FINAL PROJECT

ANALYSIS OF JAZZ MUSIC EFFECT ON COGNITIVE TASK USING CAMBRIDGE BRAIN SCIENCE (CBS) TEST

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APPROVAL SHEET

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Faculty of Industrial Technology and Systems Engineering
Institut Teknologi Sepuluh Nopember
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ABSTRACT

Music listening have been claimed to confer intellectual advantages. The available evidence indicates that music listening leads to enhanced performance on a variety of cognitive tests, but that such effects are short term and stem from the impact of music on arousal level and mood, which, in turn, affect cognitive performance. Music with lyric or without lyric affects performance when performing cognitive tests, especially on short-term memory domain. Music tempo also affects performance when performing cognitive tests. This experiment shows the effects of jazz music without lyric and with 85 bpm, 120 bpm, and 160 bpm when performing cognitive task. The cognitive task is Cambridge Brain Science (CBS) test on short-term memory domain. The CBS test are token search, paired associates, spatial span, and monkey ladder task. Participants of the experiment perform CBS test using computer in multimedia room while listening to the jazz music. The result of the experiment show that jazz music with 120 bpm have significance effect compare to 85 bpm, 160 bpm, and without music. The mean result is 7.0547 for 120 bpm, 6.6094 for 85 bpm, 6.5156 for 160 bpm, and 6.4453 for without music.

Keyword: Music, Jazz, Cognitive, Cambridge Brain Science (CBS).

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Praise to the God for His abundance blessings and miracles which enable the author to successfully accomplish this final project entitled “Analysis of Jazz Music Effect on Cognitive Task Using Cambridge Brain Science (CBS) Test” just in time. This final project is composed as a requisite to achieve a Bachelor degree in Industrial Engineering Department of Institut Teknologi Sepuluh Nopember. Along the study processes, the author faces many challenges and difficulties. However, the author receives help, motivation, and support from many parties. Here, the author would like to express the most sincere gratitude to:

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The author recognizes that this research is far from perfection. Constructive suggestions and critics will be highly appreciated. May this research deliver usefulness for both academic and practical world.

Surabaya, January 2020

Author

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INTRODUCTION

1.1 Research Background

Music is a collection of coordinated sound or sounds. Making music is the process of putting sounds and tones in an order, often combining them to create a unified composition. People who make music creatively organize sounds for a desired result, like a Beethoven symphony or one of Duke Ellington's jazz songs. Music is made of sounds, vibrations and silent moments, and it doesn't always have to be pleasant or pretty. Even the least musical person can recognize pieces of music when hear music. Music is the universal language, the language of the emotions (Dorrell, 2005)

Music listening and music lessons have been claimed to confer intellectual advantages. Any association between music and intellectual functioning would be notable only if the benefits apply reliably to non-musical abilities and if music is unique in producing the effects. The available evidence indicates that music listening leads to enhanced performance on a variety of cognitive tests, but that such effects are short term and stem from the impact of music on arousal level and mood, which, in turn, affect cognitive performance; experiences other than music listening have similar effects (Schellenberg, 2005).

Cognition is defined as the mental action or process of acquiring knowledge and understanding through thought, experience and senses (Miller & Wallis, 2009). Cognition includes different cognitive processes; some of these cognitive processes refer to mental actions that include verbal memory, short-term memory and reasoning. These subfields involve such things as memory for words and properties related to language, the ability to store things in mind for a short period of time, and the ability to think logically and sensibly about a topic. With the extreme effort that is required, the brain needs to filter out any irrelevant stimuli that are not contributing to the task at hand. If the brain processed all incoming visual, sensory and tactile stimuli, an individual's performance would be compromised (Miller & Wallis, 2009).

Studying the relationship between music and reading comprehension, researchers Perham and Currie (2014) broke down the variable of music further into categories of non-lyrical (NLYR), liked lyrical (LLYR), and disliked lyrical (DLYR). Participants were required to read four separate passages, each with an accompaniment of six multiple-choice questions taken from SAT practice exams (Perham & Currie, 2014). During the reading comprehension task, participants were either listening to a form of music, or were working in silence. It was found that performance was greatest for both the quiet and NLYR condition, and poorest for the two lyrical music conditions (DYLR and LLYR). Explicitly, performance was impaired by music with lyrics. In contrast, other studies examining reading comprehension found that performance increased during music without lyrics (Patston & Tippet, 2011)

In addition to studying the presence of lyrics, music has also been examined in terms of its affect and tempo, as seen in the study by Thompson and Schellenberg (2012). Having either a slow or fast tempo, and a low (negative) or high (positive) affect, participants were asked to complete a four-minute reading, followed by a series of questions to measure reading comprehension (Thompson & Schellenberg, 2012). Twenty-five participants were randomly assigned to one of four groups that manipulated both the affect and tempo of the played music - slow and low, slow and high, fast and low or fast and high, (silence being used as a baseline control). From each condition, the only significant difference was found in individuals who read the passages and answered questions during a fast and high music track. Repeatedly, individuals listening to music with a fast tempo and positive affect performed the worst (Thompson & Schellenberg, 2012). Because music with lyrics is similar to language in the sense that there is a hierarchical order of elements, the overlap of these cognitive processes is believed to account for the effects of music on performance (Thompson & Schellenberg, 2012). A study found that music with a high tempo led to an increase in perceived tension and alertness (van der Zwaag, 2011). Fast music tempo has also been shown to increase spatial reasoning in addition to positive effects on mood (Husain, 2011). Generally, most suitable music falls in the range of 60 and 120 beats per minute (Kellaris

& Kent, 1993). Webster and Weir (2005) also stated that music faster than 144 bpm begins to lose effectiveness in accordance to the Yerkes-Dodson law of arousal and performance. Music at 120 bpm also creates a medium level of arousal, which exerts the appropriate level of good stress to increase performance, as proposed by the Yerkes-Dodson Law (Chie & Karthigeyan, 2009).

Jazz is a popular music genre all over the world. Jazz stands out because of its unique swing, blue notes, polyrhythms, and improvisation as well as call and response vocals. Jazz music has been popular since the late 19th century. The music can be traced back to African American communities living in New Orleans back in the late 1800s. The genre has African roots in West African culture as well as African-American music traditions like blues and ragtime. Although Jazz music is greatly influenced by the experiences of African Americans in the United States, different cultures globally have contributed their own unique experiences and styles to the genre resulting in many distinctive Jazz styles. This is one of the main reasons Jazz music is universally acceptable. Besides have a universal appeal, Jazz also stands out for its health benefits. Jazz music have one of the most significant effects on mood, activity and energy levels of all music genres. Jazz music has cool tones, innovative riffs as well as complex rhythms which have been proven to bring natural relief to the mind and body (Gutierrez, 2017) according to Figure 1.1.

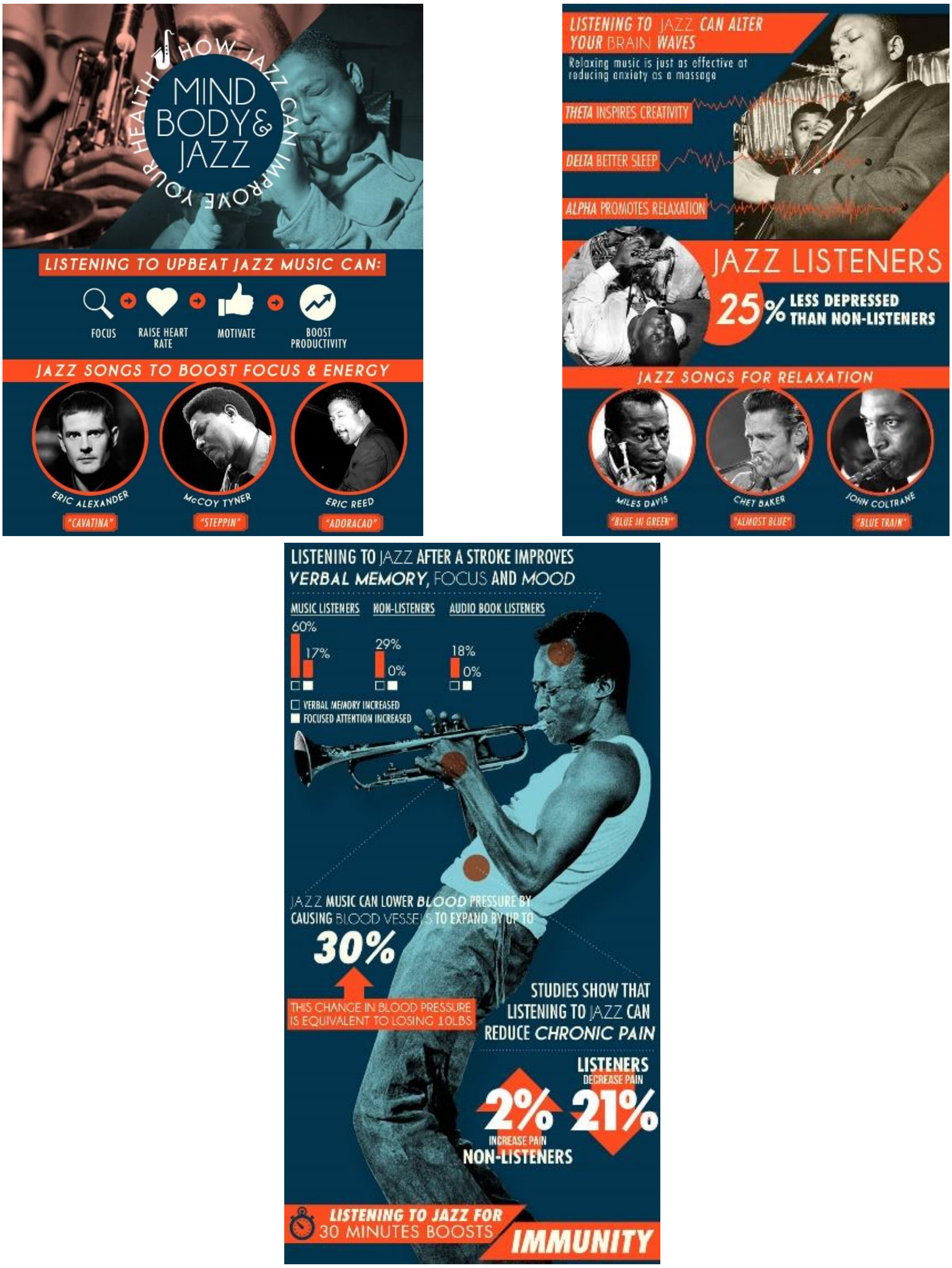

Figure 1.1 Effects of Jazz Music (Top Master's in Healthcare, 2017)

The Cambridge Brain Science (CBS) tests are computer based cognitive assessments based on well-developed psychological measures that have been thoroughly researched (Hampshire et al., 2012). These tests assess separate domains of cognition including verbal processing, reasoning and short-term memory. Verbal processing is the ability to process words and properties of language. An example of this test would be the ability of a participant to remember a brief description that applies to an image, and correctly judge the accuracy of the statement. A second example would be a challenge similar to that of the Stroop Task, where individuals have to process discrete differences between word meaning and word colour. Reasoning is an individual's ability to think logically and sensibly and can be measured by having participants manipulate objects spatially in their mind, and then deduce whether the two are similar or not. Short-term memory requires individuals to hold information in their mind that is then recalled later in the task. The ability to test different cognitive domains in the same individual, during a single testing session, will allow for comparing the effect of music on a variety of cognitive tasks – using subjects as their own control (Hampshire et al., 2012).

Through the inspection of previous literature, hypotheses were developed for the current research. Testing on cognitive task in short-term memory domain will be most affected in conditions where music with lyrics is played. When trying to hold things in memory, individuals will perform the worst when they are listening to music that contains lyrics. The current research will have four separate testing condition: Jazz music without lyric with 85, 120, 160 beats per minute (bpm) and Without Music. All songs is created by researcher and will be from an unfamiliar source to ensure that the level of familiarity is consistent across individuals, and that each participant is hearing the music for the first time in the research. Specifically, the songs chosen will be similar in terms of frequency. This will guarantee that the song is consistent from one participant to the next and theoretically should induce the same emotional state.

This research is focused to identify the effect of Jazz music on cognitive task in short-term memory domains. The test will be using Jazz music without lyric with 85, 120, 160 beats per minute (bpm) and Without Music for the comparison. The participants will be taking Cambridge Brain Science (CBS) test on short-term memory domains Without Music and with Jazz music condition. The result will be calculated and identified whether Jazz music have effect on cognitive task in short-term memory domains. In previous research, there is still no test that focused on using Jazz music.

1.2 Problem Formulation

In accordance with research background in previous subchapter, this research attempts to identify the effect of Jazz music on cognitive task on short-term memory domain using Cambridge Brain Science (CBS) test.

1.3 Research Objectives

Several objectives are arranged prior to this research. Those objectives are as follow.

1. To identify the effects of Jazz music on cognitive task in short-term memory domains.
2. To determine what music tempo with beats per minutes (bpm) that have the most effect in cognitive task in short-term memory domain.

1.4 Research Benefits

The following benefits are expected to be obtained from this research; those are as follow.

1. Add scientific insight related to Jazz music.
2. Knowing the effects of Jazz music on cognitive task in short-term memory domain.
3. Knowing the effective music bpm on cognitive task in short-term memory domain.
4. As suggestions and input to produce music that can improve cognitive performance on short-term memory domain.

1.5 Research Scope

In keeping the research reliable and valid, some limitations and assumptions are specified prior to the research.

1.5.1 Limitation

This research is considered to be reliable under a limitation. The limitations are as follow.

1. Music without lyric is better than music with lyric.

2. The music that will be used are Jazz music without lyric created by the researcher with 85, 120, and 160 beats per minute (bpm).
3. The participant music preference is ignored.
4. The participant of the experiment is university students in Institut Teknologi Sepuluh Nopember (ITS).
5. The age of respondent is between 18-25 years old.
6. The experiment does not consider the learning curve from respondents.
7. The place of experiment is in the Laboratorium Multi Media (Lab MM) of Industrial Engineering Department Institut Teknologi Sepuluh Nopember (ITS).
8. The test used is CBS Test on short-term memory domain.
9. The experiment is executed in the holiday for maximum silence when running the experiment

1.5.2 Assumption

Some aspects are assumed in the beginning to assist research validity. Assumptions which are defined for this research are as follow.

1. Most suitable music falls in the range of 60 and 120 beats per minute. (Kellaris & Kent, 1993). Music at 120 bpm also creates a medium level of arousal, which exerts the appropriate level of good stress to increase performance, as proposed by the Yerkes-Dodson Law (Chie & Karthigeyan, 2009).
2. Music faster than 144 bpm begins to lose effectiveness in accordance to the Yerkes-Dodson law of arousal and performance (Webster & Weir, 2005)
3. The participants unfamiliar with the music used in the experiment.
4. The participants unfamiliar with CBS test in the experiment.
5. The participants induced same emotional state.

1.6 Report Outline

In order to show the big picture of this research, brief explanation of report outline is described as follows.

- CHAPTER I: INTRODUCTION

  The initial chapter covers research background, problem formulation, objectives, benefits, scope of research, and report outline. A thorough outline of this report is provided in the end of this chapter.

- CHAPTER II: LITERATURE REVIEW

  Related theories are elaborated in the second chapter in order to support research comprehension. These theories are collected from reliable literatures.

- CHAPTER III: RESEARCH METHODOLOGY

  Research methodology is specified in this chapter. Research methodology will guide the research processes systematically. It is shown in a flowchart and followed by description of each process.

- CHAPTER IV: DATA COLLECTION AND PROCESSING

  The fourth chapter shows data gathered from observation, literatures, and experiment. Then, these data are processed based on methodology which is stated in previous chapter.

- CHAPTER V: ANALYSIS AND INTERPRETATION

  Results of data processing in previous chapter are analyzed and interpreted in the fifth chapter. The analysis and interpretation will lead to conclusions.

- CHAPTER VI: CONCLUSION AND RECOMMENDATION

  The last chapter gives conclusions which answer the research objectives. Recommendations are also provided for the research topic and further research.

CHAPTER II
LITERATURE REVIEW

Related theories are elaborated in this chapter in order to support research comprehension. These theories are collected from reliable literatures. Subjects in literature review are music, jazz, pop, cognition, cognitive ergonomics, and Cambridge Brain Science.

2.1 Music

Music is a collection of coordinated sound or sounds. Making music is the process of putting sounds and tones in an order, often combining them to create a unified composition. People who make music creatively organize sounds for a desired result, like a Beethoven symphony or one of Duke Ellington's jazz songs. Music is made of sounds, vibrations and silent moments, and it doesn't always have to be pleasant or pretty. Even the least musical person can recognize pieces of music when hear music. Music is the universal language, the language of the emotions (Dorrell, 2005)

Music is something that is produce by man that can be form into a work of art or complement the activities (Titon, 2009). Music was defined as a form of entertainment that lessens boredom (Milliman, 1982). Music can be generalized as type of genre such as Pop, Rock, Classical, R&B, Country, Jazz, Hip-Hop, Modern Folk, Electronic, Asian, Comedy, Caribbean and Latin American music.

2.2 Jazz

Jazz is a popular music genre all over the world. Jazz stands out because of its unique swing, blue notes, polyrhythms, improvisation as well as call and response vocals. Jazz music has been popular since the late 19th century. The music can be traced back to African American communities living in New Orleans back in the late 1800s. The genre has African roots in West African culture as well as African-American music traditions like blues and ragtime. Although Jazz music is greatly influenced by the experiences of African

Americans in the United States, different cultures globally have contributed their own unique experiences and styles to the genre resulting in many distinctive Jazz styles. This is one of the main reasons Jazz music is universally acceptable. Besides have a universal appeal, Jazz also stands out for its health benefits. Jazz music have one of the most significant effects on mood, activity and energy levels of all music genres. Jazz music has cool tones, innovative riffs as well as complex rhythms which have been proven to bring natural relief to the mind and body (Gutierrez, 2017).

2.3 Cognition

Cognition is defined as the mental action or process of acquiring knowledge and understanding through thought, experience and senses (Miller & Wallis, 2009). Cognition includes different cognitive processes; some of these cognitive processes refer to mental actions that include verbal memory, short-term memory and reasoning. These subfields involve such things as memory for words and properties related to language, the ability to store things in mind for a short period of time, and the ability to think logically and sensibly about a topic. With the extreme effort that is required, the brain needs to filter out any irrelevant stimuli that are not contributing to the task at hand. If the brain processed all incoming visual, sensory and tactile stimuli, an individual's performance would be compromised (Miller & Wallis, 2009).

2.4 Cognitive Ergonomics

According to the International Ergonomics Association (2013), cognitive ergonomics is concerned with mental processes such as perception, memory, reasoning, and motor response, as they affect interactions amongst humans and other elements of a system. It is the discipline and practices for making human-system interaction compatible with human cognitive abilities and limitations, particularly at work. It aims to ensure appropriate communications amongst human needs, works, products, environments, capabilities, and limitations (Kalakoski, 2016).

The relevant research topics in cognitive ergonomics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress, and training as these may relate to human-system design. Hence, cognitive ergonomics mainly studies cognition in work and operational settings in order to optimize human well-being and system performance. It is a subset of the larger disciplinary fields of ergonomics and human factors.

In the human-system interaction, cognitive ergonomics employ the knowledge emerging from cognitive sciences on mental processes such as perception, attention, memory, decision-making, and learning (Kalakoski, 2016). The methods of these research areas are applied to gain a better understanding of the factors that affect cognitive function.

The practical purpose of cognitive ergonomics is to elucidate the nature of human abilities and limitations in information processing. This means that the specific goal is to improve work conditions and human performance, as well as safety and health, and to avoid human errors and unnecessary load and stress. These aspects need to be comprehensively studied in the context of work and other systems (Kalakoski, 2016).

2.5 Music and Cognitive

The relationship between music and learning has been an area of interest for researchers for many years. Some studies have shown that music can enhance cognitive abilities (Hall, 1952), and others have shown that it can interfere with complex cognitive processes but not simple processes (Fogelson, 1973). In 2004, researchers conducted a study that presented the effect of Mozart's music on learning. The effect demonstrated that there may be an important relationship between certain types of music (e.g. classical) and learning (Jackson, 2004). One study involving college students showed a correlation between how awake they felt and their preference for music or silence. Results indicated a positive effect while listening to Mozart (Jones, 2006). This effect has become known as the Mozart Effect, which proposes that listening to Mozart can increase spatial abilities. The proposed increase in the construction of alpha waves may result in positive learning ability. Other studies on the Mozart Effect, however, have produced inconsistent results, often showing no significant increase in cognitive abilities. Although the results have been ambiguous, the relationship between music and learning still remains of interest to many researchers, especially to educators and others involved in the teaching profession.

The upsurge in the technology of music playing devices has made a phenomenon out of listening to music while participating in daily activities. Music is a common part of our everyday routine. It is played in the car, stores and supermarkets, professional and medical offices and more. It has also been found that many students study and do homework while listening to music. A study done by Hallam (2002) showed that elementary school students who listened to mood-calming music while completing mathematical problems were able to complete more problems and solve a higher percentage of them correctly than the group who listened to no music at all. Bowman (2007) also came across this in a similar study looking at whether Mozart music enhanced receiving ability; namely, listeing comprehension. He tested whether students learned more in the classroom by listening to Mozart music before class started. Many other studies have shown that easy listening, such as classical or instrumental soundtracks can promote cognitive performance (Wilson, 2006).

Using music without lyric will affect the domain of cognition that is short-term memory. Short-term memory requires individuals to hold information in their mind that is then recalled later in the task (Hampshire et al., 2012). Short-term memory will be most affected in conditions where music with lyrics is played. When trying to hold things in memory, individuals will perform the worst when they are listening to music that contains lyrics.

2.6 Effect of Music Tempo

There is a general consensus that music plays many underlying roles, including reducing boredom, masking ambient noise, and increasing attention to tasks (Hargreaves & North, 1997). However, research on the physiological effects of music is often conflicting and little research has been done to apply the effects of music tempo to task performance. It has been suggested that because the tasks performed in musical studies are so varied, it is expected that results would be conflicting and that the musical effects on each task must instead be studied individually (Day, 2009). Most studies specifically focusing on differing music tempos have focused on the musical augmentation of human emotions and, as with most physiological studies of music, have been plagued with mixed results (Kellaris & Kent, 1994). The effect of music tempo are as follow.

- Music with a high tempo led to an increase in perceived tension and alertness (van der Zwaag, 2011).
- Fast music tempo has also been shown to increase spatial reasoning in addition to positive effects on mood (Husain, 2011).
- Most suitable music falls in the range of 60 and 120 beats per minute (Kellaris & Kent, 1993).
- Music faster than 144 bpm begins to lose effectiveness in accordance to the Yerkes-Dodson law of arousal and performance (Webster & Weir, 2005)
- Music at 120 bpm also creates a medium level of arousal, which exerts the appropriate level of good stress to increase performance, as proposed by the Yerkes-Dodson Law (Chie & Karthigeyan, 2009).

2.7 Cambridge Brain Sciences

The Cambridge Brain Science (CBS) tests are computer based cognitive assessments based on well-developed psychological measures that have been thoroughly researched (Hampshire et al., 2012). These tests assess separate domains of cognition including verbal processing, reasoning and short-term memory. Verbal processing is the ability to process words and properties of language. An example of this test would be the ability of a participant to remember a brief description that applies to an image, and correctly judge the accuracy of the statement. A second example would be a challenge similar to that of the Stroop Task, where individuals have to process discrete differences between word meaning and word colour. Reasoning is an individual's ability to think logically and sensibly and can be measured by having participants manipulate objects spatially in their mind, and then deduce whether the two are similar or not. Short-term memory requires individuals to hold information in their mind that is then recalled later in the task (Hampshire et al., 2012).

Verbal processing domains consist of double trouble task, digit span task, and grammatical reasoning task. Reasoning domain consist of odd one out task, polygons task, rotations task, feature match task, and spatial planning task. Short-term memory domain consist of token search task, paired associates task, spatial span task, and monkey ladder task.

2.7.1 Double Trouble Task

A variant on the Stroop test (Stroop, 1935). Three coloured words are displayed on the screen: one at the top and two at the bottom in Figure 2.1. Participants must indicate which of two coloured words at the bottom of the screen (ignoring the colour of those words) correctly describes the colour that the word at the top of the screen is written in. The colour word mappings may be congruent, incongruent, or doubly incongruent, depending on whether or not the colour of the top word matches the colour that it is written in. Participants have 90 seconds to solve as many problems as possible. Primary outcome measure is the number of correctly answered problems, minus incorrect ones.

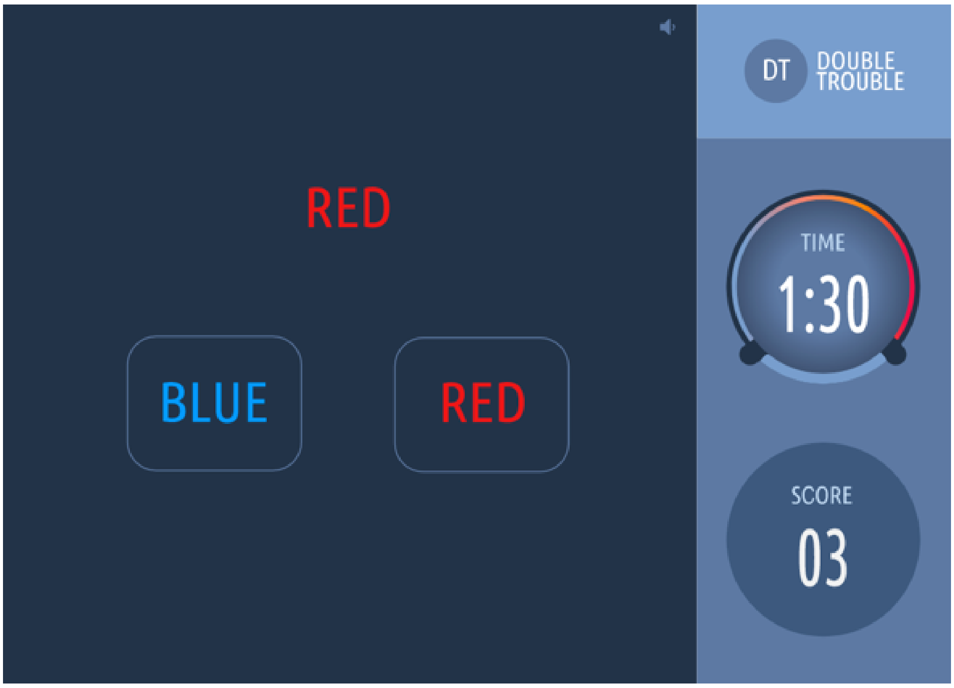

Figure 2.1 Double Trouble Task (Cambridge Brain Science)

2.7.2 Odd One Out Task

Based on a sub-set of problems from the Cattell Culture Fair Intelligence Test (Cattell, 1949). Nine patterns will appear on the screen in Figure 2.2. The features that make up the patterns are colour, shape, and number and are related to each other according to a set of rules. Participants must deduce the rules that relate the object features and select the pattern that do not correspond to those rules. Difficulty is increased or decreased depending on whether the participant got the previous trial correct. Participants have 3 minutes to solve as many problems as possible. Primary outcome measure is the number of correctly answered problems, minus the number of incorrectly answered problems.

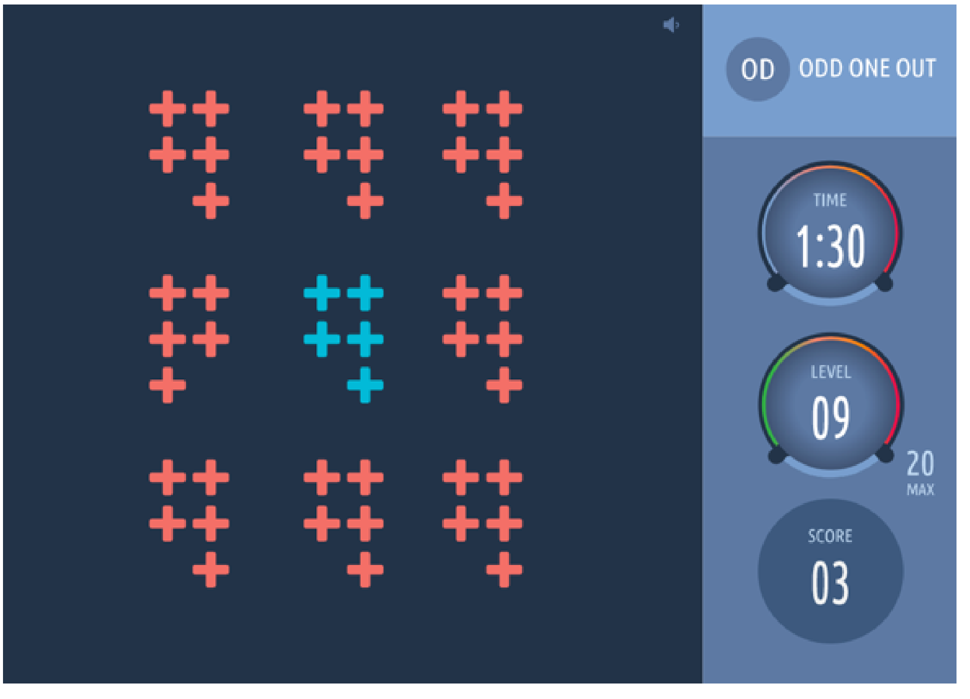

Figure 2.2 Odd One Out Task (Cambridge Brain Science)

2.7.3 Digit Span Task

A variant on the verbal working memory component of the WAIS-R intelligent test (Weschler, 1981). A sequence of numbers will appear on the screen one after another in Figure 2.3. Once the sequence is complete, participants must repeat the sequence. Difficulty is increased or decreased by one number depending on whether the participant got the previous trial correct. After three errors, the task ends. Primary outcome measure is the maximum level (i.e. the problem with the highest number of digits) that the player successfully completed.

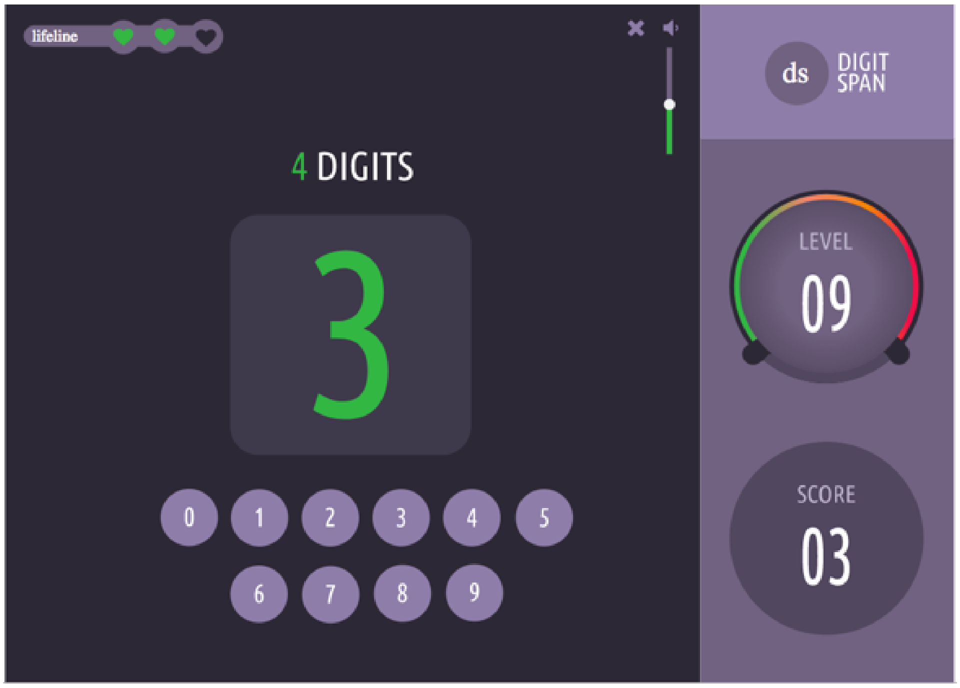

Figure 2.3 Digit Span Task (Cambridge Brain Science)

2.7.4 Feature Match Task

Based on the classical feature search tasks that have been used to measure attentional processing (Treisman & Gelade, 1980). Two grids are displayed on the screen, each containing an array of abstract shapes in Figure 2.4. In half of the trials the grids differ by just one shape. Participants must indicate whether or not the grid's contents are identical. Difficulty is increased or decreased by one shape depending on whether the participant got the previous trial correct. Participants have 90 seconds to solve as many problems as possible. Primary outcome measure is overall score - the sum of the difficulties of all successfully answered problems, minus the sum of the difficulties of all incorrectly answered problems.

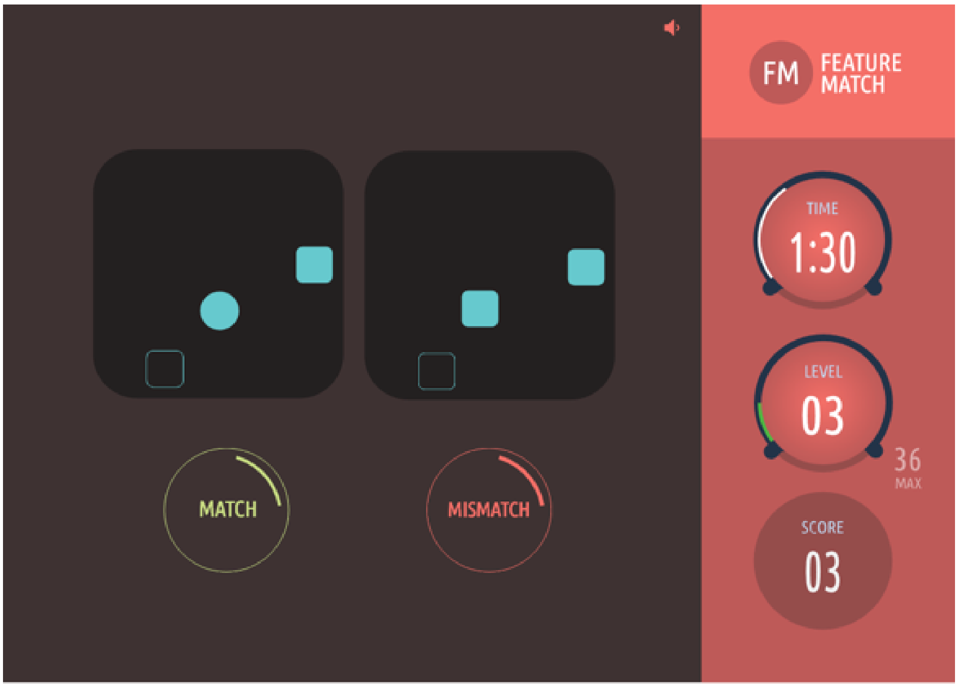

Figure 2.4 Feature Match Task (Cambridge Brain Science)

2.7.5 Polygons Task

Based on the Interlocking Pentagons Task, which is often used in the assessment of agerelated disorders (Folstein et al., 1975). A pair of overlapping polygons is displayed on one side of the screen in Figure 2.5. Participants must indicate whether a polygon displayed on the other side of the screen is identical to one of the interlocking polygons. Difficulty is increased by making the differences between the polygons more subtle or decreased by making the differences between the polygons more pronounced. Participants have 90 seconds to solve as many problems as possible. Primary outcome measure is overall score - the sum of the difficulties of all successfully answered problems, minus the sum of the difficulties of all incorrectly answered problems.

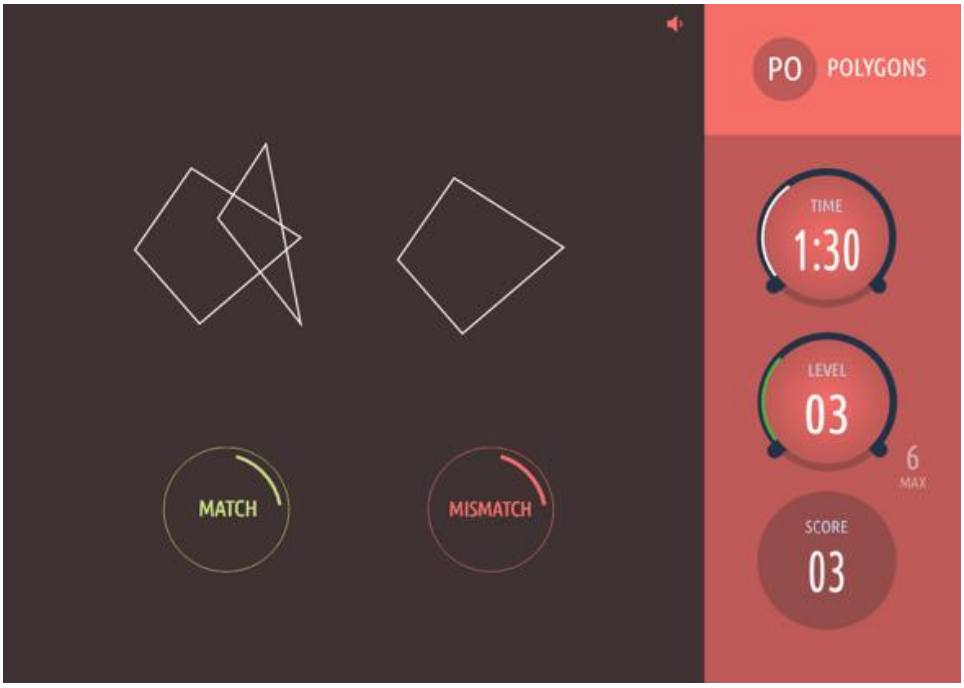

Figure 2.5 Polygons Task (Cambridge Brain Science)

2.7.6 Paired Associates Task

A variant on a paradigm that is commonly used to assess memory impairments in aging clinical populations (Gould et al., 2005). Boxes are displayed at random locations on the screen in Figure 2.6. The boxes are opened one after another to reveal an enclosed object. Subsequently, the objects are displayed in random order in the centre of the screen and participants must determine which box contains the object that is presented. Difficulty is increased or decreased by one box depending on whether the participant got the previous trial correct. After three errors, the task will end. Outcome measures are (i) maximum level completed (e.g. the problem with the most boxes that the user successfully completed) and (ii) average score: the sum of the number of boxes in all successfully solved problems, divided by the number of successfully completed problems.

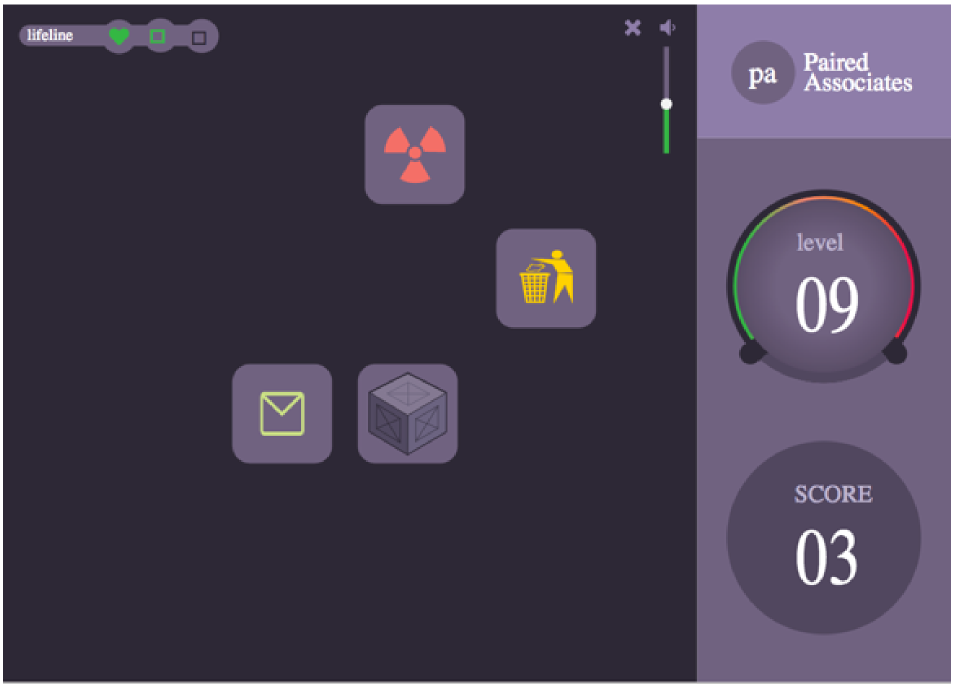

Figure 2.6 Paired Associates Task (Cambridge Brain Science)

2.7.7 Monkey Ladder Task

A variant on a task from the non-human primate literature (Inoue & Matsuzawa, 2007). Sets of numbered squares are displayed on the screen at random locations in Figure 2.7. After a variable interval of time, the numbers disappear leaving just the blank squares and participants must respond by clicking the squares in ascending numerical sequence. Difficulty is increased or decreased by one numbered box depending on whether the participant got the previous trial correct. After three errors, the task ends. Outcome measures are (i) maximum level completed (e.g. the problem with the highest number of boxes that the user successfully completed) and (ii) average score: the sum of the number of boxes in all successfully solved problems, divided by the number of successfully completed problems.

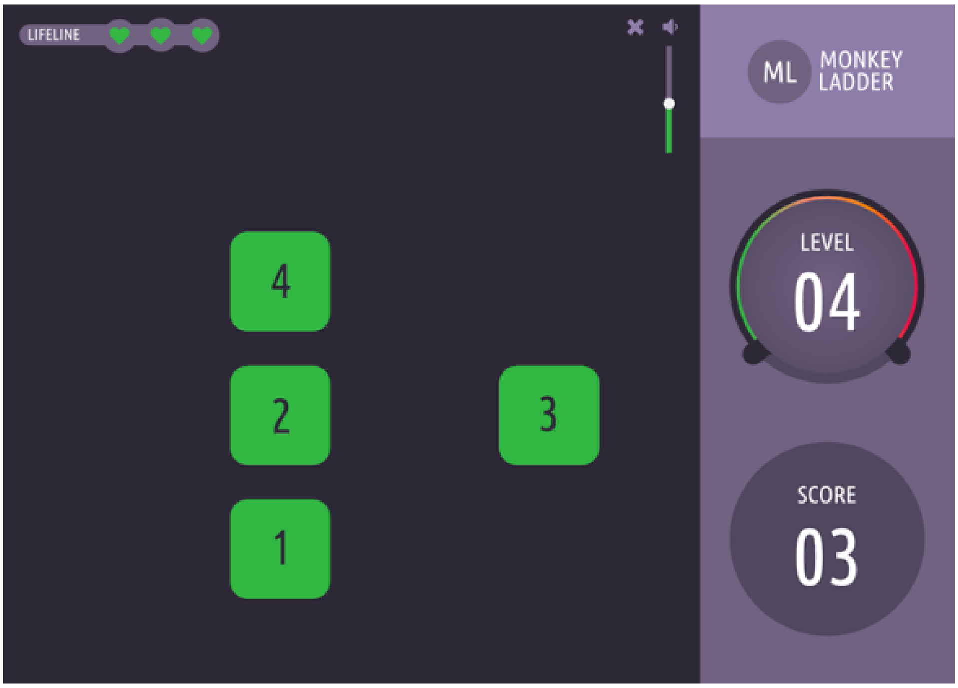

Figure 2.7 Monkey Ladder Task (Cambridge Brain Science)

2.7.8 Grammatical Reasoning Task

Based on Alan Baddeley's three minute grammatical reasoning test (Baddeley, 1968). Short sentences describing the relationship of two shapes along with an image of the shapes are displayed on the screen in Figure 2.8. Participants must indicate whether the sentence correctly describes the pair of objects displayed on the screen. Participants have 90 seconds to solve as many problems as possible. Primary outcome measure is the number of problems solved correctly, minus the number of problems answered incorrectly.

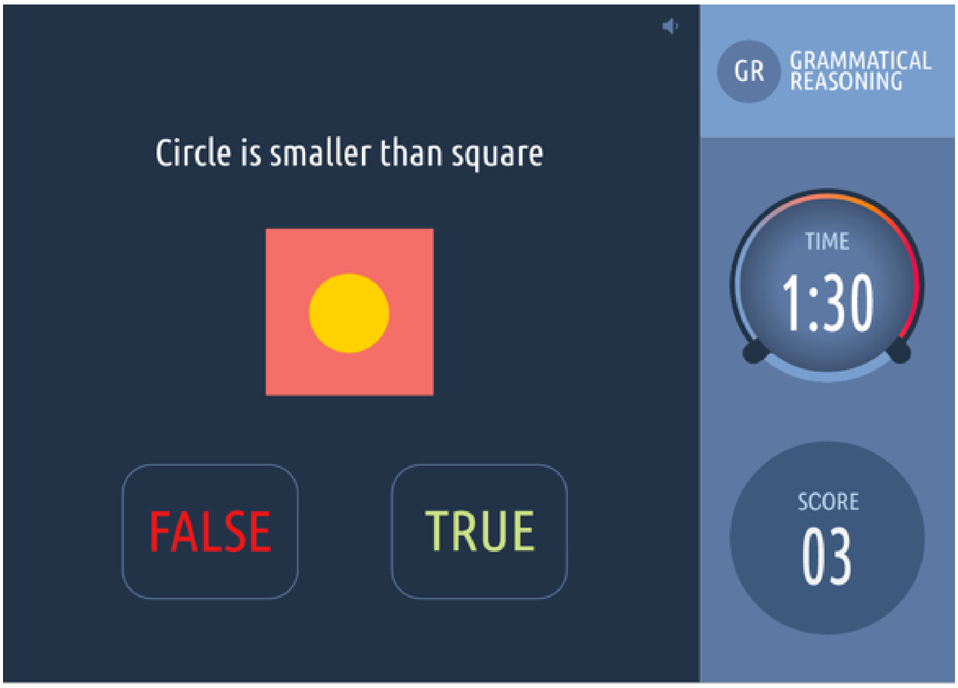

Figure 2.8 Grammatical Reasoning Task (Cambridge Brain Science)

2.7.9 Rotations Task

Often used for measuring the ability to manipulate objects spatially in mind (Silverman et al., 2000). Two grids of coloured squared are displayed to either side of the screen with one of the grids rotated by a multiple of 90 degrees in Figure 2.9. When rotated, the grids are either identical or differ by the position of just one square. Participants must indicate whether or not the grids are identical. Participants have 90 seconds to solve as many problems as possible. Primary outcome measure is overall score - the sum of the difficulties of all successfully answered problems, minus the sum of the difficulties of all incorrectly answered problems.

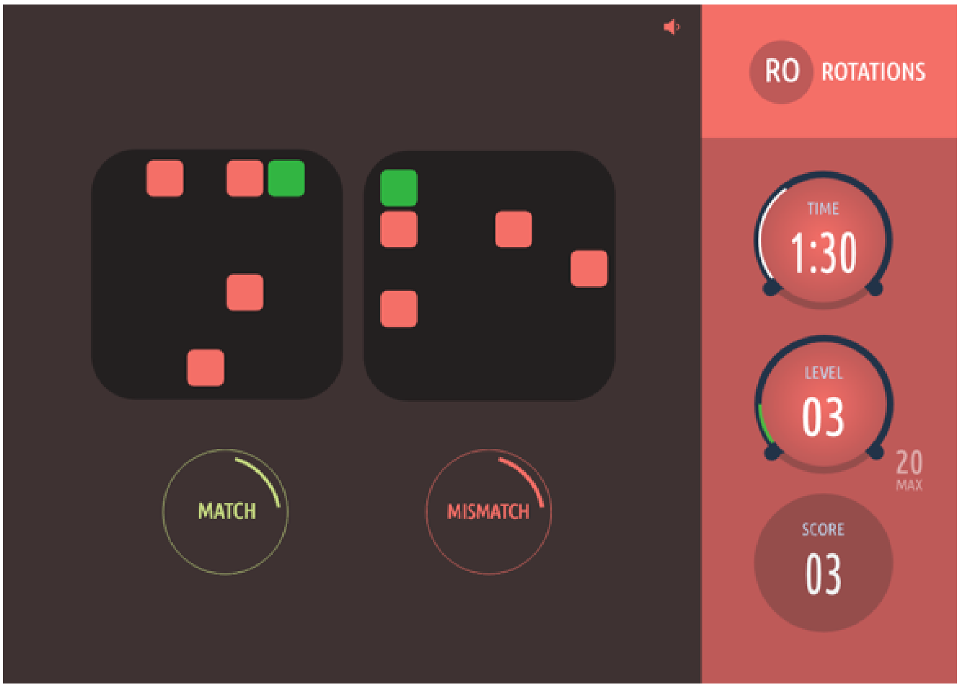

Figure 2.9 Rotations Task (Cambridge Brain Science)

2.7.10 Spatial Span Task

A variant on the Corsi Block Tapping Task (Corsi, 1972), used for measuring spatial short-term memory capacity. 16 squares are displayed in a 4 x 4 grid in Figure 2.10. A sub-set of the squares will flash in a random sequence at a rate of 1 flash every 900 ms. Subsequently, participants must repeat the sequence by clicking on the squares in the same order in which they flashed. Difficulty is increased or decreased by one box depending on whether the participant got the previous trial correct. After three errors, the task will end. Outcome measures are (i) maximum level completed (e.g. the problem with the highest number of targets that the user successfully completed) and (ii) average score: the sum of the number of targets in all successfully solved problems, divided by the number of successfully completed problems.

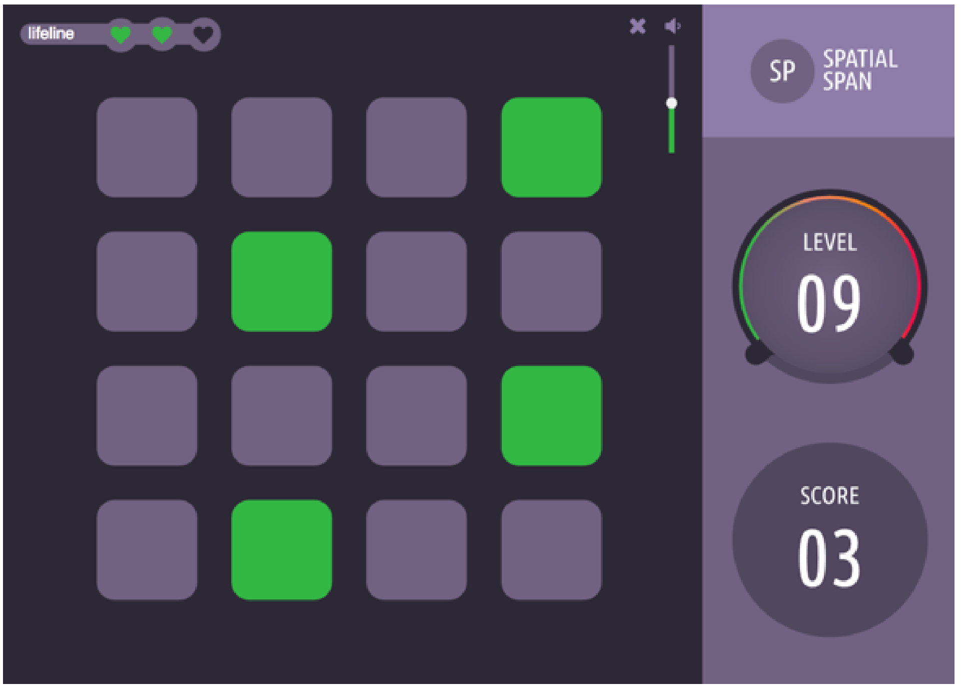

Figure 2.10 Spatial Span Task (Cambridge Brain Science)

2.7.11 Token Search Task

Based on a test that is used to measure strategy during search behaviours (Collins et al., 1998). Boxes are displayed in random locations in Figure 2.11. Participants must find a hidden "token" by clicking on the boxes one at a time. When the token is found, it is hidden within another box. The token will not appear within the same box twice, thus, participants must search the boxes until the token has been found once in each box. If they search the same empty box twice, or search a box in which the token has previously been found, this is an error and the trial ends. Difficulty is increased or decreased by one box depending on whether the participant got the previous trial correct. After three errors, the task will end. Outcome measure is the maximum level completed (e.g. the problem with the most tokens that the user successfully completed).

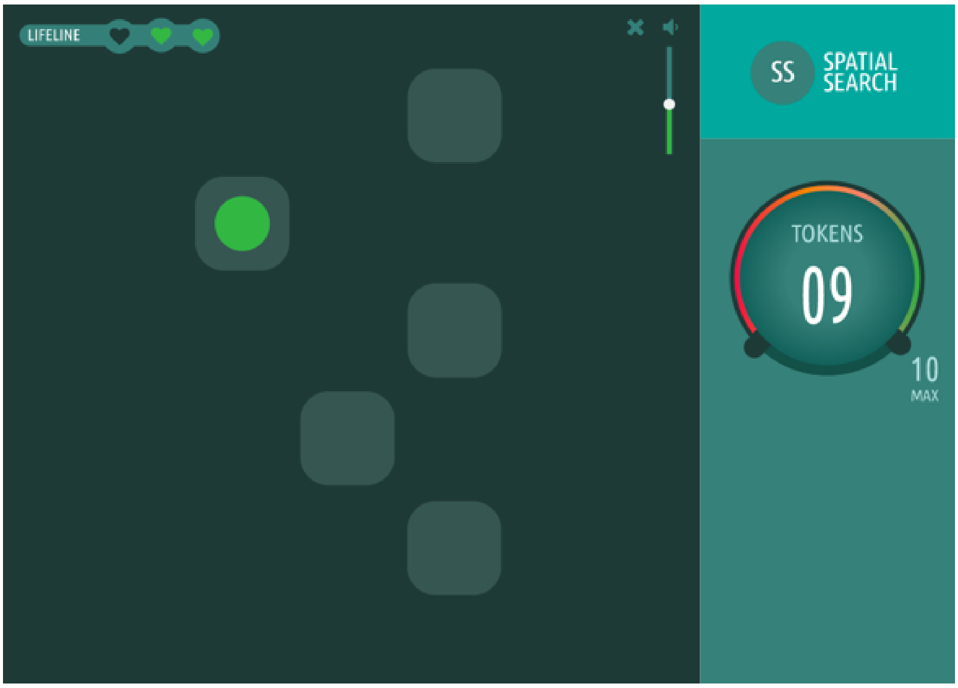

Figure 2.11 Token Search Task (Cambridge Brain Science)

2.7.12 Spatial Planning Task

A direct descendant of the “Tower of London” task, Spatial Planning is a classic neuropsychological test of planning (Shallice, 1982). When the test begins, numbered beads are positioned on a tree-shaped frame in Figure 2.12. Participants must reposition the beads so they are configured in ascending numerical order, in as few moves as possible. Problems become progressively harder, and participants have three minutes to solve as many as possible. The primary outcome measure is the overall score, calculated by subtracting the number of moves made from twice the minimum number of moves required.

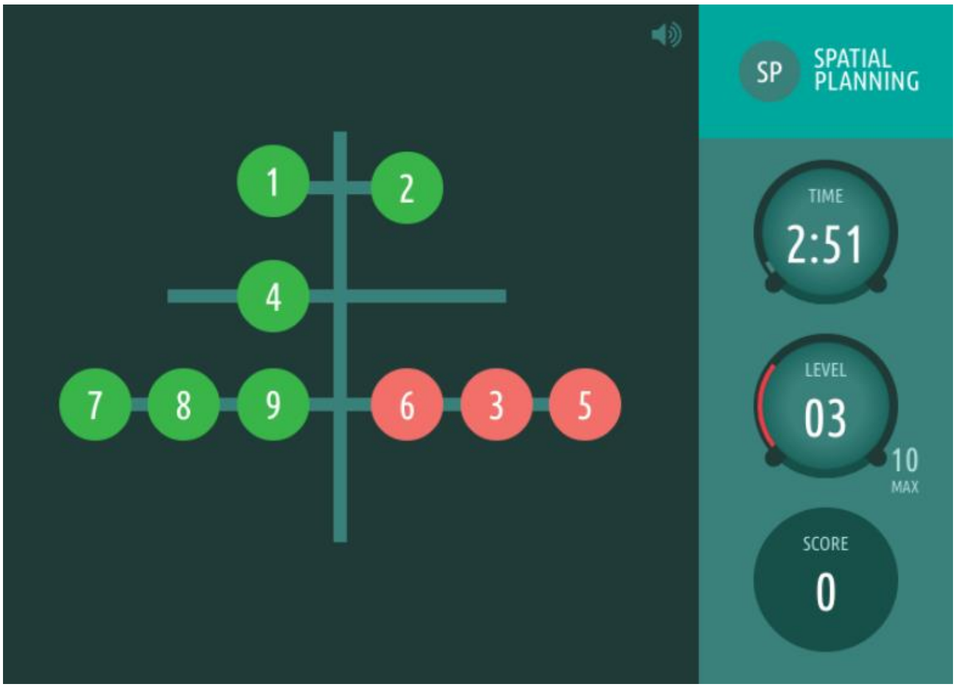

Figure 2.12 Spatial Planning Task (Cambridge Brain Science)

2.8 Previous Research

There are several previous researches which are similar to this research. Those researches are as follow.

Table 2.1 Comparison of Previous Research

	Previous Research		
Year	2012	2013	2017
Author	Danielle Bade, Ryan Bade, Derek Hoerres, Andrea Kremesreiter	Arielle S. Dolegui	Garrett Myles
Title	The Effect of Music Tempo on Concentration and Task Performance	The Impact of Listening to Music on Cognitive Performance	Effect of Background Music on Cognitive Task
Methods	Subjects performing typing test in three different scenarios: listening to no music, high tempo music, and low tempo music.	Subjects solve five arithmetic test with twenty different question on each test. Each test have different music condition.	Subjects performing series of task from Cambridge Brain Science (CBS) test.
Focus	Showing that music tempo play significant role in affecting concentration or stress when doing task.	The impact of different genres of music played at different volume levels on cognitive performance	Show the effect of background music on cognitive task.

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CHAPTER III
RESEARCH METHODOLOGY

Research methodology are specified in this chapter. Research methodology will guide the research processes systematically. It is shown in a flowchart and followed by description of each phase.

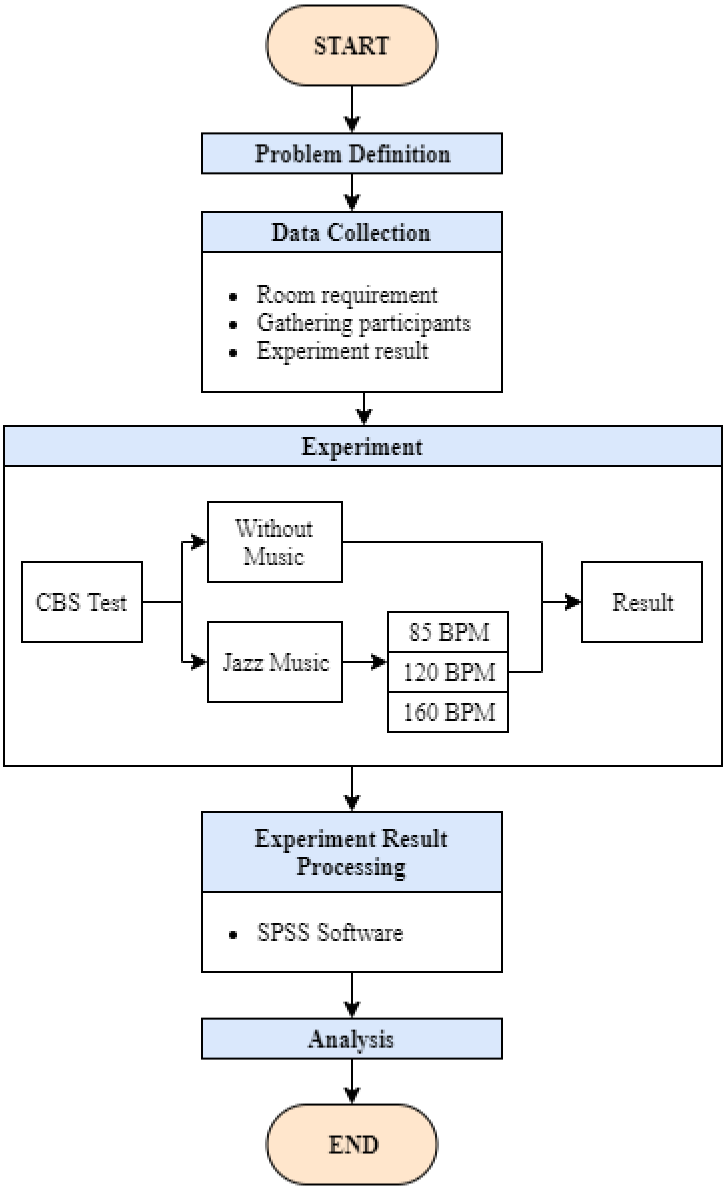

Figure 3.1 Flowchart of Research Methodology

3.1 Problem Definition

This research is to show the effect of jazz music with 85 bpm, 120 bpm, 160 bpm, and without music on cognitive task. The cognitive task is Cambridge Brain Science (CBS) test on short-term memory domain. The CBS test are token search, paired associates, spatial span, and monkey ladder.

3.2 Data Collection Phase

In data collection phase, researcher is responsible in gathering necessary data for the research. Gathering data for room requirement is necessary for the experiment. The room is multimedia room with computers to access the CBS test and the room will have sound system function to play the jazz music. The room is Laboratorium Multi Media (Lab MM) Industrial Engineering Department of Institut Teknologi Sepuluh Nopember. The researcher gather participants needed to done the experiment. When the experiment start, the researcher gather the data from the participants.

3.3 Experiment

The experiment is done in Laboratorium Multi Media (Lab MM) Industrial Engineering Department of Institut Teknologi Sepuluh Nopember with a computer for each participant and sound system to play the music. The participants will do the Cambridge Brain Science (CBS) test on the computer while listening to Jazz music with 85, 120, 160 bpm and Without Music. The test that will be used is short-term memory domain of CBS test consist of token search task (Figure 3.3), paired associates task (Figure 3.4), spatial span task (Figure 3.5), and monkey ladder task (Figure 3.6). The experiment is conducted at 09.00 AM to 11.30 AM, based on the research by Rana, Rishi, & Sinha (1996). The research concluded that the decline in performance is greatest in the afternoon, followed by the evening. The sequence of the experiment explained in the table (Table 3.1).

Table 3.1 Sequence of the Experiment

Time	Activity
09.00 – 09.15	Participants gather at Lab MM and seated in each computer
09.15 – 09.30	Researcher give brief explanation about the experiment
09.30 – 09.34	Token Search Task with Without Music condition
09.35 – 09.39	Paired Associates Task with Without Music condition
09.40 – 09.44	Spatial Span Task with Without Music condition
09.45 – 09.49	Monkey Ladder Task with Without Music condition
09.50 – 09.55	Researcher condition participants for the 85 bpm Jazz music condition
09.55 – 09.59	Token Search Task with 85 bpm Jazz Music condition
10.00 – 10.04	Paired Associates Task with 85 bpm Jazz Music condition
10.05 – 10.09	Spatial Span Task with 85 bpm Jazz Music condition
10.10 – 10.14	Monkey Ladder Task with 85 bpm Jazz Music condition
10.15 – 10.20	Researcher condition participants for the 120 bpm Jazz music condition
10.20 – 10.24	Token Search Task with 120 bpm Jazz Music condition
10.25 – 10.29	Paired Associates Task with 120 bpm Jazz Music condition
10.30 – 10.34	Spatial Span Task with 120 bpm Jazz Music condition
10.35 – 10.39	Monkey Ladder Task with 120 bpm Jazz Music condition
10.40 – 10.45	Researcher condition participants for the 160 bpm Jazz music condition
10.45 – 10.49	Token Search Task with 160 bpm Jazz Music condition
10.50 – 10.54	Paired Associates Task with 160 bpm Jazz Music condition
10.55 – 10.59	Spatial Span Task with 160 bpm Jazz Music condition
11.00 – 11.04	Monkey Ladder Task with 160 bpm Jazz Music condition
11.05 – 11.30	Finishing the experiment

The experiment start with participants doing the token search task in a condition without music, following with other task and condition. In Table 3.1, there is one minute interval between each task. This one minute interval is for the researcher to record the score of each task in the score sheet made by researcher. There is five minutes interval for switching to other condition, this is to condition the participants so that all participants have the same state when doing the task.

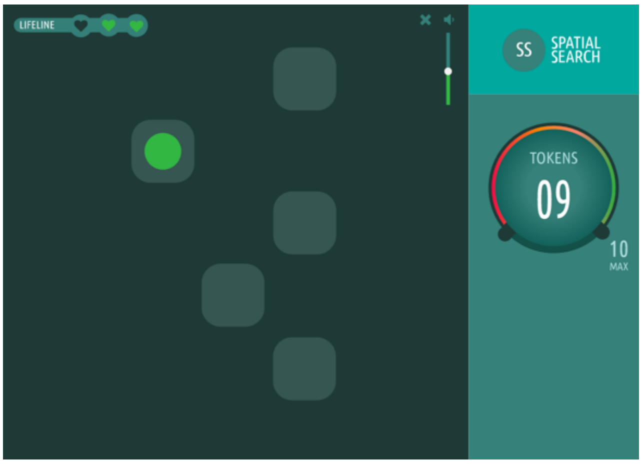

Figure 3.2 Token Search Task (Cambridge Brain Science)

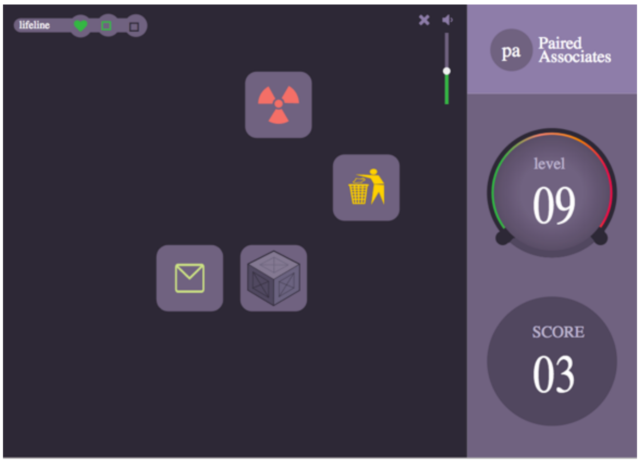

Figure 3.3 Paired Associates Task (Cambridge Brain Science)

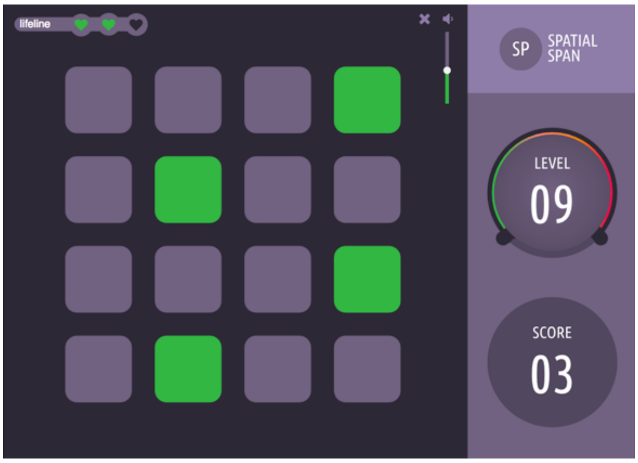

Figure 3.4 Spatial Span Task (Cambridge Brain Science)

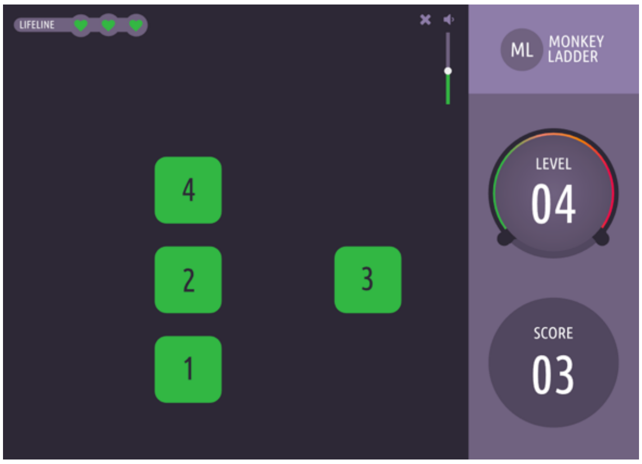

Figure 3.5 Monkey Ladder Task (Cambridge Brain Science)

3.4 Experiment Result Processing

Results obtained from experiment are calculated and interpreted using SPSS software. The result will determine what music tempo of jazz music have significance effect to participants in cognitive task, the cognitive task is Cambridge Brain Science (CBS) test on short-term memory domain.

3.5 Experiment Analysis

Results obtained from experiment result processing will be analysed in this phase. Analysis on result of token search task, paired associates task, spatial span task, and monkey ladder task, mean result of all four task, and experiment process.

CHAPTER IV

DATA COLLECTION AND PROCESSING

This chapter is classified into two main subchapters; those are data collection and data processing. Data collection will elaborate all related data which were collected. Then in data processing, those data will be processed following the aforementioned research methodology.

4.1 Data Collection

Data collection covers several subchapters; those are room requirement for experiment, participant's data, experiment process and experiment result.

4.1.1 Room Requirement for Experiment

The room requirement for this experiment need to have silence environment, good lighting, computer, and sound system. Silence environment is needed for the participants to focus on the test. Good lighting also necessary to ensure the visibility of the participants when undertake the test. The experiment is conducted in Laboratorium Multi Media (Lab MM) Industrial Engineering Department of Institut Teknologi Sepuluh Nopember. The laboratorium location is on the edge of building and not many people pass by. The laboratorium lighting is good and can be adjusted as needed. The laboratorium have computers and sound system that is needed for the experiment. Computer is necessary for accessing Cambridge Brain Science (CBS) test. The sound system is necessary for playing the jazz music to the participants. Laboratorium Multi Media (Lab MM) Industrial Engineering Department of Institut Teknologi Sepuluh Nopember is choosen for experiment because it meet the requirement for conducting the experiment.

Figure 4.1 Laboratorium Multi Media (Lab MM) Industrial Engineering Department of Institut Teknologi Sepuluh Nopember

4.1.2 Participant's Data

Participant data for the experiment. The participants are university student from Institut Teknologi Sepuluh Nopember (ITS) with age between 18-25 years old.

Table 4.1 Participant's Data

No.	Name	Gender	Age
1.	Abdiel Dikma	Male	18 years
2.	Ahmad Bunayya Tsani	Male	19 years
3.	Apriani Kartika Dewi	Female	19 years
4.	Ariq Andika Farsya	Male	20 years
5	Attahariq Trysnanda Putra	Male	18 years
6.	Bara Abdul Gani	Male	19 years
7.	Cakra Diaz	Male	20 years
8.	David Daniel	Male	21 years
9.	Dedo Indra Pratama	Male	18 years
10.	Endang Wahyuningsih	Female	24 years
11.	Fahrian Nurhidayat	Male	18 years
12.	Ibrahim	Male	20 years
13.	Ifan Eldin Khaq	Male	23 years
14.	Ihsan Pribadi	Male	19 years
15.	Imam Hanafi	Male	19 years
16.	Laily Farhana	Female	24 years
17.	Magdalena Effendi	Female	19 years
18.	Miftakhul Janah	Female	20 years
19.	Mochammad Rayhan A. S.	Male	19 years

No.	Name	Gender	Age
20.	Mohammad Nur Effendy	Male	19 years
21.	Muchammad Dimas Novianto	Male	19 years
22.	Muktianando	Male	22 years
23.	Nauval Rendrahadi	Male	20 years
24.	Nur Sulistiawanti	Female	19 years
25.	Nurul Handayani	Female	24 years
26.	Nyoman Dennis Y. D.	Male	19 years
27.	Piola Surya Anggreini	Female	21 years
28.	Reydhinata	Male	19 years
29.	Sandya Rafi A.	Male	19 years
30.	Syafniya Zilfah Aniesiy	Female	19 years
31.	Taris Farizan	Male	18 years
32.	Yohana Yoanita Azi	Female	20 years

4.1.3 Experiment Process

The experiment is conducted on November 16th, Saturday, 2019 at Laboratorium Multi Media (Lab MM) Industrial Engineering Department of Institut Teknologi Sepuluh Nopember and start from 09.00 AM to 11.30 PM. First, participants is seated in each computer with Cambridge Brain Science (CBS) Test already opened by the researcher. Then participants open Token Search, Paired Associates, Spatial Span, and Monkey Ladder task in CBS. There are four conditions in the experiment. The first condition of the experiment is without music, participants do the Token Search, Paired Associates, Spatial Span, and Monkey Ladder task while there is no music presence. The second condition is 85 bpm, participants do the Token Search, Paired Associates, Spatial Span, and Monkey Ladder task while listening to 85 bpm jazz music from the sound system. The third condition is 120 bpm, participants do the Token Search, Paired Associates, Spatial Span, and Monkey Ladder task while listening to 120 bpm jazz music from the sound system. The fourth condition is 160 bpm, participants do the Token Search, Paired Associates, Spatial Span, and Monkey Ladder task while listening to 160 bpm jazz music from the sound system. The score of participants is recorded when every task is done in each condition. The score is recorded in the score sheet made by the researcher.

Figure 4.2 Participants Undertake CBS Test

4.1.4 Experiment Result

The experiment result for each condition is recorded by researcher by writing the score in the score sheet made by the researcher when the experiment is ongoing. The unit of score of Cambridge Brain Science (CBS) test is point. The result consist of Token Search Result for Each Condition, Paired Associates Result for Each Condition, Spatial Span Result for Each Condition, and Monkey Ladder Result for Each Condition.

Table 4.2 Token Search Result for Each Condition

No.	**Name**	**Without Music**	**85 BPM**	**120 BPM**	**160 BPM**
1.	Abdiel Dikma	9	7	8	7
2.	Ahmad Bunayya Tsani	11	11	11	9
3.	Apriani Kartika Dewi	5	7	7	7
4.	Ariq Andika Farsya	6	9	7	7
5	Attahariq Trysnanda Putra	6	7	7	8
6.	Bara Abdul Gani	5	6	7	7
7.	Cakra Diaz	6	7	10	8
8.	David Daniel	5	5	7	7
9.	Dedo Indra Pratama	8	9	10	9
10.	Endang Wahyuningsih	8	8	9	8
11.	Fahrian Nurhidayat	7	7	8	8
12.	Ibrahim	8	8	9	7
13.	Ifan Eldin Khaq	6	7	8	6

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
14.	Ihsan Pribadi	8	5	7	7
15.	Imam Hanafi	6	5	5	5
16.	Laily Farhana	6	7	7	6
17.	Magdalena Effendi	5	6	6	6
18.	Miftakhul Janah	10	9	12	8
19.	Mochammad Rayhan A. S.	5	5	6	5
20.	Mohammad Nur Effendy	8	7	9	7
21.	Muchammad Dimas Novianto	8	7	8	8
22.	Muktianando	6	7	6	5
23.	Nauval Rendrahadi	5	6	6	6
24.	Nur Sulistiawanti	6	7	9	7
25.	Nurul Handayani	9	9	10	8
26.	Nyoman Dennis Y. D.	7	7	8	6
27.	Piola Surya Anggreini	8	9	10	11
28.	Reydhinata	5	5	5	5
29.	Sandya Rafi A.	7	5	6	6
30.	Syafniya Zilfah Aniesiy	7	8	9	8
31.	Taris Farizan	8	11	7	8
32.	Yohana Yoanita Azi	7	7	9	10

Table 4.3 Paired Associates Result for Each Condition

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
1.	Abdiel Dikma	6	5	4	6
2.	Ahmad Bunayya Tsani	6	5	6	4
3.	Apriani Kartika Dewi	6	5	5	4
4.	Ariq Andika Farsya	4	4	4	5
5	Attahariq Trysnanda Putra	6	4	5	6
6.	Bara Abdul Gani	3	4	5	6
7.	Cakra Diaz	6	6	6	6
8.	David Daniel	2	4	5	5
9.	Dedo Indra Pratama	5	5	5	4
10.	Endang Wahyuningsih	6	6	7	4
11.	Fahrian Nurhidayat	4	4	4	4
12.	Ibrahim	4	4	5	4
13.	Ifan Eldin Khaq	6	5	6	5
14.	Ihsan Pribadi	4	4	5	7
15.	Imam Hanafi	5	6	5	5
16.	Laily Farhana	6	5	6	5
17.	Magdalena Effendi	5	6	4	5

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
18.	Miftakhul Janah	5	6	5	5
19.	Mochammad Rayhan A. S.	4	4	5	5
20.	Mohammad Nur Effendy	6	6	6	5
21.	Muchammad Dimas Novianto	6	6	6	7
22.	Muktianando	4	6	5	7
23.	Nauval Rendrahadi	5	6	5	6
24.	Nur Sulistiawanti	6	5	7	4
25.	Nurul Handayani	5	6	6	4
26.	Nyoman Dennis Y. D.	4	5	5	5
27.	Piola Surya Anggreini	5	5	5	6
28.	Reydhinata	4	4	4	4
29.	Sandya Rafi A.	4	4	4	3
30.	Syafniya Zilfah Aniesiy	4	4	5	3
31.	Taris Farizan	6	5	6	5
32.	Yohana Yoanita Azi	3	5	6	6

Table 4.4 Spatial Span Result for Each Condition

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
1.	Abdiel Dikma	6	6	7	6
2.	Ahmad Bunayya Tsani	7	8	7	7
3.	Apriani Kartika Dewi	4	5	5	6
4.	Ariq Andika Farsya	6	5	5	5
5	Attahariq Trysnanda Putra	8	6	7	8
6.	Bara Abdul Gani	6	6	5	6
7.	Cakra Diaz	4	7	6	6
8.	David Daniel	6	6	7	7
9.	Dedo Indra Pratama	4	6	8	6
10.	Endang Wahyuningsih	5	6	6	5
11.	Fahrian Nurhidayat	7	6	6	5
12.	Ibrahim	6	5	6	6
13.	Ifan Eldin Khaq	7	7	7	6
14.	Ihsan Pribadi	6	8	7	7
15.	Imam Hanafi	7	6	6	6
16.	Laily Farhana	7	7	7	7
17.	Magdalena Effendi	6	6	6	6
18.	Miftakhul Janah	6	6	7	7
19.	Mochammad Rayhan A. S.	6	4	6	6
20.	Mohammad Nur Effendy	7	7	8	6
21.	Muchammad Dimas Novianto	6	7	8	7

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
22.	Muktianando	6	7	7	7
23.	Nauval Rendrahadi	6	6	6	5
24.	Nur Sulistiawanti	7	6	8	3
25.	Nurul Handayani	6	6	7	6
26.	Nyoman Dennis Y. D.	7	6	8	6
27.	Piola Surya Anggreini	5	6	5	6
28.	Reydhinata	6	5	7	5
29.	Sandya Rafi A.	5	5	6	3
30.	Syafniya Zilfah Aniesiy	3	4	4	4
31.	Taris Farizan	7	7	9	7
32.	Yohana Yoanita Azi	6	7	7	6

Table 4.5 Monkey Ladder Result for Each Condition

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
1.	Abdiel Dikma	7	9	8	8
2.	Ahmad Bunayya Tsani	8	8	10	9
3.	Apriani Kartika Dewi	6	7	7	8
4.	Ariq Andika Farsya	9	7	9	8
5	Attahariq Trysnanda Putra	8	8	8	8
6.	Bara Abdul Gani	9	7	8	9
7.	Cakra Diaz	8	10	10	8
8.	David Daniel	8	7	7	7
9.	Dedo Indra Pratama	8	7	9	7
10.	Endang Wahyuningsih	6	8	8	6
11.	Fahrian Nurhidayat	8	8	8	7
12.	Ibrahim	7	7	8	8
13.	Ifan Eldin Khaq	9	9	10	8
14.	Ihsan Pribadi	10	10	8	8
15.	Imam Hanafi	8	7	8	9
16.	Laily Farhana	8	8	9	8
17.	Magdalena Effendi	8	8	8	7
18.	Miftakhul Janah	8	9	9	8
19.	Mochammad Rayhan A. S.	7	8	8	8
20.	Mohammad Nur Effendy	9	8	10	8
21.	Muchammad Dimas Novianto	10	9	9	10
22.	Muktianando	8	9	9	10
23.	Nauval Rendrahadi	9	8	10	8
24.	Nur Sulistiawanti	9	9	10	9
25.	Nurul Handayani	8	8	9	8

No.	Name	Without Music	85 BPM	120 BPM	160 BPM
26.	Nyoman Dennis Y. D.	8	8	9	7
27.	Piola Surya Anggreini	9	8	8	9
28.	Reydhinata	7	8	7	7
29.	Sandya Rafi A.	7	8	7	6
30.	Syafniya Zilfah Aniesiy	9	9	9	8
31.	Taris Farizan	8	10	8	9
32.	Yohana Yoanita Azi	7	8	7	7

4.2 Data Processing

Data processing is composed by using SPSS Software. The data result for each task is calculated and identified by using SPSS software.

4.2.1 Normality Test

Normality tests are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk			Description
	Statistic	df	Sig.	Statistic	df	Sig.	
Without Music	.129	32	.194	.969	32	.480	Normal
85 BPM	.109	32	.200[*]	.978	32	.729	Normal
120 BPM	.144	32	.091	.951	32	.150	Normal
160 BPM	.133	32	.159	.965	32	.365	Normal
Without Music_1	.186	32	.006	.910	32	.011	Not Normal
85 BPM_1	.234	32	.000	.898	32	.006	Not Normal
120 BPM_1	.169	32	.021	.956	32	.212	Normal
160 BPM_1	.159	32	.038	.931	32	.043	Not Normal
Without Music_2	.226	32	.000	.852	32	.000	Not Normal
85 BPM_2	.224	32	.000	.797	32	.000	Not Normal
120 BPM_2	.260	32	.000	.867	32	.001	Not Normal
160 BPM_2	.188	32	.006	.917	32	.017	Not Normal
Without Music_3	.293	32	.000	.867	32	.001	Not Normal
85 BPM_3	.242	32	.000	.901	32	.006	Not Normal
120 BPM_3	.206	32	.001	.933	32	.047	Not Normal
160 BPM_3	.283	32	.000	.862	32	.001	Not Normal
Without Music_4	.225	32	.000	.910	32	.011	Not Normal
85 BPM_4	.270	32	.000	.862	32	.001	Not Normal
120 BPM_4	.226	32	.000	.880	32	.002	Not Normal
160 BPM_4	.237	32	.000	.905	32	.008	Not Normal

_1 = Token Search _3 = Spatial Span

_2 = Paired Associates _4 = Monkey Ladder

Figure 4.3 Normality Test for Each Task and Condition

The result of normality test can be seen in the Shapiro-Wilk Sig. value in Figure 4.3. The data is normal if Sig. value greater than 0.05, if Sig. value is less than 0.05 the data is not normal. Almost all data from token search, paired associates, spatial span, and monkey ladder task are not normal.

4.2.2 Token Search Calculation

Data processed using SPSS for Token Search Result.

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Without Music_1	32	6.9063	1.57315	5.00	11.00
85 BPM_1	32	7.1875	1.61520	5.00	11.00
120 BPM_1	32	7.9063	1.72943	5.00	12.00
160 BPM_1	32	7.1875	1.42416	5.00	11.00

Friedman Test

Ranks

	Mean Rank
Without Music_1	2.05
85 BPM_1	2.34
120 BPM_1	3.25
160 BPM_1	2.36

Test Statistics[a]

N	32
Chi-square	19.565
df	3
Asymp. Sig.	.000

a. Friedman Test

Figure 4.4 Token Search Calculation Using SPSS

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
85 BPM_1 - Without Music_1	Negative Ranks	7[a]	13.00	91.00
	Positive Ranks	15[b]	10.80	162.00
	Ties	10[c]		
	Total	32		
120 BPM_1 - Without Music_1	Negative Ranks	5[d]	9.00	45.00
	Positive Ranks	23[e]	15.70	361.00
	Ties	4[f]		
	Total	32		
160 BPM_1 - Without Music_1	Negative Ranks	11[g]	11.14	122.50
	Positive Ranks	14[h]	14.46	202.50
	Ties	7[i]		
	Total	32		
120 BPM_1 - 85 BPM_1	Negative Ranks	3[j]	16.83	50.50
	Positive Ranks	21[k]	11.88	249.50
	Ties	8[l]		
	Total	32		
160 BPM_1 - 85 BPM_1	Negative Ranks	10[m]	10.50	105.00
	Positive Ranks	10[n]	10.50	105.00
	Ties	12[o]		
	Total	32		
160 BPM_1 - 120 BPM_1	Negative Ranks	16[p]	11.63	186.00
	Positive Ranks	4[q]	6.00	24.00
	Ties	12[r]		
	Total	32		

Test Statistics[d]

	85 BPM_1 - Without Music_1	120 BPM_1 - Without Music_1	160 BPM_1 - Without Music_1	120 BPM_1 - 85 BPM_1
Z	-1.209[a]	-3.712[a]	-1.109[a]	-2.933[a]
Asymp. Sig. (2-tailed)	.227	.000	.267	.003

Test Statistics[d]

	160 BPM_1 - 85 BPM_1	160 BPM_1 - 120 BPM_1
Z	.000[b]	-3.107[c]
Asymp. Sig. (2-tailed)	1.000	.002

Figure 4.4 Token Search Calculation Using SPSS (cont'd)

Token search calculation result of mean of without music is 6.9063, for 85 bpm is 7.1875, for 120 bpm is 7.9063, and for 160 bpm is 7.1875. The Friedman test result show the mean rank of without music is 2.05, for 85 bpm is 2.34, for 120 bpm is 3.25, and for 160 bpm is 2.36. Asymp. Sig result in test statistics is .000, this result is less than 0.05, so it can be calculated in the Wilcoxon signed rank test. The Wilcoxon signed rank test is to show the result of significant difference of each condition compare to other. This result will determine the effect of jazz music with 85 bpm, 120 bpm, 160 bpm, and without music to token search task.

4.2.3 Paired Associates Calculation

Data processed using SPSS for Paired Associates Result.

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Without Music_2	32	4.8438	1.11034	2.00	6.00
85 BPM_2	32	4.9688	.82244	4.00	6.00
120 BPM_2	32	5.2188	.83219	4.00	7.00
160 BPM_2	32	5.0000	1.07763	3.00	7.00

Friedman Test

Ranks

	Mean Rank
Without Music_2	2.36
85 BPM_2	2.42
120 BPM_2	2.80
160 BPM_2	2.42

Test Statistics[a]

N	32
Chi-square	3.223
df	3
Asymp. Sig.	.359

a. Friedman Test

Figure 4.5 Paired Associates Calculation Using SPSS

Token search calculation result of mean of without music is 4.8438, for 85 bpm is 4.9688, for 120 bpm is 5.2188, and for 160 bpm is 5.000. The Friedman test result show the mean rank of without music is 2.36, for 85 bpm is 2.42, for 120 bpm is 2.80, and for 160 bpm is 2.42. Asymp. Sig result in test statistics is .359, this result is more than 0.05, so it cannot be calculated in the Wilcoxon signed rank test. This result will determine the effect of jazz music with 85 bpm, 120 bpm, 160 bpm, and without music to paired associates task.

4.2.4 Spatial Span Calculation

Data processed using SPSS for Spatial Span Result.

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Without Music_3	32	5.9688	1.09203	3.00	8.00
85 BPM_3	32	6.0938	.96250	4.00	8.00
120 BPM_3	32	6.5938	1.10306	4.00	9.00
160 BPM_3	32	5.9063	1.11758	3.00	8.00

Friedman Test

Ranks

	Mean Rank
Without Music_3	2.25
85 BPM_3	2.45
120 BPM_3	3.05
160 BPM_3	2.25

Test Statistics[a]

N	32
Chi-square	11.537
df	3
Asymp. Sig.	.009

a. Friedman Test

Figure 4.6 Spatial Span Calculation Using SPSS

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
85 BPM_3 - Without Music_3	Negative Ranks	9[a]	10.11	91.00
	Positive Ranks	11[b]	10.82	119.00
	Ties	12[c]		
	Total	32		
120 BPM_3 - Without Music_3	Negative Ranks	5[d]	10.50	52.50
	Positive Ranks	19[e]	13.03	247.50
	Ties	8[f]		
	Total	32		
160 BPM_3 - Without Music_3	Negative Ranks	10[g]	10.65	106.50
	Positive Ranks	10[h]	10.35	103.50
	Ties	12[i]		
	Total	32		
120 BPM_3 - 85 BPM_3	Negative Ranks	5[j]	7.50	37.50
	Positive Ranks	15[k]	11.50	172.50
	Ties	12[l]		
	Total	32		
160 BPM_3 - 85 BPM_3	Negative Ranks	11[m]	8.64	95.00
	Positive Ranks	6[n]	9.67	58.00
	Ties	15[o]		
	Total	32		
160 BPM_3 - 120 BPM_3	Negative Ranks	15[p]	10.93	164.00
	Positive Ranks	4[q]	6.50	26.00
	Ties	13[r]		
	Total	32		

Test Statistics[c]

	85 BPM_3 - Without Music_3	120 BPM_3 - Without Music_3	160 BPM_3 - Without Music_3	120 BPM_3 - 85 BPM_3
Z	-.551[a]	-2.997[a]	-.058[b]	-2.635[a]
Asymp. Sig. (2-tailed)	.582	.003	.953	.008

Test Statistics[c]

	160 BPM_3 - 85 BPM_3	160 BPM_3 - 120 BPM_3
Z	-.925[b]	-2.867[b]
Asymp. Sig. (2-tailed)	.355	.004

Figure 4.6 Spatial Span Calculation Using SPSS (cont'd)

Token search calculation result of mean of without music is 5.9688, for 85 bpm is 6.0938, for 120 bpm is 6.5938, and for 160 bpm is 5.9063. The Friedman test result show the mean rank of without music is 2.25, for 85 bpm is 2.45, for 120 bpm is 3.05, and for 160 bpm is 2.25. Asymp. Sig result in test statistics is .009, this result is less than 0.05, so it can be calculated in the Wilcoxon signed rank test. The Wilcoxon signed rank test is to show the result of significant difference of each condition compare to other. This result will determine the effect of jazz music with 85 bpm, 120 bpm, 160 bpm, and without music to spatial span task.

4.2.5 Monkey Ladder Calculation

Data processed using SPSS for Monkey Ladder Result.

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Without Music_4	32	8.0625	.98169	6.00	10.00
85 BPM_4	32	8.1875	.89578	7.00	10.00
120 BPM_4	32	8.5000	.98374	7.00	10.00
160 BPM_4	32	7.9688	.96668	6.00	10.00

Friedman Test

Ranks

	Mean Rank
Without Music_4	2.34
85 BPM_4	2.50
120 BPM_4	2.95
160 BPM_4	2.20

Test Statistics[a]

N	32
Chi-square	8.070
df	3
Asymp. Sig.	.045

a. Friedman Test

Figure 4.7 Monkey Ladder Calculation Using SPSS

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
85 BPM_4 - Without Music_4	Negative Ranks	9[a]	9.72	87.50
	Positive Ranks	11[b]	11.14	122.50
	Ties	12[c]		
	Total	32		
120 BPM_4 - Without Music_4	Negative Ranks	5[d]	11.70	58.50
	Positive Ranks	17[e]	11.44	194.50
	Ties	10[f]		
	Total	32		
160 BPM_4 - Without Music_4	Negative Ranks	12[g]	9.83	118.00
	Positive Ranks	8[h]	11.50	92.00
	Ties	12[i]		
	Total	32		
120 BPM_4 - 85 BPM_4	Negative Ranks	6[j]	9.67	58.00
	Positive Ranks	13[k]	10.15	132.00
	Ties	13[l]		
	Total	32		
160 BPM_4 - 85 BPM_4	Negative Ranks	14[m]	12.29	172.00
	Positive Ranks	9[n]	11.56	104.00
	Ties	9[o]		
	Total	32		
160 BPM_4 - 120 BPM_4	Negative Ranks	17[p]	13.94	237.00
	Positive Ranks	7[q]	9.00	63.00
	Ties	8[r]		
	Total	32		

Test Statistics[c]

	85 BPM_4 - Without Music_4	120 BPM_4 - Without Music_4	160 BPM_4 - Without Music_4	120 BPM_4 - 85 BPM_4
Z	-.683[a]	-2.365[a]	-.524[b]	-1.543[a]
Asymp. Sig. (2-tailed)	.495	.018	.600	.123

Test Statistics[c]

	160 BPM_4 - 85 BPM_4	160 BPM_4 - 120 BPM_4
Z	-1.089[b]	-2.604[b]
Asymp. Sig. (2-tailed)	.276	.009

Figure 4.7 Monkey Ladder Calculation Using SPSS (cont'd)

Token search calculation result of mean of without music is 8.0625, for 85 bpm is 8.1875, for 120 bpm is 8.5000, and for 160 bpm is 7.9688. The Friedman test result show the mean rank of without music is 2.34, for 85 bpm is 2.50, for 120 bpm is 2.95, and for 160 bpm is 2.20. Asymp. Sig result in test statistics is .045, this result is less than 0.05, so it can be calculated in the Wilcoxon signed rank test. The Wilcoxon signed rank test is to show the result of significant difference of each condition compare to other. This result will determine the effect of jazz music with 85 bpm, 120 bpm, 160 bpm, and without music to monkey ladder task.

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CHAPTER V

ANALYSIS AND INTERPRETATION

Results of data processing on previous chapter are analyzed and interpreted in this chapter. In this chapter the result of token search, paired associates, spatial span, and monkey ladder calculation from Cambridge Brain Science (CBS) test is analyzed. From the data obtained, it can be analyzed the effect of jazz music with tempo 85 bpm, 120 bpm, 160 bpm, and without music when perform cognitive task such as Cambridge Brain Science (CBS) test in short-term memory domain. The result of the experiment is to determine which bpm of jazz music that have significant effect with cognitive task. This result can help to create jazz music that improve performance when performing cognitive task on short-term memory domain. The experiment process is also analyzed and interpreted.

5.1 Analysis of Normality Test

The analysis of normality test from Figure 4.3.

Table 5.1 Analysis of Normality Test

	Sig.	Description	Test Used
Without Music	0,480	Normal	ANOVA SAME SUBJECT/REPEATED MEASURE
85 BPM	0,729	Normal	
120 BPM	0,150	Normal	
160 BPM	0,365	Normal	
Without Music_1	0,011	Not Normal	FRIEDMAN
85 BPM_1	0,006	Not Normal	
120 BPM_1	0,212	Normal	
160 BPM_1	0,043	Not Normal	
Without Music_2	0,000	Not Normal	FRIEDMAN
85 BPM_2	0,000	Not Normal	
120 BPM_2	0,001	Not Normal	
160 BPM_2	0,017	Not Normal	
Without Music_3	0,001	Not Normal	FRIEDMAN
85 BPM_3	0,006	Not Normal	
120 BPM_3	0,047	Not Normal	
160 BPM_3	0,001	Not Normal	
Without Music_4	0,011	Not Normal	FRIEDMAN
85 BPM_4	0,001	Not Normal	

	Sig.	Description	Test Used
120 BPM_4	0,002	Not Normal	
160 BPM_4	0,008	Not Normal	

From Table 5.1, the data distribution mostly not normal. If there is one or more data that is not normal in a group, the test used is Friedman. Token Search, Paired Associates, Spatial Span, and Monkey Ladder calculation use Friedman Test. The data is not normal because the Sig. value is less than 0.05. For example it can be seen in Table 4.2 Token Search Result for Each Condition, participant Miftakhul Janah scored 12 point on 120 bpm condition. Other participants only scored between 5 and 10, this is a sign of outlier data that can caused the Sig. value less than 0.05.

5.2 Analysis of Token Search Calculation

The analysis of token search calculation from Figure 4.4.

Table 5.2 Analysis of Token Search Calculation

Token Search	N	Mean	Std. Deviation	Minimum	Maximum	Sum	P	Description
Without Music	32	6,906	1,573	5,00	11,00	221	0,000..	There is a significant difference
85 BPM	32	7,188	1,615	5,00	11,00	230		
120 BPM	32	7,906	1,729	5,00	12,00	253		
160 BPM	32	7,188	1,424	5,00	11,00	230		

Table 5.3 Wilcoxon Signed Rank Test of Token Search Calculation

Token Search	Without Music	85 BPM	120 BPM	160 BPM
Without Music				
85 BPM	0,227			
120 BPM	0.000***	0.003***		
160 BPM	0,267	1,000	0.002***	

***= significant with alpha 1%

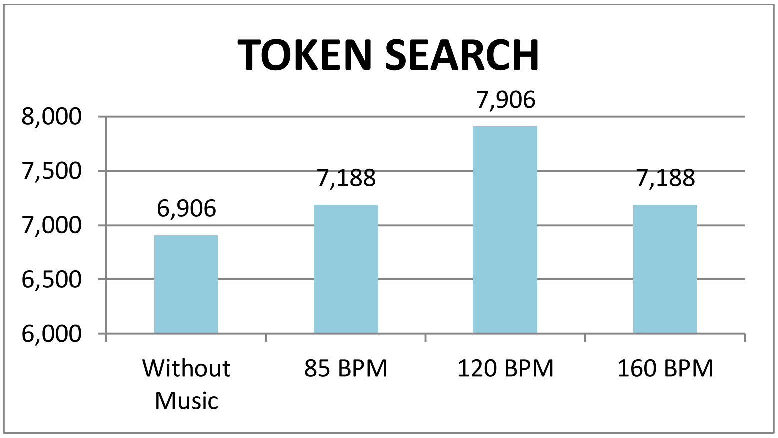

Figure 5.1 Mean Difference of Token Search of Each Condition

From Table 5.2, the result of P-value is 0.000 and less than 0.05. If the value of P-value is less than 0.05, there is a significant difference. The difference can be seen in the mean of each condition. In the Figure 5.1, the difference of mean is large. The biggest mean is 7.906 for condition 120 BPM, 7.188 for condition 85 and 160 BPM, 6.906 for condition without music Wilcoxon Signed Rank Test from Table 5.3 also states that condition 120 BPM have significant differences with condition Without Music, 85 BPM, and 160 BPM. The result of 120 BPM conditions paired with 85 BPM is 0.003***, with 160 BPM is 0.002***, and without music is 0.000*** where *** = significant with alpha 1%.

5.3 Analysis of Paired Associates Calculation

The analysis of paired associates calculation from Figure 4.5.

Table 5.4 Analysis of Paired Associates Calculation

Paired Associates	N	Mean	Std. Deviation	Minimum	Maximum	Sum	P	Description
Without Music	32	4,844	1,110	2,00	6,00	155	0,359	There is no significant difference
85 BPM	32	4,969	0,822	4,00	6,00	159		
120 BPM	32	5,219	0,832	4,00	7,00	167		
160 BPM	32	5,000	1,078	3,00	7,00	160		

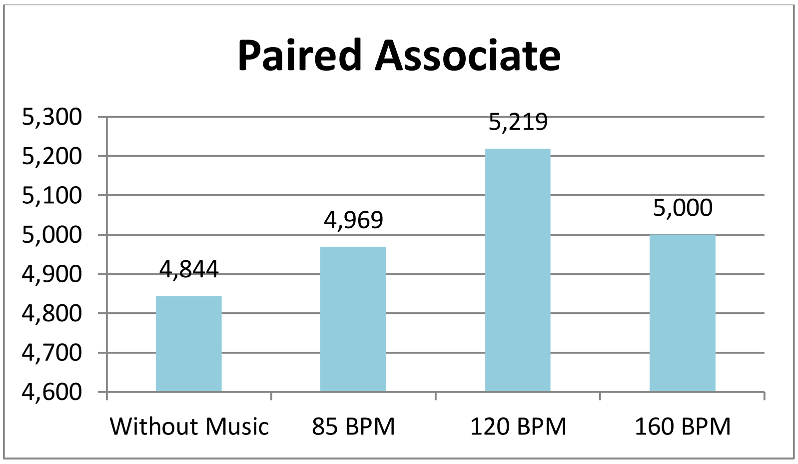

Figure 5.2 Mean Differences of Paired Associates of Each Condition

From Table 5.4, the result of P-value is more than 0.05. If the P-value is more than 0.05, there is no significant differences. The difference of mean in Figure 5.2 is very small. The biggest mean is in condition is 5.219 for 120 BPM condition, 5.000 for 160 BPM condition, 4.969 for 85 BPM condition, and 4.844 for without music condition. There is no Wilcoxon Signed Rank Test for paired associates, because there is no significant difference. The difference can be seen in the mean of each condition. The difference of the mean is not very large.

5.4 Analysis of Spatial Span Calculation

The analysis of spatial span calculation from Figure 4.6.

Table 5.5 Analysis of Spatial Span Calculation

Spatial Span	N	Mean	Std. Deviation	Minimum	Maximum	Sum	P	Description
Without Music	32	5,969	1,092	3,00	8,00	191	0,009	There is a significant difference
85 BPM	32	6,094	0,963	4,00	8,00	195		
120 BPM	32	6,594	1,103	4,00	9,00	211		
160 BPM	32	5,906	1,118	3,00	8,00	189		

Table 5.6 Wilcoxon Signed Rank Test of Spatial Span Calculation

Spatial Span	Without Music	85 BPM	120 BPM	160 BPM
Without Music				
85 BPM	0,582			
120 BPM	0.002***	0.008***		
160 BPM	0,953	0,355	0.004***	

***= significant with alpha 1%

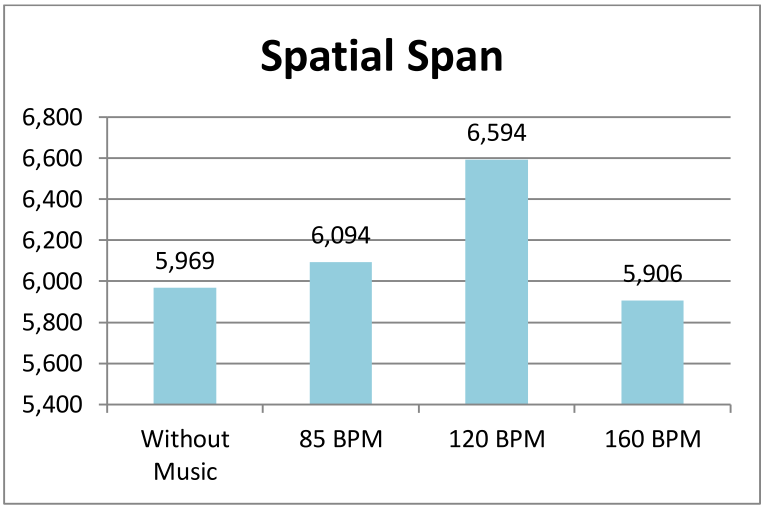

Figure 5.3 Mean Differences of Spatial Span of Each Condition

From Table 5.5, the result of P-value is less than 0.05. If the value of P-value is less than 0.05, there is a significant difference. The difference can be seen in the mean of each condition. In the Figure 5.3, the difference of mean is large. The biggest mean is 6.594 for condition 120 BPM, 6.094 for condition 85 BPM, 5.969 for condition without music, and 5.906 for condition 160 BPM. The biggest mean is condition 120 BPM. Wilcoxon Signed Rank Test from Table 5.6 also states that condition 120 BPM have significant differences with condition Without Music, 85 BPM, and 160 BPM. The result of 120 BPM conditions paired with 85 BPM is 0.008***, with 160 BPM is 0.004***, and without music is 0.002*** where *** = significant with alpha 1%.

5.5 Analysis of Monkey Ladder Calculation

The analysis of monkey ladder calculation from Figure 4.7.

Table 5.7 Analysis of Monkey Ladder Calculation

Monkey Ladder	N	Mean	Std. Deviation	Minimum	Maximum	Sum	P	Description
Without Music	32	8,063	0,982	6,00	10,00	258	0,045	There is a significant difference
85 BPM	32	8,188	0,896	7,00	10,00	262		
120 BPM	32	8,500	0,984	7,00	10,00	272		
160 BPM	32	7,969	0,967	6,00	10,00	255		

Table 5.8 Wilcoxon Signed Rank Test of Monkey Ladder Calculation

Monkey Ladder	Without Music	85 BPM	120 BPM	160 BPM
Without Music				
85 BPM	0,495			
120 BPM	0.018***	0,123		
160 BPM	0,600	0,276	0.009***	

***= significant with alpha 1%

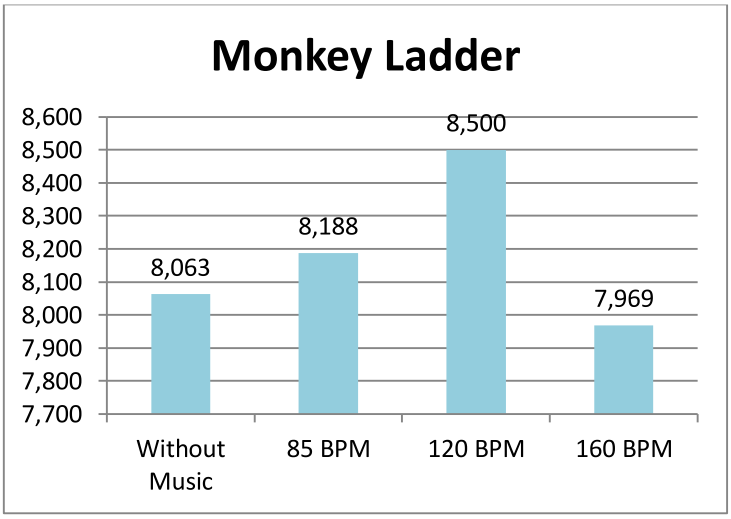

Figure 5.4 Mean Differences of Monkey Ladder of Each Condition

From Table 5.7, the result of P-value is less than 0.05. If the value of P-value is less than 0.05, there is a significant difference. The difference can be seen in the mean of each condition. In the Figure 5.4, the difference of mean is large between 120

BPM, 160 BPM, and without music condition. The biggest mean is 8.500 for condition 120 BPM, 8.188 for condition 85 BPM, 8.063 for condition without music, and 7.969 for condition 160 BPM. Wilcoxon Signed Rank Test from Table 5.8 also states that condition 120 BPM have significant differences with condition Without Music and 160 BPM. The result of 120 BPM conditions paired with 160 BPM is 0.009***, and without music is 0.018*** where *** = significant with alpha 1%.

5.6 Mean Result of Token Search, Paired Associates, Spatial Span, and Monkey Ladder

The calculation of token search, paired associates, spatial span, monkey ladder can be combine to find the total mean result.

Table 5.9 Mean Result of Token Search, Paired Associates, Spatial Span, and Monkey Ladder

Mean Result	N	Mean	Std. Deviation	Minimum	Maximum	Sum	P	Description
Without Music	32	6,4453	,70349	5,25	8,00	206,25	0,000	There is a significant difference
85 BPM	32	6,6094	,72105	5,25	8,25	211,50		
120 BPM	32	7,0547	,82729	5,75	8,50	225,75		
160 BPM	32	6,5156	,75652	4,50	8,00	208,50		

Table 5.10 Wilcoxon Signed Rank Test of Mean Result of Token Search, Paired Associates, Spatial Span, and Monkey Ladder

Mean Result	Without Music	85 BPM	120 BPM	160 BPM
Without Music				
85 BPM	0,090			
120 BPM	0.000***	0.000***		
160 BPM	0,603	0,447	0.002***	

***= significant with alpha 1%

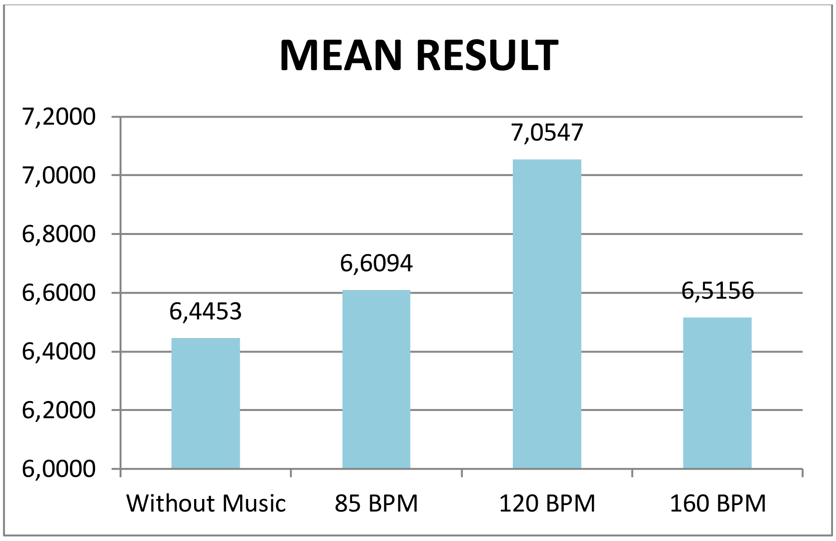

Figure 5.5 Mean Differences of Mean Result of Token Search, Paired Associates, Spatial Span, and Monkey Ladder

From Table 5.9, the result of P-value is less than 0.05. If the value of P-value is less than 0.05, there is a significant difference. The difference can be seen in the mean of each condition. In the Figure 5.5, the difference of mean is large. The biggest mean is 7.0547 for condition 120 BPM, 6.6094 for condition 85 BPM, 6.5156 for condition 160 BPM, and 6.4453 for condition without music. Wilcoxon Signed Rank Test from Table 5.10 also states that condition 120 BPM have significant differences with condition Without Music, 85 BPM and 160 BPM. The result of 120 BPM conditions paired with 85 BPM is 0.000***, with 160 BPM is 0.002***, and without music is 0.000*** where *** = significant with alpha 1%.

5.7 Analysis of Experiment

The experiment is conducted according to procedure form Table 3.1. The experiment is conducted at 09.00 AM to 11.30 AM, based on the research by Rana, Rishi, & Sinha (1996). They concluded that the decline in performance is greatest in the afternoon, followed by the evening. The participants come to Lab MM and seated in each computer. The researcher then give brief explanation about the experiment. First, participants do the token search, paired associates, spatial span, monkey ladder with without music condition. Every task finished, there is one minute interval for researcher to write the score on the score sheet made by researcher. After every condition is finished, there are five minutes interval to condition participants for the next experiment condition. This to ensure the participants are in the same state when doing the task, but the music when changing to other condition is still playing in this five minutes interval and switched when doing the next task for other condition.

According to Broadbent (1954), continuous noise exposure longer than 15 minutes attenuates performance, music can be determine as noise. In contrary to Broadbent, from the Figure 5.5 can be seen that the result of 120 BPM condition have the highest result, eventhough 120 BPM condition is tested almost after 20 minutes of music exposure from 85 BPM condition. This result can be seen as confirmatory to research by Kellaris & Kent (1993), Webster & Weir (2005), and Chie & Karthigeyan (2009).

Most suitable music falls in the range of 60 and 120 bpm, as seen in the study of Kellaris & Kent (1993). From Figure 5.5, the result of music with 85 and 120 bpm have highest result compared to music with 160 bpm. According to Webster & Weir (2005), Music faster than 144 bpm begins to lose effectiveness in accordance to the Yerkes-Dodson law of arousal and performance. From figure 5.5, the result of music with 160 bpm have the lowest result compared to music with 85 and 120 bpm that is under 144 bpm. Chie & Karthigeyan (2009) also states that music with 120 bpm will increase performance as proposed by the Yerkes-Dodson Law. The result of music with 120 bpm have the highest result compared to the other.

This experiment successfully show effect of jazz music without lyric with certain tempo in bpm on cognitive task. As such, results successfully provide support for the hypotheses that short-term memory, would be affected by manipulating variables of music (i.e. presence of lyrics). This suggests that the absence of lyrics in music does affect an individual's performance when completing CBS tests in short-term memory domain, in contrary to previous research by Garrett Myles (2017).

Results from previous literature have ranged in conclusions about music, stating both beneficial and adverse effects in different testing situations. For example, Cockerton and colleagues (1997) found beneficial effects of music on undefined cognitive tests (i.e. they did not specify the type of tests used), while Salamé and Baddeley (1988) found that vocal music caused significantly more disruption than instrumental music when individuals completed a verbal memory task. With the goal of the presented study to test the effects of music in a more consistent and controlled manner, it is possible to conclude the results of this research did just that. Controlling for both unidentified music soundtracks and cognitive tasks referenced in past literature, there was no directional effect of music (either beneficial or adverse) on performance as seen in previous studies. Instead, a more neutral result (no effect) was found. Therefore, this study can act as a reference point where researchers can continue to maintain a high level of control, while manipulating variables outside the presence of lyrics and tempo of music.

Reflecting on the design of the study of research by Garrett Myles (2017), there are potential limitations that may be responsible for why effects of music were not seen. Participants were instructed to set the volume of the speakers to a level they considered background noise. This would have resulted in volume differences across participants. Correspondingly, some participants may have set the volume to such a low level that a threshold of noise was not met to cause an effect of music on cognitive performance. This research design to set the volume of speakers to all same across participants, to ensure that a threshold of noise is met to cause an effect of music on cognitive performance. In Garrett Myles (2017) study, it is possible that the unfamiliar music was more easily ignored than if the music used in the study was familiar. If participants were familiar with the song played in each condition, they may have been more inclined to follow the music and sing along for example. This would have caused the music to be more distracting and might have caused a significant, negative effect on cognitive performance. This research is using music created by the researcher that participants are unfamiliar with the song to ensure positive effect on cognitive performance.

For further experiment, the participants can be categorized by its musical background. Past literature by Patston & Tippet (2011) has shown that differences in cognitive performance, with the presence of music, can vary depending on participants musical backgrounds (i.e. musician vs non-musician). Further improvements for the experiment is including the potential use of headphones. As most individuals use headphones when listening to music. Different cognitive tasks, ones more extreme in their difficulty, should also be used. This is because the difficulty of tests in the current experiment may not have been appropriate in testing participants. For future research the jazz music can be compare with other genre of music to see the difference in effect on cognitive task (i.e. pop music, classic music).

Results from this experiment can assist in planning both future research endeavors, as well as implement further exploration into the current study. Overall, the current investigation was able to replicate any previous findings where music produced an effect on cognitive performance. Result from this experiment can assist in creating jazz music for improving cognitive performance while doing cognitive task in short-term memory domain. Examples of short-term memory in action are the holding on to a piece of information temporarily in order to complete a task (i.e. "carrying over" a number in a subtraction sum, or remembering a persuasive argument until another person finishes talking), and simultaneous translation (where the interpreter must store information in one language while orally translating it into another). Use of jazz song while doing cognitive task in short-term memory domain can be implemented in psychologist therapy session. Psychologist need to remember patient's argument while the therapy session is ongoing. Example of today music is But Beautiful by Ralph Moore. This song is instrumental without lyric and have 120 bpm.

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CHAPTER VI
CONCLUSION AND SUGGESTION

This chapter will elaborate conclusions of this research and suggestions to improve the next research.

6.1 Conclusion

This experiment of is to determine the effect of jazz music on cognitive task using Cambridge Brain Science (CBS) test on short-term memory domain and to determine the music tempo that have the greatest performance on cognitive task on short-term memory domain.

Conclusion of this research are as follow.

1. The effect of Jazz music is increasing performance on cognitive task in short-term memory domain.
2. Jazz music with 120 bpm increase performance in cognitive task in short-term memory domain. Compared to 85 bpm, 160 bpm, and without music.
3. The calculation result of the experiment in the token search task show that 120 bpm tempo have significant difference with all other condition.
4. The calculation result of the experiment in the paired associates task show that there are no significant difference, however 120 bpm have the biggest mean.
5. The calculation result of the experiment in the spatial span task show that 120 bpm tempo have significant difference with all other condition.
6. The calculation result of the experiment in the monkey ladder task show that 120 bpm tempo have significant difference with 160 bpm and without music condition.
7. The Mean Result of Token Search, Paired Associates, Spatial Span, and Monkey Ladder show that without music have lower result than jazz music with 85, 120, and 160 bpm.

8. The Mean Result of Token Search, Paired Associates, Spatial Span, and Monkey Ladder show that 120 bpm tempo have significant difference with all other condition.
9. Most suitable music falls in the range of 60 and 120 bpm, as seen in the study of Kellaris & Kent (1993). Music with 120 bpm will increase performance as proposed by the Yerkes-Dodson Law (Chie & Karthigeyan, 2009). Music faster than 144 bpm begins to lose effectiveness in accordance to the Yerkes-Dodson law of arousal and performance (Webster & Weir, 2005). This experiment result show that music with 120 bpm have the highest performance in cognitive task on short-term memory domain. This can be seen in the mean result of all four task in CBS test on short-term memory domain, 120 bpm have the highest mean result, while 160 bpm have the lowest mean result compare to 85 bpm and 120 bpm.

6.2 Suggestion

Suggestion for this research are as follow.

1. Music maker should consider using 120 bpm for their song to increase performance on cognitive task on short-term memory domain.
2. For future research can be considered using Learning Curve Analysis for each respondent and task by modifying the method of experiment, enabling better forecasting.
3. For future research the jazz music can be compare with other genre of music to see the difference in effect on cognitive task (i.e. pop music, classic music).

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