Bachelor's thesis

Performing Arts I Music

2025

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# How do music and playing musical instruments affect brain activities?

TURKU AMK
TURKU UNIVERSITY OF APPLIED SCIENCES

Bachelor’s Thesis | Abstract

Turku University of Applied Sciences

Performing Arts Music

2025 | 20 pages

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# How do music and playing musical instruments affect brain activities?

The thesis consists of two parts. The artistic part is a video recording of the concert, which is the Flute B-level course performance, which took place in the Sigyn Hall of the Turku Arts Academy on May 10, 2024. The artistic part is the main part of this thesis. Links to the concert recording can be found in the appendix.

The aim of the author in the written thesis is to study and analyze articles related to the influence of music on the brain. In the authors` career and work it is important to motivate students to study and practice the flute not only based on the personal encouragement of their teacher but also through a scientific approach and research-based evidence. This means inspiring students to practice their instrument in a way that strengthens their intrinsic motivation, supported by an awareness grounded in scientific research.

This thesis draws on a wide range of literature and numerous scientific articles available through the Maryland National Library, the University of Arizona, and other sources.

The deeper understanding the author gained during her thesis process regarding the connection between playing a musical instrument and brain activities also contributed to her development as both a musician and a music instrument teacher.

KEYWORDS:

music, playing musical instruments, brain activities, brain disease

Opinnäytetyö (AMK) | Tiivistelmä

Turun ammattikorkeakoulu

Esittävä taide I Musiikki

2025 | 20 sivua

Anastasiia Avdiunicheva

# Miten musiikki ja soittimen soittaminen vaikuttaa aivotoimintoihin?

Opinnäytetyö koostuu kahdesta osasta. Taiteellinen osa on videotallenne konsertista, joka on Turun Taideakatemian Sigyn-salissa 10.5.2024 esitetty huilun B-tasokurssisuoritus. Linkit konsertin tallenteisiin ovat tämän opinnäytetyön liitteenä.

Kirjoittajan tavoitteena oli löytää opinnäytetyönsä avulla keinoja motivoida ja innostaa soitinopiskelijoitaan harjoittelemaan siten, että oppilaiden henkilökohtainen harjoittelutahto vahvistuu tietoisuudella, joka pohjautuu myös tieteellisiin tutkimustuloksiin.

Tässä opinnäytetyössä hyödynnettiin monenlaista kirjallisuutta ja monia tieteellisiä artikkeleita, jotka olivat saatavilla muun muassa Marylandin kansalliskirjaston ja Arizonan yliopiston verkkosivuilla.

Tekijän opinnäytetyön aikana saavuttama syvempi ymmärrys musiikin ja aivoprosessien välisestä yhteydestä auttoi häntä kehittymään myös muusikkona ja soitonopettajana.

Asiasanat:

musiikki, instrumentin soittaminen, aivoprosessit, aivosairaudet

# CONTENT



## Appendices

# 1 Introduction

My aim in this written thesis is to study and analyze articles related to the influence of music on the brain. In my career and work it is important to motivate students to study based not just on the personal will of their flute teacher, but also on a scientific approach and research results.

This thesis is based on literature and scholarly articles available on the website of the Maryland National Library, the University of Arizona, among others.

Obviously, music affects people physically but how exactly music interacts with the brain requires deep study. Music plays a significant role in human life. It not only serves as a source of pleasure but also has a significant impact on various aspects of human activity, including cognitive functions. In recent decades, research in neurobiology and psychology has increasingly confirmed the positive impact of music lessons on the brain.

Two components that are universal and may have been elements of earlier evolutionary development are the ability of people to create and respond to music, and to feel and express their feelings and emotions through dance.

My study questions in this thesis are:

- How and why do music and musical activities influence the maintenance of a healthy brain and fast mental activity?

Many researchers see music as an opportunity to prevent dementia. Experts say listening to music can calm or stimulate dementia patients. I will explore these and other questions in this thesis.

# 2 Music and brain plasticity

Brain plasticity is its ability to create new neural connections depending on changes in the surrounding reality. The higher the neuroplasticity, the more successfully we adapt to any situation, including the most extreme ones.
There are some studies which show that professional musicians have better brain neuroplasticity than those who have never played music. Some of them will be mentioned in the thesis below. Musicians not only have excellent sound processing skills, developed logical, sensory and motor skills, but also have good coordination and communication. Some amount of increased plasticity has been noticed among those people who have been involved in making music for many years, and those who have begun to study music from an early age.

## 2.1 The influence of music and playing a musical instrument on brain plasticity

The connection between music and emotions seems to have always been recognized. One of the first things music does when it enters the brain is the activation of pleasure centers, which produce and release the hormone dopamine, a neurotransmitter that makes us happy. Plato, the Athenian philosopher of the classical period of Ancient Greece, believed that music played in different modes would evoke different emotions (Mironov 2019, 1).
In general, many of us believe that the emotional meaning of music, whether happy or sad, depends, for example, on the type of chords: major chords are perceived as happy, minor chords as sad. Tempo, movement, or the speed of playback are also components of these emotional effects, slower music seems less happy than faster rhythms. This reminds us that even the word “movement” itself is an important part of emotion. When we dance, we move physically, just as we are emotionally moved by music. For example, Frank Iacono is the accompanist of the Providence Rhode Island Senior Citizens' Orchestra. He is still playing the violin at the age of 101. Here is how he speaks about the meaning

of music in his life in an interview with Elisabeth Landau for CNN: "It keeps me mentally active and gives me a lot of satisfaction". (Landau 2013.)

Scientists compete to figure out how to promote brain health and prevent dementia when people are ageing, their top recommendation for older adults is unanimous: “Stay active! Engage in hobbies and social activities!” For some people, playing music is a natural response to all these desires. Franck Iacono has been playing the violin since he was 13 simply because he loved it (Landau 2013).

But is it possible to prevent dementia by playing a musical instrument? What if you just listen to music? How many years does a person have to play a musical instrument to have a verifiable benefit to the brain? Next, I will look for answers to these questions.

## 2.2 The brains back up

Frank Iacono`s example can be looked at from the biological point of view.

Hanna-Pladdy, a neuropsychologist at Emory, is interested in exploring the biological basis in preventing dementia through music. Her theory is consistent with Gatz's: the neural networks of the brain, which are strengthened by music lessons, can prevent the detrimental effects of ageing. This is called the cognitive reserve process. (Landau 2013.)

The results of Hanna-Pladdy research, which involved only instrumentalists, were published in 2011 in the journal Neuropsychology and in 2012 in the journal Frontiersin Human Neuroscience (Landau 2013).

Hanna-Pladdy and her colleagues found in their observations that even if participants did not resume activities at an older age, they showed better results in object detection tasks, visuospatial memory, speed of thought and mental flexibility than those who did not have had a musical hobby of playing a musical instrument. The other participants in the experiment played musical instruments for at least ten years. This is especially important because as people age, they

lose motor skills or their vision weaken, which blocks playing the instrument. (Landau 2013.)

The study also shows that cognitive performance from playing musical instruments can be maintained throughout life. That is especially important.

The latest research has proved that musicians who started playing before the age of nine have significantly better verbal working memory functions than those who started later or never played. (Landau 2013.)

This is consistent with the theory of the formation of verbal skills. Linguistics research has shown that there is a critical period during which the brain is open to learning a language, but after a certain age in childhood, fluency becomes more difficult. (Landau 2013.)

Hanna-Pluddy reported: “Participants who continue to play a musical instrument into old age tend to perform better on visuospatial tasks, "showing that they retain mental flexibility into old age". In addition, she emphasizes that one of the greatest hopes is to find out how to take advantage of this plasticity when it comes to brain diseases or cognitive decline in old age. Therefore, learning to play musical instruments is a viable model for stimulating cognitive functions. (Landau 2013.)

In some research by Christo Pantev’s in Master University and by Thomas Elbert from Konstanz University in Germany as well as by other scientists, can be seen that musicians are particularly sensitive to piano sounds, mainly because their auditory cortical activity area is significantly enhanced when they hear piano sounds. This is exactly that plasticity of the brain that we were talking about. (Zhang 2020.)

The human brain has a special structure that is adapted to the needs of survival. The main task is to gather information about the internal and external environment of the body. Then process it to make decisions and responses appropriate to the situation. Music can strengthen and develop the relationship between these signals in each channel and build a network of brain functions, which can significantly improve brain activity. (Zhang 2020.)

## 2.3 Music against Alzheimer's disease

In 2014, American director Michael Rossato-Benneta directed the film Living Inside. The plot talks about the amazing results of the treatment of Alzheimer's disease and other memory disorders with the help of music. Director Michael Rossato-Bennett was inspired to make the film after meeting Dan Cohen, a volunteer who had noticed the striking effects of music on dementia patients in a care facility. Once he noticed that the behavior of patients changes markedly if they put their favorite music in the player. They not only begin to react to what is happening – motor skills return to them, speech is restored, and even memory returns. (National Research University Higher School of Economics 2014.)

A review by Gangrade (2012) examines how listening to music affects the production of neurotransmitters (e.g., dopamine, serotonin), hormones (including cortisol and endorphins) associated with the immune and nervous systems. The study summarizes the results of various neurobiological and clinical experiments showing that musical activity can induce physiological changes that contribute to improved mood, stress reduction, and emotion regulation. (Gangrade 2012.)

An article by Foster and Valentine (2001) examined how listening to music affected the recall of autobiographical events in people with dementia. The authors found that musical stimuli promoted more active and accurate memory retrieval, highlighting the role of music in supporting cognitive function in age-related decline. (Foster, Valentine 2001.)

Training a neural network is also the prevention of such complex conditions as Alzheimer's disease. Like muscles, the brain can become more plastic, strong and “pumped up,” due to hard mental work. Such work for the neural network is, in particular, music and the process of learning to play instruments. Like muscles, a trained brain is able to withstand heavy loads and cope with them for a long time. This approach may help slow the progression of neurodegenerative diseases by maintaining the brain's activity and ability to adapt over time. (National Research University Higher School of Economics 2014.)

# 3 Studies concerning music therapy and music instrument playing

The value of music as a therapy is reflected in its cultural support for social learning and emotional stability. Also, several studies show that sports and motor development with rhythmic involvement can actively promote movement recovery in patients with stroke, Parkinson's disease, cerebral palsy, and traumatic brain injury. Studies involving people with memory disorders such as Alzheimer's disease show that neural memory traces created through music are deeply rooted and more resistant to neurodegenerative influences. (Thaut 2005.)

In findings from individual randomized trials, it suggests that in music therapy that has been carried out with depressed people or people who suffer mood disorders associated, many improvements are reported. Moreover, the potential for using music therapy with patients diagnosed with neuropsychiatric disorders, including autism spectrum disorders, has led to psychotherapeutic use aimed at directly evoking emotions. (Maratos et al. 2008.)

Through music, we can gain a lot of information about the human brain. Music is a powerful method of therapy and a means of accessing and stimulating certain brain circuits.

## 3.1 How does playing a musical instrument affect the brain?

Playing a musical instrument is not just an exercise for the soul, it is a kind of simulator for the central nervous system. I came to this conclusion after studying numerous articles on studies of the influence of musical activity on the brain. Music practice has a significant impact on the development of the central nervous system: changes in the brain structure, especially in the motor and auditory cortex, as well as increased interhemispheric communication are observed (Schlaug et al. 2005).

Also, a review of neurobiological evidence showing that music training produces lasting changes in the brain's auditory, motor, and executive systems is reported in the journal “Neuron.” Musical training promotes neuroplasticity, affecting the motor, sensory and cognitive areas of the brain, making it an effective form of CNS training (Herholz & Zatorre, 2012).

What changes occur in the brain when a person begins to get acquainted with a musical instrument and then becomes a professional musician?

The flute or any musical instrument lessons, like any systematic exercise, develop people. Excellent memory and knowledge of mnemonic techniques, the ability to concentrate and quickly switch, developed fine motor skills, the emergence and consolidation of new neural connections — all this is observed by researchers in professional and novice musicians.

Another important object for scientists' attention is the reaction rate. As a child, one trains his/her reaction speed when learning to cross the road. First, when the child sees the green light, he remembers what his mother said, treads water for a while, and only then moves on. With each time, the time of reflection decreases and gradually the choice of "stand or go" becomes unconscious.

There are many similar moments like the ones described above when learning to play the flute. Reading and following the notes and the movements of the conductor's stick as well as following the flute teacher's advice are all stimuli that

develop the speed of reaction. Practicing playing a musical instrument and the development of technical playing skills allows the reaction time to be shortened and the individual elements to be managed unconsciously. This all frees up space for more complex and interesting tasks.

Canadian scientists approached the issue from a different angle: they assessed how quickly people with a musical education and non-musicians react to noise and vibration. Participants of the studies clicked the mouse when a stimulus occurred. The response rate of the musicians was on average 30% higher. That is, playing the flute can be considered the prevention of cognitive decline.

I will next gather some facts about the brain of a musical instrument player and what changes undergo in his/her brain.

## 3.2 Strong connection between the hemispheres

According to the research of Gottfried Schlaug, people who started playing music before the age of seven have a relatively larger size of the corpus callosum (increased by about 25%) - the brain structure responsible for the connection between the left and right hemispheres. According to modern ideas, the hemispheres do not have a strict "professional orientation" (left – thinks, right – draws): both sides contribute to some kind of activity. Accordingly, improving communication between them increases the degree of consistency of their reactions, implies greater variability in behavior and solving various problems. (Logolandiya 2018.)

Flutists, like other wind musicians, employ complex respiratory, motor, and auditory coordination that requires active interaction between the hemispheres.

It is well known that the use of hands in musical practice plays a role in the formation of neural pathways, especially in tasks requiring fine motor skills and bilateral coordination. Research has shown that playing stringed instruments increases the asymmetry of the hemispheres. This is due to the more active use

of the hand that plucks the strings. On the contrary, playing keyboard and wind instruments involves the harmonious development of the hemispheres, since the load is distributed evenly between both hands. This is important in terms of developing compensatory mechanisms in the case of any brain disease and is of significant importance in everyday life.

Neuroimaging studies have shown that musicians have an enlarged corpus callosum, an anatomical structure that provides communication between the hemispheres. This was verified using magnetic resonance imaging (MRI). It was shown that professional musicians have a significantly larger corpus callosum, a structure that connects the right and left hemispheres, than non-musicians. The differences are especially pronounced in those who began learning music in childhood. The authors interpret this as a sign of more intense interhemispheric interaction due to the need to coordinate both hands when playing, especially on symmetrical instruments. (Schlaug et al., 1995.)

## 3.3 Music is perceived by the brain as a foreign language

Studies of the anatomical features of the brain of famous musicians of the past and the study of similar structures of modern musicians (professionals and amateurs) suggest that for the brain, music is comparable to a foreign language. Music processing activates areas such as Wernicke’s and Broca’s regions — zones traditionally linked with language comprehension and production. The research notes that it is the playing of musical instruments that matters. Just listening to music does not have such an effect, since a passive "unsophisticated" listener cannot distinguish between individual musical "words" and "phrases". (Pavlov 2007.)

According to Asaridou and McQueen (2013), speech and music activate similar areas of the brain, especially when processing rhythm, structure, and sequencing. Music is not viewed as simply an aesthetic experience, but as a cognitive system similar to language, especially in terms of processing structure

and predictability. The authors conclude that music, like a foreign language, is perceived by the brain as a system with its own structure, rules, and semantic organization. (Asaridou, McQueen 2013.)

## 3.4 Improving the quality of the neural network

The neural network is enriched with new “highways” that connect areas that have never or rarely interacted before. As I mentioned before, the ability to quickly respond to the conductor's commands, read sheet music, listen and hear, feel the rhythm - and often all this at the same time - train the neural network, complicating it and improving its quality, which is subsequently used by the brain to solve any problems in life.

Professional musicians showed enhanced functional connectivity between auditory and motor areas. This study compared the brains of musicians and non-musicians. The results showed that musicians had enhanced connectivity between the auditory and motor systems, as well as more efficient auditory-motor pathways, allowing them to better process complex auditory and motor patterns. (Palomar-García et al. 2017.)

## 3.5 The musician's brain is more successful in resisting disease

Training a neural network is also the prevention of such complex conditions as Alzheimer's disease. Like muscles, the brain can become more plastic, strong and “pumped up,” but not due to physical exertion, but due to hard mental work. Such work for the neural network is, in particular, music and the process of learning to play instruments. A well-trained brain is more resilient to cognitive decline and may better manage the challenges associated with aging and neurodegenerative conditions. (Zhang 2020.)

Playing a musical instrument helps build cognitive reserves — a stable neural base that helps maintain mental clarity and resist age-related changes in the brain. According to a study by Pladdy and Mackay (2011), older adults with long-term experience playing musical instruments show higher cognitive performance, indicating increased resistance to brain diseases.

Particular attention is paid to the therapeutic effect of music: it has been shown that music lessons promote the restoration of speech and motor functions in people who have suffered a stroke and improve adaptation in developmental disorders. In a review article by Wan and Schlaug (2010), musical activity is considered as a means of strengthening the neuroplasticity of the brain throughout life, including old age. Music not only stimulates the development of cognitive functions, but also promotes recovery from neurological disorders, increasing the resistance of the brain to age-related and pathological changes. Schlaug (2010.)

# 4 Conclusion

Based on past research in a field in the study of brain science and music psychology, the relationship between music and the brain has become forefront. Without a doubt, the influence of music on the human brain can be determined scientifically. Music training has a huge positive effect on the development of the human brain, as well as on the development of cognitive abilities and memory.

At the beginning of this thesis, I posted the following research question:

- How and why do music and musical activities influence the maintenance of a healthy brain and fast mental activity?

Studies show that music enhances neural plasticity, supports memory, regulates emotions, and can slow down cognitive decline in aging or neurodegenerative conditions.

Musical activities stimulate the development of several brain structures. At the same time, along with the development of the brain areas responsible for the analysis of musical information, the development of those areas that do not participate in the perception of musical information in people who do not study music is also observed. Music therapy reduces the patient's anxiety level, which leads to an improvement in mood and a decrease in the reaction to psychological depression. It is important to mention that music training also shows a significant effect on improving memory at a pure molecular level.

Studies that were mentioned in this thesis have further deepened my understanding about the value and influence of music and playing musical instruments. Furthermore, this research highlights how music education can support a students` overall growth – not just as a performer but as a more flexible, attentive and emotionally aware individual. As a teacher, I will apply this knowledge by embedding music naturally into classroom activities. Using games, rhythm exercises, singing, movement, and creative tasks, I can stimulate my students' cognitive development in a playful and engaging way — supporting their mental agility and emotional well-being without them even realizing it.

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# APPENDIX 1

The links to the recording of the Flute B-level course performance:

1. L. Liebermann “Soliloquy”
   https://youtu.be/VE6EUgqBC_U
2. Sonata in E minor BWV 1034
   https://youtu.be/ox4gvQ39ZDI
3. Benjamin Godard - Valse from Suite de Trois Morceaux Op.116
   https://youtu.be/euwlYSGhvGo
4. W. A. Mozart - Concerto in G major
   https://youtu.be/0vwrqtABIj0