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The Effect of Music Intervention on Intellectual Ability and Cognitive Function Among Medical Students -Randomized Controlled Trial

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Abstract

Human brain had shift to a mode for appreciation of sound and music art proven by using brain imaging which shown that the non-dominant hemisphere is more likely to be activated when exposed to music in terms of imagining and emotion. The memory mechanisms of the brain have been proved being improved by listening to music mainly when an event in your past engages with music and now it replays where you tend to recollect every detail of the event. Hence, the objectives of this study is to evaluate the effect of different types of music on visual, number and verbal memory, concentration and reaction time. A randomized controlled trial was conducted in Melaka Manipal Medical College from October-November 2019. A total of 58 students were randomly assigned to either the music group (classical and heavy metal) or control group (did not listen to any music at all). All participants were asked to gather at the computer lab and asked to perform the specific cognitive tests (visual memory, verbal memory, number memory, continuous concentration and reaction time.). Music was played for group A and B before they performed the online test while listening with headphones while for Control group, tests were done without any music intervention. From this study, we found that there is no significant difference (P value >0.05) between the classical, heavy metal and no music group in the verbal memory, visual number memory, concentration and reaction time. Even though not significantly different (P value=0.550), heavy metal group had higher mean score of verbal memory (mean 55.5) than no music group (mean 50.6) and classical (mean 44.5). In this study, classical music does influence visual memory whereas heavy metal music influence verbal and number memory. Besides that, heavy metal music was revealed to have a positive impact on reaction time by having more rapid response.

Keywords

Randomized Controlled Trial, Music, Intellectual Ability, Cognitive Function, Medical Student

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1. Introduction

Music can be defined as art concerned with combining vocal or instrumental sounds for emotional expression, usually according to cultural standards of different races that influences the harmony relationship between melody and rhythm [1]. There are different types of music, this include heavy metal, classical, rock and roll, jazz, country, instrumental and many other more [2].

Human brain has developed and evolved differ from the great

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apes as there are several areas in the brain that have been expanded such as primary and association auditory cortices and their connections, associated with the increased size of the cerebellum and areas of prefrontal and premotor cortex linked through basal ganglia structures [3]. All these structures in the human brain had shift to a mode for appreciation of sound and music art also the ability to adjust and create external rhythmic inputs. Studied using brain imaging have shown that the non-dominant hemisphere is more likely to be activated when exposed to music in terms of imagining and emotional experience [4].

The primary functions of the temporal lobe are to process sensory information and derive it into meaningful memories, language, emotions and responsible primarily for declarative memory, that can be said out loud, and also subdivided into episodic (life events) and semantic (fact-like) memory. Located within the middle temporal lobe are the hippocampus manages the formation of new memories and the conversion of short-term memories into long-term ones and the amygdala which is responsible for the processing of emotions. The temporal lobe also has involvement in processing sounds The primary auditory cortex can process input from the ears into meaningful units like words and sentences [5]. The sounds we hear first enter the brain in an area within the superior temporal gyrus traveling from the cochlea [6].

The memory mechanisms of the brain has been proved being improved by listening to music and it stores and recollect our past memories mainly when an event in your past engages with music and when the music replays now in future you tend to recollect every detail of the event. Even it has been proven that health issues such as dementia and Alzheimer's disease shows varies improvement in the patients after continuous exposure toward music [7]. By exposing patients toward music it has been easier to treat them and the progression of the disease has been better. Patients who have been suffering from mental health issues was able to overcome it by either singing, playing instruments mainly in those people who have the experience of learning music in childhood tends to overcome mental health issues faster and easier [8].

On the other hand, concentration is defined as having exclusive attention to an object. A study had stated that listening to music in the classroom shows impact on both sides of the brain, thus facilitating learning among students. It points out that electroencephalogram tests show that music alters brain waves which makes the brain more receptive to learning [9]. This shows that music in the classroom reduces stress, increases productivity, regulates energy, and creates a relaxed, supportive learning environment which aids students in concentrating on work. If music alters brain waves to prepare the brain for learning, the application of music could be useful in a variety of settings with learners of many ages [10].

The ability to give a quick motor response to a definitive stimulus and the time taken for a motor reaction for a sensory stimulus is called reaction time. This response time includes the time required for conduction of sensory impulse, processing of stimulus and to execute motor response [11]. Thus the measure of reaction time in-turn indicates the integrity of central nervous system. If the pathways of motor and sensory system are intact reaction time will depend on the ability of central processing of stimulus. Based on exposure towards a stimulus how fast a person could perform the action on physical skill, calculation has become a custom that has gained prominence in recent years. A study was done by the Institute of Medical Sciences and Research Centre, Davangere, India concludes that there is positive improvement of auditory and visual reaction time with instrumental background music as processing of stimuli in somatosensory cortex is facilitated by the music thus producing quick motor response [10, 12].

Besides the above mentioned, it has been shown that the structure of music has a constant dynamic influence on cardiovascular and respiratory responses when correlates with musical profiles. It was pointed out that the heart rate, blood pressure, respiratory rate fluctuations mirrored the musical profile, thus highlighting the therapeutic use of music. Certain musical phrases (mostly at a rhythm of 6 cycles/min in famous arias by Verdi) can synchronize inherent heart rhythms, thus regulating cardiovascular control. This occurred regardless of respiratory modulation, which suggests the possibility of direct entrainment of such rhythms and led to the speculation that some of the psychological and somatic effects of music could be mediated by modulation of these rhythms. Studies also showed that Vocal and orchestral crescendos produce significant correlations between cardiovascular or respiratory signals and musical profile, particularly skin vasoconstriction and blood pressures [13, 14].

Another area which music had facilitate in was the neurological science. Parkinson's disease is characterized by degeneration of dopaminergic neurons and reduced innervation of the Substantia Nigra along with basal ganglia, which are responsible for the gait and walking movement. Music is processed diffusely throughout the brain, where networks for the processing of music overlap with networks that govern other human functions [15, 16, 17]. For example, neural activity in rhythm perception is closely related to that of movement regulation when involving cortical and subcortical regions such as the premotor cortex, supplementary motor area, cerebellum, and the basal ganglia.

As many of these same areas are compromised in Parkinson's disease, the ability of music to activate key motor regions during rhythm perception can serve an important compensatory purpose. Music can increase regional cerebral blood flow and stimulate the release of dopamine, which also regulates motivation and goal-directed behaviors [18, 19, 20].

We conducted this randomized controlled trial to evaluate the effect of different types of music on visual, number and verbal memory, concentration and reaction time. From this study, we hypothesized that classical music and heavy metal music can enhance the reaction time, memory and concentration compared to without music among medical students.

2. Methodology

2.1. Study Design

A randomized controlled trial parallel study was conducted on the effect of music intervention on intellectual ability and cognitive function among undergraduate medical students of private medical college, Malaysia.

2.2. Study Setting, Study Population

Melaka Manipal Medical College (MMMC), Malaysia has 2 different campuses. One campus based at Muar, Johor and another campus based at Malacca The campus in Malacca offers Bachelor of Dental Surgery (BDS), Foundation in Science (FIS) and MBBS Semester 8, 9 & 10. On the other hand, Muar campus offers MBBS Semester 6 & 7. This study was carried out in the month of October 2019 to November 2019 in MMMC Muar campus which includes only students of semester 6 &7. The population of MMMC students in semester 6 were 156 and in semester 7 were 164 out of which only 5 participants from semester 6 were invited and 53 participants from semester 7 were invited.

2.3. Sample Size

Sample size was calculated using calculator-http://statulator.com/SampleSize/ss2M.html [21]. The following result was obtained by assuming a pooled standard deviation of 182.7 units, the study required a sample size of 26 for each group (i.e. a total sample size of 52, assuming equal group sizes), to achieve a power of 80% and a level of significance of 5% (two sided), for detecting a true difference in means between the test and the reference group of -142.69 (i.e. 755.23 - 897.93) units [10].

2.4. Sampling and Randomization

Sampling method chosen was non-probability sampling and a total of 60 volunteers were invited in this study. However, on the day of intervention, 58 participants agreed to participate. They were randomized by using block randomization method into 3 groups. There were 20 participants in one group and 19 participants in the 2 groups, one as the experimental Group A (listen to classical music while answering the question provided), one as the experimental Group B (listen to heavy metal music while answering the question) and one as a control Group (not listening to any music). The inclusion criteria in this study are medical students from semester 6 and 7 (between the ages of 18 to 30) in Melaka Manipal Medical College. The exclusion criteria included those who had systemic diseases, psychiatric problems, those who consume any caffeinated drink any alcohol or drug 24 hours before the test and those who were on any medication that interfered with mental functions (antidepressants, antihistamines, and benzodiazepines and other central nervous agents).

Group A, B and C represent, classical music group, heavy metal group and control group respectively. Method of randomization chosen was block randomization using randomizer.org to obtain 20 sets of 3 unit numbers per set with the range from 1 to 3. (Refer to Figure 1)

Since randomizer.org generated the results in numerical pattern, hence number 1 represents A (classical music), 2 represents B (heavy metal music), and 3 represents C (control group). Given a block size of 3, there are 6 possible ways to equally assign participants to a block. A list of volunteer's ID was made and they were assigned into different intervention groups using block randomization mentioned above. For example, the first three participant ID were assigned respectively to block 1, 3, 2 in set #1 and after every three ID, the upcoming new sets will be applied to the participants.

Table 1. Block size of 3 with 3 music interventions.

Block number	1	2	3	4	5	6
Intervention	A	A	B	B	C	C
	B	C	A	C	A	B
	C	B	C	A	B	A

1. Intervention A represents classical music
2. Intervention B represents heavy metal music
3. Intervention C is a control group (no music)

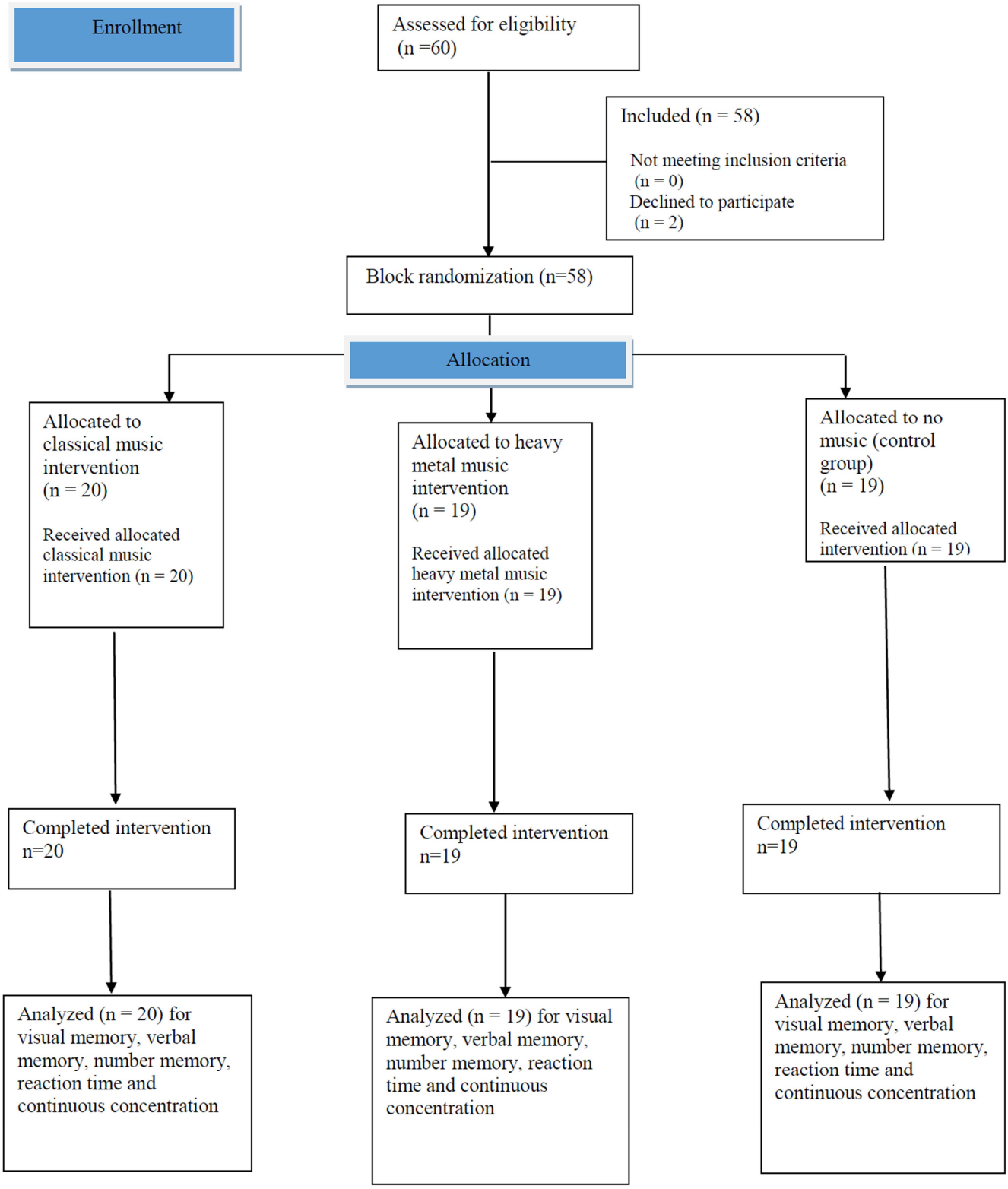

Figure 1. Consort diagram of participant evaluated and enrolled in the study.

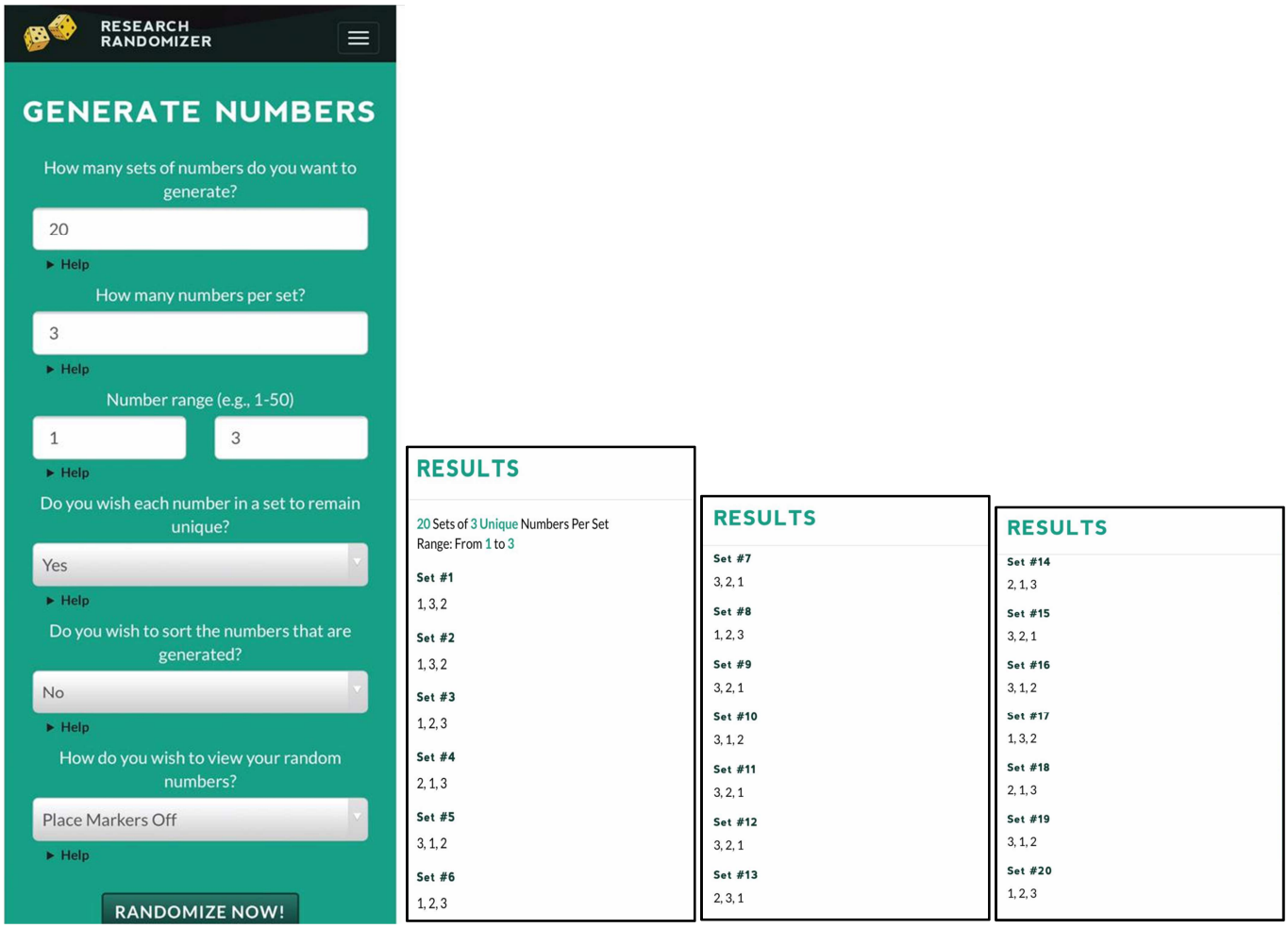

Figure 2. Block randomization using randomizer.org.

2.5. Intervention and Follow up

We had selected two types of music among different types of music genre-heavy metal and classical.

Heavy metal, is a genre of rock music that includes a group of related styles that are intense, and powerful lead by the aggressive sounds of the electric guitar and drum, which is most preferred by this generation. However, classical music is used to describe a musical style which is used by popular culture to distinguish this kind of music from jazz, rock, or other contemporary styles. The word "classical", however, actually is a period of time in Western Art Music that describes the music of Haydn, Mozart and early Beethoven, as well as other composers who lived at that time. The general time designations are Renaissance, Baroque, Classical, Romantic, and Modern [2].

Questionnaires that includes demographic data and inclusion and exclusion criteria were given to the participants prior to the intervention session. Prior intervention, computers were set with the same classical and heavy metal music with a constant volume of 60Hz. 58 participants were asked to gather at the computer lab, music was played for group A and B before they performed the online test at their best effort while listening with headphones. Meanwhile for Control group, tests were done without any music intervention. The online test for verbal, number, visual memory and reaction time were from "https://www.humanbenchmark.com"and continuous concentration test was from "https://www.testmybrain.org/" The online test lasted for 30 minutes and at the end of it, results were recorded and tabulated. Feedback forms were distributed and filled by all the participants before they were allowed to dismiss [23, 24].

"Testmybrain.org" is a test that provides a measuring tool to evaluate different section of human cognitive function such as cognitive speed, continuous concentration, test of multiple memory types and reading the minds in the eyes [24]. For humanbenchmark.com, this test includes several of assessment which consists of number memory, visual memory, verbal memory, reaction time, hearing and typing test.

Group A was designated for "Mozart and Beethoven" classical music from youtube.com with the link of: https://www.youtube.com/watch?v=jgpJVI3tDbY (classical)

while Group B was designated for "Heavy Metal Music Instrumental" from the link of: https://www.youtube.com/watch?v=Ui_pQIk01oE [25, 26].

2.6. Data Collection

After receiving the informed consent, the participants were assigned into 1 group of 20 students and 2 groups of 19 students each as a random basic. Two intervention groups, were asked to perform online test while listening to classical and another group listen to heavy metal music. Another group of participants known as the control group were not listening to music. Cognitive function tests that were assessed are memory, concentration and reaction time. Cognitive function test was conducted for all groups of participants. Under memory test, visual memory, verbal memory and number memory were included. Memory and reaction time were assessed using Human Benchmark online test. Concentration were assessed using Test My Brain online test. The scores of the intervention group and control group were compared.

2.6.1. Cognitive Test Procedures

Cognitive tests that were assessed are visual memory, verbal memory, number memory, concentration and reaction time. Below are the details of the procedure in each of the test.

2.6.2. Visual Memory

Visual memory was tested using https://www.humanbenchmark.com/ [23]. Participants were given instructions to observe cards that flipped for 2 seconds and remember. After it flipped back the participants had to enter the pattern of cards they remembered. When the level increases, the number of cards flipped will be more and the pattern of the cards will be more random. There was only 5 trial given for the participants. The highest level of participant able to progress with the level was recorded.

2.6.3. Verbal Memory

Verbal memory was tested using https://www.humanbenchmark.com/ [23]. Participants were given instructions on clicking 'seen' or 'new' button when a verbal appears. When the verbal appears for the first time participants should click new. When the same verbal reappears again participants should click seen. There was only 3 trial given to the participant. The highest level participant able to pass through was recorded at the end of the test.

2.6.4. Number Memory

Number memory was tested using https://www.humanbenchmark.com/ [23]. Participants were given instruction on memorizing the numbers based on the levels. If it is a level 1 only one number appears on the screen and participants should memorize it and type it back once the number disappears. It goes on till the participants missed any of the number they observed on the screen. The highest level the participant was able to go through was recorded.

2.6.5. Reaction Time

Reaction time was tested using https://www.humanbenchmark.com/ [23]. Participants were given instructions on clicking on the screen when it turns from red to green. Immediately after the screen change from red to green participants should click on the screen and the speed of the participants is calculated immediately. It has a chance of 5 times for the participants to try and the average value of the test is noted down.

2.6.6. Concentration Test

Concentration test was tested "https://www.testmybrain.org/" [24]. Participant were asked for consent and initial demographic such as age, gender and whether English was their native language prior to the test. Next is the serial addition task. One random number will appear on the screen each time. Then participants need to add the number on the screen to the next number that will appear, and so on, as long as the numbers keep appearing. They had to indicate whether the summation of those numbers were more than 10 or less than 10. Participants were given thrice practice time before proceeding to the real task which took 3 minutes and at the end, the result shown will be categorized whether it is above average or below average out of every ten people who took this test.

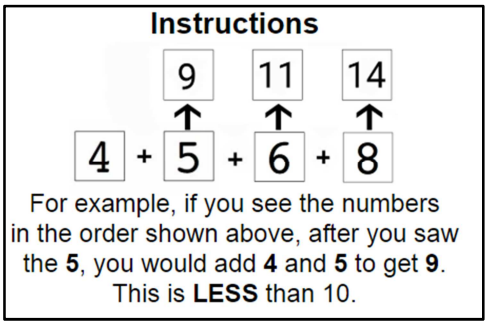

Figure 3. Example of the serial addition task for continuous concentration.

2.7. Data Processing and Analysis

We use Microsoft excel (2010) for data entry and Epi info© (version 7.2) for data analysis. For descriptive statistic mean and standard deviation was calculated for quantitative data. For categorical data, frequency and percentage were calculated. Level of significance is set at 0.05 (α). For paired comparison between two intervention groups (e.g. classical vs heavy metal), Bonferroni adjustment was made and P value less than 0.0167 was statistically significant.

Table 2. Statistical test used in the study.

Independent variable	Dependent variable	Statistical test
Type of music Classical music Heavy metal music No music	Intellectual ability and cognitive function: Visual memory Verbal memory Number memory Concentration Reaction time	ANOVA and Bonferrroni adjustment for paired comparison

2.8. Ethical Consideration

The participants were informed about the aim and procedures of this study. A written consent form long with basic profile form was distributed to all the participants who volunteered to join the research prior to the study. Participants were informed that they have the right to withdraw from the study at any stage if they wish to do so. The privacy of research participants and confidentiality of research data were ensured. Incentive was given to each participant at the end of the research. The study was approved by the Research Ethics Committee, Faculty of Medicine, Melaka-Manipal Medical College (MMMC), Malaysia.

3. Results

Table 3 shows baseline characteristics of the participants. Mean age among participants in classical group and heavy metal group was 22.6 years, in no music group was 22.7 years.

Table 3. Baseline characteristics of participants (n=58).

Variables	Classical (n=20) n (%)	Heavy metal (n=19) n (%)	No music (n=19) n (%)	Total n (%)
Age (years)				
Mean (SD)	22.6 (0.8)	22.6 (0.7)	22.7 (1.1)	22.6 (0.9)
Gender				
Male	10 (50.0)	14 (73.7)	10 (52.6)	24 (41.4)
Female	10 (50.0)	5 (26.3)	9 (47.4)	34 (58.6)
Ethnicity				
Chinese	5 (25.0)	5 (26.3)	0	10 (17.2)
Indian	4 (20.0)	4 (21.1)	9 (47.4)	17 (29.3)
Malay	8 (40.0)	8 (42.1)	5 (26.3)	21 (36.2)
Others	3 (15.0)	2 (10.5)	5 (26.3)	10 (17.2)
Coffee consumption				
Yes	10 (50.0)	8 (42.1)	12 (63.2)	30 (51.7)
No	10 (50.0)	11 (57.90)	7 (36.8)	28 (48.3)
Alcohol consumption				
Yes	0	0	0	0
No	20 (100.0)	19 (100.0)	19 (100.0)	0
Daily exercises				
Yes	10 (50.0)	7 (36.8)	4 (21.1)	21 (36.2)
No	10 (50.0)	12 (63.2)	15 (79.0)	37 (63.8)
On medication				
Yes	1 (5.0)	1 (5.3)	1 (5.3)	3 (5.2)
No	19 (95.00)	18 (94.7)	18 (94.7)	55 (94.8)

As for the gender, in classical group there were 10 males and 10 females; in heavy metal group there were 14 males and 5 females; in no music group there were 10 males and 9 females, in total there were 24 males and 34 females.

Next is ethnicity, in total of 10 Chinese participants, out of 5 was in classical group, another 5 was in heavy metal group. As for Indian out of 17 persons, 4 was in classical group, 4 was in heavy metal group and 9 was in no music group. There were 21 participants of Malay ethnicity which has the highest proportions of the sample size where 8 was in classical group, 8 was in heavy metal group and 5 was in no music group. Lastly, there were 10 participants with other ethnicity where 3 participants were in classical group, 2 participants were in heavy metal and 5 participants was in no music group.

Besides that, among those who consumed coffee 10 was in classical, 8 was in heavy metal group and 12 was in no music group make up a total of 30 persons. Among the 28 persons who did not consume coffee, 10 was in classical group, 11 was in heavy metal group, and 7 was from no music group. There were no participants who consume alcohol in this study.

Participant who exercised daily make up a proportion of 21 participants where 10 was in classical group, 7 was in heavy metal and 4 was in no music group. As for those who did not exercised daily had a higher number of 38 persons, where 10 from classical, 12 from heavy metal and 15 form no music group.

Lastly, based on the medications there were only 3 participants who was on medications which are 1 participant in classical, 1 participant in heavy metal, 1 participant in no music.

Table 4. Memory, reaction time, continuous concentration between classical, heavy metal music and no music group.

Outcome	Mean(SD)			F(df1, df2)	P value
	Classical	Heavy metal	No music		
Verbal memory	44.5 (26.1)	55.5 (40.0)	50.6 (26.0)	0.6 (2, 55)	0.550
Visual memory	10.3 (1.8)	9.6 (1.8)	9.4 (1.9)	1.3 (2, 55)	0.283
Number memory	10.2 (2.6)	9.2 (2.3)	9.7 (1.8)	0.8 (2, 55)	0.433
Reaction time	324.4 (50.0)	322.9 (105.1)	325.1 (70.2)	0.004 (2, 55)	0.996
Continuous concentration	51.3 (6.5)	50.1 (10.4)	52.4 (8.7)	0.3 (2, 55)	0.715

(ANOVA test)

Table 4 shows the association between memory, reaction time, continuous concentration between classical, heavy metal music and no music group. Regarding verbal memory, heavy metal had the highest mean value compared to classical and no music group. Heavy metal group had a mean score of 55.5, no music group had a mean score of 50.6 and classical had a mean score of 44.5. However, the P value is 0.55 which was not significant.

Next, for visual memory, classical group had the highest mean value compared to heavy metal and no music group. Classical music had a mean score of 10.3, heavy metal group had a mean score of 9.6 and no music group had a mean score of 9.4. However, the P value is 0.283 which was not significant.

For number memory, classical group had the highest mean value compared to heavy metal and no music group. Classical music had a mean score of 10.2, no music group had a mean score of 9.7 and heavy metal group had a mean score of 9.2. However, the p value is 0.433 which was not significant.

For reaction time, heavy metal had the lowest mean value compared to classical music group and no music group (lowest score indicates better reaction time). Heavy metal music group had a mean score of 322.9, classical music group had a mean score 324.4 and no music had a mean score of 325.1. However, the P value is 0.996 which was not significant.

Next for continuous concentration, no music had the highest mean value compared to classical music group and heavy metal music group. No music had a mean score of 52.4, classical music group had a mean score of 51.3 and heavy metal music group had a mean score of 50.1. However, the P value 0.715 which was not significant.

In conclusion, based on the comparison between classical, heavy metal and no music, verbal memory has the highest mean score of 55.5 in heavy metal compared to classical music and no music.

Table 5. Memory, reaction time, continuous concentration between classical and heavy metal music.

Outcome	Mean (SD)		Mean difference (95% Confidence interval)	P value
	Classical	Heavy metal		
Verbal memory	44.5 (26.1)	55.5 (40.0)	-11.0 (-32.8, 10.8)	0.312
Visual memory	10.3 (1.8)	9.6 (1.8)	0.7 (-0.4, 1.9)	0.217
Number memory	10.2 (2.6)	9.2 (2.3)	1.0 (-0.6, 2.5)	0.237
Reaction time	324.4 (50.0)	322.9 (105.1)	1.5 (-51.5, 54.4)	0.956
Continuous concentration	51.3 (6.5)	50.1 (10.4)	1.2 (-4.4, 6.7)	0.683

(P value less than 0.0167 was statistically significant)

Table 5 shows the association between verbal memory, visual memory, number memory, reaction time and continuous concentration between classical and heavy metal music. Regarding verbal memory, heavy metal had a higher mean value than classical group. The heavy metal music had mean score of 55.5 while classical music group has 44.5 with mean difference of 11 (95% CI -32.8 to 10.8) which was not significant (P value=0.312).

As for visual memory, classical group had a higher mean value than heavy metal group. The classical music had mean score of 10.3 while heavy metal group has 9.6 with mean difference of 0.7 (95% CI -0.4, 1.9) which was not significant (P value=0.217).

Next, for number memory, classical group had a higher mean value than heavy metal group. The classical music had mean score of 10.2 while heavy metal group has 9.2 with mean difference of 1.0 (95% CI -0.6, 2.5) which was not significant (P value=0.237).

For reaction time, heavy metal group had a lower mean value than classical music (lower value indicate better reaction time). The classical music had mean score of 324.4 while heavy metal group has 322.9 with mean difference of 1.5 (95% CI -51.5, 54.4) which was not significant (P value=0.956).

Next, for continuous concentration, classical group had a

higher mean value than heavy metal group. The classical music had a mean score of 51.3 while heavy metal group had 50.1 with mean difference of 1.2 (95% CI -4.4, 6.7) which was not significant (P value=0.683).

In conclusion, based on the comparison between classical and heavy metal, verbal memory has the highest mean score of 55.5 in heavy metal compared to classical music.

Table 6. Memory, reaction time, continuous concentration between classical and no music.

Outcome	Mean (SD)		Mean difference (95% Confidence interval)	P value
	Classical	No music		
Verbal memory	44.5 (26.1)	50.6 (26.0)	-6.1 (-23.1, 10.8)	0.467
Visual memory	10.3 (1.8)	9.4 (1.9)	0.9 (-0.3, 2.1)	0.147
Number memory	10.2 (2.6)	9.7 (1.8)	0.5 (-1.0, 1.9)	0.569
Reaction time	324.4 (50.0)	325.1 (70.2)	-0.7 (-40.1, 38.7)	0.971
Continuous concentration	51.3 (6.5)	52.4 (8.7)	-1.1 (-6.1, 3.8)	0.636

(P value less than 0.0167 was statistically significant.)

Table 6 shows verbal memory, visual memory, number memory, reaction time and continuous concentration between classical and no music group. For verbal memory, no music group had a higher mean value than classical group. which is 44.5. The mean value for control group has 50.6 while classical music group has 44.5 with mean difference of difference -6.1 (95% CI -23.1, 10.8) which was not significant (P value=0.467).

As for visual memory, classical group had a higher mean value than no music. The classical music had mean score of 10.3 while no music group has 9.4 with mean difference of 0.9 (95% CI -0.3, 2.1) which was not significant (P value=0.147).

Next, for number memory, classical group had a higher mean value than no music group. The classical music had mean score of 10.2 while no music group has 9.7 with mean difference of 0.5 (95% CI -1.0, 1.9) which was not significant (P value=0.569).

For reaction time, classical group had a lower mean value than no music group (lowest value indicate better reaction time). The no music group has a mean value of 325.1 while classical music had mean of 324.4. As a result, the mean difference is -0.7 (95% CI -40.1, 38.7) which is not significant (P value=0.971).

In continuous concentration, the no music group had a higher mean value than classical group. The no music had mean score of 52.4 while classical group had 51.3 with mean difference of -11 (95% CI -6.1, 3.8) which was not significant (P value=0.636).

In conclusion, based on the comparison between classical, heavy metal and no music, verbal memory has the highest mean score of 55.5 in heavy metal compared to classical music and no music.

Table 7. Memory, reaction time, continuous concentration between heavy metal and no music.

Outcome	Mean (SD)		Mean difference (95% Confidence interval)	P value
	Heavy metal	No music		
Verbal memory	55.5 (40.0)	50.6 (26.0)	4.9 (-17.3, 27.0)	0.660
Visual memory	9.6 (1.8)	9.4 (1.9)	0.2 (-1.1, 1.4)	0.792
Number memory	9.2 (2.3)	9.7 (1.8)	-0.5 (-1.9, 0.9)	0.437
Reaction time	322.9 (105.1)	325.1 (70.2)	-2.2 (-48.0, 86.0)	0.568
Continuous concentration	50.1 (10.4)	52.4 (8.7)	-2.3 (-8.6, 4.0)	0.464

(P value less than 0.0167 was statistically significant)

Table 7 shows verbal memory, visual memory, number memory, reaction time and continuous concentration between heavy metal and no music. Regarding verbal memory, heavy metal had a higher mean value than no music. The heavy metal music had mean score of 55.5 while no music group has 50.6 while with mean difference of 4.9 (95% CI -17.3, 27.0) which was not significant (P value=0.660).

As for visual memory, heavy metal music group had a higher mean value than no music group. The heavy metal music had mean score of 9.6 while no music group has 9.4 with mean difference of 0.2 (95% CI -1.1, 1.4) which was not significant (P value=0.792).

Next, for number memory, no music group had a higher mean value than heavy metal music group. The no music group had a mean score of 9.7 while heavy metal group has 9.2 with mean difference of -0.5 (95% CI -1.9, 0.9) which was not significant (P value=0.437).

For reaction time, heavy metal group had a lower mean value than no music group (lowest value indicate better reaction time). The no music had a mean score of 325.1 while heavy metal group had 322.9 with mean difference of -2.2 (95% CI -48.0, 86.0) which was not significant (P value=0.568).

Next, for continuous concentration, no music group had a higher mean value than heavy metal group. The no music had mean score of 52.4 while heavy metal group has 50.1 with mean difference of -2.3 (95% CI -8.6, 4.0) which was not significant (P value=0.464).

In conclusion, based on the comparison between heavy metal and no music, verbal memory has the highest mean score of 55.5 in heavy metal compared to no music.

4. Discussion

A randomized controlled trial parallel design was used to determine the effect of different types of music on visual, number and verbal memory, concentration and reaction time. We hypothesized that classical music and heavy metal music can enhance the reaction time, memory and concentration compared to without music among medical students.

Currently there were a number of studies that describe regarding the effect between different types of music toward cognitive function of brain like continuous concentration, memory and reaction time [4, 8-12]. In this study, we found that there was no significant difference of memory, reaction time and concentration between the intervention group (classical and heavy metal group) and control group (without music) though the heavy metal group had higher verbal memory, and reaction time.

This study showed that those who were in classical music group, had a better visual and number memory score compared to heavy metal music group and no music group. A study done by Trevecca Nazarene University on the effect of music genre on memory task the results supported our hypothesis, in which classical music group scoring the highest on the memory task with a significant score than the rap group [27]. Therefore this suggests that classical music may affect memory retention. However, it was not applied for verbal memory test and reaction time as heavy metal music was having the highest mean score for memory test and had the shorter reaction time when compared to other groups in our study. Heavy metal group obtained the highest score for verbal memory, though it was not significant, there is a big difference in mean score compared to other groups. As for, reaction time, a study done by the Institute of Medical Sciences and Research Centre, Davangere on their employees aged between 20-40 years, showed significant improvement in visual reaction time with music in the background either heavy metal or instrumental [10]. Though, it was mentioned that reaction time was improved in both background music, heavy metal does affecting visual reaction time which explains heavy metal group and classical group in this particular study has shorter reaction time compared to no music group. For continuous concentration test, the no music group score was better compared to classical group and heavy metal group. However, there was not much difference and it was not significant.

Similarly, upon comparing the effect of classical music and heavy metal music, we found that classical music group had a better outcome on memory retention than those who listened to heavy metal music. This was supported by a study done from Trevecca Nazarene University that prevailed classical group had a better performance of memory tasks by scoring significantly better compared to the rap group [27]. This finding was consistent with our result that revealed classical music group had a positive impact on visual memory and number memory. However, in this study, verbal memory was unexpectedly better with heavy metal music with mean score of 55.5 than classical music with mean score of 44.5. Other study from California State Project had also proved and revealed that the highest percentage of remembrance was seen in the metal group with 38% higher recognition compared to those in baroque soft music group. According to Gautam Tammewar's study, when people were exposed to heavy metal music, they tend to try harder to put an arrest to external distractions hence they were able to concentrate and memorize better [28].

Furthermore, heavy metal group uniquely had a shorter reaction time than classical group which was found out in our study. However, the differences were only by 1.5 milliseconds hence it was not significant to prove that it was better. This finding was consistent to a study from the University of Michigan, stating that the reaction time of classical music condition had no significant different from those of heavy metal [33]. Other than reaction time, classical music had improved concentration on the participants in this study. According to a study done by the University of London's Institute of Education, those primary children who were exposed to classical music had developed better level of concentration, discipline and social skills [22]. In conclusion, classical music gave a positive impact on visual memory, number memory and continuous concentration. In contrast to those in heavy metal group that resulted in a better verbal memory and had a slightly better reaction time compared to the classical group.

Next, this study also shows that there was a positive effect on visual memory, number memory and reaction time effect of classical music and no music group. Based on the previous study, the effects of background music on cognitive tasks are highly inconsistent, reporting either no effect, declines or improvements in performance mean score of verbal memory 17.3 with music and 45.3 without music [29]. This was similarly in our study as well where the verbal memory without music has high mean score of 50.6 and with classical music has mean score of 44.5. The difference between both

mean score is 6.1 with a large difference compared to the other components [30]. Based on the study on classical music effects on visual memory, stated that background classical music would have a positive effect on an individual's visual memory. It was found that there is significantly there was a difference between with and without classical music. The average time for completing the task with music (339.93) and without music (377.80) were significantly different where participants performed significantly faster while listening to music [34]. So, it can be concluded that classical music has a positive effect on visual memory. Contrary to our study, classical music group has the highest mean score of 10.3 and no music group has mean score of 9.4 the difference between the classical and no music mean score is 0.7

Based on the study of the effect of music genre on a number memory task by Darragh Bugter and randy carden from Trevecca Nazarene University, it was hypothesized that the classical music group would have the best performance on a number memory task where no music has mean score of 104.85 classical music mean score of 100.10 [28]. In our study which shows that classical music with a mean score of 10.3 has impact on number memory task compared to no music with a mean score of 9.4 with slight difference of mean score which is 0.5. Based on a study on the effects of music exposure in time reaction to multiple stimuli for correct reactions time the mean score for no music group is 475.28 while the mean score for classical music group is 249.23 [27]. In comparison with our study, the mean score for reaction time is highest in classical music 324.4 while in no music the mean score is 325.1 hence there was a significant difference between classical music and no music which is the mean score difference between both is -0.7. The reaction time mean score for classical music is 324.4 while no music mean score is 325.1.

The previous study of effects of popular and classical background music on math test scores of undergraduate students indicated there are no music listening style variables that have any statistically significant effect on the test score difference either the classical or the no background music listening condition. With no background music the math test taken, was a statistically significant predictor of math performance under both the classical and popular music listening conditions [36]. Classical music group is 11.85 and no music group has mean score of 12.02. Based on our study, continuous concentration for classical has mean score 51.3 while for no music has mean score of 52.4. The mean difference for both was -1.1.

We found that verbal memory with heavy metal music has higher mean score of 55.5 and without music has mean score of 50.6. The difference between both mean score is 4.9 with a large difference compared to the other components. This result was supported based on the study of the effects of auditory distraction on memory with verbal recall in student of Florida high school. The findings of studies on the effects of background music on verbal memory are highly inconsistent, reporting either no effect, or improvements in performance mean score of verbal memory 14.75 with music and 14.25 without music. Besides that, based on study of the impact of listening to music on cognitive performance, when performing cognitive test without any background music (Mean=12.94) compared to loud intensity music (Mean=11.99), without music group had shown a higher mean where is proven in our study- no music group had a higher mean value than heavy metal music group [32]. The no music group had a mean score of 9.7 while heavy metal group has 9.2 [31]. Based on study effect of music on visual and auditory reaction time: a comparative study. The finding was not significant when comparing reaction time between both heavy metal music and without music group statistically. For the mentioned study above, the reaction time for without music group was lower than heavy metal music group giving a value of 1502.7 and 1445.61 which had shown in our study where heavy metal group (325.1) had a lower mean value than no music group (322.9) (lowest value indicate better reaction time) [12].

The strength of our study is that the objective measurement (verbal memory, number memory and visual memory, reaction time and continuous concentration) were able to be recorded completely. As for the test we had chosen, all of them were easy to comprehend and user-friendly. Moreover, participants were only required to be present once as there were no follow up done in this study. However, there were also few limitations found in this study. The amount of participants who volunteered were only 58 students which makes our sample size smaller and hence the result cannot be reflected to the whole population. To get more accurate and representative results, our sample size should be increased. Besides that, subjective measurement such as the feelings and the performance of participants were not assessed after the intervention and these unknown factors may as well give effects to our study results.

According to this research and previous studies that had been done, music plays an important role in cognitive function and intellectual abilities in different components such as short term memory, reaction time and concentration. Since this study was conducted with a limited time and small sample size, further studies are needed to investigate the effects of different types of music with prolonged exposure of music intervention. Other than that, the effects of music on auditory reaction time can also be assessed in the future in comparison to visual reaction time.

5. Conclusions

In conclusion, different types of music such as classical and heavy metal genre does affect cognitive functions of the brain such as visual, verbal and number memory. In this study, classical music does influence visual memory whereas heavy metal music influence verbal and number memory. Besides that, heavy metal music was revealed to have a positive impact on reaction time by having more rapid response. Last but not least, we found out that different types of music have no effect on continuous concentration as no music group had a better outcome than those who had music interventions.

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