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**BAHÇEŞEHİR UNIVERSITY**

# MUSICAL BACKGROUND EFFECT ON COGNITION: MOZART VS. SILENCE

**Master's Thesis**

**RAHEQ JAMAL ALGUNAID**

**ISTANBUL, 2021**

**THE REPUPLIC OF TURKEY**
**BAHCEŞEHİR UNIVERSITY**

**GRADUATE SCHOOL**
**NEUROSCIENCE MASTERS PROGRAM**

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**APPROVAL PAGE**

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**MASTER THESIS APPROVAL FORM**

| | |
|---|---|
| **Program Name:** | Neuroscience (eng, thesis) |
| **Student's Name and Surname:** | Raheq Jamal Abdulqader AlGunaid |
| **Name Of The Thesis:** | MUSICAL BACKGROUND EFFECT ON COGNITION: MOZART VS. SILENCE |
| **Thesis Defense Date:** | 23-june-2021 |

This thesis has been approved by the Graduate School which has fulfilled the necessary conditions as Master thesis **Assoc. Prof. Dr. Burak KÜNTAY**

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## ABSTRACT

MUSICAL BACKGROUND EFFECT ON COGNITION: MOZART VS. SILENCE

Rahek Jamal Algunaid

NEUROSCIENCE MASTER'S PROGRAM

Thesis Supervisor: ASSOC. PROF. DR. SELEN GUR OZMEN

June 2021, 45 Pages

**Purpose:** The study was done to compare and analyse the impact of background music "Mozart vs. Silence" on cognition. research over the years shows an intwined effect of background music over our cognitive abilities as the research is being conflicted with results both showing negative and positive effect. our study will focus on Mozart classical piece (Eine kleine Nachtmusik, k.25) vs silence, the main objective of this study is to show the cognitive effect of background listening to Mozart and silence and compare their effect.

**Methodology:** Since the purpose of this research is related to the analysis of the effects of Mozart vs. Silence on the cognitive function, this research has been conducted in two phases; during the first phase will have the participants toke a cognitive battery. (PsyTool) that includes task switching, Stroop, Wisconsin card sorting, Fitts law, and Corsi block while being in silence. One after a week the same test but this time Mozart in the background. twenty-two females, thirteen males were enrolled in the study. the data was analyzed using SPSS 25.

**Results:** The participants test results were compared between Silence and Mozart in the background, the difference of task switching incongruent (P=0.033), Stroop congruent (p=0.004), Stroop incongruent (p=0.008). between both conditions were statistically significant while Corsi block and Fitts law and Wisconsin's results were insignificant.

**Conclusion:** The mozart session showed little to no difference when compared to the silence session in Wisconsin card sorting, Fitts law, Corsi block and a better performance in stroop congruent and stroop incongruent, and task switching incongruent. Wisconsin is used to measure attention, cognitive flexibility, working memory, abstract thinking and set shifting while task switching is used for attention shifting, goal retrieval, task set reconfiguration processes, and inhibition of prior task set. It can be concluded that classical background music has certain cognitive advantage over silence conditions in executive functions but not in all the domains so in the end we can conclude that it depends on the settings of the background music and the cognitive domains its targeting.

**Keywords**: Music, Cognition, Mozart effect, Background Music, Neuropsychological Assessment.

# ÖZET

MUSICAL BACKGROUND EFFECT ON COGNITION: MOZART VS. SILENCE

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NEUROSCIENCE MASTER'S PROGRAM

Thesis Supervisor: ASSOC. PROF. DR. SELEN GUR OZMEN

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**Amaç**: Çalışma, "Mozart vs. Silence" fon müziğinin biliş üzerindeki etkisini karşılaştırmak ve analiz etmek amacıyla yapılmıştır. Yıllar boyunca yapılan araştırmalar, hem olumsuz hem de olumlu etki gösteren sonuçlarla çeliştiğinden, arka plan müziğinin bilişsel yeteneklerimiz üzerinde karmaşık bir etkisi olduğunu göstermektedir. Çalışmamız Mozart klasik eseri (Eine kleine Nachtmusik, k.25) ve sessizlik üzerine odaklanacaktır. Bu çalışmanın temel amacı Mozart'ı arka planda dinlemenin ve sessizliğin bilişsel etkisini göstermek ve etkilerini karşılaştırmaktır.

**Metodoloji**: Bu araştırmanın iki evrede gerçekleştirilmesi planlanmıştır. İlk aşamada katılımcının sessiz bir arka planda Görev Değiştirme, Stroop, Wisconsin kart sıralama, Fitts yasası ve Corsi blok testini içeren bir kognitif test bataryası ile test edilmesi planlandı. Bir hafta sonra aynı test bataryası bu sefer Mozart (Eine kleine Nachtmusik, k.25) arka plandayken tekrarlandı. Yirmi iki kadın, on üç erkek çalışmaya alındı. Veriler SPSS 25 kullanılarak analiz edildi.

**Sonuçlar**: Katılımcıların test sonuçları arka planda Silence ve Mozart arasında karşılaştırıldı, görev değiştirme farkı uyumsuz (P=0.033), Stroop uyumlu (p=0.004), Stroop uyumsuz (p=0.008). her iki koşul arasında istatistiksel olarak anlamlı bulunurken, Corsi blok ve Fitts yasası ile Wisconsin'in sonuçları önemsizdi.

**Tartışma**: Mozart oturumu, Wisconsin kart sıralama, Fitts yasası, Corsi bloğundaki sessizlik oturumu ve stroop uyumlu ve stroop uyumsuz ve görev değiştirme uyumsuz olarak daha iyi bir performansla karşılaştırıldığında çok az fark gösterdi veya hiç fark göstermedi.. Wisconsin, dikkat, bilişsel esneklik, çalışma belleği, soyut düşünme ve görev değiştirmeyi ölçmek için kullanılırken, görev değiştirme testi de; dikkat değiştirme, hedef alma, görev kümesi yeniden yapılandırma süreçleri ve önceki görev kümesinin engellenmesi için kullanılır. Sonuç olarak çalışmamızın sonuçlarında klasik fon müziğinin yürütücü işlevlerde sessizlik koşullarına göre belirli bilişsel avantajları olduğu, ancak bu avantajın tüm bilişsel alanlarda olmadığı sonucuna varılabilir.

**Anahtar Sözcükler:** Müzik, Biliş, Mozart Etkisi, Fon müziği, Nöropsikolojik Değerlendirme.

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## ABBREVIATIONS

| | | |
|---|---|---|
| AD | : | Alzheimer's Disease |
| ADHA | : | Attention deficit hyperactivity disorder |
| BAU | : | Bahcesehir University |
| fMRI | : | Functional Magnetic Resonance Imaging |
| GSC | : | Global Switch Cost |
| LSC | : | Local Switch Cost |
| MMSE | : | Mini-mental State Exam |
| MRI | : | Magnetic Resonance Imaging |
| PSQI | : | Pittsburgh Sleep Quality Index |
| WCST | : | Wisconsin Card Sorting Task |

# 1. INTRODUCTION

## 1.1 CONTEXUAL BACKGROUND

Music can generally be defined as a form of art and cultural activity, which is a mixture of rhythm, sonic characteristics, pitch, and texture. In general, music is everywhere, at any time and any place, since all the people in the world are somehow linked with music. Moreover, it can be stated that the presence of music has seen from the ancient period.(Shepherd 2020) highlighted that for more than 55,000 years, music has been played and enjoyed by the people across the globe; although, the very first music has been introduced in Africa and then advanced to become a major constituent of human life. Music is a choral or contributory sound that mixes and produces the expression of emotion, the beauty of form, harmony (Scrine 2021). Music can be happy, sad, sleepy, healing, spine-tingling, all kinds of things. The human ear interprets music as soft, high, low, short, rapid, and smooth.

The basic components of the music are melody, harmony, rhythm texture, and expression (dynamics, tempo, articulation). The rhythm is the element of the "time" in the music; in this component, the beat is kept in the following structural rhythmic pulse of the music. The essential aspects of the rhythms are the Duration, Tempo, and Meter. The second component is the dynamic. In this context, it has been identified that all part related to the relative loudness of the music under the Dynamic's basic elements. The third component is the Melody which is the Linear or the horizontal presentation of the pitch. The report of (Abutabenjeh and Jaradat 2018) has analysed that the most often famous musical computations have contained the unforgettable Melody. The next component is harmony, which is considered the virtualisation of the pitch. Often, harmony is assumed as the art of combining pitches into the chords. The respective cords are arranged into the pattern of sentence-like, are called the chord progressions. These components severely affect the brain of listeners. The brain is an organ of the nervous tissue that direct responses accordingly, sense, emotions, language, communication, thinking, and memory. Therefore, the music is

processed via several ways. In addition, there are the fou lobes of the brain the frontal, parietal, piratical and occipital lobes. In this context, it has been recognised that the electronic signals are taken into the brain through the nerve cells which are called the neurons by the cochlear nerve system. The signal travels along with the cochlear nerve system into the cerebral cortex. Besides, the other brain areas add the power to recognise the diverse elements of the music, when music reach to the memory part it shows the different response to the different people it varies.

According to (Scrine 2021) music therapy is one of the most common treatments for many people, who have the disease like Alzheimer. Music also plays a role in medications for people, as music reduce depression and stress, and provide comfort and happiness. In addition to this, music also helps decrease the level of stress hormone cortisol from the body. With the help of music, people relax their mind and make themselves feel better. In the context of IQ level, the study of (Giordano et al. 2020) elaborated that music sharpens a person's mind and boosts the level of IQ and improves verbal and visual skills. Background music helps in improving the cognition centres within the brand, while allowing the individual to experience a change in their memory attention, and the performance of cognitive tasks. Background music plays a chief role if a person is looking for boosting his or her mental performance. Motivation level also increases by background music, as a person enjoy music and work hard to get the result. Background music can also have a huge relaxing influence on body and mind both, particularly slow and classical music. Listening to different sort of song can have also change the mood and emotions, especially joyful music.

## 1.2 RESEARCH PROBLEM

In daily life, music is well-known as a human trait. In addition to this, from many types of research, it has been proved that music influences the process of cognition and emotions as well. The researcher must work hard to evaluate any difference in the impact of background music on the cognitive functions, as this type of study is being conducted for the first time in turkey. The focus of this study is specifically towards the determination of the impact of

music vs. silence on cognition. As different people have different perceptions about music and its effects, it is quite challenging to determine the effect of Mozart and Silence on the cognitive abilities of the individuals.

## 1.3 RESEARCH AIM AND OBJECTIVES

The research aims to evaluate and compare the effect of the Mozart vs. Silence on the cognition function.

a. To determine the significance of music and its effects on cognition.
b. To explore the effect of Mozart vs. Silence on different cognitive functions.
c. To identify the effect of Mozart and Silence on the performance and cognitive abilities.

## 1.4 RESEARCH QUESTIONS

Based on the aim and objectives, the questions of this research are as follows.
What is the influence of Mozart vs. silence on cognitive functions? .

## 1.5 RESEARCH SIGNIFICANCE

Music has played a great role in our daily lives in rhythms, various pitches, and musical notes. Nowadays, music has been become a part of our life and incorporated into all aspects of life, for example, student listens to music while studying, office workers listen to music during work, etc. Consequently, this study has significant value, as the main theme is to determine the outcome of music on cognition, mood, and productivity level. After reviewing the literature of many studies, it has been identified that it is important to examine the effect of Mozart and Silence on the performance and abilities of a person, which makes this research more valuable.

# 2. LITERATURE REVIEW

## 2.1 MUSIC AND ITS EFFECT

Music is an art by which a person can express himself with the help of sound, which is known as the main characters in music (Rogenmoser et al. 2018). The music consists of a special kind of art and words that can easily express feelings and moods. In general, music has no such meanings, it has different meanings and perspective for different people, like, music is unique in the life of each person. For a musician, music is the life they eat, live, and breathe as well; however, for a normal person music is just a hobby of time pass (Aguiar 2017). Music has been used and enjoyed for the past many years in almost all over the world; keep in consideration the main objective of this study, there is both positive and negative effect of music on human. According to many types of research, music has negatively affected the cognition process and memory; however, some researchers also concluded that memory is positively impacted by background music.

In this aspect, (Zhang et al. 2017) highlighted that music positively affects emotions and a detrimental impact on memory, particularly on cognitive performance. For the mental health condition, music has somehow considered a distractor, specifically in tasks that need to be done with full concentration and effort. On the contrary, (Shepherd 2020) argues that background music has positively affected a person's memory and enhances the level of recalling the memory. Music can be beneficial for improving the memory domain, whether it is short term memory or long term. However, (Koelsch et al. 2019) identified that music is valuable for immediate memory but it is not good for long-term memory recall. Furthermore, (Murata et al. 2017) concluded that music plays a great role in enhancing students' performance during lectures, mainly if music is of classical and baroque context. Background music creates a relaxing mood during the performance of cognitive tasks (Hegde 2017).
Listening power and mood swings also get resolved by background music. For most people, music is the best way to reduce loneliness and change sadness into happiness. According to

(Pisarczyk 2018) the overall effect of music is positive on pain management, as the stress of work, sensation, postoperative pain etc. can be easily reduced with the help of music. Music is now present everywhere, like in shopping malls, at home, in the office, in travelling, etc. Background music can have both positive and negative impact according to the circumstances. (Packyanathan et al. 2019) elaborated that music relates to the automotive nervous system such as the function of the brain, heartbeat, and blood pressure. Music is also connected with feelings and emotions, which are included in the limbic system. (Bedetti et al. 2019) stated that music is the key factor in the history of human and society that helps people relax their minds and communicate and express their feelings.

## 2.2 EFFECT OF CLASSICAL MUSIC ON MOOD AND PREFORMANCE

Deceptively, the fact cannot be denied that the music and mood cannot be separated. However, some music may not narrate the story, but all the music must express the emotions whether strongly or softly, a definite emotion or a mixture of emotions. Therefore, some sort of effective responses is often experienced by the music listeners. The main reason behind the people's engagement with the music is due to some sort of their emotional experience (Thompson et al. 2011). on the other hand, in recent years, music just attained obtaining huge attention within information science, when the music mood was regarded as one of the most significant factors in seeking music information and organisation. According to (Perham and Currie 2014) the mood is an enduring condition, which is originated from the word "mod." Moods play a significant role, working actively behind the scenes in our daily functions of lives.

According to a study by (nazari *et al.* 2012) it stated that music highly affects the emotions and moods states along with the performances of the individual. In the psychological perspective of music, the affective effects of music are referred to as both emotions and the mood, however, emotion seems to be more popular (Müllensiefen et al. 2014). Listening to different types of music leads an individual to reduce stress. (Bradt et al. 2013) illustrated that the individuals listening to depressing music subject determine to have more sorrow in

ambiguous faces and for clear faces, less cheerfulness was reported. It was reported by (Wristen 2013) that after listening to the depressing music, the perception of the individual is altered. However, the effect of the mood on the behaviour of the consumer was determined along with the effects on the responses of the consumer.

Moreover, (Hultén 2015) also determined that the shopping behaviour of the customers and their mood are highly impacted by the music. (Raglio 2015) identified that the moods of the patients were also altered, and the therapy of the music seemed to be successful for dealing with the pessimistic condition in the population of neurorehabilitation. The anxiety and depression were also reduced in the patient by music therapy. According to (Masataka and Perlovsky 2013), music plays a profound role in the cognitive functioning. The performance boosts along with that the reading and literacy skills are enhanced because of music. Moreover, music also affects reasoning ability, mathematical abilities, recalling abilities positively and it is also helpful for ADHD children for the movement disorder (Carrer 2015).

In the recent year it has been identified that in the present era that the use of classical music is continuously increasing in the human lives. It has been heard in the supermarket, in the car and most of the time in the home classical music has a great involvement. However, it negative effects on the brains has also been identified, like any another sound the music arrives in the ear of the sound waves (Boaz et al. 2018). The external ear collects the sound waves, and the ear of the canal funnels them to the eardrum. It has been determined from the physiology of a brain that as the waves strike the eardrum, they cause it to vibrate, the vibration is conveyed with the chain of the small bones in the middle ear until they reach to the third bone.

## 2.3 EFFECT OF BACKGRROUND MUSIC ON COGNITION

According to (Shih et al. 2012), many individuals listen to the music while performing any complex task such as preparing for the test, reading for a class, and completing homework assignment as well. Entering a school that has high academic cut-offs, studying in an

environment where the maximum performances can be obtained is extremely critical. looking at (Honing and Ploeger 2012) argued cognition as the mental process for obtaining knowledge and understanding thoughts, senses, and experiences. For instance, verbal memory, reasoning and short-term memory are included in the mental actions that are referred to by some of the cognitive processes (Schellenberg and Weiss 2013) . The previously mentioned sub-fields includes such things as the ability for storing the things for short term, memory for words and properties that are related to language, and the ability to think logically and sensibly regarding a topic. Therefore, (Guhn et al. 2019) argued that when the individual is involved in any academic activities that are stated previously, there might be many processes involved related to cognitive ability. In accordance with the extreme efforts required, the brain is required to filter out the irrelevant stimuli that are participating in achieving the task at hand.

After a study done by (Burunat et al. 2014) he determined that the core executive function which is typically known as working memory is the ability to hold process and manipulate the information within memory. It is also considered to be significant in both decision-making and reasoning. Moreover, to (Shih et al. 2012) investigated in his study that the students who perform any task in silence, or by listening to soft and calm music, tend to perform better as compared to the students who listen to the aggressive music while performing any task. Therefore, it is suggested that different background music will have a different impact on the individuals based on the choices of their type of music and along with the language of the music also have some profound effects (Rebuschat et al. 2012). Moreover, (Guhn et al. 2019) identified that the individuals who are more involved in listening to the music that uplifts were more involved in offering help as compared to the individuals who listens to the annoying music. It was also found that the brain and the performances of the individual are highly impacted by the music. Additionally, it also affects the perception and the quality of the work. Moreover, it was also found that the perception of the individuals regarding time is also affected by the music (Honing and Ploeger 2012).

## 2.4 MOZART VS. SILENCE

According to (Masataka and Perlovsky 2013), the Mozart effects is referred to the theory that the scores of one portion of the IQ test can be boosted temporarily by listening to the music composed by Mozart. However, on the other hand, (Kirste et al. 2015) argued that the two hours of silence daily can enable the generation of new cells in the hippocampus i.e. a key brain region that is linked with emotion, learning and memory as well. While (Trappe and Voit 2016) claimed that the media imagination, politician, and the general public is sparked by the enhancement in the non-musical domain that is led by the background music exposure. Even though, the exposure to the music was involved by both proposed effects. However, they both have a different application of cognition. (Zimmermann et al. 2019) found that listening to Mozart for 10 minutes has a direct but short-term effect on the spatial abilities. In one of the studies of (Pauwels and Mariani 2014) the undergraduates who listened to the music composed by Mozart performed better on the standardised test of spatial abilities that were conducted just afterwards as compared to the other colleagues, who listened to the instructions that were relaxing before the tests or those who were left in silence.

According to (Johnson et al. 2015) the interpretation of this data is quite problematic as when the exposure to the stimulus effects of succeeding processing of the similar stimulus (i.e. repetition priming) or connected stimuli (i.e. semantic or associative priming), the priming effects occurs. Particularly, the processing of the dissimilar stimuli is unaffected due to which the doubt has occurred regarding the likelihood that the revelation to the music spatial abilities is well-informed (Trappe and Voit 2016). Moreover, the priming effects might be observed within and across the modalities when the items of the study and tests are referred to the similar object or event. Particularly, the priming effects of the cross-modal are weaker as compared to within model affects (Zimmermann et al. 2019). According to the hypothesis of arousal-mood, arousal and mood are highly affected by listening to music, due to which the performance of the individual is also impacted on several cognitive skills. Furthermore, according to (Masataka and Perlovsky 2013) listening to sad music enables the reduction in the heart rate along with skin-conductance level and it also increases the blood pressure of

the individual. On the other hand, the pulse transmission time is increased and the amplitude of the pulse is reduced by listening to frightening music while listening to the happy sounding music enables the decrease in depth of the respiration (Costa-Giomi 2015).

# 3. RESEARCH METHODOLOGY

## 3.1 OVERVIEW OF THE CHAPTER

The chapter of research methodology offers the valued insights related to the strategies and choices being used in the research and the ways in which the research has established a methodological fit given the research purpose i.e., to explore the different background musical exposure vs. silence effect on the cognition. In this chapter, in-depth detail has been provided about the used software to analyse the information about the effect of the Mozart.

## 3.2 DESIGN

To explore and compare the effect of the Classical music on the cognitive function vs. silence mode. This research was designed to divide into 2 sections, over the length of the one week. In this context, the participants have listened to a classical musical piece by the Mozart to the test the background effect as it different, the piece of music was chosen the Mozart. The underlying reason to adopt the Mozart is that the a specially theory has been represented regarding the Mozart which indicate that in the silence and on the non-silence the performance of the individual got effected, it was tested on the participant By the use of the Mozart, and more specifically the mozart_eine_kleine_nachtmusik_k_525, it was chosen based on Fast tempo and major mode music tend to induce a positive/happy mood and higher arousal levels (Gabrielsson and Lindström 2010). as reported in the context of the Mozart effect, fast tempo and major mode music tend to induce a positive/happy mood and higher arousal levels, whereas slow tempo and minor mode music induce a more negative/sad mood and lower arousal levels.

the aim was to induce a positive emotion/mood and high arousal levels, based on its melody's pitches and the rhythms, at the time of the listening a set of a cognitive tests will be performed, in this context, the group was asked to re-join after 5-7 days and retake the test but in this time the test was taken in the silence. In the first enrolment the questionnaire forms

were filled by the participants, a constant from then at the first session and a tested set were performed, it took around 40-50 minutes.

### 3.3 DATA COLLECTION PROCESSES

The data collection process is the main aspect of the research to resolve the research issue, in this context the appropriate source is required to be chosen for achieving the research goal. Particularly, in this research to investigate the effects of Mozart and silence on the performance of the individual primary sources have been chosen. Primary data is referred to as the first-hand data which is gathered by the first-hand sources. The underlying reason for this adoption is that the primary sources have ensured to have the significant evidence to extract the meaning from the responses. Besides, the primary data has enabled to holistically recognise the effect of Mozart and silence on the individual's performances directly from the experiences of the participants.

With respect to data collection, the study was divided into 2 sections, and both sections were completed in one week. the first section was done on day 1 and the second section was done on the $5^{th}$ date of the same week. In the first section, the participants were required to listen to Mozart's classical piece while conducting cognitive tests, and the purpose of doing do was to understand and test the background effect, and this was conducted in reference to the fact that listening to classical music induces positive mood/emotion, as well as higher arousal levels. Upon the completion of this test, the group of participants will be requested to revisit and retake the test, but in silence. With respect to this trial, the participants have also requested to perform a series of cognitive tests, which would approximately take 40-50 minutes of their valuable time, and these tests would be conducted over a computer-based software to test their short-term memory, long term memory, divided attention and sustained attention, speed processing and planning abilities.

The study was conducted at Bahçeşehir University, Graduate School of Health Sciences Department of Neuroscience. It was approved by Bahçeşehir University Ethics Committee on 11.12.2019. Ethics Committee form is given in the appendix 1.

### 3.3.1 The Population of The Study

This research has been conducted in Istanbul in these surveys; adults of both genders in were allowed to be participants. The participants ages vary between 18 and 40 years have been enrolled. In particular, the estimated number of the targeted pollutions for this study was approximately 40. The sample size of this study was calculated through the OpenEpi software version 3.01. This software has been used in this research because this software is considered for calculating the sample size for unequalled cross-sectional and cohort studies, including clinical trials. In this context, this software has calculated the sample size for the cross-sectional studies with a 1:1 ratio for exposed. Per cent of exposed with the outcomes of 28, confidence interval of 95% and power of the 80% have been selected based on the previous data through formulating the appropriate formula, the minimum sample was the 82 with a ratio of 41:41. Our sample was under the estimated number due to the pandemic happening in the world the sample had to been reduced to 35 participants.

### 3.3.2 Inclusion Criteria

a. Becks Depression Inventory Score 1-16 with/without medication.
b. Becks Anxiety Inventory Score 0-25 with/without medication.
c. 18–40-year-old healthy individuals.
d. Mini Mental Status Score of 30.
e. Male and Female participants.

### 3.3.3 Exclusion Criteria

a. Becks Depression Inventory Score above 16 with/without medications.
b. Becks Anxiety Inventory Score above 25 with/without medications.
c. Visual problems e.g., Colour blindness.
d. Any physical disability.

e. Professional musicians.
f. Music students.
g. Hearing problems ‘hearing aids ‘.

## 3.4 NEUROPSYCHOLOGICAL TESTING

The length of study was one week. On Day 1 while listing to Mozart, the participants undertake a battery of cognitive tests that analyze their cognitive abilities such as motivation, attention, hand-eye coordination, short-term memory, visual-spatial perception, tracking ability, task switching, problem solving skills, inhibition, and response time. The tests that were preformed were FITT’s Law, CORSI Block test, Task Switching (cued), Wisconsin Card Sorting Task, Stroop Test. The testing was done using a laptop-based website Psytoolkit.org. the same testing was redone between the $5^{th}$ day and the $7^{th}$ day but in the silence mode.

### 3.4.1 PsyToolkit

a. Web based software.
b. PsyToolkit is a free-to-use toolkit for demonstrating, programming, and running cognitive-psychological experiments and surveys.
c. PsyToolkit is frequently used for academic studies, for student projects, and for teaching cognitive and personality psychology.

(Stoet 2017);(Windows and Macintosh 2010).

### 3.4.2 Beck’s Anxiety Scale

The BAI contains 21 questions, each answer being scored on a scale value of 0 (not at all) to 3 (severely). Higher total scores indicate more severe anxiety symptoms. The standardized cutoffs are:

a. 0–7: minimal anxiety.
b. 8-15: mild anxiety.

c. 16-25: moderate anxiety.
d. 26-63: severe anxiety.

(Fydrich et al. 1992).

### 3.4.3 Beck's Depression Scale

One of the most used screening tests it is designed to be used on the ages of 13 and above it is a multiple-choice self-reported inventory.

There are 21 expressions, and each statement contains 4 different sentences, it is numbered between 0 and 3. The Patients chooses the closest expression to them, considering their mental state in the last week.

The scoring is:

a. 0-9 minimal depression.
b. 10-16 mild depression.
c. 17-29 moderate depression.
d. 30-63 severe depression.

(Inventory 2015);(Abdel-Rahman et al. 2011).

### 3.4.4 Pittsburgh Sleep Quality Index

The test was done to measure the patterns and the quality of sleep during the last month Usually, 19 different items create 7 components consisting of: sleep latency, sleep duration, problems in sleep, use of medications, functional problems during the day, subjective sleep quality and efficiency of sleep which ultimately gives a single global score.(Smyth, 2000) .

As discussed by (Manzar et al. 2018) the Pittsburgh Sleep Quality Index can be identified as a self-reporting questionnaire that performs the assessment of the sleep quality of individuals over a time period of 1 month. The literature reveals the fact that the sleep quality scores in the Pittsburg sleep quality index range from 0 to 14 and a score of 5 or more indicates the poor sleep quality among individuals.

### 3.4.5 Mini-Mental State Exam

the Folstein Test is a 30-points questionnaire which is widely used to measure cognitive imparment. According to (Van Patten et al. 2019) the mini-mental state examination score can be identified as an important metrics for observing memory loss aspects among individuals. The scores usually range from 25 to 35 points. Scores that are above 24 out of 30 reflect a normal cognition among individuals. Contrary to this, the scores below that cognitive impairment are examined for their mental state.
It takes between 5 and 10 minutes, (*Mini-Mental State Examination (MMSE)* n.d.).

### 3.4.6 Fitts's law

Fitts's law states that the amount of time required for a person to move a courser (e.g., mouse cursor) from an area to another targeted area in our version is moving the curser from the small yellow rectangle to another red one that will appear on the screen the Fitts law states that the longer the distance and the smaller the target's size, the longer it takes.

It is used for eye-hand coordination and motor control, visual-spatial perception and tracking ability.(Fitts 1954).

### 3.4.7 Corsi Block Test

It is used to measure spatial working memory. It involves mimicking a computer as it taps a sequence of up to nine identical spatially separated blocks. The sequence starts out simple, usually using two blocks, but becomes more complex until the subject's performance suffers. This number is known as the Corsi Span, and average is about 5-6 for normal human subjects.

According to (Siddi et al. 2020), the Corsi block tapping test was developed in 1971 and it can be identified as an important metric for the measurement of spatial memory with minimal involvement of verbal mediation.

- used to asses Non-verbal - visuo-spatial short term working memory. (Millner 1970).

### 3.4.8 Task Switching Test

Task switching is used to assess the cognitive ability and the information process in the whole feedback lope. In this test, participants carried out two types of tasks one was referred to as color and the other was referred to as shape it had two trial each task and would alternate between tasks without giving away the sequence and the participant was required to press a certain keyboard key to answer to the task for example regarding the shape task letters b and n were used B referring to circle and n referring to rectangle . (Meiran 1996).

### 3.4.9 Wisconsin Card Sorting Test

Wisconsin card sorting test is used to measure higher-level cognitive processes as attention, working memory, abstract thinking and set shifting. Several different cards are presented to the participant the difference in the cards include 4 shapes with different numbering from 1-4 “stars, circle, plus sign, square”. The participant is told to match the cards, but not how to match, after every few rounds the rules of matching will change and so is the sequences of it. The participant is told whether a particular match is right or wrong. (Berg 1948).

### 3.4.10 Stroop Test

Is used for selective attention capacity and skills, as well as their processing speed ability, even more it used for response inhibition, information processing speed. the tests consist of words blue, green, red, and yellow are written but presented in different coloured ink then then the words state, the participant is asked to press the button of the colour of the ink they see not the word they read for example:

Blue: the participant is supposed to press the red not the blue.

Red: the participant here is supposed to press the blue not the red.

(Stroop 1992).

## 3.5 ETHICAL CONSIDERTION

Since to achieve the research goal, primary data needs to be collected, therefore, it was important to ensure the range of the ethical measures and the principle. In this context, no participant was forced to be a part of this survey, no one was forced to share their opinions regarding the musical effect. Besides, according to basic ethical manner the participants were already informed about the aims and objective of this research. In addition, all participants were allowed to stop this at any time.

## 3.6 STATISTICAL ANALYSIS

To analyse our data, we will be using Statistical Package for the Social Sciences (SPSS 17). SPSS is software for editing and analysing all sorts of data.

# 4. RESULTS

## 4.1 RESULT AND ANALYSIS

### 4.1.1 Demographics

#### 4.1.1.1 Gender

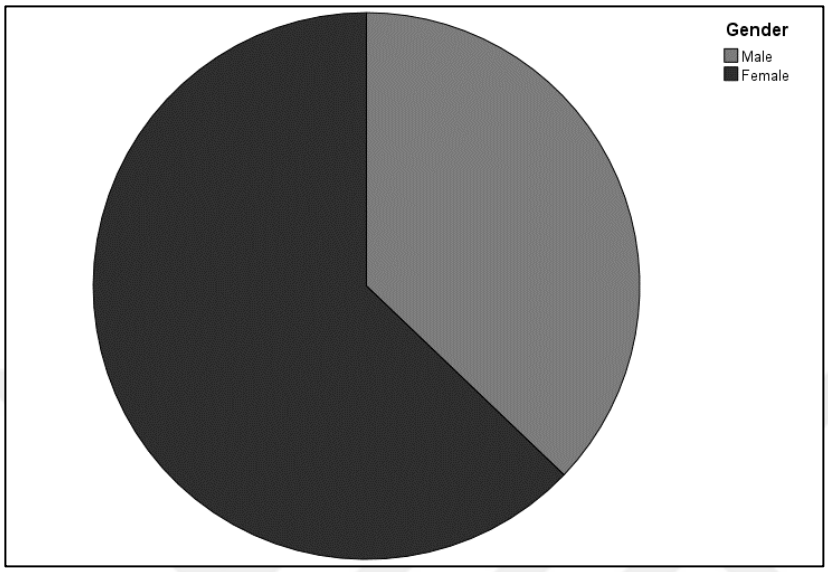
A total of 35 participants were recruited, and it is worth mentioning that 22 of them were females, and the remaining 13 were males. This has been sufficiently presented in the following tabular and graphical illustrations.

**Table 4.1:Frequency data for gender.**

| **Gender** | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | Male | 13 | 37.1 | 37.1 | 37.1 |
| | Female | 22 | 62.9 | 62.9 | 100.0 |
| | Total | 35 | 100.0 | 100.0 | |

Table 1 reflects the frequency numeric data for males and female genders while Figure 1 depicts the pie chart representation of the same data.

**Figure 4.1: Pie Chart for frequency of gender data**




### 4.1.1.2 Age

The age of the survey participants can be identified as the second important demographical variable considered in the research. The age of the participants varied from individual to individual, and it is worth mentioning that the youngest participant to complete the tests was 22 years and the oldest participant was 36 years of age, the mean and standered devations 26.49±2.79.

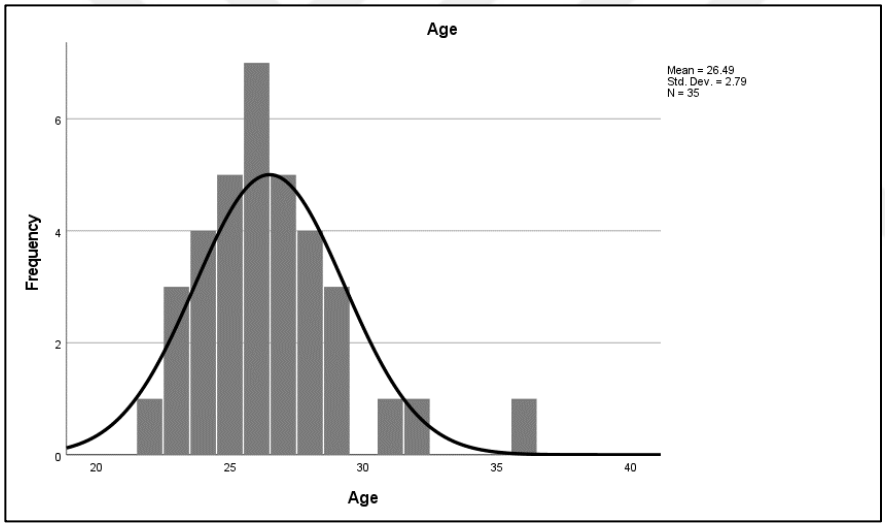
**Table 4.2: Frequency data for the age of participants**

| Age | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | 22 | 1 | 2.9 | 2.9 | 2.9 |
| | 23 | 3 | 8.6 | 8.6 | 11.4 |
| | 24 | 4 | 11.4 | 11.4 | 22.9 |
| | 25 | 5 | 14.3 | 14.3 | 37.1 |
| | 26 | 7 | 20.0 | 20.0 | 57.1 |
| | 27 | 5 | 14.3 | 14.3 | 71.4 |
| | 28 | 4 | 11.4 | 11.4 | 82.9 |
| | 29 | 3 | 8.6 | 8.6 | 91.4 |

| | | | | | |
|---|---|---|---|---|---|
| | 31 | 1 | 2.9 | 2.9 | 94.3 |
| | 32 | 1 | 2.9 | 2.9 | 97.1 |
| | 36 | 1 | 2.9 | 2.9 | 100.0 |
| | Total | 35 | 100.0 | 100.0 | |

Table 2 reflects the data collected for the age of the survey participants and corresponding data on per cent, valid per cent and cumulative per cent in tabular form. Likewise, Figure 2 demonstrates the bar chart for the frequency of the different age groups that participated in the survey.

**Figure 4.2: The bar chart of age data of survey participants**




### 4.2.1 Pittsburgh Sleep Quality Index

It can be observed from table 3 that the sleep quality scores significantly vary among different survey participants.

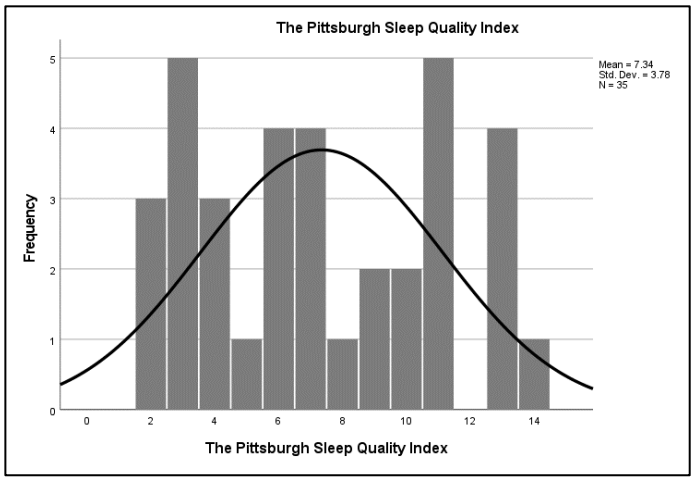
**Table 4.3: The Pittsburgh sleep quality index frequency analysis**

| The Pittsburgh Sleep Quality Index | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | 2 | 3 | 8.6 | 8.6 | 8.6 |
| | 3 | 5 | 14.3 | 14.3 | 22.9 |

| | | | | | |
|---|---|---|---|---|---|
| | 4 | 3 | 8.6 | 8.6 | 31.4 |
| | 5 | 1 | 2.9 | 2.9 | 34.3 |
| | 6 | 4 | 11.4 | 11.4 | 45.7 |
| | 7 | 4 | 11.4 | 11.4 | 57.1 |
| | 8 | 1 | 2.9 | 2.9 | 60.0 |
| | 9 | 2 | 5.7 | 5.7 | 65.7 |
| | 10 | 2 | 5.7 | 5.7 | 71.4 |
| | 11 | 5 | 14.3 | 14.3 | 85.7 |
| | 13 | 4 | 11.4 | 11.4 | 97.1 |
| | 14 | 1 | 2.9 | 2.9 | 100.0 |
| | Total | 35 | 100.0 | 100.0 | |

However, Figure 3 highlights the fact that the mean score for the Pittsburgh sleep quality index is 7.34 with a standard deviation of 3.78. it can be observed that the average score is not higher than a level that indicates severe sleep issues among individuals however the scores are sufficient for justification of the low quality of sleep among research participants.

**Figure 4.3: Bar chart for Pittsburgh sleep quality Index.**




### 4.2.3 Mini-Mental State Examination Score

In the context of current research as reflected in Table 4, the all the frequency of the mini-mental score remained 35 which indicates the participation of all the survey respondents in the mini-mental state examination.

The graphical illustration reflected in Figure 4 indicates that the average mini-mental score among surrey participants is 30 and with 0 standard deviations. It can be interpreted from these statistics that the scores are good and demonstrate normality of cognition among the survey participants.

### 4.2.4 Becks Depression Inventory

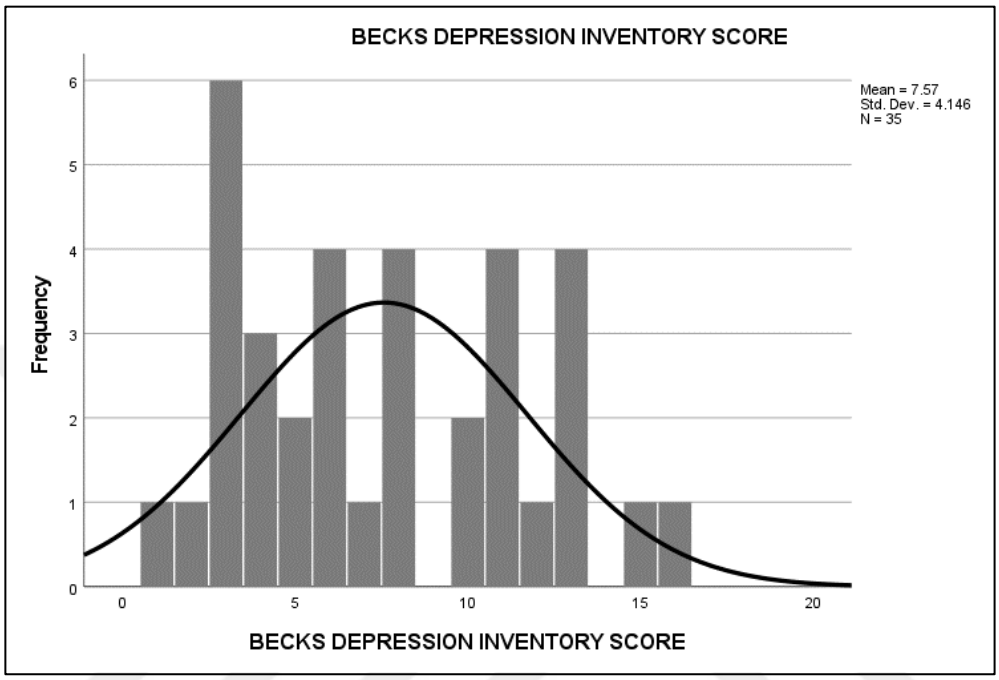
In the context of the current study that aims to observe the effect of different musical exposure versus silence on human cognition, Table 1 depicts the frequency of participants for different BDI scores as collected from different research participants.

**Table 4.4: Frequency data on the Becks depression inventory score.**

| BECKS DEPRESSION INVENTORY SCORE | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | 1 | 1 | 2.9 | 2.9 | 2.9 |
| | 2 | 1 | 2.9 | 2.9 | 5.7 |
| | 3 | 6 | 17.1 | 17.1 | 22.9 |
| | 4 | 3 | 8.6 | 8.6 | 31.4 |
| | 5 | 2 | 5.7 | 5.7 | 37.1 |
| | 6 | 4 | 11.4 | 11.4 | 48.6 |
| | 7 | 1 | 2.9 | 2.9 | 51.4 |
| | 8 | 4 | 11.4 | 11.4 | 62.9 |
| | 10 | 2 | 5.7 | 5.7 | 68.6 |
| | 11 | 4 | 11.4 | 11.4 | 80.0 |
| | 12 | 1 | 2.9 | 2.9 | 82.9 |
| | 13 | 4 | 11.4 | 11.4 | 94.3 |
| | 15 | 1 | 2.9 | 2.9 | 97.1 |
| | 16 | 1 | 2.9 | 2.9 | 100.0 |
| | Total | 35 | 100.0 | 100.0 | |

The histogram for frequency data as reflected in Figure 5 indicates that the means BDI score was 7.57 with a standard deviation of 4.14. It can be interpreted from these statistics that most of the survey participants have no or minimal depression since the average score lies between 0 and 9.

**Figure 4.4: Bar chart for frequencies of becks depression among participants.**




### 4.2.5 Becks Anxiety Inventory

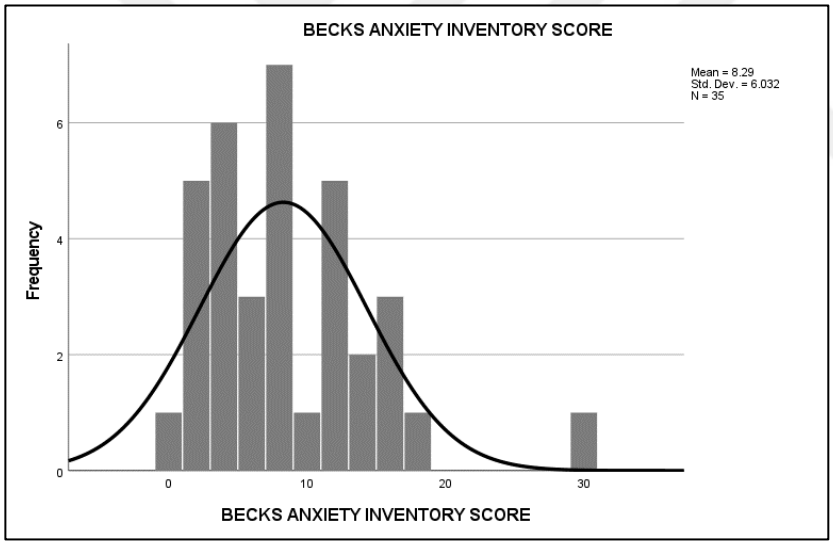
The results obtained in current research for different research participants and corresponding BAI scores have been reflected in Table 6. The table reflects the frequency of research participants for different BAI scores.

**Table 4.5: The frequency data on Beck's anxiety inventory score**

| BECKS ANXIETY INVENTORY SCORE | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | 0 | 1 | 2.9 | 2.9 | 2.9 |
| | 1 | 2 | 5.7 | 5.7 | 8.6 |
| | 2 | 3 | 8.6 | 8.6 | 17.1 |
| | 3 | 2 | 5.7 | 5.7 | 22.9 |
| | 4 | 4 | 11.4 | 11.4 | 34.3 |
| | 5 | 1 | 2.9 | 2.9 | 37.1 |
| | 6 | 2 | 5.7 | 5.7 | 42.9 |

| | | | | | |
|---|---|---|---|---|---|
| | 7 | 1 | 2.9 | 2.9 | 45.7 |
| | 8 | 6 | 17.1 | 17.1 | 62.9 |
| | 9 | 1 | 2.9 | 2.9 | 65.7 |
| | 11 | 1 | 2.9 | 2.9 | 68.6 |
| | 12 | 4 | 11.4 | 11.4 | 80.0 |
| | 13 | 1 | 2.9 | 2.9 | 82.9 |
| | 14 | 1 | 2.9 | 2.9 | 85.7 |
| | 15 | 2 | 5.7 | 5.7 | 91.4 |
| | 16 | 1 | 2.9 | 2.9 | 94.3 |
| | 18 | 1 | 2.9 | 2.9 | 97.1 |
| | 29 | 1 | 2.9 | 2.9 | 100.0 |
| | Total | 35 | 100.0 | 100.0 | |

**Figure 4.5: The graphical illustration of the frequency of becks anxiety scores.**




The frequency data in Table 6 can be better interpreted with the help of the graphical illustration depicted in Figure 6. It can be observed from the figure that the mean score for BAI was 8.29 with a standard deviation of 6.032 which reflects that most of the survey participants have mild levels of anxiety.

## 4.3 COGNITIVE TEST RESULTS

### 4.3.1 Corsi

The Corsi test data analysis shown in Table 6 reflects that the mean score of the 1st session at 4.97 with a standard deviation of 0.923.

for the 2nd session the mean is 5.34 with a standard deviation of 8.38.

**Table 4.6: paired sample statistics for silence vs Mozart music exposures.**

| Paired Samples Statistics | | | | | |
|---|---|---|---|---|---|
| | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | FIRST SESSION | 4.97 | 35 | .923 | .156 |
| | SECOND SESSION | 5.34 | 35 | .838 | .142 |

From table 7 we can see the correlation between the first and the second session is 0.127.

**Table 4.7: paired sample t-test correlations for corsi.**

| Paired Samples Correlations | | | | |
|---|---|---|---|---|
| | | N | Correlation | Sig. |
| Pair 1 | FIRST SESSION & SECOND SESSION | 35 | .127 | .467 |

From table 8 we can see a p value of 0.068 > 0.05 which is an indication that there is not significance difference between both sessions.

**Table 4.8: The paired sample t-test statistics for corsi.**

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | FIRST SESSION - SECOND SESSION | -.371 | 1.165 | .197 | -.772 | .029 | -1.886 | 34 | .068 |

### 4.3.2 Fitts law

Table 9 reflects that data on mean and standard deviation for different components of Fitts's law such as Fitts's mean response time, Fitts's median response time, Fitts's minimum response time and Fitts's error rate with reference to the silence and Mozart music and their effect on cognitive abilities of the research participants. For instance, in the case of Fitts's mean response time 1st session, it can be observed that the mean was 778.52 with a standard deviation of 184.04 while for the 2nd session, the mean was 740.53 with a standard deviation of 140.78.

**Table 4.9: The paired sample t-test statistics for fitts law.**

| Paired Samples Statistics | | | | | |
|---|---|---|---|---|---|
| | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | FIRST SESSION MEAN RESPONSE TIME | 778.5200 | 35 | 184.04216 | 31.10880 |
| | SECOND SESSION MEAN RESPONSE TIME | 740.5386 | 35 | 140.78978 | 23.79782 |
| Pair 2 | FIRST SESSION MEDIAN RESPONSE TIME | 730.697 | 33 | 180.1903 | 31.3671 |

| | | | | | |
|---|---|---|---|---|---|
| | SECOND SESSION MEDIAN RESPONSE TIME | 699.076 | 33 | 129.6796 | 22.5743 |
| Pair 3 | FIRST SESSION MIN RESPONSE TIME | 231.97 | 33 | 173.181 | 30.147 |
| | SECOND SESSION MIN RESPONSE TIME | 166.39 | 33 | 134.292 | 23.377 |
| Pair 4 | FIRST SESSION MAX RESPONSE TIME | 1571.21 | 33 | 384.831 | 66.990 |
| | SECOND SESSION MAX RESPONSE TIME | 1504.12 | 33 | 361.661 | 62.957 |
| Pair 5 | FIRST SESSION ERROR RATE | 3.29 | 35 | 6.295 | 1.064 |
| | SECOND SESSION ERROR RATE | 2.00 | 35 | 3.678 | .622 |

From table 10 we can see the correlations between the results of each session and pair taking for example the error rate, the correlations was 0.152 while for max response time was 0.192.

**Table 4.10: the paired sample t-test correlation for fitts law.**

| **Paired Samples Correlations** | | | | |
|---|---|---|---|---|
| | | N | Correlation | Sig. |
| Pair 1 | FIRST SESSION MEAN RESPONSE TIME & SECOND SESSION MEAN RESPONSE TIME | 35 | .089 | .613 |
| Pair 2 | FIRST SESSION MEDIAN RESPONSE TIME & SECOND SESSION MEDIAN RESPONSE TIME | 33 | .091 | .616 |
| Pair 3 | FIRST SESSION MIN RESPONSE TIME & SECOND SESSION MIN RESPONSE TIME | 33 | .229 | .199 |
| Pair 4 | FIRST SESSION MAX RESPONSE TIME & SECOND SESSION MAX RESPONSE TIME | 33 | .194 | .279 |
| Pair 5 | FIRST SESSION ERROR RATE & SECOND SESSION ERROR RATE | 35 | .152 | .382 |

The paired sample test reflected in Table 11 compares the means of different components of Fitt's law in from of Fitt's mean response time, Fitt's median response time, Fitt's minimum

response time and Fitt's error rate. The results of the paired sample test with respect to Fitts Law, indicate that there was no significant difference between silence and Mozart music with reference to their impact on the human motor system.

**Table 4.11: The paired sample t-test statistics for fitts law**.

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | FIRST SESSION MEAN RESPONSE TIME - SECOND SESSION MEAN RESPONSE TIME | 37.98143 | 221.60055 | 37.45733 | -38.14102 | 114.10388 | 1.014 | 34 | .318 |
| Pair 2 | FIRST SESSION MEDIAN RESPONSE TIME - SECOND SESSION MEDIAN RESPONSE TIME | 31.6212 | 212.2547 | 36.9488 | -43.6410 | 106.8834 | .856 | 32 | .398 |
| Pair 3 | FIRST SESSION MIN RESPONSE TIME -SECOND SESSION MIN RESPONSE TIME | 65.576 | 193.275 | 33.645 | -2.957 | 134.108 | 1.949 | 32 | .060 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pair 4 | FIRST SESSION MAX RESPONSE TIME - SECOND SESSION MAX RESPONSE TIME | 67.091 | 474.231 | 82.553 | -101.064 | 235.246 | .813 | 32 | .422 |
| Pair 5 | FIRST SESSION ERROR RATE - SECOND SESSION ERROR RATE | 1.286 | 6.789 | 1.148 | -1.046 | 3.618 | 1.120 | 34 | .270 |

### 4.3.3 Stroop

Table 12 reflects the mean and standard deviation for the overall Stroop effect with reference to the 1st session can be observed as 116.49, with a standard deviation of 120.64. However, in the case of 2nd session the mean was 106.69, and the standard deviation is 104.02.

**Table 4.12: The paired sample t-test statistics for stroop.**

| Paired Samples Statistics | | | | | |
|---|---|---|---|---|---|
| | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | FIRST SESSION CONGRUENT | 910.80 | 35 | 158.166 | 26.735 |
| | SECOND SESSION CONGRUENT | 801.00 | 35 | 128.946 | 21.796 |
| Pair 2 | FIRST SESSION INCONGRUENT | 1026.11 | 35 | 180.863 | 30.571 |
| | SECOND SESSION INCONGRUENT | 907.54 | 35 | 129.525 | 21.894 |
| Pair 3 | FIRST SESSION EFFECT | 116.49 | 35 | 120.640 | 20.392 |
| | SECOND SESSION EFFECT | 106.69 | 35 | 104.025 | 17.583 |

Regarding table 13 we can see the correlation between the overall effect of – 0.16.

**Table 4.13: The paired sample t-test correlations for stroop.**

| Paired Samples Correlations | | | | |
|---|---|---|---|---|
| | | N | Correlation | Sig. |
| Pair 1 | FIRST SESSION CONGRUENT & SECOND SESSION CONGRUENT | 35 | -.076 | .663 |
| Pair 2 | FIRST SESSION INCONGRUENT & SECOND SESSION INCONGRUENT | 35 | -.289 | .092 |
| Pair 3 | FIRST SESSION EFFECT & SECOND SESSION EFFECT | 35 | -.168 | .333 |

The paired sample test was also conducted for identification of the differences between the components of the Stroop effect while considering both silence and Mozart groups. The paired sample T-test results depicted in Table 14 reflect that Stroop congruent shows a significance of 0.004 which is less than 0.05. Similarly, the Stroop incongruent showed a significance of 0.008 which is again less than 0.05. Conclusively, it can be argued that with reference to the Stroop effect the mean score of congruent and incongruent are statistically significantly higher in the Mozart music compared to no music (p=0.004, p=0.008). While the mean length Stroop effect did not show any statistical difference in both the silence and Mozart group.

**Table 4.14: The paired sample t-test statistics for stroop.**

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | Df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | FIRST SESSION CONGRUENT - SECOND SESSION CONGRUENT | 109.800 | 211.552 | 35.759 | 37.129 | 182.471 | 3.071 | 34 | **.004** |
| Pair 2 | FIRST SESSION INCONGRUENT - SECOND SESSION INCONGRUENT | 118.571 | 251.039 | 42.433 | 32.337 | 204.806 | 2.794 | 34 | **.008** |
| Pair 3 | FIRST SESSION EFFECT - SECOND SESSION EFFECT | 9.800 | 172.056 | 29.083 | -49.303 | 68.903 | .337 | 34 | .738 |

### 4.3.4 Task Switching Cued

In the context of the current study Table 15 depicts the mean and standard deviation statistics for different components of task switching. such as task switching average rate correct, task switching response time repeat, task switching response time switching, task switching congruent, task switching incongruent, task switching cost and task switching interference, with reference to both silence and Mozart music groups. As an example, the mean and standard deviation values for task switching average rate correct for 1$^{st}$ session is 673.89 and the standard deviation is 183.47, while, in case of 2$^{nd}$ session the mean is 597.77 with a standard deviation of 113.19.

**Table 4.15: The paired sample t-test statistics for task switching cued.**

| Paired Samples Statistics | | | | | |
|---|---|---|---|---|---|
| | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | FIRST SESSION AVRT COORECT | 673.89 | 35 | 183.472 | 31.012 |
| | SECOND SESSION AVRRT CORRECT | 597.77 | 35 | 113.191 | 19.133 |
| Pair 2 | FIRST SESSION RT REPEAT | 637.34 | 35 | 165.361 | 27.951 |
| | SECOND SESSION RT REPEAT | 577.40 | 35 | 90.911 | 15.367 |
| Pair 3 | FIRST SESSION RT SWITCHING | 691.06 | 35 | 232.320 | 39.269 |
| | SECOND SESSION RT SWITCHING | 602.51 | 35 | 173.018 | 29.245 |
| Pair 4 | FIRST SESSION CONGRUENT | 669.20 | 35 | 189.660 | 32.058 |
| | SECOND SESSION CONGRUENT | 598.34 | 35 | 115.582 | 19.537 |
| Pair 5 | FIRST SESSION INCONGRUENT | 684.49 | 35 | 177.271 | 29.964 |
| | SECOND SESSION INCONGRUENT | 602.63 | 35 | 116.598 | 19.709 |
| Pair 6 | FIRST SESSION COST | 69.54 | 35 | 87.700 | 14.824 |
| | SECOND SESSION COST | 48.37 | 35 | 110.406 | 18.662 |
| Pair 7 | FIRST SESSION INTERFERENCE | 14.00 | 35 | 90.361 | 15.274 |
| | SECOND SESSION INTERFERENCE | 4.29 | 35 | 71.282 | 12.049 |

From table 16 we can see the correlation statistics between the results taking for example the interference we can see its -0.128.

**Table 4.16: The paired sample t-test correlations for task switching cued.**

| Paired Samples Correlations | | | | |
|---|---|---|---|---|
| | | N | Correlation | Sig. |
| Pair 1 | FIRST SESSION AVRT COORECT & SECOND SESSION AVRRT CORRECT | 35 | -.119 | .495 |
| Pair 2 | FIRST SESSION RT REPEAT & SECOND SESSION RT REPEAT | 35 | -.153 | .379 |
| Pair 3 | FIRST SESSION RT SWITCHING & SECOND SESSION RT SWITCHING | 35 | -.111 | .524 |
| Pair 4 | FIRST SESSION CONGRUENT & SECOND SESSION CONGRUENT | 35 | -.189 | .277 |
| Pair 5 | FIRST SESSION INCONGRUENT &SECOND SESSION INCONGRUENT | 35 | -.059 | .737 |
| Pair 6 | FIRST SESSION COST & SECOND SESSION COST | 35 | .425 | .011 |
| Pair 7 | FIRST SESSION INTERFERENCE &SECOND SESSION INTERFERENCE | 35 | -.128 | .463 |

The paired sample test was conducted for observing the differences between the means of different components of task switching such as task switching average rate correct, task switching response time repeat, task switching response time switching, task switching congruent, task switching incongruent, task switching cost and task switching interference as reflected in Table 17. The results of the paired sample tests indicated that there exists a significant effect of both silence and Mozart music with reference to the incongruent since the significant value for these variables is less than 0.05.

**Table 4.17: The paired sample t-test statistics for task switching cued.**

| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | FIRST SESSION AVRT COORECT - SECOND SESSION AVRRT CORRECT | 76.114 | 226.786 | 38.334 | -1.789 | 154.018 | 1.986 | 34 | .055 |
| Pair 2 | FIRST SESSION RT REPEAT – SECOND SESSION RT REPEAT | 59.943 | 200.543 | 33.898 | -8.946 | 128.832 | 1.768 | 34 | .086 |
| Pair 3 | FIRST SESSION RT SWITCHING -SECOND SESSION RT SWITCHING | 88.543 | 304.739 | 51.510 | -16.139 | 193.224 | 1.719 | 34 | .095 |
| Pair 4 | FIRST SESSION CONGRUENT - SECOND SESSION CONGRUENT | 70.857 | 240.032 | 40.573 | -11.597 | 153.311 | 1.746 | 34 | .090 |
| Pair 5 | FIRST SESSION INCONGRUENT - SECOND SESSION INCONGRUENT | 81.857 | 217.839 | 36.821 | 7.027 | 156.687 | 2.223 | 34 | **.033** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pair 6 | FIRST SESSION COST - SECOND SESSION COST | 21.171 | 107.972 | 18.251 | -15.918 | 58.261 | 1.160 | 34 | .254 |
| Pair 7 | FIRST SESSION INTERFERENCE - SECOND SESSION INTERFERENCE | 9.714 | 122.062 | 20.632 | -32.216 | 51.644 | .471 | 34 | .641 |

### 4.3.5 Wisconsin Card Sorting

Table 18 reflects the mean and standard deviation values for different components of Wisconsin's card scoring test such as Wisconsin's card sorting error number, Wisconsin's card sorting perseveration and Wisconsin's card sorting non- perseveration with reference to both silence and Mozart music background.

**Table 4.18: The paired sample t-test statistics for wisconsin card sorting.**

| Paired Samples Statistics | | | | | |
|---|---|---|---|---|---|
| | | Mean | N | Std. Deviation | Std. Error Mean |
| Pair 1 | FIRST SESSION ERROR NUMBER | 12.23 | 35 | 4.833 | .817 |
| | SECOND SESSION ERROR NUMBER | 12.23 | 35 | 5.391 | .911 |
| Pair 2 | FIRST SESSION PERSERVATION | 8.40 | 35 | 3.274 | .553 |
| | SECOND SESSION PRESERVATION | 8.17 | 35 | 3.510 | .593 |
| Pair 3 | FIRST SESSION NON PERSERVATION | 3.83 | 35 | 2.345 | .396 |
| | SECOND SESSION NON PERSERVATION | 4.23 | 35 | 2.579 | .436 |

**Table 4.19: The paired sample t-test correlations for wisconsin card sorting.**

| Paired Samples Correlations | | | | |
|---|---|---|---|---|
| | | N | Correlation | Sig. |
| Pair 1 | FIRST SESSION ERROR NUMBER & SECOND SESSION ERROR NUMBER | 35 | -.106 | .545 |
| Pair 2 | FIRST SESSION PRESERVATION & SECOND SESSION PRESERVATION | 35 | -.234 | .176 |
| Pair 3 | FIRST SESSION NON PRESERVATION & SECOND SESSION NON PRESERVATION | 35 | .075 | .670 |

The information depicted in Table 19 summarizes the findings of the research with the help of paired sample test. The result of the test indicates that the results are not significant with reference to results of Wisconsin's card sorting error rate, perseveration, and non-perseveration since all showed a P value of more than 0.05.

**Table 4.20: The paired sample t-test statistics for wisconsin card sorting**

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| Paired Samples Test | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference | | | | |
| | | | | | Lower | Upper | | | |
| Pair 1 | FIRST SESSION ERROR NUMBER - SECOND SESSION ERROR NUMBER | .000 | 7.612 | 1.287 | -2.615 | 2.615 | .000 | 34 | 1.000 |
| Pair 2 | FIRST SESSION PERSEVERATION - SECOND SESSION PERSEVERATION | .229 | 5.331 | .901 | -1.603 | 2.060 | .254 | 34 | .801 |
| Pair 3 | FIRST SESSION NON-PERSEVERATION -SECOND SESSION NON-PERSEVERATION | -.400 | 3.354 | .567 | -1.552 | .752 | -.706 | 34 | .485 |

# 5. DISCUSSION

In Our study that was done, this study was entirely based on the musical impacts on the cognitive, in particular, a questionnaire was presented to screen and select healthy adult participants based on the inclusion and exclusion criteria. The selected participant take a series of Neuropsychological Tests and was submitted to listening to Mozart while doing it and was asked to come back 5 days after to retake the tests but in silence conditions. The data was collected, and analysis was applied to the different parameters, the results were studied to see the differences between the two groups.

It's worth mentioning that the test retest reliability is considered in this research as a web-based software was used Psytool , in the software there is different type of sequences in each test that was applied and for each participant the sequence of the test was changed to remove the learning curve of the participant as each did a different form of the test when retaking it , according to (Chiu and Lee 2019) a clinical trial was done to check the reliability of test-rest in Wisconsin's card sorting and it showed that it had an acceptable test-retest reliability, with regards to Stroop, in a study that was done by (Franzen et al. 1987) to test the reliability the results showed an absences of significant effects indicating that the reliability of Stroop is rather stable throughout the period of one to two weeks. To support the use of alternate form of the test according to the meta-analysis (Calamia et al. 2013) using alternating form is linked with a reduced test-retest correlation.

Main purpose and the aim of this research was to compare and analyses the impact of the diverse type of background music vs silence in this case it was Mozart on cognitive function vs. silence mood. In this research it identified the significance of music and its effect on cognitive functions.

In this research to achieve the research goal, the positivism research philosophy was chosen with the support of the deductive research approach by this combination the primary quantitative data have been gathered via enrolment process and cognitive testing. In this

research, both kinds of impacts have been analysed both positive and negative. Music has diverse impacts on emotions, and it has a detrimental impact on memory, specifically on cognitive performance.

A Visual motor coordination speed analysis was done by using Fitts's law and it showed that participant who underwent the testing in both conditions showed a no difference in their results which suggest that it had no significance difference in reference to their impact on the human motor system.(Poletti et al. 2017) run a study about the differences in healthy individuals and cognitively impaired patients was done to examine the differences between the participants would have on the test and it was noticed that younger healthy adults did better than the patients .

In respect to the Stroop test that was done we can see a significance difference in the congruent which indicates to semantic facilitation, and incongruent which indicate for semantic interference meaning when the colour of the ink doesn't match the word , their mean results showed a higher speed, in regards to the incongruent result This can be explained to the Relative Speed of Processing Theory implying that there is a hold-up when the brain is recognizing the ink colour of the word when it comes to the brain, meanwhile the brain reads words much faster when compared to recognizing colours , suggesting background Mozart music facilities in decreasing the processing confusion between the word and the colour which implies to a higher ability of the decision-making stage, another theory is the selective attention theory, which states that colour recognitions require more attention in opposite to word recognition, this can be a result of two allocation of attention in relationship with the response or a high inhibition of distractors, in some theories that this inhibition that happens indicates the ability of the brain to regulate behaviour as the brain need to overcome the word response in relation to the conditioned colour. (Lamers et al. 2010)(Stirling 1979). However in respect to the overall stroop effect there was no difference which contradict the study of (Kumaradevan et al. 2021) which was done to test different background music (classical, metal and silence) it concluded that the rection time showed that it was significantly decreased with classical and heavy metal background music in

comparison with the silence condition, furthermore the positive effect that was noted in the congruent and incongruent speed with its underlying mechanism cannot be explained and not very well understood, on the other hand an experimental research results revealed that music like Mozart which have a dissonant intervals intensified the interference during Stroop compared to a consonant music, which supported our findings (Masataka and Perlovsky 2013).

In the end we can conclude that the sematic facilitation and sematic interference was better in the Mozart session implying that there is a positive effect in selective attention, speed processing, higher inhibition of distractors and higher ability in decision making.

In task switching test that was performed in regards to the Mozart session we can see that there is no significance results in terms of the speed of average rate in all correct, task repeat, task switch, congruent , task cost and interference, it's worth mentioning that the local switch cost (LSC) defined as the task cost can be measured as the difference between task repeat and task switch while global switch cost (GSC) demonstrated by the task interference is the difference between congruent and incongruent. To notice the cognitive differences between both sessions we look at the GSC and LSC as we can see there was no significance difference between both session which leads to believe that there was no background musical effect when it comes to cognitive functions such as attention shifting, goal retrieval, task set reconfiguration processes, and inhibition of prior task set. These results support the idea that background music disrupt attention and can take a sum of your memory capacity as the task cost and interference shows a lower mean in the silence session. Those findings also supports the theory which is called the "cognitive-capacity hypothesis" (Bruya and Tang 2018) postulating that there is a set of resources available at a given time in order to process any given cognitive task at any moment (Baddeley, 2003) ,which is why background music can interfere with cognitive abilities and even further disrupt it (Angel et al. 2010),further more when looking at the results of(Furnham and Strbac 2002); (Furnham and Bradley 1997) which stated that background music is dependent on task complexity: the more the task is complex the stronger the negative effect of music is.

According to (Schellenberg and Weiss 2013) that having a background music while doing a cognitively hard task that requires more executive functions which propose a limitation to the cognitive processing considering it a restricting factor.

In respect to the executive control which includes shifting, inhibition, working memory, planning/organization and problem solving, we can notice that the Mozart group results showed no significance in the overall data that was collected from applying Wisconsin's card sorting then that of the silence session. Which supports the results that was found by a trial that was conducted by (Feizpour et al. 2020) measure the cognitive differences between male and female cognition in different setting it was found that music decreases the number of correct trials in music condition in both sexes. Other reports have indicated that adverse effect cognitive tasks like immediate and delayed recall (Cassidy and Macdonald 2007) on reading (Furnham & Bradley 1997);(Furnham & Strbac 2002) and lastly on perception and spatial reasoning (Zhou et al. 2018). Contradicting to our finding we come to the study that was done by (Day et al. 2009) the results showed a high and improved accuracy in sustained attention response task while listening to a faster tempo music.

# 6. CONCLUSIONS AND LIMITIONS

## 6.1 CONCLUSIONS

In the end the cognitive differences between the background music and silence showed that the Mozart session had a superior advantage to the silent session in the terms of executive functions, decision making, selective attention …etc, considering the outcome of this research we can assume that background music has a positive effect on cognitive functions depending on the setting of the background music regarding the individuals and space. as some of the results showed fluctuations in the data.

## 6.2 LIMITIONS OF THE RESEARCH

Limitations have been identified in this research which have elaborated below:

a. In this research, the main limitation that in this research is the number of participant as it was conducted during the start of the pandemic of covid-19 and due to social distancing.
b. In this research, due to the quantitative research design, limited sources have been used to elaborate the musical effect on the cognition.
c. The timings between the first and the second session was only one week which was to ensure the continuation of participation in the study.

## 6.3 RECOMMENDATION FOR FUTURE RESEARCH

The key recommendations for the future researchers include:

a. Future researchers are recommended to use the mixed method to explore the musical effect of cognition, by which they can get both empirical and theoretical findings. Through the mixed methods the future researchers will be able to offer the incredible findings. By which they can add more value to the research.

b. Future researchers are recommended to consider the point of view of the musicians as well, to add more value for evaluating the musical effect on the performances and mood of the individuals. In addition, this can help to the researchers in offering the perspective of both that might help to understand the values of the Mozart, classical and Jazz.
c. Future researchers are recommended to use a qualitative research design in which through the critical analysis the impact of the musical effect on the cognition can be evaluated by the qualitative data.

## REFERENCES

### *Periodicals*


Abdel-Rahman, E.M., Balogun, S.A., Kepple, A., Ma, J.Z., Turgut, F., Kovesdy, C.P., Balogun, R.A., 2011. Beck Depression Inventory and survival in elderly hemodialysis patients. Nephrol. Dial. Transplant. 26, 2064–2065. https://doi.org/10.1093/ndt/gfr086

Abutabenjeh, S., Jaradat, R., 2018. Clarification of research design, research methods, and research methodology: A guide for public administration researchers and practitioners. Teach. Public Adm. 36, 237–258. https://doi.org/10.1177/0144739418775787

Aguiar, L., 2017. Let the music play? Free streaming and its effects on digital music consumption. Inf. Econ. Policy 41, 1–14. https://doi.org/10.1016/j.infoecopol.2017.06.002

ANGEL, L.A., POLZELLA, D.J., ELVERS, G.C., 2010. Background Music and Cognitive Performance 1,2 . Percept. Mot. Skills 110, 1059–1064. https://doi.org/10.2466/04.11.22.pms.110.c.1059-1064

Baddeley, A., 2003. Working memory: Looking back and looking forward. Nat. Rev. Neurosci. 4, 829–839. https://doi.org/10.1038/nrn1201

Bedetti, C., Principi, M., Di Renzo, A., Muti, M., Frondizi, D., Piccirilli, M., D'Alessandro, P., Marchiafava, M., Baglioni, A., Menna, M., Gubbiotti, M., Elisei, S., 2019. The Effect of Mozart's Music in Severe Epilepsy: Functional and Morphological Features. Psychiatr. Danub. 31, 467–474.

Berg, E.A., 1948. A simple objective technique for measuring flexibility in thinking. J. Gen. Psychol. 39, 15–22. https://doi.org/10.1080/00221309.1948.9918159

Boaz, A., Hanney, S., Borst, R., O'Shea, A., Kok, M., 2018. How to engage stakeholders in research: Design principles to support improvement. Heal. Res. Policy Syst. 16, 1–9. https://doi.org/10.1186/s12961-018-0337-6

Bradt, J., Dileo, C., Potvin, N., 2013. Music for stress and anxiety reduction in coronary heart disease patients. Cochrane database Syst. Rev. CD006577.

https://doi.org/10.1002/14651858.CD006577.pub3

Bruya, B., Tang, Y.Y., 2018. Is attention really effort? Revisiting Daniel Kahneman's influential 1973 book attention and effort. Front. Psychol. 9, 1–10. https://doi.org/10.3389/fpsyg.2018.01133

Burunat, I., Alluri, V., Toiviainen, P., Numminen, J., Brattico, E., 2014. Dynamics of brain activity underlying working memory for music in a naturalistic condition. Cortex. 57, 254–269. https://doi.org/10.1016/j.cortex.2014.04.012

Calamia, M., Markon, K., Tranel, D., 2013. The robust reliability of neuropsychological measures: Meta-analyses of test-retest correlations. Clin. Neuropsychol. 27, 1077–1105. https://doi.org/10.1080/13854046.2013.809795

Carrer, L.R.J., 2015. Music and sound in time processing of children with ADHD. Front. Psychiatry 6, 1–7. https://doi.org/10.3389/fpsyt.2015.00127

Chiu, E., Lee, S., 2019. Test – retest reliability of the Wisconsin Card Sorting Test in people with schizophrenia Test – retest reliability of the Wisconsin Card Sorting Test in people with schizophrenia. Disabil. Rehabil. 0, 1–5. https://doi.org/10.1080/09638288.2019.1647295

Costa-Giomi, E., 2015. The Long-Term Effects of Childhood Music Instruction on Intelligence and General Cognitive Abilities. Updat. Appl. Res. Music Educ. 33, 20–26. https://doi.org/10.1177/8755123314540661

Fitts, P.M., 1954. The information capacity of the human motor system in controlling the amplitude of movement. J. Exp. Psychol. 47, 381–391. https://doi.org/10.1037/h0055392

Franzen, M.D., Tishelman, A.C., Sharp, B.H., Friedman, A.G., 1987. An investigation of the test-retest reliability of the stroop colorword test across two intervals. Arch. Clin. Neuropsychol. 2, 265–272. https://doi.org/10.1016/0887-6177(87)90014-X

Furnham, A., Bradley, A., 1997. Music while You Work: The Differential Distraction of Background Music on the Cognitive Test Performance of Introverts and Extraverts. Appl. Cogn. Psychol. 11, 445–455. https://doi.org/10.1002/(sici)1099-0720(199710)11:5<445::aid-acp472>3.3.co;2-i

Furnham, A., Strbac, L., 2002. Music is as distracting as noise: The differential distraction

of background music and noise on the cognitive test performance of introverts and extraverts. Ergonomics 45, 203–217. https://doi.org/10.1080/00140130210121932

Fydrich, T., Dowdall, D., Chambless, D.L., 1992. Reliability and validity of the beck anxiety inventory. J. Anxiety Disord. 6, 55–61. https://doi.org/10.1016/0887-6185(92)90026-4

Giordano, F., Zanchi, B., De Leonardis, F., Rutigliano, C., Esposito, F., Brienza, N., Santoro, N., 2020. The influence of music therapy on preoperative anxiety in pediatric oncology patients undergoing invasive procedures. Arts Psychother. 68, 101649. https://doi.org/10.1016/j.aip.2020.101649

Guhn, M., Emerson, S.D., Gouzouasis, P., 2019. A Population-Level Analysis of Associations Between School Music Participation and Academic Achievement. J. Educ. Psychol. 112, 308–328. https://doi.org/10.1037/edu0000376

Hegde, S., 2017. Music therapy for mental disorder and mental health: the untapped potential of Indian classical music. BJPsych. Int. 14, 31–33. https://doi.org/10.1192/s2056474000001732

Honing, H., Ploeger, A., 2012. Cognition and the Evolution of Music: Pitfalls and Prospects. Top. Cogn. Sci. 4, 513–524. https://doi.org/10.1111/j.1756-8765.2012.01210.x

Hultén, B.M.L., 2015. The impact of sound experiences on the shopping behaviour of children and their parents. Mark. Intell. Plan. 33, 192–215. https://doi.org/10.1108/MIP-03-2014-0060

Inventory, P., 2015. Inventory for Measuring Depression 561–571.

Johnson, S., Gur, R.M., David, Z., Currier, E., 2015. One-Session Mindfulness Meditation: A Randomized Controlled Study of Effects on Cognition and Mood. Mindfulness (N. Y). 6, 88–98. https://doi.org/10.1007/s12671-013-0234-6

Kirste, I., Nicola, Z., Kronenberg, G., Walker, T.L., Liu, R.C., Kempermann, G., 2015. Is silence golden? Effects of auditory stimuli and their absence on adult hippocampal neurogenesis. Brain Struct. Funct. 220, 1221–1228. https://doi.org/10.1007/s00429-013-0679-3

Koelsch, S., Vuust, P., Friston, K., 2019. Predictive Processes and the Peculiar Case of Music. Trends Cogn. Sci. 23, 63–77. https://doi.org/10.1016/j.tics.2018.10.006

Kumaradevan, K.S., Balan, A., Khan, K., Alji, R.M., Narayanan, S.N., 2021. Modulatory

role of background music on cognitive interference task in young people. Ir. J. Med. Sci. 190, 779–786. https://doi.org/10.1007/s11845-020-02365-6

Lamers, M.J.M., Roelofs, A., Rabeling-Keus, I.M., 2010. Selective attention and response set in the Stroop task. Mem. Cogn. 38, 893–904. https://doi.org/10.3758/MC.38.7.893

Manzar, M.D., BaHammam, A.S., Hameed, U.A., Spence, D.W., Pandi-Perumal, S.R., Moscovitch, A., Streiner, D.L., 2018. Dimensionality of the Pittsburgh Sleep Quality Index: A systematic review. Health Qual. Life Outcomes 16, 9–11. https://doi.org/10.1186/s12955-018-0915-x

Masataka, N., Perlovsky, L., 2013. Cognitive interference can be mitigated by consonant music and facilitated by dissonant music. Sci. Rep. 3. https://doi.org/10.1038/srep02028

MILNER, B., 1970. Memory and the Medial Temporal Regions of the Brain. Biol. Mem. 29–50. https://doi.org/10.1016/b978-0-12-564350-4.50011-7

Müllensiefen, D., Gingras, B., Musil, J., Stewart, L., 2014. The musicality of non-musicians: An index for assessing musical sophistication in the general population. PLoS One 9. https://doi.org/10.1371/journal.pone.0089642

Murata, H., Bouzarte, Y., Kanebako, J., Minamizawa, K., 2017. Walk-In Music: Walking Experience with Synchronized Music and Its Effect of Pseudo-Gravity, in: Adjunct Publication of the 30th Annual ACM Symposium on User Interface Software and Technology, UIST '17. Association for Computing Machinery, New York, NY, USA, pp. 177–179. https://doi.org/10.1145/3131785.3131822

NAZARI, M.A.L.I., NABIZADEH CHIANEH, G., VAHEDI, S., ROSTAMI, M., 2012. VALIDITY AND RELIABILITY OF SELF-ASSESSMENT MANIKIN. Res. Psychol. Heal. 6, 52–61.

Packyanathan, J.S., Lakshmanan, R., Jayashri, P., 2019. Effect of music therapy on anxiety levels on patient undergoing dental extractions. J. Fam. Med. Prim. care 8, 3854–3860. https://doi.org/10.4103/jfmpc.jfmpc_789_19

Pauwels, E.K.J., Mariani, G., 2014. Mozart , Music and Medicine 403–412. https://doi.org/10.1159/000364873

Perham, N., Currie, H., 2014. Does listening to preferred music improve reading comprehension performance. Appl. Cogn. Psychol. 28, 279–284.

Pisarczyk, K., 2018. Music and Its Effects on Stress 1–27.

Poletti, C., Sleimen-Malkoun, R., Decker, L.M., Retornaz, F., Lemaire, P., Temprado, J.J., 2017. Strategic variations in fitts' task: Comparison of healthy older adults and cognitively impaired patients. Front. Aging Neurosci. 8, 1–10. https://doi.org/10.3389/fnagi.2016.00334

Raglio, A., 2015. Effects of music and music therapy on mood in neurological patients. World J. Psychiatry 5, 68. https://doi.org/10.5498/wjp.v5.i1.68

Rebuschat, P., Rohrmeier, M., Hawkins, J.A., Cross, I., 2012. Language and Music as Cognitive Systems. https://doi.org/10.1093/acprof:oso/9780199553426.001.0001

Rogenmoser, L., Kernbach, J., Schlaug, G., Gaser, C., 2018. Keeping brains young with making music. Brain Struct. Funct. 223, 297–305. https://doi.org/10.1007/s00429-017-1491-2

Schellenberg, E.G., Weiss, M.W., 2013. Music and Cognitive Abilities. Psychol. Music 14, 499–550. https://doi.org/10.1016/B978-0-12-381460-9.00012-2

Scrine, E., 2021. The Limits of Resilience and the Need for Resistance: Articulating the Role of Music Therapy With Young People Within a Shifting Trauma Paradigm. Front. Psychol. 12. https://doi.org/10.3389/fpsyg.2021.600245

Shepherd, J., 2020. Difference and Power in Music, in: Solie, R.A. (Ed.), . University of California Press, pp. 46–65. https://doi.org/doi:10.1525/9780520916500-004

Shih, Y.N., Huang, R.H., Chiang, H.Y., 2012. Background music: Effects on attention performance. Work 42, 573–578. https://doi.org/10.3233/WOR-2012-1410

Siddi, S., Preti, A., Lara, E., Brébion, G., Vila, R., Iglesias, M., Cuevas-Esteban, J., López-Carrilero, R., Butjosa, A., Haro, J.M., 2020. Comparison of the touch-screen and traditional versions of the Corsi block-tapping test in patients with psychosis and healthy controls. BMC Psychiatry 20, 1–10. https://doi.org/10.1186/s12888-020-02716-8

Stirling, N., 1979. Stroop Interference: An Input and an Output Phenomenon. Q. J. Exp. Psychol. 31, 121–132. https://doi.org/10.1080/14640747908400712

Stoet, G., 2017. PsyToolkit : A Novel Web-Based Method for Running Online Questionnaires and Reaction-Time Experiments 44, 24–31. https://doi.org/10.1177/0098628316677643

Stroop, J.R., 1992. Studies of interference in serial verbal reactions. J. Exp. Psychol. Gen. 121, 15–23. https://doi.org/10.1037/0096-3445.121.1.15

Thompson, W.F., Schellenberg, E.G., Letnic, A.K., 2011. Fast and loud background music disrupts reading comprehension. Psychol. Music 40, 700–708. https://doi.org/10.1177/0305735611400173

Trappe, H.-J., Voit, G., 2016. The Cardiovascular Effect of Musical Genres. Dtsch. Arztebl. Int. 113, 347–352. https://doi.org/10.3238/arztebl.2016.0347

Van Patten, R., Britton, K., Tremont, G., 2019. Comparing the Mini-Mental State Examination and the modified Mini-Mental State Examination in the detection of mild cognitive impairment in older adults. Int. psychogeriatrics 31, 693–701. https://doi.org/10.1017/S1041610218001023

Windows, M., Macintosh, A., 2010. PsyToolkit : A software package for programming 42, 1096–1104. https://doi.org/10.3758/BRM.42.4.1096

Wristen, B.G., 2013. Depression and Anxiety in University Music Students. Updat. Appl. Res. Music Educ. 31, 20–27. https://doi.org/10.1177/8755123312473613

Zhang, Y., Cai, J., An, L., Hui, F., Ren, T., Ma, H., Zhao, Q., 2017. Does music therapy enhance behavioral and cognitive function in elderly dementia patients? A systematic review and meta-analysis. Ageing Res. Rev. 35, 1–11. https://doi.org/10.1016/j.arr.2016.12.003

Zimmermann, M.B., Diers, K., Strunz, L., Scherbaum, N., Mette, C., 2019. Listening to Mozart Improves Current Mood in Adult ADHD - A Randomized Controlled Pilot Study. Front. Psychol. 10, 1104. https://doi.org/10.3389/fpsyg.2019.01104