

rhythm. Meanwhile, result showed musicians have higher recall scores on each rhythmic pattern as compared to non-musicians on both attempts. Hence, this research had supported the concepts of musicianship where the idea of musical training was beneficial in recalling verbal information as stated earlier by a few researches.

The following Chapter 5 discussed each finding in details as well as theoretical and practical implications of research and suggestions for future study.

CHAPTER 5: CONCLUSION

5.1 Introduction

This Chapter concludes the dissertation titled *The Effect of Rhythmic Pattern on Short Term Memory of 10 Digit Recall between Music and Non-Music Undergraduate Students*. The following sections present a summary of research findings and methodology, implication of research, limitations, and suggestions for future research.

5.2 Summary of Findings and Implication of Findings

This research first carried out a literature review in defining the gap in past researches. Music has been studied on its effect as an aid in memory, however, there is a lack of study in looking at specific musical elements, such as a detailed investigation into different rhythmic patterns in application to digit recall. Therefore, in this study, a few rhythmic patterns were designed based on the gap in the literature, and then applied to a ten-digit sequence and its effect was tested on two groups of subjects: musicians and non-musicians. From the experiment, the research design was found adequate and research objectives were achieved.

This research revealed a few new theoretical findings for the effect of rhythm on verbal short term memory. Firstly, rhythm serves as a mnemonic device in assisting verbal memory on digit recall. Secondly, musicians provided better mean score as compared to non-musicians; meanwhile the importance of rehearsal of digit recall with the aid of rhythm on verbal short-term recall was presented.

As a summary, various analysis using SPSS showed there is a significant effect on using rhythmic pattern in the recall of ten-digit sequence. In addition, specific rhythmic pattern such as the dotted rhythm was found the most effective in short term or working memory recall. This research also discovered that subjects with background in music

training generally achieved a better score compared to non-musicians. Nevertheless, regardless of musical training, there is a significant difference of higher score achievement when the ten digit sequence was announced with rhythmic pattern, showing effectiveness of how rhythmic pattern applied to number recall may help working memory.

The results discovered in this research suggest new findings in contributing to the area of studies in music psychology and education. This study indicated that rhythmic pattern may be applied as a tool in improving working memory in digit recall, and that the ideal of repetition with rhythmic pattern had shown a positive impact on verbal memory in both musicians and non-musicians. The combinations of rhythmic aid in this study has proven to be effective, and may contribute improvement if applied to daily or regular task involving individuals of all ages that requires working memory in digit recall.

In terms of musical training, previous research showed significant result where formal music training were able to enhance verbal memory academically and practically (Wallace, 1994; Chan et al., 1998; Jakobson et al., 2008). The findings in study add a step further in suggesting that music training is important in order to optimize the effect of rhythmic pattern application to digit recall in improving working memory. Furthermore, the study also suggest that a more in depth analysis into musical elements is required in the research area of music psychology, which is quite often absent in research (refer Section 2.5.3), where music is seen as a tool in general, but its detailed musical parameters were not studied in depth. The present study tested on a few types of rhythmic patterns instead of one, providing a choice of variables to be tested, as the possibilities of a large amount of different rhythmic patterns and arrangement must be taken into consideration.

5.3 Limitation of Research

Firstly, there was a limitation in the attempt of trial given. Due to the insufficient time frame, only two attempts were carried out. Although result showed that respondents performed better in 2nd attempt as a whole, they should not be expected to perform well when more attempts were given. Thus, result may be altered if more trials were given. Furthermore, rhythmic pattern where dotted rhythm performed the best for each attempts are not likely to achieve well in the following attempt.

A second limitation in this study was the history of musical training among respondents. Non-musicians as stated earlier may not have little knowledge to any musical experience. However, several non-musicians reported to have been engaged with informal musical lessons while schooling. In spite of that, those respondents were still categorized as non-musicians in this study.

Moreover, musicians showed differences in terms of the age began attending music lessons and number of instruments played. The majority of musicians started playing music during secondary school and mostly took up one instrument except a few. Hence, result may have been influenced due to the character dissimilarity among musicians. The incapability of searching similar criteria affected in producing a solid result between musicians and non-musicians when digit was presented rhythmically. Furthermore, the education background of non-musicians may not be similar as there were not from the same faculty as compared to musicians. Therefore, future researchers are encouraged to be more alert in selecting respondents.

Next, researcher did not have a chance to run through rehearsals before the actual experiments took place and hence result may be influenced due to the order given. According to the rhythmic pattern order, dotted rhythm was the 1st rhythmic pattern and triplet rhythm was the last. Result showed that respondents performed the best on dotted

rhythm and poorly performed on triplet rhythm. Therefore, it is strongly believed that the order may have affected the final result.

Additionally, respondents were placed in a comfortable classroom to avoid distraction happened. However, several disturbances such as environmental distractions were beyond control. Noise pollution and students passing by along corridor interfered respondents' concentration during the experiment as the classroom was not sound-proof and door was not locked entirely.

Lastly, both musicians and non-musicians were tested on the week of lecture 10th and 11th; therefore they may have been stressed with academic issues as final exam was around the corner. In addition, attending classes and accumulating coursework may cause anxiety that may have affected the result of recall tasks.

The reliability of the instrument items are limited by the small number of pilot study sample due to constraint of time. The reliability of the research instrument can be ascertained in future study.

5.4 Suggestion for Future Research

On the basis of the results of this study, future research may focus on the types of musicians. For example, vocalist and instrumentalist may have different level of cognitive functions. Researchers could focus on which form of musical training needed to be used in order to assist digit numbers recall on verbal memory as instrumentalists may have performed better than vocalist. Furthermore, further research ought to look into the years of musical training received among musicians. A difference on total years played by musicians may affect the result of digit numbers recall. For instance, musicians with a training period of more than 10 years may perform better on verbal memory as compared to those who played less than 10 years.

Studies should also discover the ideal of rhythmic mnemonic on words or sentence recall instead of digit numbers. For example, word with a long spelling or sentences

form by many words may seems difficult to recall, hence rhythmic patterns that showed a significant result on digit numbers recall may have similar effect on words or sentences recall as well.

Additionally, further study should look into the long term effect of rhythmic mnemonic on digit numbers recall between musicians and non-musicians. This research provided a significant result on short term effect, thus showing there would probably have the same result on long-term memory. Therefore, pre and post-test should be given where respondents try to recall the 10 digit numbers one or two weeks later. Future research might be able to find out if musicians perform better than non-musicians on longer period.

Last, further research should lay much focus on clinical used. Researches should examine the combination effect of rhythmic mnemonic and musical training on children suffering from Attention-Deficit Hyperactivity Disorder or adult with learning disabilities.

5.5 Conclusion

In conclusion, this study examined the effect of rhythmic patterns on verbal memory between musicians and non-musicians. A two-way ANOVA and SPANOVA showed that there was a significant difference upon each objective where rhythm has the main effect on recalling and each rhythmic pattern performed differently in assisting digit numbers recall. Furthermore, musicians have a better recall score than non-musicians across 2 trials and thus the result supported the effect of musical training for some reasons.

Rhythm or more precisely, rhythmic patterns have the ability to chunk information and retrieve cue in enhancing better recall. Therefore, rhythmic mnemonic can be used as an effective tool for memorization activity involving digit numbers in daily life.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

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Publication

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Appendix A

QUESTIONNAIRE
Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

2. Age: _____ years old
3. Gender: ☐ Male ☐ Female
4. Department: ☐ Music ☐ Non-music
5. Primary language: ☐ Malay ☐ English ☐ Chinese
6. Any background in formal music training:
   ☐ No (Please go to Part B)
   ☐ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☐

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☐

Can you play a basic piece of music? Yes ☐ No ☐

Do you attend any music classes before? Yes ☐ No ☐

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☐

Please list your major instrument _____ (GRADE:_____)

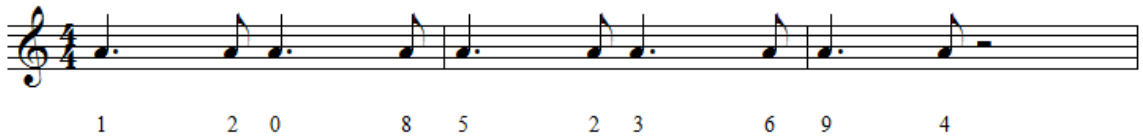
Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? _____ years old.

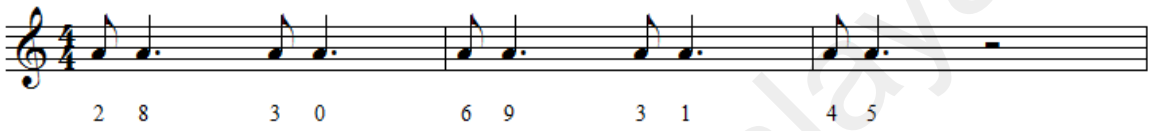
Music Examination Board Attended: ☐ Trinity, ☐ ABRSM, other: please specify_____.

Appendix B: Rhythmic patterns used

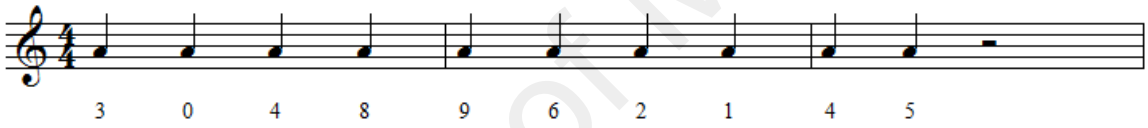
g) Dotted rhythm



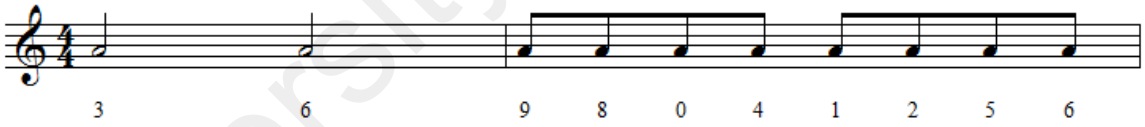
h) Inverted dotted rhythm



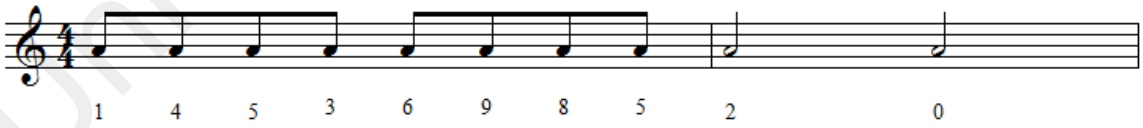
i) No rhythmic pattern



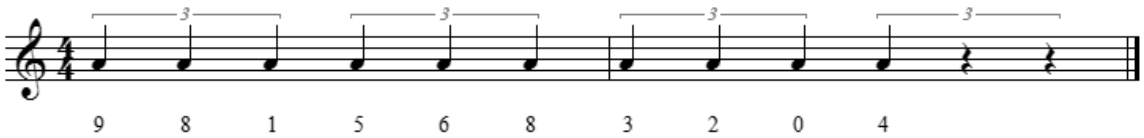
j) Long short rhythm



k) Short long rhythm

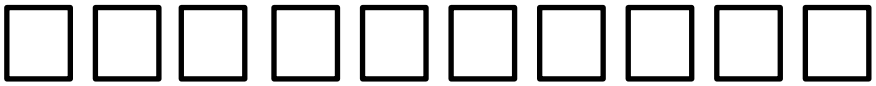


l) Triplets



Appendix C: Recall Forms

Numbers recall 1

1. 1ST ATTEMPT 

2. 1ST ATTEMPT 

3. 1ST ATTEMPT 

4. 1ST ATTEMPT 

5. 1ST ATTEMPT 

6. 1ST ATTEMPT 

Numbers recall 2

1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 21 years old
2. Gender: ☑ Male ☐ Female
3. Department: ☐ Music ☑ Non-music
4. Primary language: ☑ Malay ☑ English ☐ Chinese
5. Any background in formal music training:
   - ☑ No (Please go to Part B)
   - ☐ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☑

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☑

Can you play a basic piece of music? Yes ☐ No ☑

Do you attend any music classes before? Yes ☐ No ☑

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☐

Please list your major instrument _____ (GRADE:_____)

Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? _____ years old.

Music Examination Board Attended: ☐ Trinity, ☐ ABRSM, other: please specify_____)

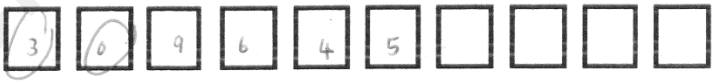
Part B: Please fill up the numbers in the boxes after each listening test

1. 1ST ATTEMPT 

2. 1ST ATTEMPT 

3. 1ST ATTEMPT 

4. 1ST ATTEMPT 

5. 1ST ATTEMPT 

6. 1ST ATTEMPT 

1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 21 years old
2. Gender: ☑ Male ☐ Female
3. Department: ☐ Music ☑ Non-music
4. Primary language: ☑ Malay ☐ English ☐ Chinese
5. Any background in formal music training:
   - ☑ No (Please go to Part B)
   - ☐ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☑

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☑

Can you play a basic piece of music? Yes ☑ No ☐

Do you attend any music classes before? Yes ☐ No ☑

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☐

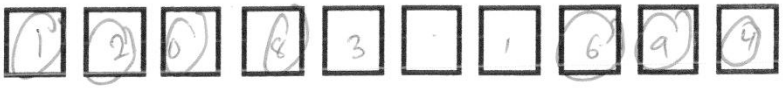
Please list your major instrument _____ (GRADE:_____)

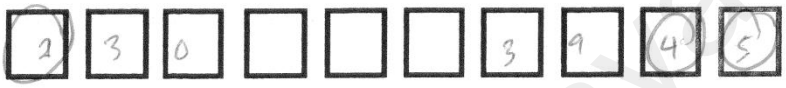
Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? _____ years old.

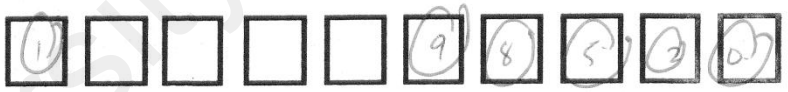
Music Examination Board Attended: ☐ Trinity, ☐ ABRSM, other: please specify_____)

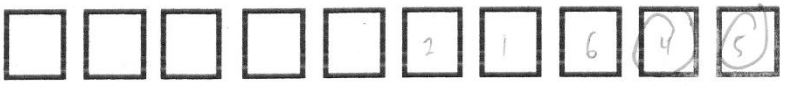
Part B: Please fill up the numbers in the boxes after each listening test

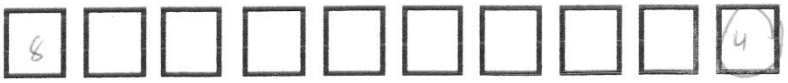
1. 1ST ATTEMPT  7

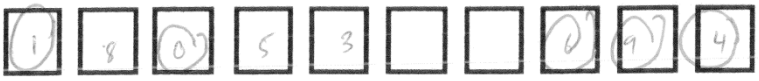
2. 1ST ATTEMPT  3

3. 1ST ATTEMPT  2

4. 1ST ATTEMPT  6

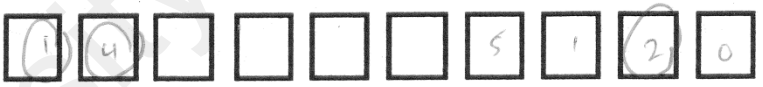
5. 1ST ATTEMPT  2

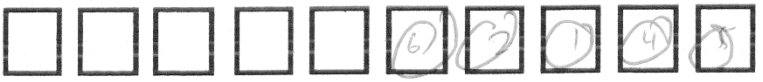
6. 1ST ATTEMPT  1

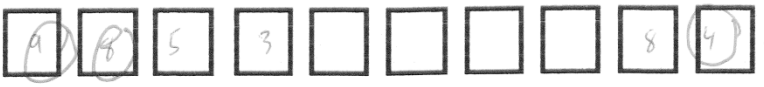
1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 19 years old
2. Gender: ☐ Male ☑ Female
3. Department: ☑ Music ☐ Non-music
4. Primary language: ☑ Malay ☑ English ☐ Chinese
5. Any background in formal music training:
   - ☑ No (Please go to Part B)
   - ☐ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☑

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☑

Can you play a basic piece of music? Yes ☐ No ☑

Do you attend any music classes before? Yes ☐ No ☑

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☐

Please list your major instrument _____ (GRADE:_____)

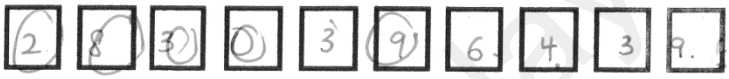
Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? _____ years old.

Music Examination Board Attended: ☐ Trinity, ☐ ABRSM, other: please specify_____)

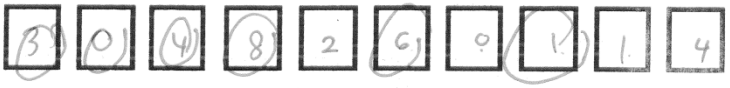
Part B: Please fill up the numbers in the boxes after each listening test

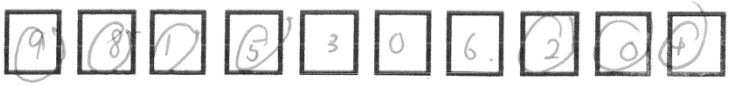
1. 1ST ATTEMPT 

2. 1ST ATTEMPT 

3. 1ST ATTEMPT 

4. 1ST ATTEMPT 

5. 1ST ATTEMPT 

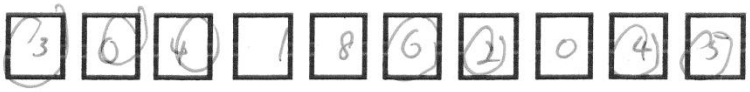
6. 1ST ATTEMPT 

1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 22 years old
2. Gender: ☑ Male ☐ Female
3. Department: ☐ Music ☑ Non-music
4. Primary language: ☑ Malay ☐ English ☐ Chinese
5. Any background in formal music training:
   - ☑ No (Please go to Part B)
   - ☐ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☑

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☑

Can you play a basic piece of music? Yes ☐ No ☑

Do you attend any music classes before? Yes ☐ No ☑

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☐

Please list your major instrument _____ (GRADE:_____)

Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? _____ years old.

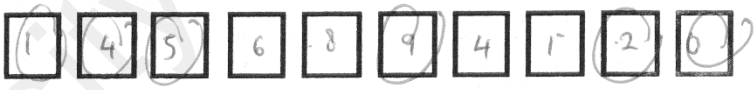
Music Examination Board Attended: ☐ Trinity, ☐ ABRSM, other: please specify_____)

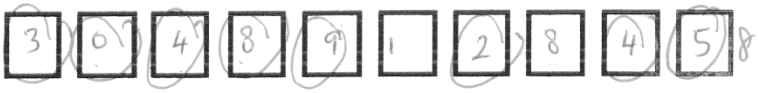
Part B: Please fill up the numbers in the boxes after each listening test

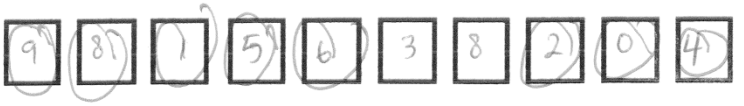
1. 1ST ATTEMPT 

2. 1ST ATTEMPT 

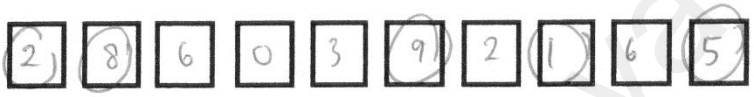
3. 1ST ATTEMPT 

4. 1ST ATTEMPT 

5. 1ST ATTEMPT 

6. 1ST ATTEMPT 

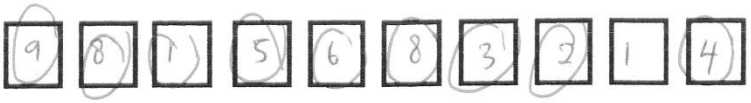
1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 21 years old
2. Gender: ☐ Male ☑ Female
3. Department: ☑ Music ☐ Non-music
4. Primary language: ☐ Malay ☐ English ☑ Chinese
5. Any background in formal music training:
   - ☐ No (Please go to Part B)
   - ☑ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☐

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☐

Can you play a basic piece of music? Yes ☐ No ☐

Do you attend any music classes before? Yes ☐ No ☐

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☑

Please list your major instrument Piano (GRADE: Diploma)

Please list any other instruments you play _____ (GRADE:_____)

Age when you begin with music? 5 years old.

Music Examination Board Attended: ☐ Trinity, ☑ ABRSM, other: please specify_____)

Part B: Please fill up the numbers in the boxes after each listening test

1. 1ST ATTEMPT [1][2][0][8][5][7][3][6][9][4] 10

2. 1ST ATTEMPT [2][ ][ ][ ][2][3][6][9][4][5] 3

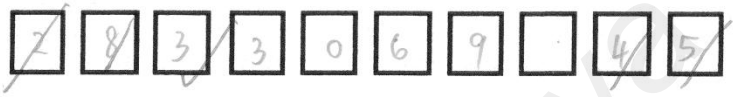
3. 1ST ATTEMPT [3][4][9][2][0][4][1][2][8][6] 9

4. 1ST ATTEMPT [1][4][5][3][8][1][4][5][2][9] 7

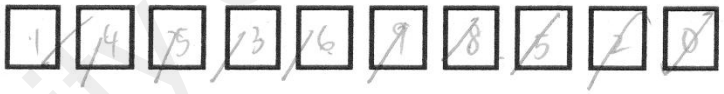
5. 1ST ATTEMPT [3][4][9][8][ ][0][ ][1][4][5] 4

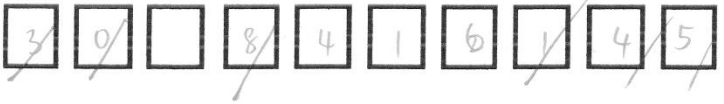
6. 1ST ATTEMPT [9][8][ ][ ][ ][ ][3][2][0][4]

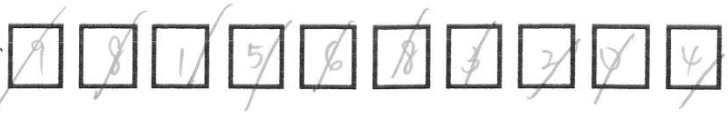
1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 20 years old
2. Gender: ☐ Male ☑ Female
3. Department: ☑ Music ☐ Non-music
4. Primary language: ☐ Malay ☑ English ☐ Chinese
5. Any background in formal music training:
   - ☐ No (Please go to Part B)
   - ☑ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☐

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☐

Can you play a basic piece of music? Yes ☐ No ☐

Do you attend any music classes before? Yes ☐ No ☐

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☑

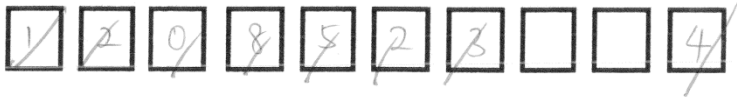
Please list your major instrument Piano (GRADE: 8)

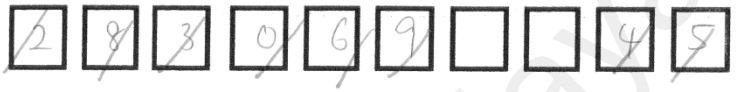
Please list any other instruments you play _____ (GRADE: _____)

Age when you begin with music? 4 years old.

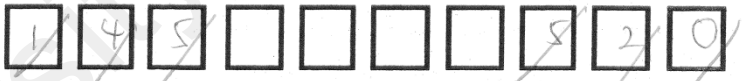
Music Examination Board Attended: ☑ Trinity, ☐ ABRSM, other: please specify_____)

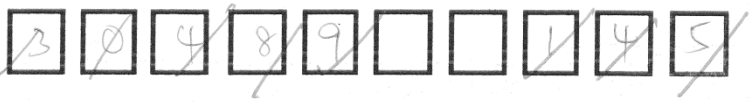
Part B: Please fill up the numbers in the boxes after each listening test

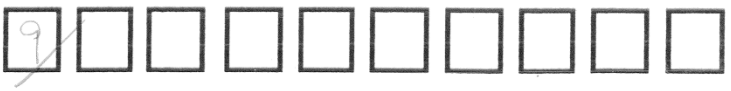
1. 1ST ATTEMPT 

2. 1ST ATTEMPT 

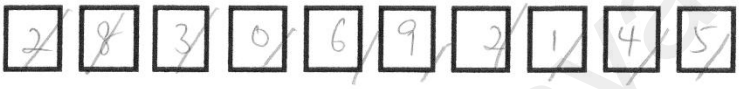
3. 1ST ATTEMPT 

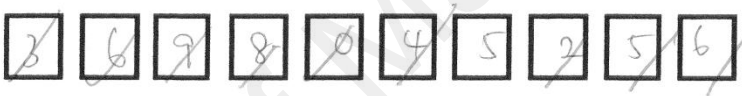
4. 1ST ATTEMPT 

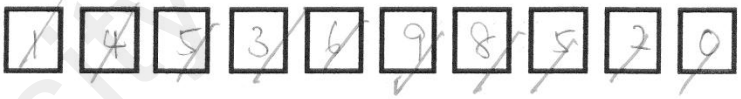
5. 1ST ATTEMPT 

6. 1ST ATTEMPT 

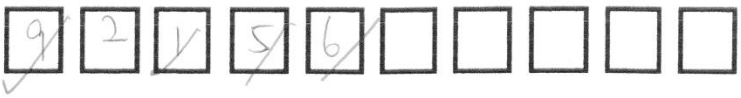
1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 21 years old
2. Gender: ☐ Male ☑ Female
3. Department: ☑ Music ☐ Non-music
4. Primary language: ☐ Malay ☐ English ☑ Chinese
5. Any background in formal music training:
   - ☐ No (Please go to Part B)
   - ☑ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☐

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☐

Can you play a basic piece of music? Yes ☐ No ☐

Do you attend any music classes before? Yes ☐ No ☐

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☑

Please list your major instrument piano (GRADE: 8)

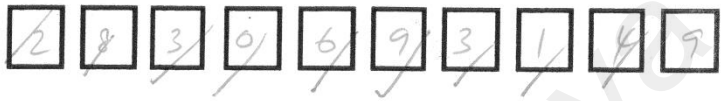
Please list any other instruments you play — (GRADE: —)

Age when you begin with music? 6 years old.

Music Examination Board Attended: ☐ Trinity, ☑ ABRSM, other: please specify_____)

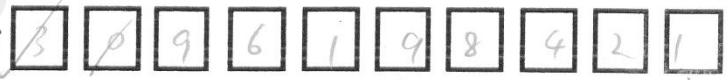
Part B: Please fill up the numbers in the boxes after each listening test

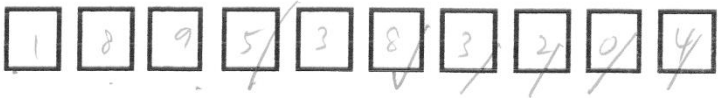
1. 1ST ATTEMPT 

2. 1ST ATTEMPT 

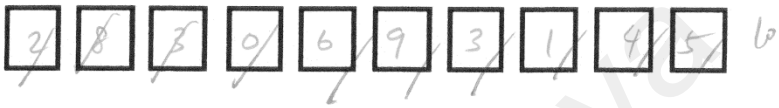
3. 1ST ATTEMPT 

4. 1ST ATTEMPT 

5. 1ST ATTEMPT 

6. 1ST ATTEMPT 

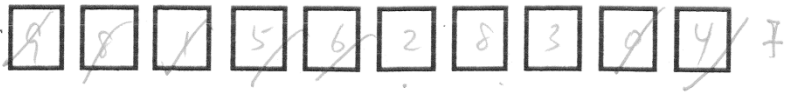
1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT 

QUESTIONNAIRE

Answer all the following items in this questionnaire.

Part A: Background

Please write your age in the item 1, and tick √ the boxes which are relevant to you for item 2 to 5.

1. Age: 21 years old
2. Gender: ☑ Male ☐ Female
3. Department: ☑ Music ☐ Non-music
4. Primary language: ☐ Malay ☐ English ☑ Chinese
5. Any background in formal music training:
   - ☐ No (Please go to Part B)
   - ☑ Yes (Please go to Part C)

Part B: Non-Musicians column (PLEASE TICK)

Do you have hearing disorder? Yes ☐ No ☐

Can you read music score (e.g. a single-lined melody)? Yes ☐ No ☐

Can you play a basic piece of music? Yes ☐ No ☐

Do you attend any music classes before? Yes ☐ No ☐

Part C : Musicians column (PLEASE TICK)

Do you suffer from auditory processing disorder? Yes ☐ No ☑

Please list your major instrument violin (GRADE: diploma)

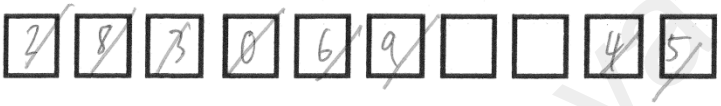
Please list any other instruments you play piano (GRADE: 5)

Age when you begin with music? 4 years old.

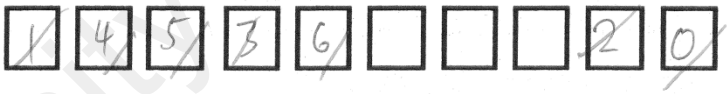
Music Examination Board Attended: ☑ Trinity, ☑ ABRSM, other: please specify_____)

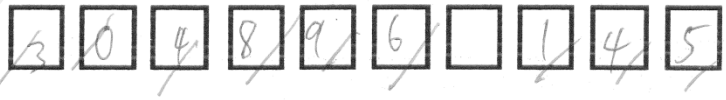
Part B: Please fill up the numbers in the boxes after each listening test

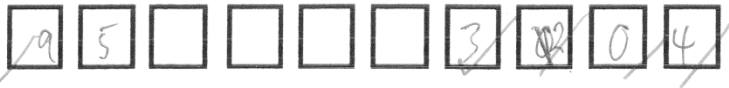
1. 1ST ATTEMPT 

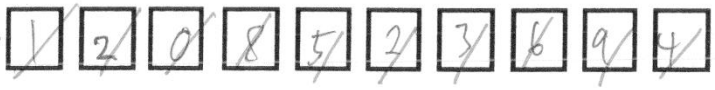
2. 1ST ATTEMPT 

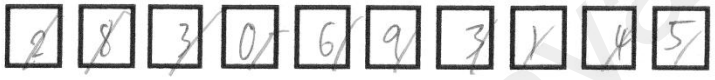
3. 1ST ATTEMPT 

4. 1ST ATTEMPT 

5. 1ST ATTEMPT 

6. 1ST ATTEMPT 

1. 2nd ATTEMPT 

2. 2nd ATTEMPT 

3. 2nd ATTEMPT 

4. 2nd ATTEMPT 

5. 2nd ATTEMPT 

6. 2nd ATTEMPT