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The Role of Music, Dance, Movement, and Frequency in the Process of Neuroplasticity

Marco Vinícios de Oliveira Santana[1], Klebert de Paula Malheiros[1], Carlos Henrique Marchiori[1*], Èrico Meirelles de Melo[1]
[1]Researcher of Instituto Marco Santana, Goiânia, Goiás, Brazil

Abstract: Recent studies have found that if movement is combined with music, dance, and frequency, the effects of these activities are greater than those provided separately. Both increase neuroplasticity by creating new pathways of neuronal connections through different mechanisms, and their synergistic action offers better results, as music and dance influence cognitive abilities. Music is a powerful stimulus for neuroplasticity. To verify the role of music, dance, movement, and frequency in neuroplasticity. This paper is a narrative review of the literature, which is intended to explain and discuss a given subject from a theoretical or contextual perspective, to allow the reader to acquire or update knowledge on a specific topic. The search for scientific articles in Google Scholar, Biological Abstracts, HAL, Qeios, ResearchGate, Scielo, and SSRN. The inclusion criteria considered were: original articles and reviews, published nationally and internationally in full, available electronically, and published in Portuguese, English, and Spanish.

Keywords: Brain, Cognitive abilities, Memory, Music therapy, Neuromodulation.

Research Paper

***Corresponding Author:**
Carlos Henrique Marchiori
Researcher of Instituto Marco Santana, Goiânia, Goiás, Brazil

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1.0. INTRODUCTION

1.1. Neuroplasticity

Neuroplasticity is the human brain's ability to adapt at a neurological level. The brain changes as people grow and develop. It is sometimes called brain plasticity. The brain also changes in response to experiences and trauma. Like walking through a meadow, the most frequently used neural pathways become more pronounced, and less-used pathways fade. Neural pathways are connections between brain cells, or neurons, that allow the brain to send signals throughout the body through the nervous system (Krakauer *et al.,* 2012; García, 2022; Ramírez, 2025).

The scientifically exciting aspect of neuroplasticity is that we can reshape our brain and nervous system. Research on neuroplasticity has led to innovation and the development of best practices in many fields, including psychology, medicine, and education. With the right therapies, more efficient learning and recovery from brain injury and psychologically traumatic events are possible. An excellent example in the medical field is patients suffering from Broca's aphasia (Laver *et al.,* 2017; García, 2022; Estudyando, 2025).

This neurological disorder is caused by damage to specific areas of the brain. This damage is usually the result of a stroke, during which blood flow to parts of the brain is blocked. Individuals with Broca's aphasia experience difficulties with speaking and writing fluently, although their comprehension of spoken and written language typically remains intact. Speech-language pathologists can utilize patients' functional neuroplasticity to help their brains generate new neurons and rewire neurological pathways, thereby restoring function (Figure 1) (Laver *et al.,* 2017; García, 2022; Heinbockel, 2022; Estudyando, 2025).

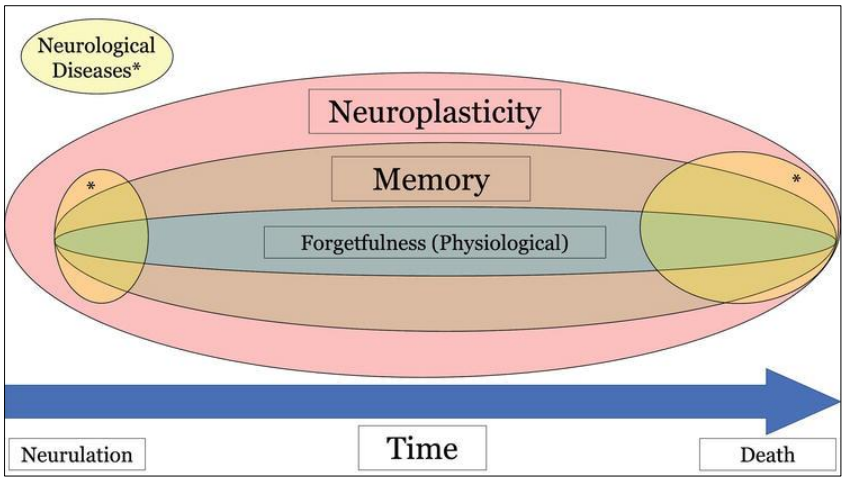

Figure 1: The relationship between memory and forgetfulness involves all the processes, the neuroplasticity. This is evident from the formation of the nervous system in neurulation and continues through the time to the moment of the subject's death. Also, the presence of neurological illness modifies both functions
Source: Doi: 10.5772/intechopen.101295

Music is not only processed in the brain, but it also affects its functioning. The physiological changes with exposure to music are multiple and range from the neurovegetative modulation of variability patterns of endogenous heart rate rhythms, respiratory rhythms, brain electrical rhythms, circadian sleep-wake cycles, to the production of several neurotransmitters linked to pleasure, reward, and the pain neuromodulation system. Musical training and prolonged exposure to music, considered pleasurable, increase the production of neurotrophins in our brain in challenging situations. This can determine an increase in neuron survival and changes in connectivity patterns in so-called brain plasticity (Blogspot, 2016; Chatterjee *et al.,* 2021; Cazzola, 2024; Yang *et al.,* 2024).

1.2. Music Therapy

This approach encompasses techniques and methodologies to address various neurological dysfunctions. Thus, the focus is not only on rhythms, melodies, harmonies, and musical structures, but also on stimulating specific. These musical elements are carefully selected and applied to activate brain regions that may be compromised due to various disorders. She integrates music with movement, language, and cognitive functions, creating a multisensory therapeutic experience. Music is a form of artistic expression, a powerful brain development and rehabilitation. For this reason, these interventions have been used in cases of stroke and traumatic brain injury. The results indicate that music can facilitate functional recovery in people with neurological disorders (Chatterjee *et al.,* 2021; Cazzola, 2024).

Promotes attention, improves memory, and enhances language skills. It improves concentration and increases problem-solving skills. It encourages learning through rhythm. Furthermore, music activates different areas, resulting in greater brain plasticity. Music therapy also influences physical well-being, as it can relieve pain and improve sleep quality. During sessions, singing or playing instruments can strengthen respiratory muscles (Balderas *et al.,* 2004; Schelz *et al.,* 2011; Bunt, 2014; Silverman, 2015; Ramírez, 2025).

The interaction between music and brain neuroplasticity is generating growing interest. This concept explores how the brain can adapt and improve through music. The paper, focused on Neurologic Music Therapy (NMT), reveals how musical interventions can train and transform neural networks (Chatterjee *et al.,* 2021; Cazzola, 2024).

Music therapy has a unique place in the health field. Balance, physical well-being, and improving quality of life. These professionals use music as a therapeutic tool, either as a presence or a means of expression. They treat a variety of conditions. The work of the music therapist goes beyond that. Composition, listening, and musical improvisation. They analyze patients' responses to music to identify problems and determine potential treatment strategies. Music therapy can also complement other treatment methods. For example, music therapy can be combined with cognitive-behavioral methods to generate better results (Figure 2) (Schelz *et al.,* 2011; Bunt, 2014; Silverman, 2015; Ramírez, 2025).

Figure 2: Magnetic Resonance Imaging (MRI) showing the different areas of the brain corresponding to types of music heard in each part of the brain

Source: https://harrypottersr.blogspot.com/2019/12/how-music-brain-effect.html?lr=1747933182624

Music therapy offers multiple benefits that positively impact various areas of life. Below are the main emotional, cognitive, and physical benefits. Music therapy improves emotional well-being by facilitating the expression of feelings. Difficult emotions. Furthermore, this practice helps reduce symptoms of anxiety and depression. It also fosters a sense of belonging and social connection, creating a safe environment for sharing experiences. The positive effects on cognitive function are noticeable during music therapy sessions (Schelz *et al.,* 2011; Bunt, 2014; Silverman, 2015; Ramírez, 2025).

1.3. The Frequency

The definition of frequency is the measure of the number of repetitions of a phenomenon per unit of time. In the case of sound, these are wave patterns in which the frequency indicates the number of cycles of the wave repeated per second. Frequencies are usually measured in Hertz (Hz), which refers to the propagation of electromagnetic waves and the methods of producing and detecting them (South Plug, 2017; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020).

As you may know, all matter vibrates, since the atoms that make up the different molecules of everything vibrate against each other, generating their unique vibrational frequency. And this is where science and music once again find a space for joint exploration. By exposing ampoules containing identical human DNA to four types of music of different frequencies, Gregorian chants, Sanskrit chants, classical music, and rock rein discovered that the absorption rate of ultraviolet light, an essential function of healthy DNA, increased by 5% to 9% in the samples exposed to Gregorian and Sanskrit chants. This indicates that exposure to these affects the human body (South Plug, 2017; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Desperta, 2025).

1.4. OBJECTIVE

To verify the role of music, dance, movement, and frequency in neuroplasticity.

2.0. METHODS

This paper is a narrative review of the literature, which is intended to explain and discuss a given subject from a theoretical or contextual perspective, to allow the reader to acquire or update knowledge on a specific topic. The search for scientific articles in Google Scholar, Biological Abstracts, HAL, Qeios, ResearchGate, Scielo, and SSRN. The inclusion criteria considered were: original articles and reviews, published nationally and internationally in full, available electronically, and published in Portuguese, English, and Spanish.

3.0. Selected Studies

3.1. Neuroplasticity

Recent studies have found that if movement is combined with music, the effects of these activities are greater than those provided by each of them separately. Both increase neuroplasticity by creating new pathways of neuronal connections through different mechanisms, and their synergistic action offers better results, as music and dance influence cognitive abilities. Music is a powerful stimulus for neuroplasticity (Figure 3) (Chronopoulou and Riga, 2012; Jauset-Berrocal, 2013; Jauset-Berrocal, 2016).

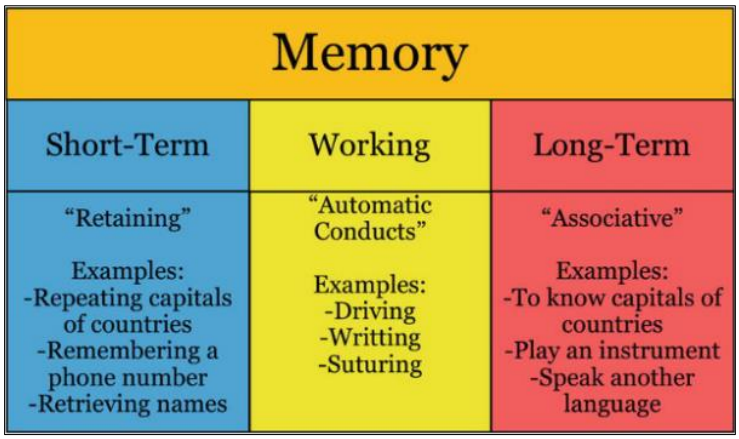

Figure 3: It demonstrates the memory function: short-term, working memory, and long-term with its main characteristics and examples of each subtype
Source: Doi: 10.5772/intechopen.101295

Neuroscience researchers consider a musician's brain to be an example of plasticity. Musical interpretation requires, among other things, maintaining attention, planning movements, using memory, and being disciplined. It involves a series of cognitive, motor, and emotional actions.

Both Passive Listening and Instrumental Learning Are:

1. Increased neural connections and networks.
2. Greater auditory sensitivity.
3. Increased ease of acquisition.
4. Of language, logic, and abstraction, among others.
5. In adult life, acting as a protector against neurodegenerative diseases (Figure 4) (Verghese *et al.,* 2003; Verghese *et al.,* 2006; Dhami *et al.,* 2015; Jauset-Berrocal, 2016).

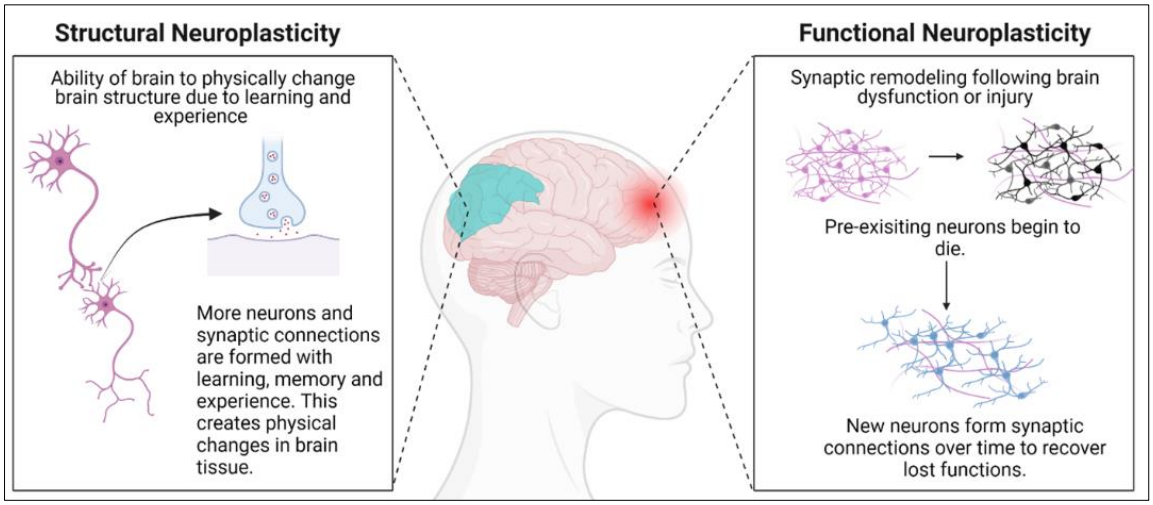

Figure 4: Neuroplasticity is popularly categorized into two categories: Structural neuroplasticity refers to physical brain tissue remodeling in response to learning and new experiences, while neuroplasticity occurs when existing neurons propagate and form new synaptic connections after functional loss following injury
Sources: Image created with Biorender.com, The Regents of the University of California, and https://biotech.ucdavis.edu/blog/neuroplasticity

Musical training has been considered an interesting framework for investigating induced neuroplasticity in healthy brains. Although certain brain differences predispose certain individuals to learn to play an instrument more easily, longitudinal studies show that listening to and producing music generate functional changes in the brain's motor network and its connections with the auditory system (Julião, 2023).

Important transformations also occur when we learn a new language. This is in the short term in young people, adults, and older adults alike. Therefore, when we begin to familiarize ourselves with the language, its vocabulary, and grammatical structures, our brain undergoes the modifications that make this possible (Julião, 2023).

To our environment, learn new things, or recover from a brain injury, it's thanks to the brain's ability to change and strengthen its connections based on experience. This is called neuroplasticity, and some exercises improve this skill. The brain is like a muscle: the more you train it, the further it reaches its capabilities. Don't miss these activities, be surprised at how close you've been to them all along (Aguilar *et al.,* 2014; Fuchs and Flügge, 2014; Tolahunase *et al.*, 2018; Price and Duman, 2020; Flores, 2022; Juarez, 2025).

3.1.1. Neuroplasticity Exercises for Adults

1. Reading

Reading promotes cortical reorganization, especially in the occipital lobe responsible for vision. Reading can cause structural and functional brain changes. This is one of the ideal neuroplasticity exercises for adults.

2. Exercise

Many studies have already linked physical exercise with improved mental health. Its effects go beyond expending energy and sleeping better: neurogenesis and synaptogenesis are increased. It also actively reduces symptoms of depression and anxiety.

3. Play

Simulation games, board games, video games, and role-playing games. All of them challenge different cognitive abilities. Attention, imagination, motor coordination, and logical thinking are some processes involved. As you can see, games that exercise the mind are not just for children. Likewise, riddles, puzzles, crosswords, Sudoku, and other puzzles are also useful. All this classic entertainment is a way to do brain exercises (Aguilar *et al.,* 2014; Fuchs and Flügge, 2014; Tolahunase *et al.*, 2018).

4. Listen To or Play Music

Music is one of the most pleasurable and stimulating activities for your brain. If you learn to play an instrument in addition to listening to music, you add movement to listening, generating even more neurons. (Tolahunase *et al.*, 2018; Price and Duman, 2020; Flores, 2022; Juarez, 2025).

5. Use Your Non-Dominant Hand

If you're one of those people who are very skillful with one hand and clumsy with the other, this exercise will be useful. Stirring coffee, brushing your teeth, switching utensils, and even writing, all contribute to exercising the homologous area of the opposite hemisphere. You'll find it challenging, but your brain will appreciate it.

6. Learn Something New

Learning a new skill will not only make you a multifaceted person, but it will also force your brain to confront unfamiliar skills. It's a way to take it out of its comfort zone and strengthen existing ones. Caring for plants, drawing, speaking other languages, and knitting are endless options.

7. Change Your Routine

There's nothing more comfortable for your brain than your daily routine. The images you receive, smells, movements, and more will also change. It may seem insignificant.

8. Meditate

Meditation trains your attention span and promotes an increase in neuroplasticity biomarkers. It's one of the most recommended brain plasticity exercises for cases of major depression and anxiety, so don't hesitate to try it (Price and Duman, 2020; Flores, 2022; Juarez, 2025).

9. Socialize

Emotions and processes such as empathy and motivation cannot be left out of this list of brain neuroplasticity activities. Socialization is a rich source of stimulation in this regard. Be sure to meet with your loved ones frequently and make the time you spend together. Talk, do activities, take care of yourself, and let yourself be taken care of.

10. Sleep

A good night's sleep consolidates the day's learning and regenerates parts of the brain used during waking hours. Don't neglect sleep hygiene; you consolidate your neuroplasticity (Aguilar *et al.,* 2014; Fuchs and Flügge, 2014; Tolahunase *et al.*, 2018; Price and Duman, 2020; Flores, 2022; Juarez, 2025).

3.1.2. Neuroplasticity Exercises for Children

1. Observe and Describe

Language requires the most training for proper development in all areas of life. We suggest a simple exercise: show the child an illustration or photograph and ask them to describe what they see.

2. The Tangram

The tangram is one of the Montessori toys. It consists of a square divided so that, when separated, pieces of different geometric shapes remain. With them, you can create many shapes and solve challenges. It's as easy as printing it, gluing it to a piece of cardboard, and starting to play (Tolahunase *et al.*, 2018; Price and Duman, 2020; Flores, 2022; Juarez, 2025).

3. Matching Cards

This is the typical game of flipping a series of cards face down, one by one, and then matching them by memory. You can find it online, buy a physical card, or even draw it at home. It's a great activity for developing working memory.

4. Coloring the Numbers

With this task, you encourage little ones' visual and attentional search skills. It consists of creating a grid with numbers inside each box. Then, assign a color to each number and ask the child to color them accordingly.

5. Connecting Concepts

Write three or more columns with different concepts. There must be a correspondence between each column so the child can connect the words. For example, one of the terms in the first column would be pineapple, another in the second would be apple, and the third, mango.

6. Emotional Theater

Emotional development and expression are fundamental pillars of children's personal growth. In this activity, they choose one of several cards with emotions written on them to act out.

7. Chatting

One of the simplest and, at the same time, most useful activities for developing brain flexibility is talking. You can help someone develop by letting them express themselves or guiding their thinking through questions and answers. If your little one talks a lot, don't tell them to be quiet: their brain is expanding (Aguilar *et al.,* 2014; Fuchs and Flügge, 2014; Tolahunase *et al.*, 2018; Price and Duman, 2020; Flores, 2022; Juarez, 2025).

3.2. The Music

3.2.1. Brain Structures in Dance Practitioners with Music

1. Hippocampus: They are located along the longitudinal axis of the brain, one in each of the medial parts of the temporal lobes, and form the medial wall of the inferior horns of the lateral ventricles (hippocampus, gyrus, and subiculum.
2. Motor cortical areas: The motor cortex is one of the parts of the telencephalon, which in turn is part of the encephalon. Its main function is to promote movement.
3. Parietal lobe. The occupies about a quarter of each cerebral hemisphere, and is involved in two main functions: Sensation, perception, integration, and interpretation of information.
4. Putamen: Structure located in the lateral part of the striate nucleus of the brain, which plays a crucial role in motor control and the regulation of various cognitive functions.
5. Cerebellum: The cerebellum contains about half of the neurons in the entire brain and is responsible for receiving information at an unconscious level and coordinating motor and sensory activities, such as muscle control, vision, touch, and hearing. It is responsible for balance and body posture, receiving sensory impulses from the most important locomotor structures, such as muscles, tendons, joints, organs related to balance, and the eyes.
6. Inferior frontal cortex mirror neurons: Mirror neurons empathic, social, and imitative behaviors. Their mission is to reflect on the activity we are observing (Figure 5) (Dhami *et al.,* 2015; Olszewska *et al.,* 2021).

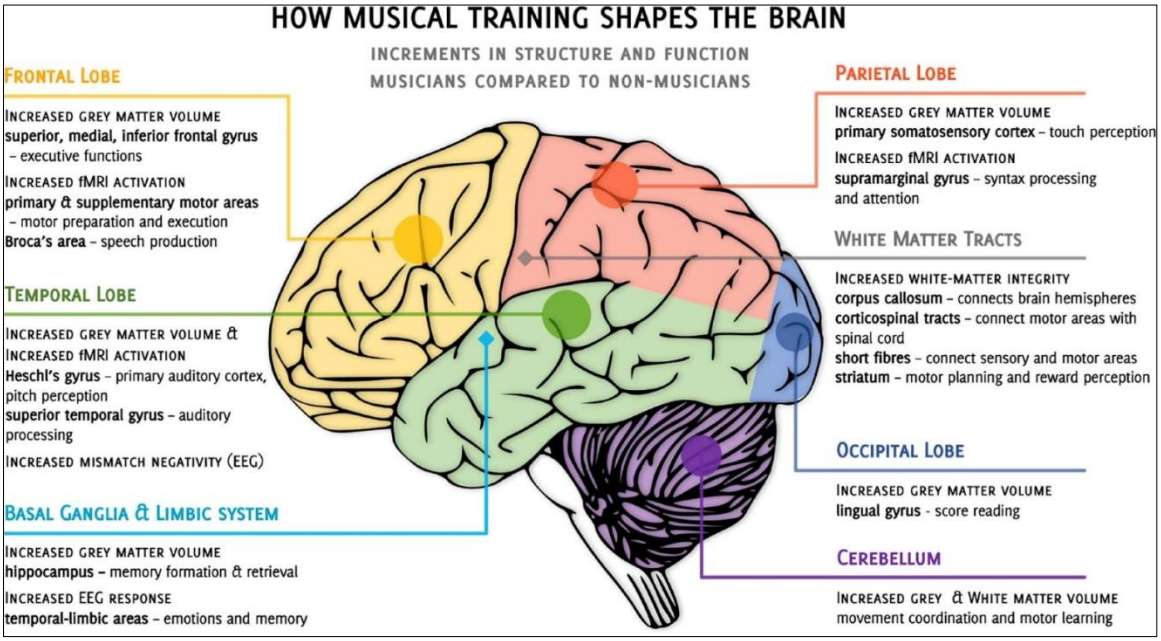

Figure 5: Overview of cross-sectional studies on the incremental differences observed when comparing musicians to non-musicians. Cortical structures, subcortical structures, fMRI, functional magnetic resonance imaging, EEG, electroencephalography. How musical training shapes the adult brain: predispositions and neuroplasticity
Source: Doi: 10.3389/fnins.2021.63082

The plastic capacity, or neuroplasticity, is the basis for learning and adaptation based on experience and environmental stimuli. Music and movement promote increased neural connections between different brain areas, physiological and cognitive functions; both activities are performed simultaneously (Jauset, 2016).

Musical training offers the necessary conditions for studying brain plasticity in humans, as it is one of the most complex and multimodal activities of daily living. Research into the effects of short- and long-term musical training provides extremely relevant information on how the human brain constantly reorganizes in response to new demands or specific environmental influences (Justel and Abraham, 2012; Lucero, 2024).

3.2.2. Neuroplasticity Presents Two Concepts That Relate Neuroscientific Aspects to Music That Are Fundamental to You

1. The biological nature of neuroplasticity and the "biological" substrate of musical experience. Music is perceived in its aesthetic dimension concerning the existence of our hearing organization and the human brain, where neuroplasticity essentially develops.
2. Relationship between free improvisation music and the processes underlying neuroplasticity. The audio-performance relationship between artists presents certain analogies with neural circuits in which each neuron emits signals to another, and, in turn, receives signals from different neurons, each other, or from the network forms (Justel and Abraham, 2012; Lucero, 2024).

The relationship between music and the brain is multifaceted and complex. When listening to music, several brain areas are activated simultaneously, including regions responsible for hearing, movement, emotions, and memory (Dhami *et al.,* 2015; Jauset-Berrocal, 2016).

Some of the Key Components of this Interaction Are:

1. Auditory cortex. Processes sounds and their characteristics, such as pitch and rhythm.
2. Limbic system: Regulates emotions; music can provoke intense emotional responses.
3. Prefrontal cortex: Involved in decision-making and planning, activated during music creation and appreciation.
4. Hippocampus: Related to memory, music can evoke memories and emotions (Aguilar, 2004; Silverman, 2015; Angeles Health System Hospital, 2025; Ramírez, 2025).

3.2.3. Cognitive Benefits of Music:

1. Improved memory.
2. Stimulation of child development.
3. Increased attention and concentration.
4. Facilitates language learning.
5. Enhances creativity (Aguilar, 2004; Silverman, 2015; Angeles Health System Hospital, 2025; Ramírez, 2025).

3.2.4. Emotional Benefits of Music:

1. Emotional Regulation.
2. Improved Well-being.
3. Stress Reduction.
4. Strengthening Social Connection.
5. Pain Management (Aguilar, 2004; Silverman, 2015; Angeles Health System Hospital, 2025; Ramírez, 2025).

3.2.5. Practical applications of music in mental and physical health:

1. Music therapy.
2. Cognitive rehabilitation.
3. Pain management and palliative care.
4. Athletic performance (Aguilar, 2004; Silverman, 2015; Angeles Health System Hospital, 2025; Ramírez, 2025).

The relationship between music and the brain is a fascinating area of study that reveals how music is in our daily lives. The cognitive and emotional benefits improve memory regulation and stress reduction (Aguilar, 2004; Silverman, 2015; Angeles Health System Hospital, 2025; Ramírez, 2025).

3.3. Cognitive, Music, and Plasticity

We can define cognitive stimulation as a set of techniques for the functioning of different abilities and functions through a series of specific, structured situations and activities. One of the neurobiological bases of stimulation is brain plasticity, which involves mechanisms. It represents the brain's ability to recover and restructure itself, adapting to new situations and attempting to reestablish the altered balance, whether due to brain damage or secondary to a neurodegenerative disease (Ben-Yishay *et al.,* 1987; Mateer, 2000; Kandel, 2007; Kolb *et al.,* 2010; Jauset-Berrocal *et al.*, 2018).

Brain plasticity refers to the nervous system's ability to change its structure and function throughout life in response to environmental diversity. If cognitive stimulation techniques are based on the intrinsic characteristics of music, we can speak of musical cognitive stimulation. Learning, the establishment of new neural connections, is based on plasticity, and one of its fundamental requirements is repetition, as it leads to greater synaptic efficacy and better consolidation of neural connections (Ben-Yishay *et al.,* 1987; Mateer, 2000; Kandel, 2007; Kolb *et al.,* 2010; Jauset-Berrocal *et al.*, 2018).

Therefore, the musical techniques described below are based on systematic practice and repetition to improve the performance of cognitive abilities. Attention is also necessary for memory, executive functions, and communication. Therefore, it is essential to prioritize it

through specific interventions (Figure 6) (Ben-Yishay *et al.,* 1987; Mateer, 2000; Kandel, 2007; Kolb *et al.,* 2010; Merrett *et al.,* 2013; Jauset-Berrocal *et al.*, 2018).

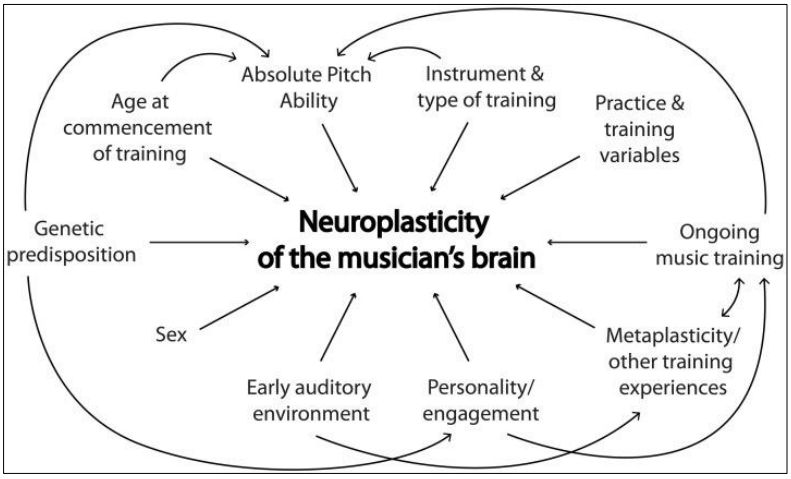

Figure 6: A schematic representation of the moderating variables of music-induced neuroplasticity and their interactions
Source: Doi: 10.3389/fpsyg.2013.00606

Jauset-Berrocal *et al.,* (2018) concluded in their article that when a person begins a neurorehabilitation process, regardless of the etiology of their disease, they encounter numerous professionals involved in their treatment who offer multidisciplinary and comprehensive services. There are many efforts to develop new intervention techniques, with sophisticated, high-cost devices, and the development of innovative therapies, but the tool that this work has dealt with, music, should not be forgotten (D'Esposito and Postle, 2015; Jauset-Berrocal *et al.*, 2018).

Remember its low cost, ease of application by legal professional specialists, and high non-invasive methods. Musical techniques for cognitive rehabilitation, proposed by neurological music therapy, should be considered another tool capable of intervening in cognitive processes such as executive function, attention, memory, and psychosocial skills (Krakauer *et al.,* 2012; D'Esposito and Postle, 2015; Jauset-Berrocal *et al.*, 2018).

Neuroplasticity plays a fundamental role in how drummers perform and contribute to music. Playing the drums requires precision to execute complex rhythms. This challenge to motor coordination stimulates brain areas such as the motor cortex and cerebellum, which are responsible for executing movements. As drummers hone their skills, they strengthen the connections between these brain areas, improving the coordination and precision of their hits (D'Esposito and Postle, 2015; Carasatorre *et al.,* 2016)

Drumming also challenges memory, like any instrument. Drummers must remember sequences of rhythms and patterns in real time, which exercises working memory, a crucial function for keeping time and switching between patterns during their performance. Brain plasticity enhances this ability by strengthening the neural connections responsible for such memory (Chaieb *et al.,* 2017; Clemenson *et al.,* 2018; Harrypottersr.blogspot, 2019; Quesada, 2025).

Drum playing is not simply about following a preset rhythm, but about expressing emotions, ideas, and originality through percussion, reflecting the brain's flexibility to adapt and reconfigure itself in response to musical experience. The ability to improvise, experiment with patterns and sounds, and compose fills and additional parts demonstrates how brain plasticity allows drummers to develop new neural connections that support creativity and musical expression, breathing (D'Esposito and Postle, 2015; Carasatorre *et al.,* 2016; Chaieb *et al.,* 2017; Clemenson *et al.,* 2018; Quesada, 2025).

Have a favorite singer or band and a piece of music you love to listen to repeatedly? Science tells us that it's not just good, it's recommended. Because listening to your favorite music improves your brain plasticity. We saw the benefits of music for those suffering from Alzheimer's: a way to awaken their lethargy, stimulate their receptivity, boost their mood, and play their favorite music from their youth. Likewise, patients in the early stages of Alzheimer's disease also benefit. In other words, that memory is stimulated, and structural changes occur in the prefrontal cortex. Repeatedly listening to music with personal meaning optimizes brain plasticity in patients with mild cognitive decline [Researchers at the University of Toronto] (Sabater, 2022).

What it achieves is to slow down this process only in patients who are in the earliest stages. Thus, it is beneficial to introduce this strategy into traditional stimulation therapies or workshops for people with Alzheimer's. It only slows down the process in patients in the earliest stages. She points out that this type of music therapy is something we can all do at home; the benefits have a lasting effect on the brain. It activates a very specific neural network linked to emotional and autobiographical memory [Dr. Corinne Fischer, director of geriatric psychiatry at St. Michael's Hospital of Unity Health in Toronto] (Sabater, 2022).

3.4. Music, Neurogenesis, and Neuronal Survival

From igniting our emotions to enhancing our cognitive abilities, music has the power. One of the most captivating aspects of this influence is its impact on neurogenesis and neuronal survival. By delving into the intricate relationship between music and the brain, we can uncover how musical aptitude shapes our neural pathways and promotes neuroplasticity (Clemenson *et al.,* 2018; Music396.com, 2023).

1. The role of musical aptitude in shaping neural networks. Individuals with a high musical aptitude often exhibit distinct brain activity and connectivity. Research has shown that musical training and mastery can lead to structural changes in the brain, particularly in regions associated with auditory processing, motor coordination, and emotional regulation (Harrypottersr.blogspot, 2019; Sabater, 2022).

2. Music as a protective force for neuronal survival.
3. The healing power of music on neurological disorders (Figure 7) (Harrypottersr.blogspot, 2019; Sabater, 2022).

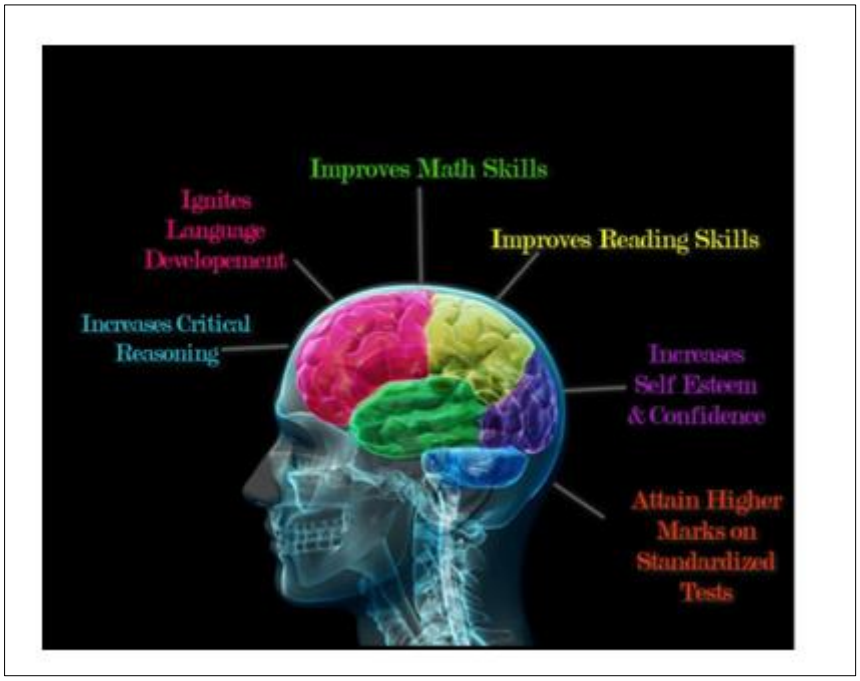

Figure 7: The positive impact of music has on the brain
Source: https://harrypottersr.blogspot.com/2019/12/how-music-brain-effect.html?lr=1747933182624

In addition to promoting the birth of new neurons, music also plays a crucial role in supporting neuronal survival**.** By interacting with music, people can activate neuroprotective mechanisms that protect existing neurons from degeneration and improve their resilience to aging or neurological disorders (Clemenson *et al.,* 2018; Music396.com, 2023).

Music's impact on the brain goes beyond promoting neurogenesis and neuronal survival; it also has great potential as a therapeutic intervention for people with neurological disorders. Numerous studies have highlighted the beneficial effects of music-based interventions on conditions such as Alzheimer's disease, Parkinson's disease, and stroke-related impairments. (Clemenson *et al.,* 2018; Music396.com, 2023).

Understanding neurogenesis and neuronal survival offers new insights into music's limitless potential as a transformative force in shaping brain resilience, adaptability, and well-being (Clemenson *et al.,* 2018; Music396.com, 2023).

3.5. The Frequency

Binaural sound can be defined as an illusion of auditory perception when we hear a different acoustic frequency in each ear through headphones as a single frequency. The perceived frequency is the difference between the two heard frequencies. For example, if we hear a frequency of 325 Hz through the right earphone and 315 Hz through the left, the binaural beat will be 10 Hz, and our brain will perceive a low-frequency rhythm resulting from the composition of two different sounds. But be careful, if the difference between the two

frequencies exceeds 40 Hz, our brain will perceive them as distinct, and the desired effect will no longer occur (South Plug, 2017; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Desperta, 2025).

The brain responds to this sound perception by altering neuronal waves, turning into frequencies of well-being and relaxation. For example, delta waves between 0.5 and 3 Hz are the slowest and have been associated with deep sleep states, so delta binaural beats are very relaxing and can induce dream states. Beta waves between 12 and 38 Hz correspond to the state of active thought and wakefulness, so beta binaural beats have proven useful for increasing cognitive performance, improving mood, and improving long-term memory (Figure 8) (South Plug, 2017; Bakker-Marshall *et al.*, 2018; Booth, 2019; Rojas-Álvarez *et al.,* 2020; Desperta, 2025).

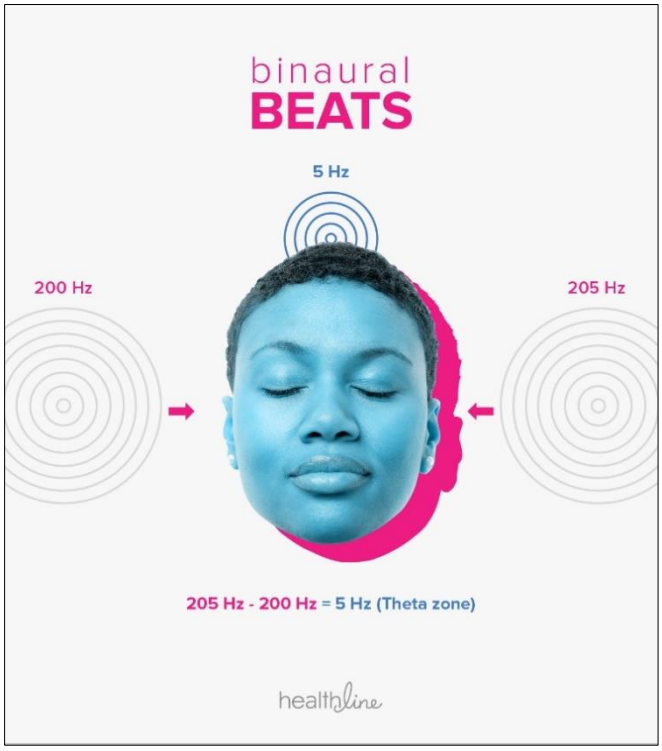

Figure 8: "Binaural" means "relating to both ears. "When you play a tone with a slightly different frequency into your left and right ear, say, 200 hertz (Hz) in one and 210 Hz in the other — they travel separately to your inferior colliculus, the part of your brain that gathers auditory input. There, the tones "squelch" together into a so-called "beat" at a perceived new frequency. (In this case, it would be 10 Hz

Sources: Clifford Segil, D.O., Stephanie Booth, and https://cliffordsegil.com/this-is-your-brain-on-binaural-beats/

Binaural music uses two low frequencies. The brain tends to synchronize with this frequency. Brain waves vary in frequency and are associated with different states of consciousness. Binaural music can be designed to induce certain brain wave frequencies. The influence of binaural music on brain waves is an emerging field in brain healing, especially regarding neuroplasticity, which is the brain's ability to form new neural connections. Research is underway to explore how binaural music, by emitting specific frequencies, can create an environment conducive to neuroplasticity (Gao *et al.,* 2014; South Plug, 2017; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Desperta, 2025).

Theta and alpha waves are associated with states of relaxation, meditation, and creativity, and are believed to promote learning and memory, which are essential for new neural connections. A mental environment more conducive to neuroplasticity can be created. This opens up the possibility that binaural beats could be useful in brain injury recovery and improving brain function in people with neurological disorders. The future of binaural music in brain healing is promising and presents fertile ground for exploration and innovation (South Plug, 2017; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Desperta, 2025).

3.5.1. From the point of view of neurophysiology, brain waves are divided into categories

1. Alpha:

Those between 7.5 and 13 waves per second (Hz). They are usually best seen in the back of the head on both sides, being wider on the dominant side. It is the rhythm most commonly observed for most of life, especially after age 30. We visualize scenes inside our mind, the imagination is activated, and the person is calm and relaxed. It is presented in deep relaxation and meditation (Leahey and Harris, 1998; Adams and Janata,

2002; Janata *et al.,* 2002a; Janata *et al.,* 2002b; Tillman *et al.,* 2003; Ovando, 2009).

2. Beta:

They have a frequency of 14 or more Hertz. They are usually seen on both sides with symmetrical distribution and are more evident frontally. They are accentuated by sedative-hypnotic drugs, especially benzodiazepines and barbiturates. They may be absent or reduced in areas with damage to the cerebral cortex. They are generally considered a normal or dominant rhythm in patients who are alert or anxious, or when their eyes are open (Leahey and Harris, 1998; Adams and Janata, 2002; Janata *et al.,* 2002a; Janata *et al.,* 2002b; Tillman *et al.,* 2003; Ovando, 2009; Engel and Fries, 2010; Vernon *et al.,* 2014; Scholz *et al.,* 2017).

3. Theta:

These have 3.5 to 7.5 Hz and are considered "slow" activity. They are abnormal in awake adults, but perfectly normal in children up to 13 years of age and during sleep. They can be seen as a focal disturbance in lesions located below the cerebral cortex, and in widespread distribution in a diffuse disorder, metabolic encephalopathy (Leahey and Harris, 1998; Adams and Janata, 2002; Janata *et al.,* 2002a; Janata *et al.,* 2002b; Tillman *et al.,* 2003; Ovando, 2009; Vernon *et al.,* 2014; Scholz *et al.,* 2017).

4. Delta:

These are 3 Hz or less. They tend to have the largest amplitude and the slowest waves. They are quite normal and are the dominant rhythm in infants and stages 3 and 4 of sleep. They can appear localized only in certain areas due to lesions below the cerebral cortex, and in a general distribution. In diffuse lesions, metabolic encephalopathy with hydrocephalus or lesions deep in the eye line in the middle. They are usually most prominent frontally in adults: Delta frontal rhythmic intermittent, and later in children: Delta occipital rhythmic intermittent (Leahey and Harris, 1998; Adams and Janata, 2002; Janata *et al.,* 2002a; Janata *et al.,* 2002b; Tillman *et al.,* 2003; Ovando, 2009).

5. Gamma:

Higher frequencies reportedly boost your brain waves into a state that may make you more alert, focused, or better able to recall memories (Figure 9) (Booth, 2019).

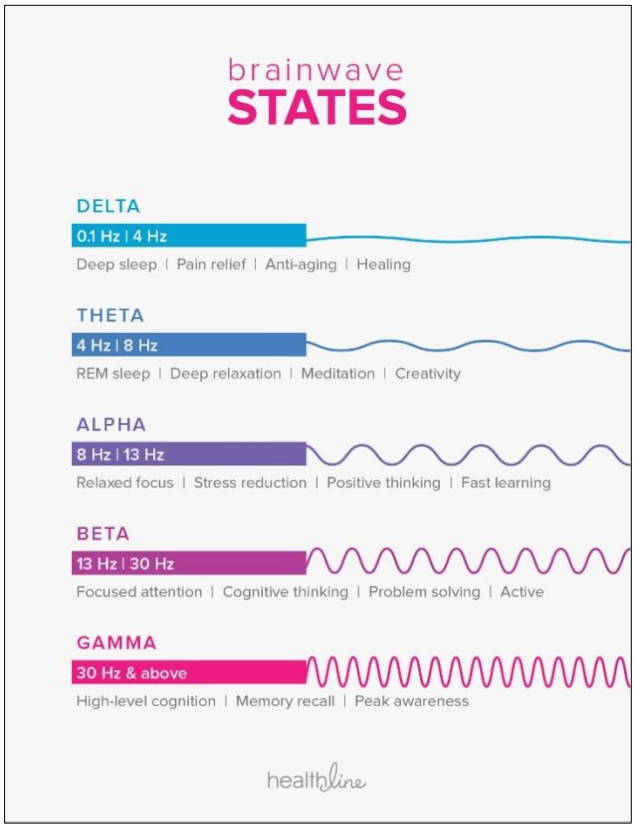

Figure 9: Brain waves are patterns of electrical activity

Sources: Clifford Segil, D.O., Stephanie Booth, and https://cliffordsegil.com/this-is-your-brain-on-binaural-beats/

Generated in the brain that can influence our mood, cognition, and overall well-being. Imagine that every mood has its melody! From the serenity of a calm sea to the unbridled excitement of a roller coaster. When we delve into the science of brain waves, we discover a fascinating world where electricity and chemistry intertwine to create our emotional experience. These waves, recorded through technologies such as

electroencephalography, give us clues about how we feel and think at any given moment (Janata *et al.,* 2002b; Tillman *et al.,* 2003; Ovando, 2009; PsicologiaYa.com, 2025).

Brain waves are patterns of electrical activity that occur in the brain and can be measured through Electroencephalography (EEG). These waves reflect communication between neurons and play a crucial role in regulating various brain functions, including mood. One of the most fascinating aspects of the human brain is its ability to adapt and change. Brain plasticity allows us to learn, remember, and regulate our emotional state (Vernon *et al.,* 2014; Scholz *et al.,* 2017; PsicologiaYa.com, 2025).

In this sense, different brain regions are involved in emotional processing, but one in particular stands out for its influence on our mood. It is important that external factors such as stress, lack of sleep, diet, and physical activity can significantly influence the activity of these brain regions and, consequently, our mood. (Scholz *et al.,* 2017; PsicologiaYa.com, 2025).

Therefore, Taking Care of Our Mental and Emotional Health is Essential to Maintaining Proper Brain Balance:

1. Brain waves reflect communication between neurons and are key in mood regulation.
2. The amygdala is a fundamental brain region for emotional processing and mood regulation.
3. Other brain areas, such as the hypothalamus and the prefrontal cortex, also participate in this regulation.
4. External factors such as stress and lack of sleep can affect brain activity and mood (Vernon *et al.,* 2014; Scholz *et al.,* 2017; PsicologiaYa.com, 2025).

Among these are theta waves, which are associated with deep relaxation, creativity, intuition, and greater access to the subconscious. Consciously listening to theta waves through meditation, music, or specialized recordings can improve our mental and emotional health (Vernon *et al.,* 2014; Scholz *et al.,* 2017; PsicologiaYa.com, 2025).

Below Are Some of the Most Notable Benefits:

1. Stress reduction: Theta waves are linked to decreased stress hormones, which can help reduce anxiety and promote relaxation.
2. Promoting creativity: Being in a state of mind makes it more likely to generate innovative ideas and creative solutions to problems.
3. Improving sleep: Listening to theta waves before bed can promote sleep onset and a better night's rest.
4. Facilitating learning: Being in a state of a theater can enhance the ability to absorb new information and improve the learning process.
5. Exploration of the subconscious: Theta waves allow us to access deeper layers of our mind, which can facilitate therapeutic work and self-exploration (Vernon *et al.,* 2014; Scholz *et al.,* 2017; PsicologiaYa.com, 2025).

The human body is composed of cells, which are composed of atoms. These atoms interact and operate based on the energy received, which includes the energy produced by sound waves. The Universe, the Sun, Saturn, the Moon, and the Earth exhibit mathematical proportions 432 (Figure 10) (Ingenieriamusical.net, 2024; Sanamente net, 2025).

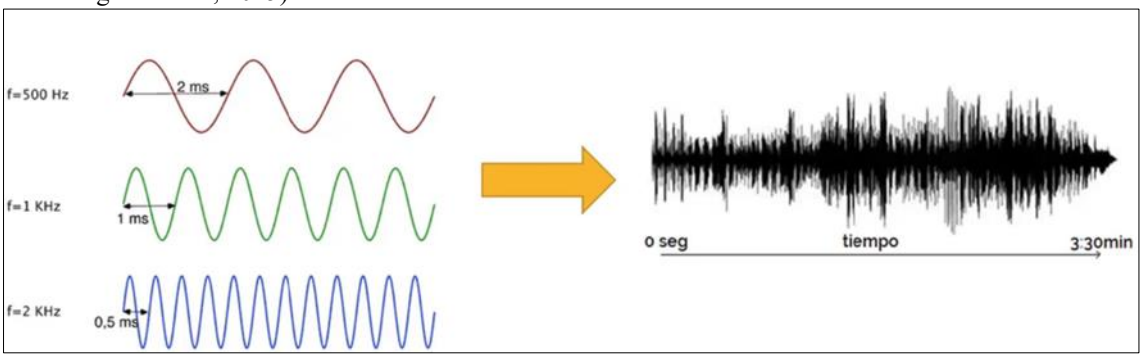

Figure 10: If 1000 oscillations must enter in one second, that wave will be narrower than a wave that contains 500 oscillations per second

Sources: Ingenieriamusical.net and https://ingenieriamusical.net/mezcla-y-masterizacion/que-es-la-frecuencia-aplicada-a-la-musica/

Today's music is based on 440 Hz and therefore does not harmonize with its natural vibration. The difference between 440 Hz and 432 Hz is only 8 vibrations per second, but this difference is perceptible in the experience of human consciousness. A concert at 432 Hz has profound positive effects on our consciousness and our cells (Sanamente.net, 2025).

3.5.2. Music at 432 Hz Transmutes and Heals the Soul, Mind, and Body by Affecting and Improving

1. The human heart improves its heart rate.
2. The DNA double helix replication rate.

3. Peak brain function – bi-hemispheric synchronization of the.
4. The musical geometry of creation (Ingenieriamusical.net, 2025; Sanamente.net, 2025).

Understanding the frequencies of musical notes is essential for musicians, as it helps them tune their instruments and create appropriate musical harmonies. Furthermore, it is also useful for sound technicians and recording engineers (Figure 11) (Llacanfil, 2013; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Binaural Beats 2025).

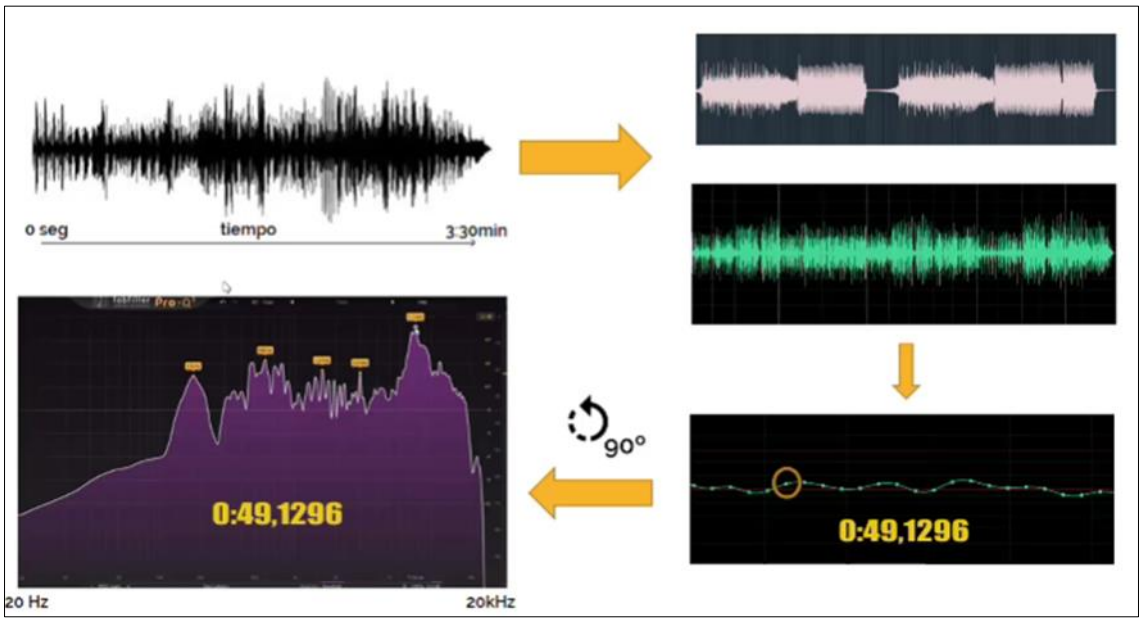

Figure 11: If at this point at the time rounded in orange on the top image we could rotate the view perpendicularly, what we would see would be the frequency spectrum, as you can observe in the following image: As you can see, this frequency spectrum is a concrete moment of the song, at 0:49,1296, therefore, our song is formed by millions of frequency spectra, counting in thousandths

Sources: Ingenieriamusical.net and https://ingenieriamusical.net/mezcla-y-masterizacion/que-es-la-frecuencia-aplicada-a-la-musica/

3.5.3. Some of the Practical Uses of Musical Note Frequencies Include

1. Instrument tuning: Musical notes have a specific frequency and pitch. Musicians use tuning forks, electronic tuners, or pianos to adjust the tuning of their instruments. Ensuring an instrument is tuned to the correct frequency is vital to sound good.
2. Creating harmonies: Musical harmonies are based on the relationship between the frequencies of musical notes. Musicians use note frequencies to create chords and melodies that sound good together. If the notes are out of tune, the resulting harmony will sound discordant and uncomfortable to the ear.
3. Studio Recordings: Recording engineers use note frequencies to ensure a high-quality recording. Ensuring good tuning and that the notes are at the correct frequency is vital for a good-sounding recording.
4. Tuning sound systems: Sound technicians adjust live sound systems. If the notes are out of tune, the resulting sound will be of poor quality and can negatively affect the audience's experience.
5. Musical note frequencies are critical in high-quality music. Understanding their use is essential for musicians, sound technicians, and music producers (Llacanfil, 2013; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Binaural Beats 2025).

Understanding note frequencies, pitches, scales, and musical chords allows musicians to create pleasing and emotionally evocative music. With these tools, musicians can create a piece of music with a specific intention and purpose (Llacanfil, 2013; Bakker-Marshall *et al.*, 2018; Rojas-Álvarez *et al.,* 2020; Binaural Beats 2025).

3.5.4. About Frequency, Better Music

1. Frequency is the inverse of time and is measured in hertz. One hertz equals one wave oscillation in one second.
2. The audible hearing range for humans is between 20 Hz and 20,000 Hz.
3. The frequency spectrum of an audio signal will be within the human hearing range.
4. The frequency spectrum of our entire song at each time instant "t" = “time” will be the sum of

the frequency spectra of each of the tracks playing at that same instant "t".

5. The total number of frequency spectrum samples in our entire song will depend on the frequency or sampling rate being used, multiplied by the total length of our song in seconds.
6. It is recommended to use sampling rates of 48,000 Hz or higher to ensure high-fidelity sound and avoid aliasing (Ingenieriamusical.net, 2024).

3.6. Music+dance (Music and music - English) (Music+dance: O "Baile" - Portuguese) and (Music+dance El "Baile" - Spanish) Movement, Neuroplasticity, and Health

3.6.1. The Music

One rhythm is inherent to biological systems, and its perception unconsciously produces a tendency toward synchronization. The connections between the auditory and motor areas, and those that originate from the brainstem to the motor neurons, are responsible for us following the rhythm of the music, whether with our entire fingers (Chronopoulou and Riga, 2012; Jauset-Berrocal, 2013).

The dance increases cognitive reserve and may help against neuronal degeneration. When practiced in a group, it is also cited as beneficial in depression due to the increase in endorphins and oxytocin, an increase in self-esteem, and an improvement in physical and mental balance (Chronopoulou and Riga, 2012; Jauset-Berrocal, 2013; Jauset, 2016).

Practice, the neural connections associated with these functions are strengthened and expanded, contributing to brain plasticity. It can challenge the brain in unique ways, as it involves learning and remembering movement sequences, coordinating different body parts to the rhythm of the music, and responding to cues from a dance partner. These challenges stimulate brain plasticity by requiring the continuous adaptation and adjustment of neural connections to improve dance performance (Abello *et al.,* 2018; Calderón and Gil, 2018; Synapsis, 2020; World Dance, 2024; Amaral, 2025).

Dance, an artistic expression rich in culture and emotion, is intrinsically linked to neuroplasticity, the brain's ability to reconfigure its neural connections in response to new experiences.

The Positive Impact of Dance on the Brain Goes Beyond Motor Development, Because:

1. Regular dance practices promote significant memory, attention, and problem-solving.
2. They reduce stress and anxiety levels, strengthening emotional well-being.
3. Shape new ways of thinking and feeling, establishing innovative ways to approach brain health through the body.
4. Immerse yourself in rhythms and movements, and you uncover a transformative path that optimizes our cognitive and emotional potential, demonstrating that dance is a critical tool for promoting robust mental health and resilience (Figure 12) (Stewart, 2014; Synapsis, 2020; World Dance, 2024; Amaral, 2025).

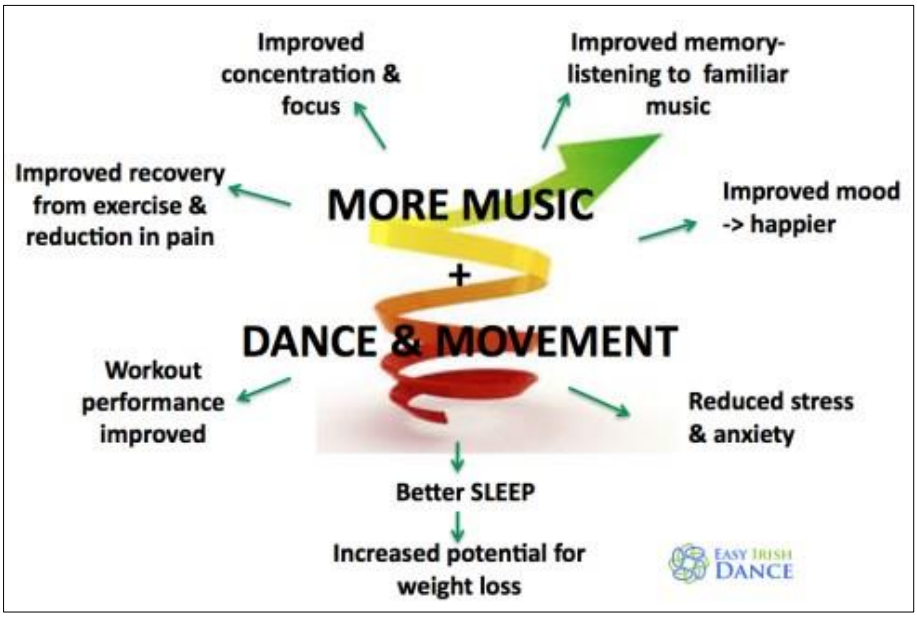

Figure 12: Recent research into all of these elements, music, exercise and movement, sleep, weight loss, mood, concentration, memory, and performance, shows that they are all intricately interconnected, and it is not that difficult to improve your health by moving, listening to, and dancing to music

Source: Posted in Fitness benefits, Good for health, Health benefits, Irish dancing, Irish music, Mental health benefits, Rhythm dance, Well-being | Tagged Dance & exercise, Dr. Siobhan Banks, Dr. Timothy, J Sharp, health, health and dance, health and music, health benefits of dance and music, sleep, sleep and weight loss, weight gain

3.6.2. Mechanisms by Which Dance Stimulates Neuroplasticity

1. Coordination and synchronization: In dance, the coordination of complex movements requires the activation of several brain areas in harmony, such as the motor cortex, cerebellum, and structures related to musical and spatial perception. This simultaneous action stimulates the creation of new synapses and strengthens existing ones.
2. Memory and creativity: Memorizing choreography and improving the rhythm of music challenge working memory capabilities and creativity, triggering neurogenesis, the birth of new neurons, especially in the hippocampus, a region central to memory.
3. Auditory and emotional integration: It activates the limbic system, which is responsible for emotions, providing emotional enrichment that aids plasticity neurotransmitters such as dopamine (Synapsis, 2020; World Dance, 2024; Amaral, 2025).

3.6.3. Impact of Movement on Neuroplasticity

Movement, a central element in dance practice, plays a crucial role in brain transformation. Neuroplasticity is fundamental to our cognitive and emotional development. The brain readjusts itself in response to stimuli such as learning new steps or adapting to different rhythms. The rhythmic and coordinated movements in dance are powerful stimuli for neuroplasticity, capable of assisting in cognitive adaptation and emotional repair (Kaczmarek, 2020; Synapsis, 2020; World Dance, 2024; Amaral, 2025).

3.6.4. Health

1. Cognitive and emotional benefits of dance.
2. Improvements in cognitive function, memory, and attention
3. Reduction of stress and increased emotional resilience.
4. Development of interpersonal and social skills (Bläsing *et al.,* 2012; Synapsis, 2020; World Dance, 2024; Amaral, 2025).

4.0. CONCLUSION

Recent studies have found that if movement is combined with music, dance, and frequency, the effects of these activities are greater than those provided separately. Both increase neuroplasticity by creating new pathways of neuronal connections through different mechanisms, and their synergistic action offers better results, as music and dance influence cognitive abilities. Music is a powerful stimulus for neuroplasticity.

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