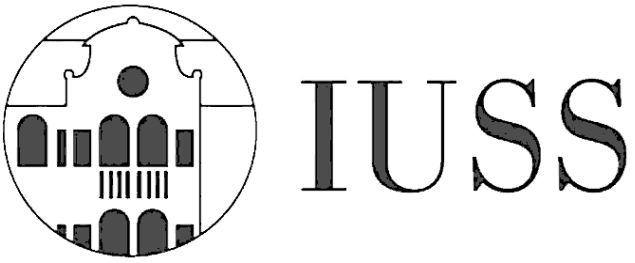
UNIVERSITY OF PAVIA – IUSS SCHOOL FOR ADVANCED STUDIES PAVIA

Department of Brain and Behavioral Sciences (DBBS)

MSc in Psychology, Neuroscience and Human Sciences



MUSIC-EVOKED EMOTIONAL MEMORIES AND ITS CLINICAL IMPLICATIONS

Supervisor:

Prof. Laura Ferreri

Thesis written by

Anna Vi

Academic year 2023-2024

Introduction

Music has been a big part of people's everyday life since ancient times extending back 250 000 years or more. It plays a much more important role compared to what we think. Music has held a significant position in influencing societies, collective identities, and cultivating interpersonal relationships, spanning various cultures and historical periods. The development of music, from the early periods to modern civilization, has demonstrated transformation in style, structure, and function, reflecting the characteristic of each society while also establishing a human experience that suprasses cultural barriers. Additionally, through history people studied it from different fields to find the nature of music. Musicians, philosophers, psychologists, neuroscientists and anthropologists proposed different theories concerning the origins of music.

The famous philosophers such as Pithagoras, Aristotle, Plato claimed that music has preventive and healing properties, also emphasizing that it established order in the universe and kept harmony in the individual's body and soul. It was noticed that melody and rhythm are able to change mood and influence emotions. In ancient Greece the musical art unified the three fields such as dance, poetry and music so Plato had some ideas related to music interventions. The use of music interventions was also widespread in ancient China and India.

In modern life the impact of music is more than just entertainment; it shows the effect on mental health and emotional well-being. Music-based interventions is a valuable tool that is used for treatment of various conditions such as anxiety, dementia, dyslexia, chronic pain. A lot of studies proved that music helps to reduce stress, regulates mood, improves cognitive functions and motivation, involves physical rehabilitation, and enhances communication skills. It has been a beneficial method through attentive reception of thoughtfully selected music playlists.

Both as an artist and a listener, music is a form of self-expression. To express thoughts, feelings, and experiences in a concrete manner through music, one must be true to the original. Through practicing and practicing a musical skill, such as singing or playing an instrument, self-esteem and creativity can be enhanced. Another way to convey ideas, feelings and experiences is by participating in activities like songwriting and composing. Music and songs are a powerful tool for exploring one's own world and sharing it with others.

As was mentioned before, music is a power tool for society. It has a notable capacity to unify people and create social relationships. Whether through collective singing and dancing or attending live performances and music festivals, shared musical experiences help to create a bond between individuals. Music functions as a universal platform where possible to form bonds, interactions, and backgrounds. The sense of cooperation that music plays in a way of building social connections and promoting positive associations.

Moreover, music is not just for entertainment, it is one of the fundamental things in human lives. So it is important to remember that music has a power to comfort and inspire people. Its universal appeal expresses cultural differences and fundamental aspects of human experience. By fully embracing the power of music, we have opportunities to enrich our nurture souls, lives, and establish enduring connections with others.

The main purpose of this thesis is to understand the role of music in memory, emotions, and mental health. Also, in this thesis would be considered the implications of music-based interventions in Alzheimer disease and dementia. Research suggests that music, specifically known music, potentially could evoke emotional memories and improve clinical outcomes in Alzheimer’s patients.

Music-evoked emotional memories are facilitated by the preservation of specific brain regions responsible for music memory, such as the amygdala and hippocampus, which are

less susceptible to disease than other cognitive functions. This protection allows the activation of undamaged neural networks and facilitates the retrieval of emotional memories linked to music. In addition, music has the ability to trigger the release of neurotransmitters such as dopamine and serotonin, stimulating emotional processing areas of the brain.

This thesis concerns the fundamental mechanisms and clinical significance of emotional memories evoked by music in persons with Alzheimer's disease and dementia, as well as the potential efficacy of utilizing these mechanisms in music-based interventions to enhance their quality of life and support caregivers.

One approach is the efficacy of music-based interventions employing familiar music and songs from an individual's history to stimulate emotional memories and improve memory recall. This approach is based on the theory that musical memory is preserved even in late stages of Alzheimer's disease. The therapists can have access to a patient's experience and memories by using familiar music, to improve social interaction, emotional state, and overall well being.

Another approach is that a personal music playlist consists of an individual's music preferences. By using a meaningful playlist for individuals, the therapists can have advantages of music-based interventions by involving the brain's emotional processing and memory recall mechanisms. Moreover, individuals stimulate cognitive and motor functions because they are involved in the process of making playlists.

1.1 Music in psychology

In psychology music takes a valuable and big spot. The field of music psychology explaining the psychological aspects of musical influence on behavior, well-being and emotions. Researchers in this field use psychological theories to understand the impact of musical behaviors, musical sounds and effects.

Studies have found musical influence on psychological functions. Researchers investigate fundamental questions focused on how music is used and its various functions. The main scholars discussed potential functions of music from a theoretical point of view. There are present two main theories such as evolutionary approaches and non-evolutionary approaches. All functions of music are the result of these theories.

Evolutionary approaches propose the idea that music is a product of evolutions and development. Charles Darwin discussed variable possibilities of music importance for biological aspects. He suggested that sounds produced by ancestors were more musical rather than linguistic, with more consistency in rhythm and pitch. As Darwin, Miller (2002) is one of the representatives of this approach and proposed that music-making is valuable for biological fitness. According to his view, the people who engage in musical activity can be considered healthy and strong, signaling to potential partners about good physical conditions similar to the animal's world.

This theory explains how music played a role in human evolution such as social relationships (ex. group formation and social bounding), partner choice, and parental caring. These viewpoints consider music through evolutionary psychology and survival advantages. Supporting this statement Folk (2004a,b) argued that singing and humming is significant for infant-mother attachment.

One of the views regarding these theories provided by Dissanayake (2009), he discussed that people use music to cope with self awareness and emotions. Music can help to fight with anxiety and stress that was proved by a lot of studies. Researchers found evidence that music can be used as treatment for mood disorders.

Another point of view is non-evolutionary approaches. This theory is focused on the way that individuals use music in everyday life but without implication behaviors in adaptive functions and evolutionary origins. Regarding the non-evolutionary approach are discussed two approaches such as "use-and-gratifications*"* approach and experimental aesthetic.

The use-and-gratifications approach was proposed by Arnett (1995), emphasizes the needs and concerns of listeners and how they actively choose and use music to fulfill these needs. It explores how music is used for purposes such as entertainment, sensation seeking, identity formation, cultural identification and sensation seeking.

Building upon this, the experimental aesthetic investigates the subjective experience of beauty in music and the resulting pleasure derived from it. Studies in this area explore how music can evoke memories, mood, associations, experiences in listeners, focusing on aesthetic experience rather than evolutionary origins.

By integrating these two viewpoints, it becomes apparent how individuals interact with music in various dimensions. The use-and-gratifications provides a framework of understanding the active role listeners play in choosing and using music while the experimental aesthetic explores deeper into subjective, experiential aspects of music appreciation and the pleasure it can evoke.

The non-evolutionary approaches to understanding the role and function of music do not rely on theories of biological evolution to explain the origins and development of music. Rather, these viewpoints center on the contemporary practical applications and perceptions of music, without necessarily exploring its evolutionary beginnings. The comparison of music

to "cheesecake" is frequently employed to demonstrate the non-evolutionary viewpoint. Similar to how cheesecake is a tasty and enjoyable food, yet not essential for biological survival, music is perceived as a cultural artifact that offers cognitive, emotional, and physiological advantages without being inherently tied to evolutionary adaptations.

In addition, the non-evolutionary approaches are evident that the most functions summarize into cognitive, emotional and physiological functions.The scholars approached the functions of music from empirical investigations. There are two main approaches that should be distinguished. The first is the observational approach, the researchers tend to uncover and document the way the music is used in everyday life. The main focus is identifying and observing the different ways in which people are involved with music in various contexts. This approach seeks the understanding of the practical functions of music. On the other hand, the inferential approach to infer the fundamental structure that regulates the utilization of music. Researchers employing this method examine evidence to prevalent aspects, motifs or classifications within the purposes of music. By inferring patterns from the evidence, it identifies fundamental relationships or functions that present among different ways of using music. Both approaches provide deeper understanding of functions of music in real-life settings. These empirical investigations throw light on the diverse ways that could potentially exist among diverse applications of music.

Studies proposed numerous functions that exist while listening to music but there is no agreement on the nature and numbers of the functions. Different researchers provide different amounts of music's functions that were found by surveys. For instance: Chamorro-Premuzic and Furnham (2007) identified 15 functions of musical dimension that were distinct in three dimensions: rational, emotional and background; Boer (2009) found 10 underlying dimensions; Lonsdale and North (2011) identified 30 uses that were divided into

six dimensions. Following the examples may conclude that there is no unifying meaning of how much exactly is music provided to individuals.

The research conducted by Schäfer et al.(2013) explored the various ways people used the music such as emotional, rational and background uses as well as its role in self-reflection and social bounding. There were around 129 reasons for using music and 834 participants were recruited and with a very diverse age range from 8 to 85 years. The aim of the study was comprehensive understanding of functions of music by analyzing the range of potential musical functions.

Information about how music affects people's experiences was collected through a questionnaire in the study. Through various channels, including local choirs and German universities, academics shared links to online surveys and distributed leaflets.

Participants were requested to evaluate their level agreement with statements related to their motives for engaging in music listening to use the scale for range from 0 (disagree) to 6 (completely agree). The participants were guided to think of any musical genre and any context in which they would engage in music.

The researchers performed a principal component analysis in order to ascertain the fundamental dimensions of musical functions. It was found that this analysis identified three separate dimensions such as regulating arousal and mood, attaining self-awareness, and expressing social relatedness. These dimensions explained approximately 40% of the variability in the data across various genders and age groups. The study recognized the constraints of using self-reported data and introspective insights into motivations. Nevertheless, due to limited empirical data gathering methods, they chose a survey-based approach.

The scientists have been exploring fundamental distinct dimensions within the functionalities of music using statistical techniques, like factor analyses and cluster analyses, to reveal these dimensions among amounts of variables. Nevertheless, there is a lack of the basic functions of music due to the various methods and approaches utilized in these studies.

The significance of incorporating a diverse set of variables in the investigations to guarantee the emergence of all relevant factors or aspects. The scholars suggest re-examining the issue of musical functions by commencing with the most expansive inventory to date of possible music-related functions. They intend to enroll a cross-sectional sample of participants encompassing various age cohorts and a broad spectrum of socio-economic status to ensure a diverse representation.

In addition, the results of this study are also important for understanding the social function of music. Research shows that people today are interested in music mainly for personal reasons, such as maintaining a positive emotional state, creating a pleasant personal space, and relieving boredom. This individualistic approach to music consumption may reflect the Western emphasis on self-awareness and self-expression.

The interest of influencing music on well-being is also considered from the biological perspective emphasizing the importance of understanding human musicality. To explore more biological mechanisms though music influence scientists use evidence-based music interventions with potential therapeutic use. Deeply understanding of neurobiological effects can lead to more effective personalized approaches to mental health and well-being.

For better understanding the neurobiological effect needs to consider the tonality and rhythm of music. The tonal context significantly impacts the psychological perception of musical pitch, as it determines the arrangement of similarities and distinctions between the tones, along with their temporal dynamics. Also, the tonal emotional expression and perception of tones in music are known to influence emotions and anxiety levels. From a

neurobiological perspective, tonality of music is capable of activating particular brain areas linked to emotional processing, including the amygdala and the prefrontal cortex. The neural conditions to tonal changes are able to affect emotional conditions and play a role in regulating mood. Tonality consists of the three main aspects such as harmony, melody and timbre.

The neurobiological impact of music's rhythm is profound. Rhythm refers to the temporal structure of music, that includes the duration and stress on notes. Music's rhythm has the ability to synchronize neural firing patterns by entraining activity in the auditory-motor cortex. This synchronization can result in improved cognitive functions, motor coordination, and emotional regulation. Research has demonstrated that various genres of music have the ability to engage distinct regions of the brain, consequently exerting a noteworthy influence on our emotional well-being. As an instance lively music featuring a fast tempo has the capacity to initiate the secretion of dopamine in the brain, thereby cultivating feelings of joy and satisfaction, whereas slow tempo can evoke the oxytocin that relates to a sense of relaxation and calm. So The therapeutic effects of music on mental health, in part, can be attributed to rhythmic entertainment.

In addition, music can stimulate the brain's reward circuitry by releasing neurotransmitters like dopamine, which is linked to pleasure and motivation. This stimulation can create positive emotional reactions and pleasure of listening to music. During the act of listening to music, instances of heightened thrill or "chills" are linked to elevated dopamine attachment in the nucleus accumbens, a critical brain area responsible for reward processing. This upsurge in dopamine plays a part in the enjoyable sensation of music listening. Also, the images from fMRI prove this statement and show the brain's response to music correlates with subjective liking.

In the frame of the rewarding system proposed a concept of “tripartite network” concerned with musical reward encompasses the nucleus accumbens (NAc), ventral tegmental area (VTA) and the hypothalamus. This network establishes a connection between cravings and enjoyment and their association with autonomic and neuroendocrine responses, emphasizing the intricate interaction of brain areas implicated in the pleasurable aspects of music.

The ultimate fundamental component of human musicality is sociality. Sociality in music relates to the social perspectives of music utilization and generation, emphasizing the significance of music in interpersonal communication and the advancement of social bonds between individuals. Music has the control to bring individuals together, empowering collective encounters and reinforcing connections through a shared understanding of melodic expression. Through collaborative exhibitions, shared playlists, and interpersonal melodic trades, music gets to be an implies of communication and social association, fortifying connections and giving a sense of having a place and community.

In conclusion, the engagement of the reward system when listening to music highlights the important influence that music has on our mood, motivation, and overall well-being. Exploring the mechanisms by which music triggers the brain’s reward pathways could provide valuable insights into why music can be an effective way to boost mood, reduce stress, and promote mental health.

The article by Bowling D.L. presents a conceptual model that emphasizes the importance of recognizing differences in individual sensitivity to key elements of musicality, including tonality, rhythm, reward and social interaction. By assessing patients' history of musical engagement and their sensitivity to these musical elements, healthcare professionals can gauge the potential effectiveness of music-based interventions. Patients with a strong affinity for music and high sensitivity to tonality, rhythm, rewards and social qualities are

considered suitable candidates for music therapy. On the other hand, patients who dislike music or do not find music rewarding may be less likely to benefit from such interventions. By focusing on elements that resonate with patient preferences and neurobiological responses, and by making treatment more personalized with unique musicality profiles, healthcare providers will be able to standardize interventions and improve treatment effectiveness.

Understanding the science of musicality is vital for the levelheaded application of melodic intercessions to mental wellbeing and wellness. To begin with, understanding how music influences the brain and mental wellbeing permits healthcare suppliers to personalize treatment. This custom fitted approach leads to more viable and individualized mediations. Moment, understanding the science of human musicality gives a logical premise for utilizing music in mental wellbeing treatment. This interface between melodic components and clinical results makes a difference to construct evidence-based approaches and increments the adequacy and unwavering quality of music-based treatments. Third, by recognizing that there are person contrasts in reactions to music on a natural level, healthcare experts can personalize treatment procedures based on each patient's particular melodic inclinations and sensitivities. This personalized approach can progress restorative results and persistent engagement. Fourth, by connecting music treatment to a natural system, healthcare experts can build up reliable treatment rules and guarantee consistency within the implementation of music interventions totally different settings. This standardization bolsters quality control and encourages the consolidation of music into customary therapeutic practice. At last, a comprehensive biological understanding of human musicality will invigorate inquire about and development within the field of music-based intercessions. By revealing the ways in which music impacts mental well-being, researchers can produce unused mediations, move forward existing methods, and investigate unused openings to utilize music as a restorative

apparatus. In brief, understanding the method and its noteworthiness can move forward persistent prosperity and results.

Researchers across studies defined the correlation between music and individual wellness throughout various life stages, emphasizing the wide-ranging advantages of music at different points in one's life. They note that the favorable effects of music can be observed during early childhood, adolescence, and later stage of adulthood.

Investigate appears that music features a critical effect on early childhood instructive advancement. Music encounters amid this time have been connected to various formative and cognitive benefits, with positive impacts on scholastic accomplishment. Moreover, support in music-related exercises amid early childhood has been connected to more noteworthy social cohesion and integration. Taking an interest in music exercises makes a difference in creating critical social abilities such as interaction, participation, and coordination. Music gives a stage for youthful children to associate with their peers and construct connections in a collaborative and comprehensive environment.

Overall, incorporating music into early childhood education and development programs not only improves educational outcomes, but also promotes social inclusion and cohesion in young children. This highlights the multiple benefits of music in promoting overall growth and well-being in the early years of life.

There is empirical evidence that participating in music education during adolescence improves young people's ability to encode sounds, which can lead to improved reading comprehension. By actively participating in music activities that involve instruction and practice, adolescents can develop more robust auditory processing skills that support a range of cognitive tasks, including reading comprehension. Furthermore, existing research shows that listening to music has a positive impact on adolescents' emotional well-being and sense of agency. Music has the ability to evoke emotions, provide comfort and strengthen

self-expression. Young people often use music as a means of self-expression and emotional regulation, which can increase their overall well-being and sense of autonomy.

In outline, combining music instruction with the passionate benefits of tuning in to music to improve cognitive abilities such as sound encoding can play a part within the general advancement and well-being of youthful individuals at this critical life arrangement. These discoveries are vital for coordination music instruction and music tuning in openings into youthful people's lives to bolster their enthusiastic, social and cognitive improvement.

Different physical and mental focal points that can considerably improve the common wellbeing and wellbeing of older adults have been connected to association in music in more seasoned adulthood. Melodic exercises like playing instruments, moving, or singing can move forward physical wellness in more seasoned grown-ups. These exercises offer possibilities for social interaction and engagement, which play an imperative part in protecting physical wellbeing and versatility in this age gathering. Music has been shown to have positive impacts on cognitive work, passionate wellbeing, and memory in older adults. Tuning in to music can diminish push and uneasiness, whereas locks in music-making exercises can instill a sense of accomplishment.

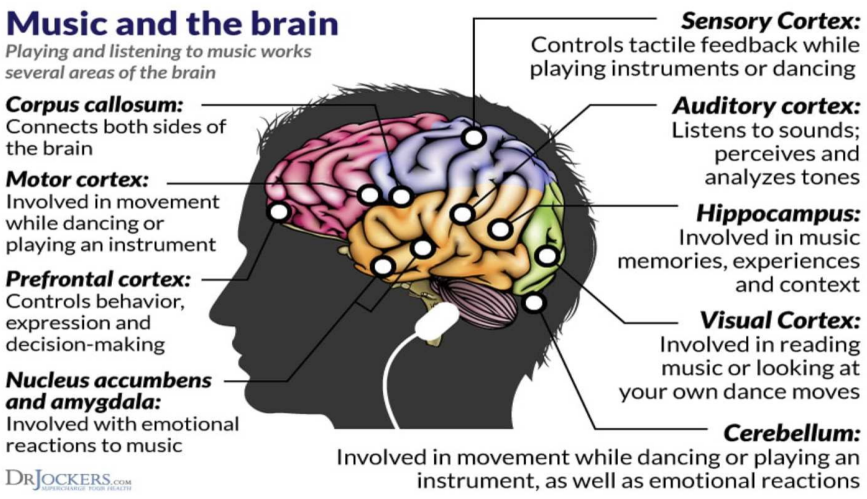
In conclusion, the combination of physical involvement in music and psychological benefits of listening and participation in music can positively impact the comprehensive health and well-being of older individuals, promoting and enhancing quality of life in their later stages of adulthood.

Researchers presented several practical implications for music-based interventions to social, emotional, cognitive individuals across different age groups. Programs are created to harness the therapeutic properties of music to promote quality of life. For instance: music interventions programs, community music programs, educational initiatives, engagement in

musical activities and professional composers and music leaders. Implementing music interventions programs in various ways to promote well-being and health.

Music and memory

A lot of theories support the strong relations between music and memory, specifically could track the relations in associations. Music is a powerful tool for encoding information, restoring it and recalling memory. During the listening music in the human's brain activates neuronal connections in different areas such as prefrontal cortex, auditory cortex, amygdala, motor cortex, hippocampus and Broca's area (Fig.1). Exactly, the prefrontal cortex and hippocampus are responses for memory and memory processes. Neuroimaging research centered on autobiographical memories evoked by music (MEAMs) provides insight into the neuronal processes involved in recalling memories triggered by music (Barrett et al., 2010; Janata et al., 2007; Schulk- ind, Hennis, & Rubin, 1999). By analyzing brain activities researchers can pinpoint the pathway that involves the process of the recall of autobiographical memories.



Neuroimaging research conducted by functional magnetic resonance (fMRI) and positron emission tomography (PET) on MEAMs enhances our comprehension of the complex connection between memory, music and cognition by uncovering the neural basis of how music acts as a trigger for autobiographical memories and impacts cognitive functions in the brain.

The process of activation of neurons appears unconsciously but it has a powerful impact on cognitive and emotional conditions. For example, to hear the favorite music from adulthood evoke happy memories from that time and feelings of nostalgia and warmth.

According to study (Barrett et al., 2010), song familiarity and autobiographical salience are two context-level constructs that can influence feelings of nostalgia. These contracts include: familiarity with the song; degree to which the song is associated with a personal memory; level of autobiographical salience of the song; emotional arousal experienced while listening to the song; specific emotions elicited during listening to the song (Fig.2). These context-level constructs help to explain why individuals experienced nostalgia on a different level.

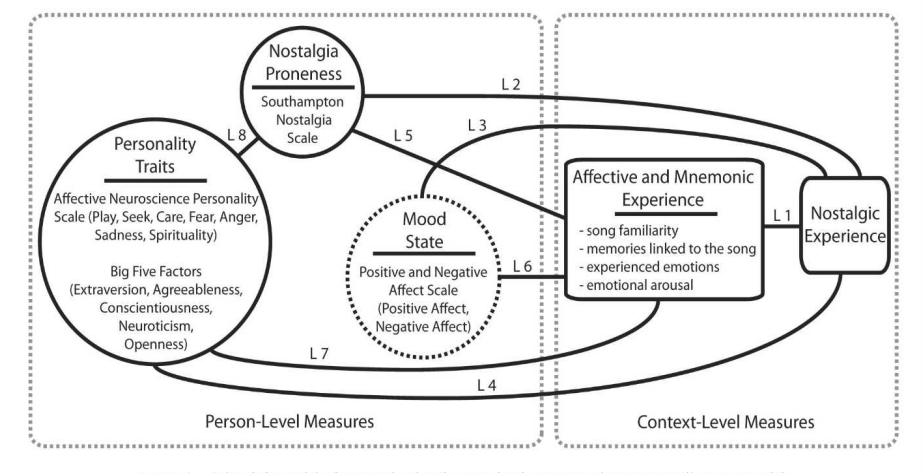


Figure 2. A heuristic model of context level and personal level that may contribute to nostalgic experience. Barrett FS, Grimm KJ, Robins RW, Wildschut T, Sedikides C, Janata (2010).

In addition, research discovered that individual differences in nostalgia proneness and mood state play a significant role in music-evoked nostalgia.

Within the scope of Music-Evoked Nostalgia research Barrett et al., (2010), individuals with heightened levels of nostalgia proneness exhibit a greater inclination towards experiencing nostalgia while interacting with music. In the field of Music-Evoked Nostalgia research, individuals exhibiting elevated levels of nostalgia proneness displayed a heightened predisposition to experiencing nostalgia while engaging with music. Thus, those with an inherent inclination towards nostalgia are more prone to experiencing intensified nostalgic responses elicited by music.

The intensity and occurrence of nostalgic responses to music can be influenced by unique personal characteristics. The importance of unique personal characteristics that influence the intensity and occurrence of nostalgic responses to various stimuli is underscored by this.

Individual emotional states influenced feelings of nostalgia. Specifically, individuals in negative emotional states tended to experience higher levels of nostalgia when listening to music, in contrast to those in positive or neutral emotional states. This suggests that negative emotions trigger nostalgia and intensify nostalgic feelings brought on by music.

People with negative emotions are more likely to find solace and comfort in nostalgic memories, which may lead to an increased nostalgic response to music. This shows the relationship between emotional states and nostalgia and suggests that an individual's mood affects how they interact with nostalgia.

The results show that variation in personality traits such as sadness' as measured by the ANPS and 'neuroticism' as assessed by the Big Five Inventory are important indicators of nostalgia proneness. People with higher levels of neuroticism are more likely to experience nostalgia.

Although significant relationships were found between individual-level constructs and contextual-level variables in this study, the overall effect of interactions across levels on the prediction of nostalgia experiences was modest. This suggests that while individual personality traits influence perceived nostalgia, the interaction between these traits and contextual factors may have a subtle effect on the overall experience of nostalgia.

The cultural impact is significant for individuals' preference in music from infancy through adulthood. Babies as young as 4-8 months old exhibit tendencies towards musical rhythms specific to their own culture, while during adolescence, individuals' capacity to recognize and favor musicfrom their own culture is strongly established. Familiarity with culturally typical musical attributes, obtained through exposurefrom early on, significantly shapes musical preferences. Recognizing the cultural influence on musical preferences is crucial for acknowledging the richness of musical expression across the globe.

The aim of this study (Demorest et. al., 2010) was to investigate the influence of culture on music perception and memory by analyzing differences in brain activation patterns of music listeners from familiar and unfamiliar cultural backgrounds. It was expected that different brain activation patterns would be observed when remembering and recalling music from one's own cultural background compared to music from a foreign cultural background, especially in the right frontal cortex. In this study, fMRI scans were used to monitor brain activity during activities in which subjects listened to new music from a culture foreign to their own and identified specific musical excerpts. The primary goal is to understand how cultural familiarity affects neural processes involved in music perception and memory, and thus to elucidate the neural mechanisms underlying music processing in different cultural contexts.

To observe the brain activities while listening to culturally familiar and unfamiliar music researchers used fMRI to distinguish if there is any difference in brain activation. In

the Fig.3, below clearly could be observed which brain areas are activated.

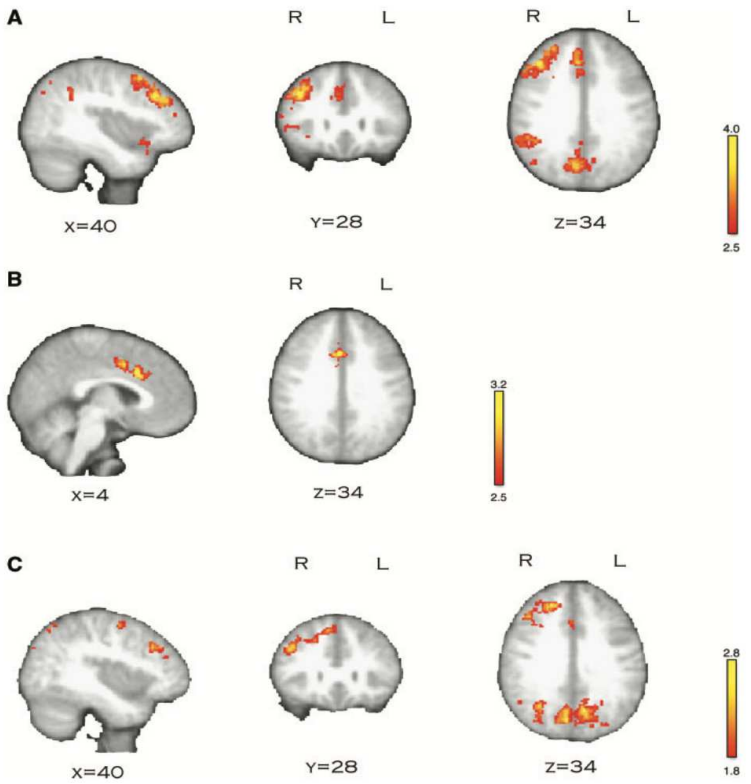


Figure 3 Difference map showing area of greater activation during listening to culturally unfamiliar music in angular gyrus, posterior precuneus and middle frontal areas. Demorest SM, Morrison SJ, Stambaugh LA, Beken M, Richards TL, Johnson C. (2010)

Significantly increased activity in the right cingulate gyrus was detected in every participant while engaging in the music memory task involving culturally unfamiliar music. This particular region of the brain, in conjunction with the prefrontal cortex and precuneus,has been linked to the recollection of music and the spatial orientation of auditory stimuli.

The participants were greatly in task of culturally familiarity music. In the result they were better in remembering and recognizing music that belongs to their own. This finding indicates that people tend to have better memory recollection for music that is culturally relevant to them, perhaps due to their exposure to and greater comprehension of the musical traditions, compositions, and genres within their own cultural context.

The study outlines various limitations and issues. One of the notable issues is the cultural specificity of the study, which primarily compares Turkish culture with Western cultural standards. Furthermore, the limited sample size raises further questions about the strength of the study. This limited population has the potential to produce biased results, undermining the reliability of the conclusions drawn from the study.

This considers how nature with one's own culture influences the way people see and keep in mind music. It appears that individuals tend to keep in mind music from their own culture way better. In spite of the fact that brain districts related with music handling give important data, translating neural actuation designs in connection to social recognition is complex and can be affected by distinctive points of view. It is pivotal to encourage thinking about and consider personal contrasts and social differences to move forward our understanding of how social recognition impacts brain reactions to melodic boosts. These discoveries have suggestions for investigating how individuals see music and give openings for future investigation analyzing the exchange of neural forms related to culture, memory and music handling.

Music-evoked autobiographical memories (MEAMs) are associated with strong emotions such as happiness, sadness, excitement and nostalgia (Barrett et al., 2010; Janata et al., 2007; Schulkind, Hennis, & Rubin, 1999). Even culturally the tradition relates important events with music (e.g. weddings, birthdays, funerals and initiations). In one study it was found that the most popular music was significantly higher measured in emotional response.

Related research has shown that music can act as a powerful trigger for autobiographical memory recall. This is especially true in individuals with acquired brain injury who have no underlying deficit in autobiographical recall memory and have intact pitch perception (Baird & Samson, 2013). This suggests that music may support the

rehabilitation of autobiographical amnesia by acting as a stimulus for the recall of personal events and experiences.

Music's ability to elicit vivid autobiographical memories has been attributed to its emotional depth (Altenmüller et al. 2014) This phenomenon has been termed the 'replay effect' in music psychology, highlighting music's exceptional ability to evoke past experiences, including related images, sounds and emotions (Altenmüller et al. 2014).

Music is able to evoke memories from multiple times of period and across generations. The phenomenon is named as the “reminiscence cascade phenomenon”. Krumhansl and Zupnick in 2013 studied this phenomenon, in the result they found that music-evoked autobiographical memories (MEAMs) display multiple “cascading reminiscence bumps”.

Krumhansl and Zupnick, 2013, conducted a study of young adults' exposure to popular music over a 50-year period. Participants exhibited a typical 'recall bump'. This bump is more common in individuals between the ages of 10 and 30 compared to other life stages.

Although a strong reminiscence bump is identified for personal or autobiographical memories, the evidence is varied for public events.Some research has shown a reminiscence bump solely for significant public events that have a dominant influence on collective memory, while not for other public events.

Distinct differences between personal and public events indicate that the recollection of significant personal and public events may be influenced by different cognitive mechanisms. While the life-script framework effectively addresses the reminiscence bump in personal memories, it does not provide a comprehensive rationale for the observed patterns related to public events. Interestingly, they also found the second reminiscence bumps for music that was popular when their parents were young. This bump triggered by music from

the previous generation, suggests that music has a unique ability to evoke memories and bridge generational divides that transcend individual lifetime.

In conclusion, the reminiscence cascade phenomenon can serve as a powerful trigger in evoking autobiographical memories, connecting individuals not only to individual past but also to the collective memories of previous generations.

The study conducted by Amy M. Belfi, Brett Karlan & Daniel Tranel (2016) focuses on the vividness of memories evoked by music compared to memories triggered by famous faces. The primary goal is to define whether there is a distinction in the vividness of detail and clarity between memories recalled though MEAMs and those prompted by viewing famous faces. In this study 30 healthy candidates, ages from 30 to 72 years. Participants listened to 30 songs and viewed 30 famous faces, reporting on the memory evoked.

The findings of the study showed that MEAMs were more vivid in detail compared to memories triggered by faces. It supports the hypothesis that autobiographical memories recalled by music have a higher level of clarity and richness in details. MEAMs is more deep in internal details (Fig. 4) that refers to personal feelings, thoughts associated with memory.

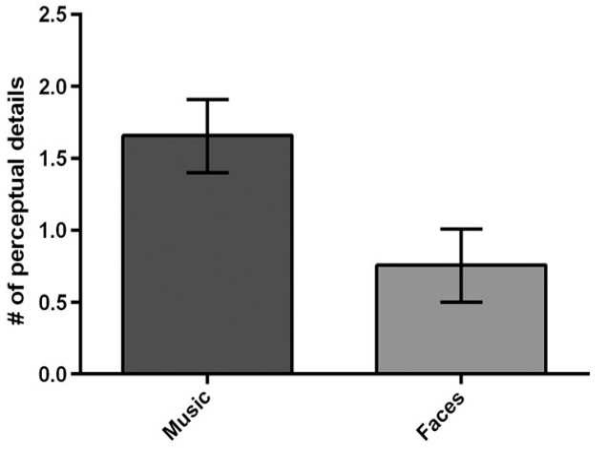


Figure 4. Total number of perceptual detail for music and faces. Baguley, 2012; Loftus & Masson, (1994).

In contrast, memories triggered by the viewing of famous faces have more external details (Fig. 5) such as contextual information of certain memories. This phenomenon underscores the significant interaction among acknowledgement, affect, and recollection, as well as the distinct manner in which our brains encode and recall data linked to culturally important and familiar figures.

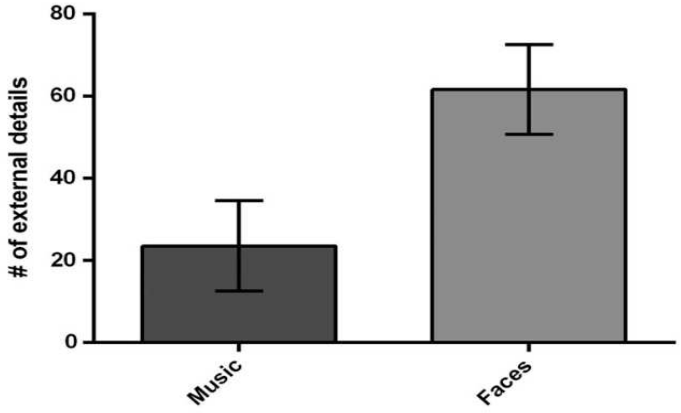


Figure 5. Total number of external details for music and faces. Baguley, 2012; Loftus & Masson, (1994).

In Fig. 6 (Amy M. Belfi, wet al., 2016) also can be observed the sex differences among participants. Women had more vivid memories in both tasks compared to men. However, in general for both genders in music cues the bar is higher than in face stimulus. This gender difference suggests that in general women are more clear and detailed in recall of autobiographical memories than men.

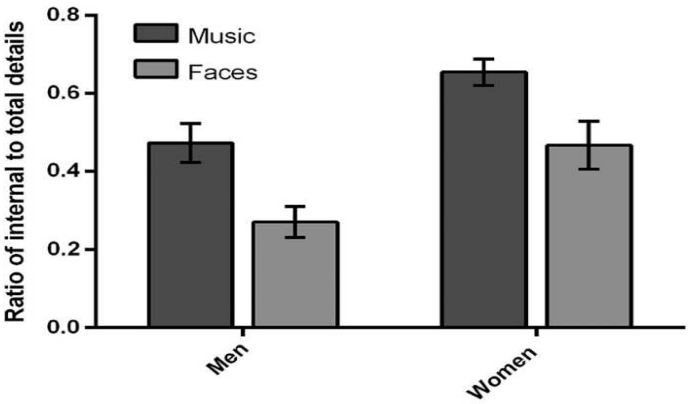


Figure 6. Sex differences in ration of internal to total details (Amy M. Belfi, Brett Karlan & Daniel Tranel (2016) Music evokes vivid autobiographical memories, Memory, 24:7, 979-989, DOI: 10.1080/09658211.2015.1061012)

Overall, the study proves the idea that MEAMs are richness and vividness to memories-evoked compared to memories by visual stimulus. Interestingly, findings that visual stimulus is more effective in external details in memories could be because the faces were famous and it triggered more details that relate with environment and the context information. Compared to memories triggered by music, music more relates with internal statements of individuals and evokes memories with emotions, relations and warms that relate to certain memories.

General research has predominantly concentrated on investigating MEAMs in controlled laboratory environments with music cues chosen by the experimenter or in collaboration with participants to make personalized playlists. However, there is an increasing acknowledgment of the necessity to investigate these memories in the context of daily life experiences.

In the study Jakubowski & Ghosh, 2021 explored music-evoked memories in everyday life. They employed a naturalistic methodology to examine the situational characteristics, content, and attributes of Music-Evoked Autobiographical Memories (MEAMs) occurring spontaneously within individuals' everyday experiences. Utilizing a diary-based approach over a seven-day period, participants were instructed to document

specifics of their MEAMs and music consumption patterns. This was intended to capture the occurrence rate, emotional undertones, and contextual elements related to these memories within authentic environmental contexts.

Participants in the research (Jakubowski & Ghosh, 2021) indicated encountering MEAMs) about once a day, with some degree of disparity among individuals. These recollections commonly manifested during day-to-day activities like driving, traveling, relaxing, and houseworking, eating, working, and exercising. The contextual elements of these recollections concur with standard situations where individuals typically engage in music consumption, underscoring the interconnectedness of music, recollection, and everyday occurrences.

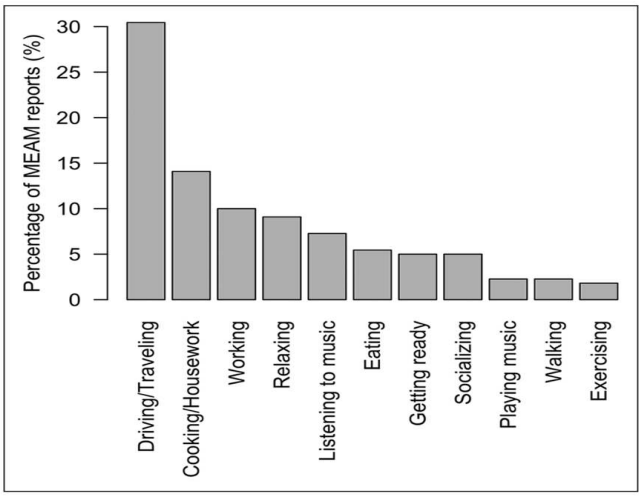


Figure 7. Activities during which a music-evoked autobiographical memory occurred. Jakubowski, K., & Ghosh, A. (2021).

Jakubowski and Ghosh, 2021 presented a new method for documenting music-evoked autobiographical memories (MEAMs) in their research. They highlighted the frequent occurrence of MEAMs in daily life, which can transport individuals to dynamic positive, and social experiences. Despite the absence of experimental control,the study effectively captured real MEAM occurrences. The presented approach creates opportunities for investigating the contextual elements of naturally occurring MEAMs and their influence on individuals' life

narratives and evolving self-perception.The study's results aid in understanding the spontaneous and emotionally profound characteristics of MEAMs, emphasizing the role of music in triggering autobiographical memories and its impact on personal identity and life narratives.

Researchers do not mention the specific limitation and criticism. However, one of the possible criticisms is a small size of participants. Also, participants self-reported through diary may present biases or inaccuracy in memory recall.

Moreover, music has an impact on verbal memory encoding. Numerous studies support the strong relations between verbal memory and music. Individuals who have received musical training as adults demonstrate significantly improved performance on verbal memory assessments in comparison to individuals without musical training. Notably, these cognitive advantages seem to be confined to verbal memory and do not extend to visual memory. Significantly, the beneficial effects of music on verbal memory are observed to endure over an extended period, persisting for years following the cessation of musical training. Furthermore, taking musical training at a younger age is associated with greater enhancements in verbal memory skills.

Researchers have several explanations of how music can improve verbal memory. First, music engages in multiple systems such as motor, auditory and emotional processing that improve the effectiveness of encoding information. The synchronization of these systems may help facilitate the information. In addition, the emotional factor is power in recalling memories and in forming them.

The understanding of relations, music and verbal memory is crucial for the real world because musik-based interventions are beneficial for the population such as learning disabilities, brain injuries and dementia. Also, children show better results in learning and language if they are musical trained.

The connection between verbal memory and music is proved neurologically and behaviorally so as music interventions level up the cognitive functions of individuals. This relations perspective in the scientific field and in the real world.

The study (Ferreri et.al., 2013) introduction explores the relationship between music listening and its influence on verbal memory encoding. It highlights the favorable effects of music, including enhancement of memory function and reduction of prefrontal cortex activity. The main aim of the study is to investigate the impact of music on specific memory processes and to ascertain how these impacts can improve cognitive functions and memory preservation.

Listening to music during encoding is suggested to improve verbal memory by creating a supportive context that aids in organizational, associative, and semantic processes. This enriched context during encoding is believed to enhance memory performance during retrieval. Furthermore, the presence of music during encoding was found to have a positive impact on subsequent item recognition in verbal memory tasks.

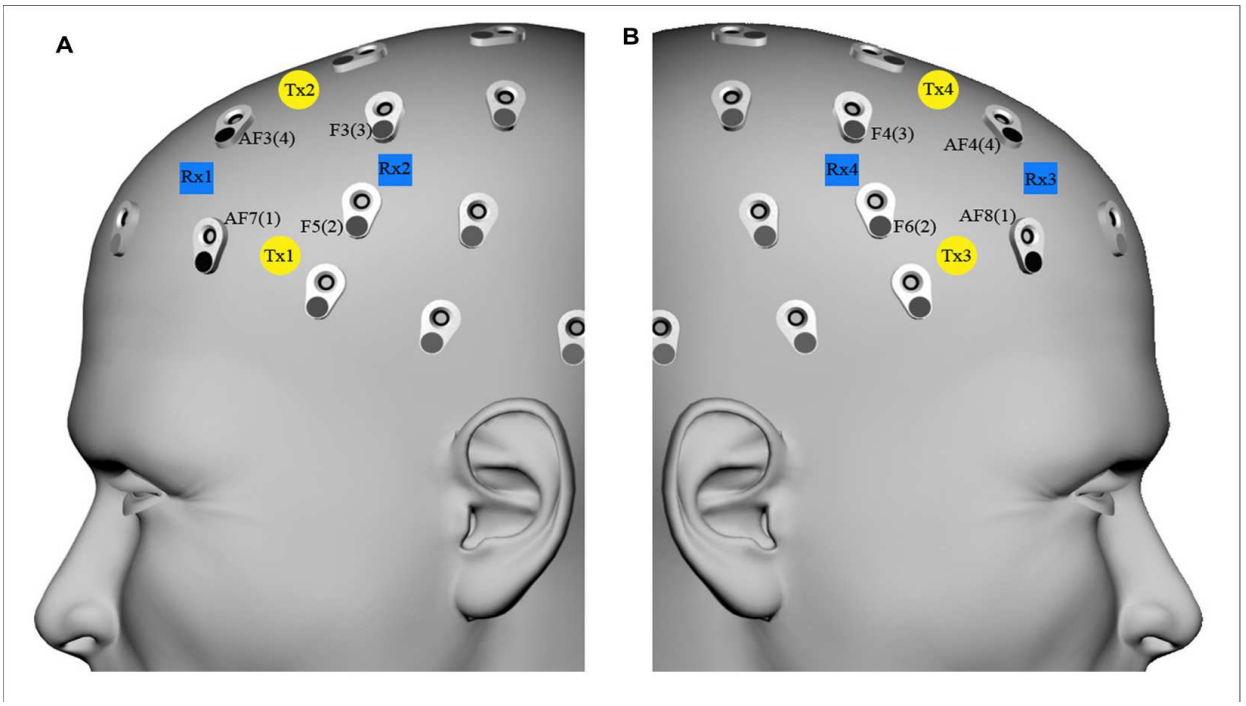


Figure 8. fNIRS optode localization on the forehead scalp region overlying the dorsal part of the prefrontal cortex. Ferreri, Laura & Bigand, Emmanuel & Bugaiska, Aurélia. (2015).

Figure 8, showed a significant decrease in dorsal prefrontal cortex (DLPFC) when words were presented with music compared to silence. This result suggests that music listening while word recognition improves the performance in verbal tasks.

Understanding these mechanisms and implicating them in real help to individuals significantly improves cognitive skills. Especially to apply it to patients with dyslexia, dementia and Alzheimer's disease.

Summing up the chapter, I can conclude that the influence of music on memory is so influential that it is impossible to ignore it.We listen to music every day and don't even think about how it affects our brain. It is generally accepted to think that music is more for entertainment and consolation in emotions, but in fact we do not take full advantage of the opportunities that music gives us.

Using music in the study of new information will significantly increase the effectiveness of the acquired material. It is better to form it into a long memory. And by associating music with one or another memory, we get the very effect of nostalgia, which is sometimes simply necessary for mental well-being.

However, not all genres of music have a positive effect on memory and attention. Scientists have proven that pop music negatively affects mindfulness and memory due to the monotony of the rhythm.

Excessive music listening also has a negative impact on attention (Chen et al., 2023). While some claim that music improves work efficiency, research has shown that listening to lyrical music can be distracting, especially when performing tasks that require verbal processing (Vasiliev et al.)

Music and emotion

Music has the power to evoke personal emotions such as happiness, sadness, joy and melancholy. An important aspect of music's influence on emotions is the use of musical elements such as rhythm, melody, harmony and tempo. For example, fast tempos and bright melodies evoke feelings of joy and elation, while slow, deep sounds are associated with sadness and longing. Emotional responses to music are also influenced by individual tastes, cultural background and personal experiences.

Research has shown that singing can effectively regulate emotional states and help people cope with stress and anxiety. This phenomenon is attributed not only to music's function as distraction and relaxation, but also to its ability to allow complex emotional states that are difficult to put into words.

The resulting emotions interact with the brain's neural rewards and emotional processing. When listening to music, the limbic system in the amygdala, which responds to emotions, actively releases dopamine, which is linked to reward and pleasure. This neurochemical response explains why music promotes feelings of euphoria.

One prominent approach is a cognitive appraisal theory that explains emotions are elicited by an individual's cognitive evaluation or appraisal of a stimulus, including music. So the musical features such as pitch, tempo, rhythm, directly influence on the emotional valence and arousal. For example, the fast tempo is usually associated with happiness and slow tempo with sadness.

Action tendency theories provide an alternative viewpoint, positingthat emotions prime individuals for particular action reactions, such as approaching or avoiding a stimulus. In the field of music, specific musical elements may unconsciously provoke physiological

changes and action tendencies that result in emotional responses.For instance, a fast tempo and high volume may evoke sensation of excitement and the tendency to become active.

On the opposite feeling theories characterize emotions as individual internal perceptions that result from physiological alterations within the body. In the context of music, the auditory elements can directly prompt bodily reactions, such as changes in heart rate and skin conductance. These physical responses are subsequently interpreted as emotional sensations, encompassing happiness, sadness, or fear.

In general, research has shown that the relationship between music and emotion is a multifaceted phenomenon involving cognitive, physiological and subjective processes. Emotional responses are determined by variables such as an individual's musical competence, cultural heritage and personal connection to music. Despite the valuable perspectives provided by various theories, there is no single comprehensive theory that can fully explain this complex phenomenon.

The multiple mechanism theory suggests that music triggers emotions through a mixture of six mechanisms: brainstem reflexes, evaluative conditioning, emotional contagion, visual imagery, episodic memory and musical anticipation. These mechanisms are intricately intertwined to elicit emotional responses to music. This framework is based mainly on the work of Berlyne 1971; Meyer 1956, but adds the work of Juslin & Sloboda 2001. Integrating both theories provides a broad description of the mechanisms.

Brainstem reflexes are psychological processes that elicit an emotional response to music by interpreting basic acoustic features as signals of important or urgent events. This process suggests that certain musical elements, such as unexpected transitions, volume, dissonance and rapid temporal sequences, can evoke arousal or discomfort in individuals. Reflexes in the brainstem are responsible for sensory, motor, auditory and emotional arousal. It plays an important role in reflexive responses to music. Rapidly, alertness to concentrate on

potentially important stimuli in the environment increases. This mechanism involves stimulation of the central nervous system and is influenced by neurotransmitters such as norepinephrine and serotonin.

Evaluative conditioning refers to the psychological process by which music is repeatedly paired with positive or negative stimuli to elicit emotions. This association ensures that a particular event or experience consistently evokes a particular emotion in the individual. Repeated pairings ensure that music independently evokes similar emotional responses in the absence of the original stimulus. This conditioning process represents classical conditioning in which a neutral stimulus, called the conditioned stimulus, is associated with an emotionally effective stimulus, called the unconditioned stimulus. As a result, the conditioned stimulus elicits the same emotional response as the unconditioned stimulus. Surprisingly, evaluative conditioning can occur without the individual being consciously aware of the link between the music and the emotional response, emphasizing the automatic and implicit nature of this mechanism.

Emotional contagion refers to the psychological process by which emotions towards the music are evoked through the listener's interpretation and reproduction of the emotional expressions conveyed by the music. This in turn triggers similar emotions. The listener internally reflects the emotional content of the music, creating a shared emotional experience between the music and the listener. The emotional impact of music through emotional contagion during listening demonstrates the profound ability of music to elicit and communicate emotions at the interpersonal level. By interpreting and internalizing the emotional content of music, individuals form an emotional bond with the music and potentially participate in the emotional state expressed by the music. This process emphasizes the importance of empathy, reflection and shared emotional encounters in influencing the emotional impact of music on individuals.

Visual symbolism capacities as a cognitive prepare that inspires an passionate reaction within the person, such as when the intellect visualizes pictures whereas tuning in to music. This component includes the arrangement of mental representations or scenarios within the individual's intellect created by sound-related jolts, eventually driving to feelings interwoven with the envisioned visual substance. When mental visualizations are accompanied by music, different situations, scenes and stories can be visualized that are impacted by the enthusiastic tone and rhythm of the music and the topics of the verses. Such inventive visualizations have the potential to inspire feelings closely related to the envisioned substance, coming about in an all encompassing and immersive passionate experience in which both sound-related and visual jolts are coordinated.

Episodic memory may be a cognitive handle in which music triggers the review of a particular occasion in a person's life, which in turn triggers an passionate reaction in that individual. This frame of memory is related with the review of personal encounters and occasions related with a specific minute or put, regularly with passionate and relevant highlights related to that occasion. Long winded memory is significant in affecting enthusiastic reactions to music through the affiliation of music with individual life occasions and encounters. Music that brings out emotionally critical or significant recollections can inspire solid enthusiastic reactions and trigger sentiments of nostalgia, connection and reverberation with the past within the audience. This preparation highlights the vital impact of individual recollections and life encounters on the passionate effect of music on people. Introduction to music that brings out long winded recollections permits individuals to review past occasions, circumstances and their association to the music being played. This kind of memory brings out the beginning feelings felt at the time and causes a repetition of the enthusiastic state related with the past involvement.

Musical anticipation (Meyer, 1956) refers to the psychological process that creates emotions in the listener as a result of the development of a piece of music being realized or violated as expected. This process is based on the idea that listeners familiar with a particular musical style or genre form internal predictions and expectations about arrangements, harmonies, rhythms, and other musical components. While listening to music, their brains form predictions about what will happen in the music based on patterns, repetitions and established criteria of musical arrangement. These predictions lead to emotional responses when the music meets or fails to meet the listener's expectations, resulting in feelings of happiness, surprise, anxiety and determination.The concept of musical anticipation is strongly linked to the idea of musical syntax, where individuals' hierarchical perception of musical arrangements and frames can predict upcoming musical events.

All the mechanisms listed here are crucial for understanding how music evokes different emotions. Recognizing that emotional responses to music are multifaceted and influenced by a variety of factors, researchers suggest that our understanding of emotional processes in music should go beyond musical anticipation. Musical anticipation, which predicts musical progression based on familiar patterns, is important, but it does not encompass all the emotional responses that music can elicit.

The music-emotion theory encompasses various frameworks that seek to explain how music evokes emotional response. According to this perspective (Konečni et al. 2008) , music itself does not directly elicit emotions. Instead, the impact of M → E is often influenced by memories, associations, and various social behaviors that provoke emotions, such as dancing (Fig. 9). Juslin & Västfjäll identified at least the six psychological mechanisms underlying the M → E (Fig.8)

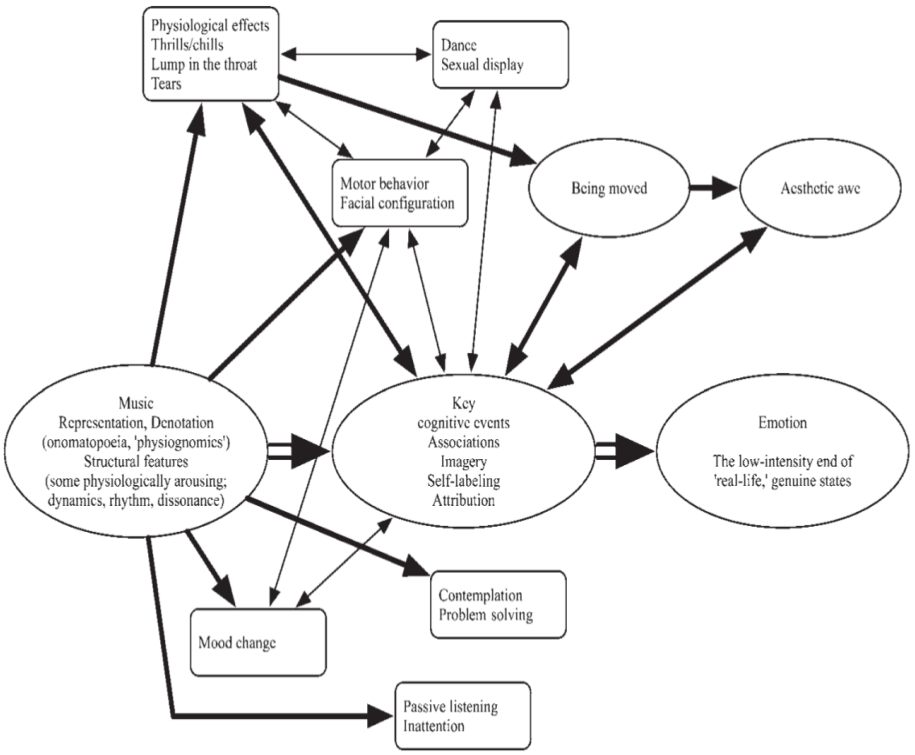


Figure 9. Relationships relevant to the induction of emotion by music. Konečni et al. (2008)

The Fig. 9 represents the flowchart of processing how listeners process music and form emotional responses that involve the complex interaction. The process of music exposure starts when listeners are exposed to a piece of music. It covers various contexts, such as listening to songs on radio or background music in a film, and attending a concert. In addition, based on the prior experience of music, the listeners form the expectations about music. The expectations of music influence the factors such as familiarity with musical structure, genre of the music, listeners's mood and the setting. So If music goes in a way with an individual's expectations, it can lead to feelings of satisfaction, joy and pleasure. The listener's enjoy the music more. However, if music represents a different way from expectations, it can evoke emotions such as surprise, tension and sometimes discomfort . The emotional impact in this case depends on context and listeners' personal experience.

The theoretical framework of Leonard Meyer (1956), Emotions and Meaning in Music, is the most influential in studying musical emotions. Regarding the theory, music produces the emotions based on the listener's expectations and what happens in fact, experiencing different degrees of tension and relaxation. Meyer defined three sources of expectations. The first, extra-opus knowledge, refers to general patterns in a music style. This is about the listener's knowledge of melody, rhythm, and harmony and their expectations in musical context. The second source, intra-opus knowledge, about experience only a certain piece of music and expectations based only on this piece. And the last, implication-realization model (Narmour 1990;1992), refers that generally listeners expect small changes in pitch but if there are big differences that fills a gap.

The PET study Blood and Zatorre (2001) showed brain responses during active listening that point in specific time points with strong emotions as physiological responses. In another fMRI study (Krumhansl 2005) represented activity in the area of the secondary auditory cortex when listener's detect violations in rhythm and chord. In addition, in study (Koelsch et al. 2005) when unexpected chords elicit orbitofrontal cortex activation, this area also supports the emotional processing.

The previous studies support the idea that the brain reacts to changes in music that differ from expectations. So unconsciously, every time during the listening music or song individuals have expectations from chord and rhythm based on previous experience. So any violations in chord or rhythm elicit ambiguous emotional responses. By contrast the music that expected elicit more positive emotional response but also negative based on an individual's past experience with certain music.

The importance of explaining reactions to music argued by researchers. Some may be interested in why music evokes reactions. Some are more interested in specific effects of various musical features. Also, the absence of mapping the particular emotional response

while listening to music leaves a big gap in this area. When individuals listen to music alone it elicits reactions that may be completely different while listening to the same music in a group. So the group sharing the music as a powerful tool for socializing may have stronger emotional responses. So we can experience the same music in different ways. The fact that is known is the general emotional response in brain stem reflex, auditory cortex, episodic memory that show activity during the music.

Moors, A., & Kuppens, P. (2008) in their article explain the theory of two types of emotions and consider the aspect of understanding how music evokes emotional responses. In type 1, emotions directly connect with music. These emotions evoke the listener's evolution liking or disliking the music. In type 2, emotions are linked to context of music or symbolic meaning. They are more abstract such as nostalgia, sadness,or happiness. The distinction between type 1 and type 2 represents how the appraisal is working in musical context. While the type 1 is more straightford and concrete, like or dislike, the type 2 does not always require cognitive appraisal in the same way.

By distinguishing type 1 and type 2 researchers may understand better emotional responses on music. The sea differences between them help to understand how the reactions are not the same evoked by music. Also, support the idea that emotional response to music does not always require cognitive appraisal, it could be intuitive and instinctive.

Some time recently that, we talked as it were almost the positive impact of music on feelings and the instruments of how music causes feelings in common. Be that as it may, it ought to be famous that music can cause not as it were positive feelings, but moreover negative ones.

One of the main factors influencing the emotional perception of music is the content of the lyrics. Some lyrics may contain negative messages, such as the promotion of violence, hatred and aggression, which cause stress, anxiety and depressed mood in listeners. For

example, research has shown that music texts containing sexual violence and violence in relationships increase negative emotions and form negative attitudes in youth and adults (Wang & Jiang, 2022).

It is not only texts and lyrics that have a negative impact on emotions. The tone of music also has a negative impact on emotions. Research has shown that listening to melancholic music causes negative emotions such as apathy and sadness (Hahn, et al. 2022)

The study (Chen et al., 2023) hypotheses the possible negative influence music has on cognitive functions such as attention, behavioral changes. Notably that this study is focused on adolescence.

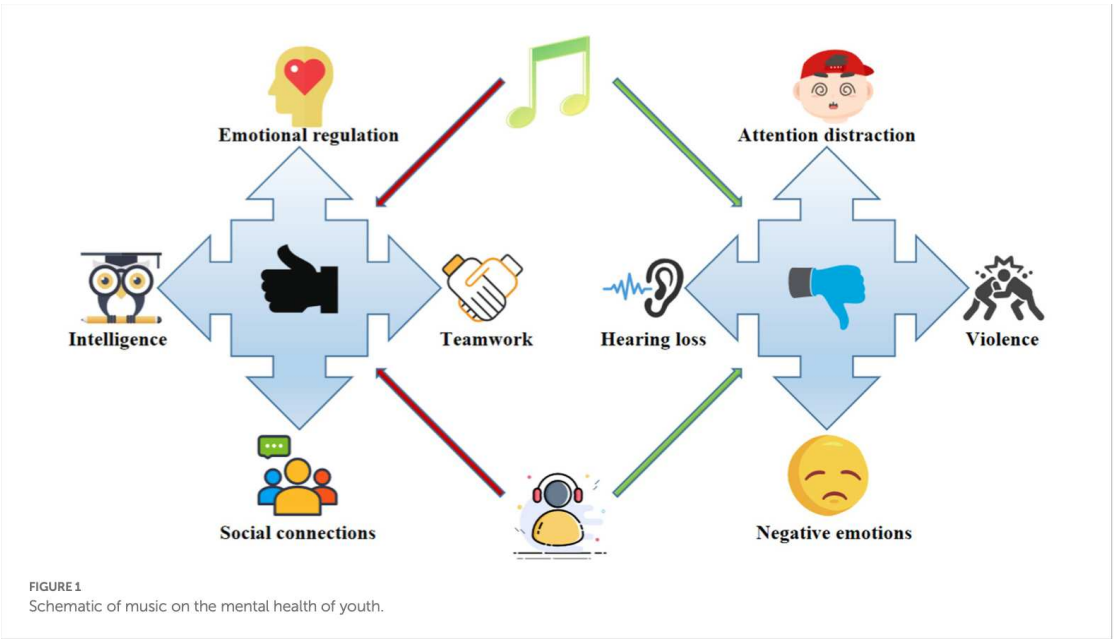


Figure 10. Schematic of music on the mental health of youth. Chen et al., (2023)

Fig. 10 schematically shows how different music may influence in positive ways also in negative ways.When the music carries an aggressive character in the lyrics or in the intensity of the melody. This can lead to inattention, irritability and aggression. Many people may dismiss this because they do not take the influence of music seriously. However, do not

forget that music affects both the conscious part of the brain's processes and the unconscious part.

The results showed that music has a significant effect on mental health as in positive and negative ways. On the one hand, it has an impact on social connections, intelligence, emotional regulation and creativity. On the other hand, music evokes negative emotions and violence because of the aggressive melody or lyrics; excessive listening may decrease the hearings; and distract attention.

Music-evoked emotional memories

In the previous chapters were presented articles and studies that music is able to different emotional responses such as sadness, happiness, joyful, loneliness; and memories. This chapter will present more studies as examples of the strong relation between music, memory and emotions in one context.

Emotions such as music have a big impact on formation memory. In both cases involved in conscious level and unconscious level. Previously the study proved the theory that situations or memories with emotional context are better recollected in memory and easily recognized later. Also, the same effect with music, if music had emotional responses it would be more memorable. So emotional contests are crucial for formation of memory and in relations between music, memory.

Music is able to evoke strong emotional memories that could be positive and negative based on the past events and previous experience. So music helps to form the memory that is associated with a certain piece of music.

The scientist from University of California found that music helps to form more strong long-term memories. The study by McClay, M., et al. (2023) used music to manipulate the emotions of volunteers who performed simple tasks on a computer. Researchers have found that the dynamics of emotions turn neutral experiences into memorable events.

Over time the brain has a tendency to group the episodes of memories because information that is restored to the brain is too much. This process involved two processes: The first, unified and compressed memories; the second, expands and separates each memory as experience expands into the past. The working of the two processes help to form clear memories.

The researchers found the music composers that created a certain music to elicit sad, joyfull, calm feelings and anxiety. The participants listened to the music, while imaging the story, at the same time on the computer were presented neutral pictures such as a ball, piece of watermelon and a wallet. Also, clicking the mouse detects emotional changes in music response. Later, the participants were tested again and watched the same pair of pictures. In the result, they showed that they better remember the pictures that were before or after emotional changes.

On the next day participants came again to check long-term memory. They remembered pictures that had emotional changes on a piece of music rather than a neutral response. Specifically, if they experienced strong positive emotions. These findings suggest that positive emotions unify different elements of experience into a memory. It is leading to better order memory and more compressed.

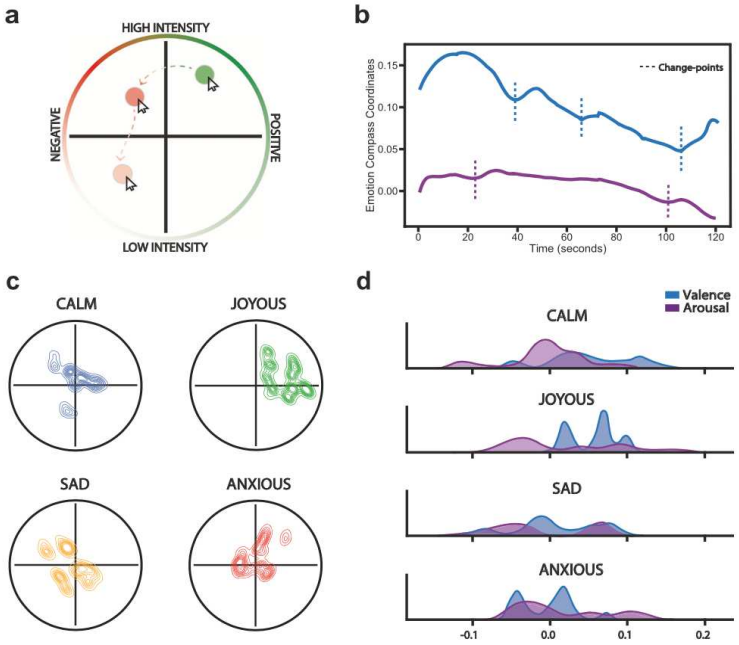


Figure 11. Emotion compass mechanisms and emotion category profiles. McClay, M., et al. (2023)

To track the emotional dynamics, continuous valence and arousal ratings was used by the Emotion compass tool (Fig. 11). The change point algorithm identified the change in the mean and slope algorithm. Also, the researchers used a data driven approach to identify the emotional valence and boundaries in felt emotions while participants listened to music.

In addition, the research highlights that neutral information encoded during the high-arousal emotional state is better remembered that indicates a role of positive effect. These findings have significant implications for clinical practice. It suggests that manipulating emotional states could improve memory encoding and remembering.

Also, to understand how the music-evoked emotional memories, highlights the concept of mood-congruency. Mood- congruency is the tendency of individuals in the current emotional state able to recall information that is consistent with that mood. Specifically, when

a person is in an emotional state such as angry, happy, sad, or anxiety, they are more likely to recall the memory when they were in the same emotional state.

For instance, if an individual is happy, they have a tendency to recall information or memory that evokes happiness. In contrast, if someone is angry, they will recall negative memories or information to match the current mood state. This effect occurs because we perceive and process information through emotions, increasing access to memories that corresponds to the current mood.

To support the mood-congruency effect in music-evoked memories, the study by Talamini, E., et al.(2022) hypothesized that emotions evoked by music would lead to better memorization of congruent images rather than incongruent.

Participants did a task with 15 excerpts of music that evoke a current emotion. Following each excerpt,they viewed a set of pictures that were emotionally congruent with music and incongruent.

The result supported the hypothesis and showed the participants were more accurate in recognizing congruent images that match to emotions evoked by music. The notion, emotions induced by music have a positive effect on memory recall and cognitive processes.

However, the limitation of this study is now being able to analyze how different types of emotions affect recognition accuracy. Also, the inability to compare the recognition of emotional pictures with neutral ones.

Young people have a better memory than older people and it is explained by brain plasticity. However, is there age difference in music-evoked emotional memories?

The study by Salakka, I., et al. (2021) hypotheses the specific acoustic features evoke the emotional response and autobiographical memories among older adults. The study

explores how musical features influence emotional valence, arousal, emotional intensity, and how they relate and recall memories.

In this study, 113 participants, healthy older adults, the age range from 60 to 86. Participants listened to which 140 song excerpt. These excerpts included the popular song from the 1950's to the 1980's. Participants were asked to rate songs based on the five domains: emotional valence (pleasant/unpleasant the song), arousal (the effect of arousal state), emotional intensity (strength emotional response by music), familiarity (familiar/unfamiliar the song) and autobiographical salience (personal evoke memories based on experience). These ratings were collected by using behavioral assessments, to analyze the correlation between emotional responses and memories evoked by music.

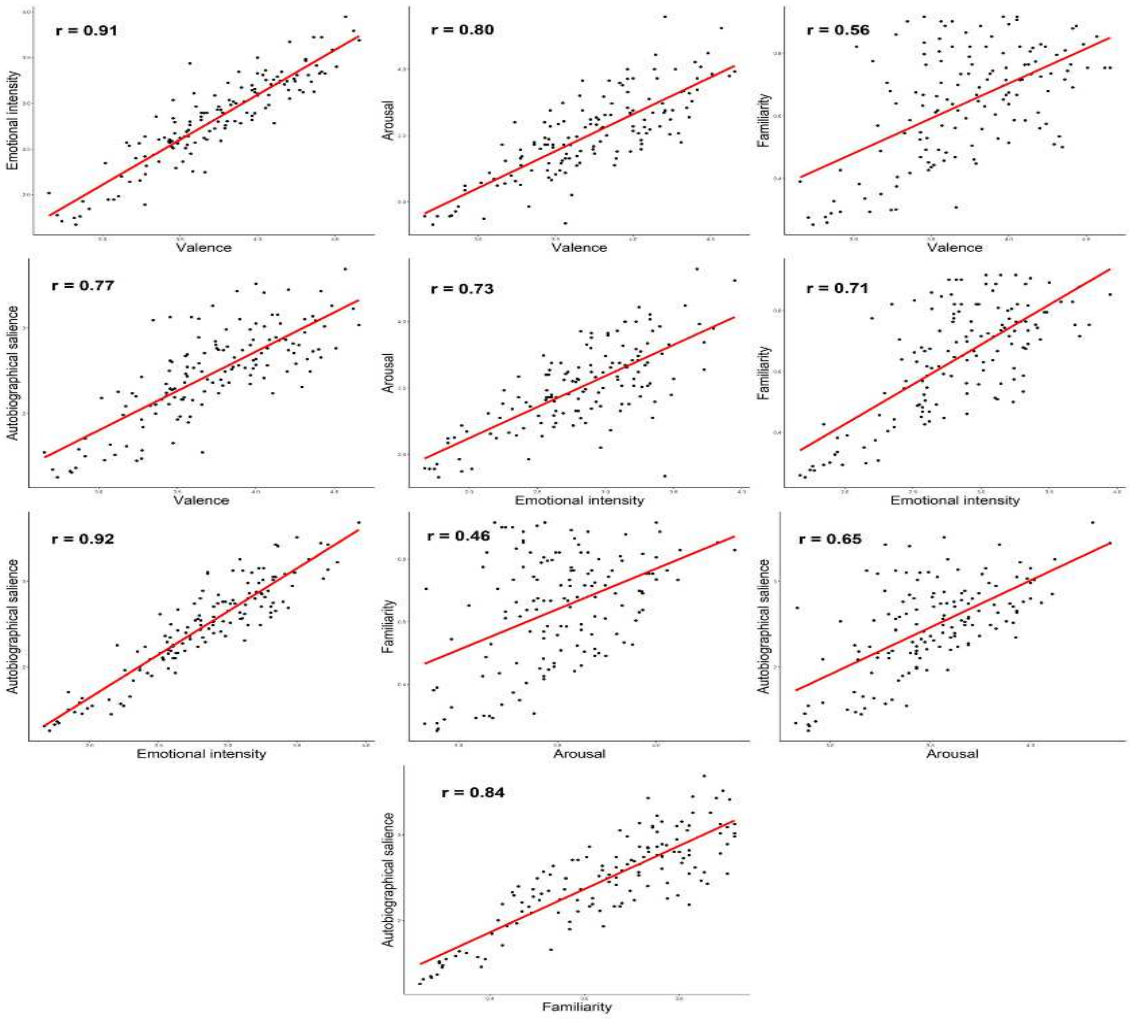


Figure 12. Relationships between the behavioral ratings of the songs. Salakka, I., et al. (2021)

In the result (Fig.12), they found positive correlations between emotional responses and memories evoked by music. Also, the familiarity and autobiographical salience have the highest correlation with emotional intensity, that means the strong emotional responses relate with personal memories. In addition,the correlations between memories evoked by music and emotional response might be greater in older adults rather than younger because of the nostalgic nurture of music selected from participant's earlier life stage.

The study Salakka, I., et al. (2021), supports the hypothesis of the strong connection music-evoked emotions and memories in older adults. The emotional intensity is crucial for memory recall, also familiarity of the song is boosting the emotional responses and the pleasantness of remembering personal experiences. Also, noted that older adults have a stronger nostalgia connected with music from their past that evoke significant emotional response. These findings could be helpful in therapeutic implications, especially with older adults to improve the well-being and memory recall.

Summarizing the results of this chapter, we can conclude that the complex work of music and emotions can evoke strong emotional memories. This is because a person remembers information better if they have experienced a certain emotional context. In addition, music can cause the effect of nostalgia and evoke autobiographical emotions. Together, they provide a more powerful tool for memorizing certain information in a long memory. It is also a kind of filter, so the brain cannot constantly remember everything, then the information is erased over time or goes into a long memory, then music is the trigger for calling them.

Using music as a trigger to evoke emotional memories can be effectively used in music therapy for patients with dementia and Alzheimer's. Since such patients have a long memory in the early stages and music helps them to evoke memories.

Clinical implications

Alzheimer's disease is a form of progressive dementia. The development of the disease leads to a gradual loss of cognitive function in patients in the older age group (60-65 years). Individuals suffering from senile dementia experience memory loss, decreased attention span, loss of speech, spatial orientation, and basic thinking skills.

Alzheimer's disease is the most common type of dementia in the world. It occurs more often in women. They account for up to 60% of diagnosed cases. Many doctors attribute this fact to the higher life expectancy of women compared to men.

Pharmacological and physical therapy treatments for Alzheimer's disease do not achieve a cure or slow its progression. The therapy protocols followed by clinics are aimed at alleviating symptoms and improving the quality of life of people suffering from dementia.

Psychosocial therapy plays an essential role in preserving the quality of life of patients. Doctors help sick people to adapt to the disease. In the late stages of dementia, psychotherapists use art therapy, sensory integration methods, music therapy and memory stimulation.

The effect of music within the treatment of dementia and Alzheimer's infection has been a theme of developing interest in later a long time among the logical community, restorative experts and caregivers of older people. These illnesses are characterized by the

progressive loss of memory, cognitive work and other mental capacities, essentially reducing the quality of life of patients and their loved ones.

Music therapy is an approach that has shown potential to improve the emotional state, cognitive functioning and general well-being of patients with dementia and Alzheimer's disease. The method is based on the use of musical sounds and elements to achieve specific therapeutic goals, such as improving mood, reducing aggressive behaviors, stimulating cognitive processes and improving the quality of interaction in social settings.

In a small study (Norberg et al., 1986) music was the only stimulus that elicited a response from people in the end stages of Alzheimer's disease. They measured response by measuring heart rate, breathing, blinking and mouth movements (Dawson et al., Page 62) Aldridge also cites evidence that music therapy is important in improving the quality of life of people with Alzheimer's disease. A sense of belonging and acceptance of others is conveyed through music (Aldridge 1994, p. 275)

One of the key aspects of music's impact on dementia patients is its ability to stimulate cognitive function. Research shows that even with significant memory loss, music can activate memorized melodies and lyrics, which aids recall and improves verbal response in patients. This is because music activates different areas of the brain, including those responsible for processing musical and verbal stimuli.

There is research that supports the fact that Alzheimer's patients are able to retain musical perception (Gerdner and Swanson, p. 285). I call the ability to memorize music when many other abilities and memories seem inaccessible “musical memory.” I see this when a patient remembers all the words in a song but rarely speaks or cannot string a sentence together. I see it when we sing a song and five minutes later the patient is still humming it. This is what makes music “...a powerful catalyst for memories ...” (Gerdner and Swanson, p. 285).

Music moreover features a solid affect on the enthusiastic state of individuals with dementia. It can bring out positive feelings, diminish anxiety and depression, and diminish aggression and negative feelings. Usually especially vital given that numerous individuals with dementia endure from passionate ups and downs, social separation and sadness.

Music therapy increases social interaction in people with dementia. This is because musical activities serve as a means of interacting with others, including healthcare professionals, family and friends. Singing, improvising and listening to songs together can help create a positive atmosphere and strengthen bonds with others.

The growing interest in non-pharmacological therapies, particularly to improve the behavioral and cognitive symptoms in patients with Alzheimer's disease. Even though this intervention is popular, the evidence regarding the effectiveness has been inconsistent. The systematic review by Bleibel, M., et al. (2023) summarized the evidence of effective impact of music intervention by self or with combinations with pharmacology to improve the cognitive functions of patients with AD compared to patients that do not receive music interventions. The review focused on the publishing that had cognitive outcomes such as attention, memory, and general cognitive function.

In this systematic review was performed the meta analyses (PRISMA 2009) and Preferred Reporting Items for Systematic Reviews. Also, they used PICO framework:

P: Alzheimer's disease

I: Music therapy (alone or with pharmacological interventions)

C: Alzheimer's patients with interventions or without

O: Cognitive functions

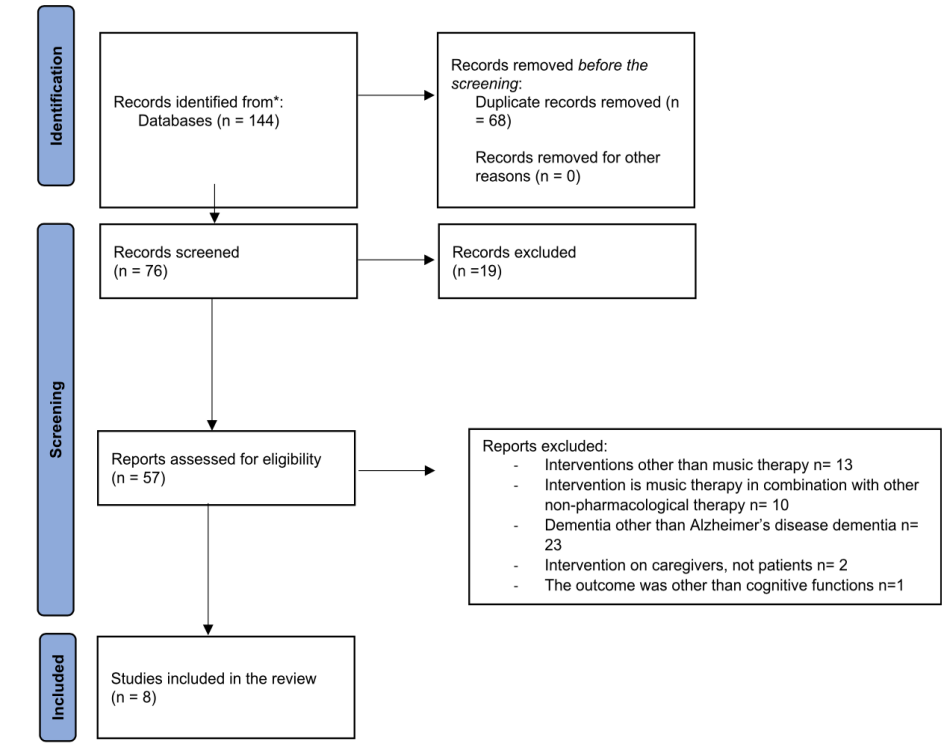


Figure 13. PRISMA flow diagram of the selection procedure. Bleibel, M., et al. (2023)

The Fig.13 is a flowchart of identified papers and exclusion criteria. So in total were identified 144 publishing. After the exclusion of duplicate and cut off relevant papers, 57 left. And at the end only 8 papers left because of exclusion and inclusion criterias.

The study by Narme, et al. the conducting effectiveness of cooking and music interventions. The study lasted 4 weeks. The results showed the positive effect in emotional regulation, decreased the severity of behavioral disorders, and even distress for the caregivers.

The study by Pongan tested the effectiveness of singing versus painting among AD patients. This lasts around 12 weeks. In both tasks there were positive results, decreased anxiety, sadness, and depression. However, one advantage singing has among painting is improving verbal memory.

The study by Sakamot, et al. focused on the effectiveness of music interventions. The positive effect was observed in emotional regulations and short-term memory. Also, music therapy had a good impact on long-term psychological and behavioral symptoms of dementia.

Gómez, G., and Gómez, G., studied the possible effect on language and memory and showed an increase on MMSE. The study compared active music versus passive music. In the result patients with AD showed improvement of cognitive and behavioral functions during the active music interventions.

Lyu, et al. studied music therapy in improving cognitive functions and mental well-being in patients with AD. In this study participants were asked to recall 15 verbal words immediately and after 30 minutes. The results showed that music effective verbal fluency, reduced psychiatric symptoms and distress caregivers.

The study by Innes et.al tested musical therapy over 12 weeks. The cognitive functions such as memory, attention, psychomotor speed, and working memory were tested by different assessments such as Memory Functioning Questionnaire and Trail making test. The participants were tested twice after 3 months and 6 months. The result showed that music therapy helps to improve cognitive functions, in working memory, psychomotor speed, and attention.

Alzheimer's disease is a big challenge for adults. Unfortunately, it cannot be cured, but it is possible to improve the quality of life of people and their caregivers. The above studies have proven that not only pharmacological treatment can help, but also music therapy. It has a positive effect on mental health and improves cognitive skills such as memory, attention, memorization of new things and psychiatric speed. The authors recommend a better study of music for Alzheimer's patients as it will be a really strong tool to improve effectiveness in a long-term perspective.

`The study conducted by Gulliver, A., et al. (2021) proposed the Music Engagement Program for AD patients. The researchers expected that involvement in music activities leads to improvement in emotional well-being and reduces depression and anxiety. It was hypothesized that the interactive program, including familiar songs and social participation, would improve patients' mood, increase engagement, and foster social connections, ultimately contributing to a better quality of life. The goal of the program was to demonstrate that music can serve as an effective non-pharmacological intervention in residential care for people with cognitive impairment. In the study 25 people, 16 residents, 6 staff, and 3 from the family or community members. Fig. 14 showed the participants' characteristics and follow-up the studies assessment.

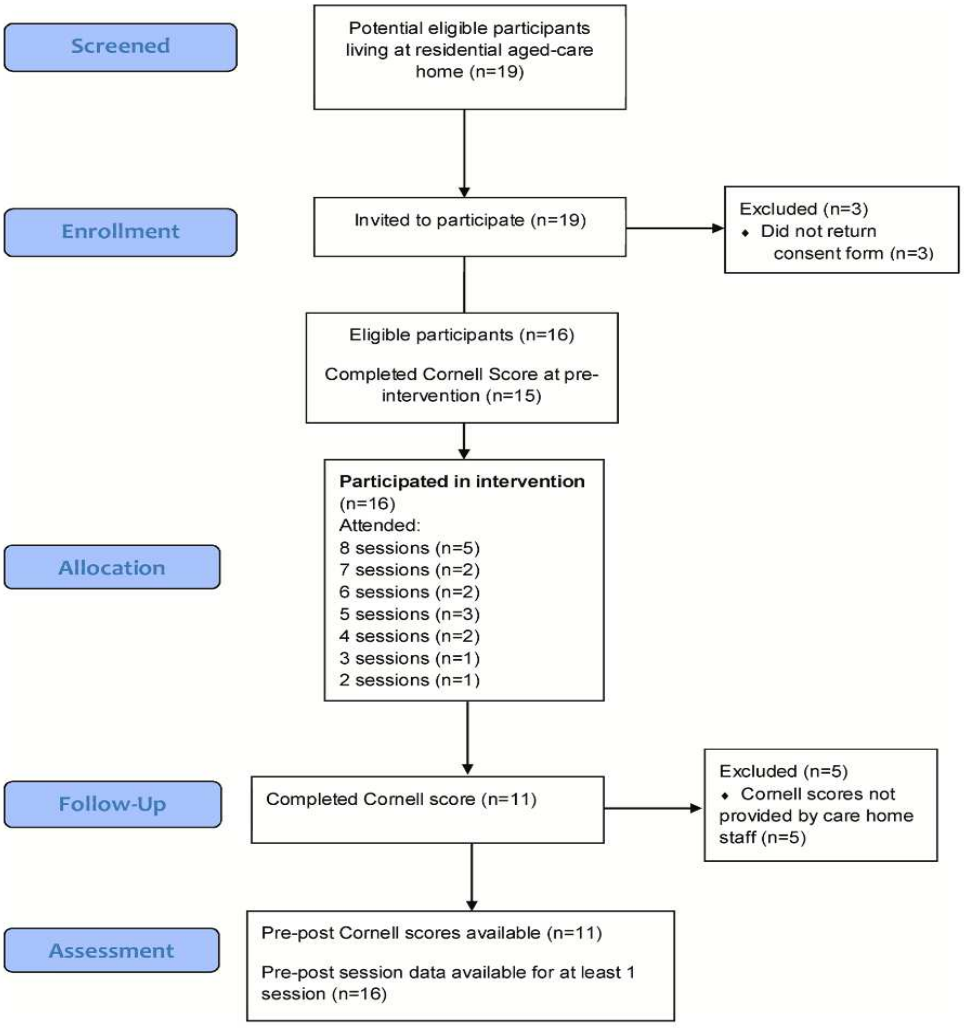


Figure 14. Trial flow chart. Gulliver, A., et al. (2021)

Information of enthusiastic well-being and side effects of sadness were collected some time recently and after the program to distinguish the changes. Subjective information was collected from family community individuals by meeting to investigate their desires of the program. Quantitative information conducted utilizing matched tests t-tests to evaluate changes in depression scores and enthusiastic well-being. The information was analyzed to assess the viability of MEP.

Participants showed a significant improvement in emotional well-being after the program that was clearly observed in Fig.15 participants were self-reported before and after music sessions. Also, the quantitative analyses presented decreased depression symptoms among those who participated in music therapy. It suggests that music effectively copes with depression symptoms.

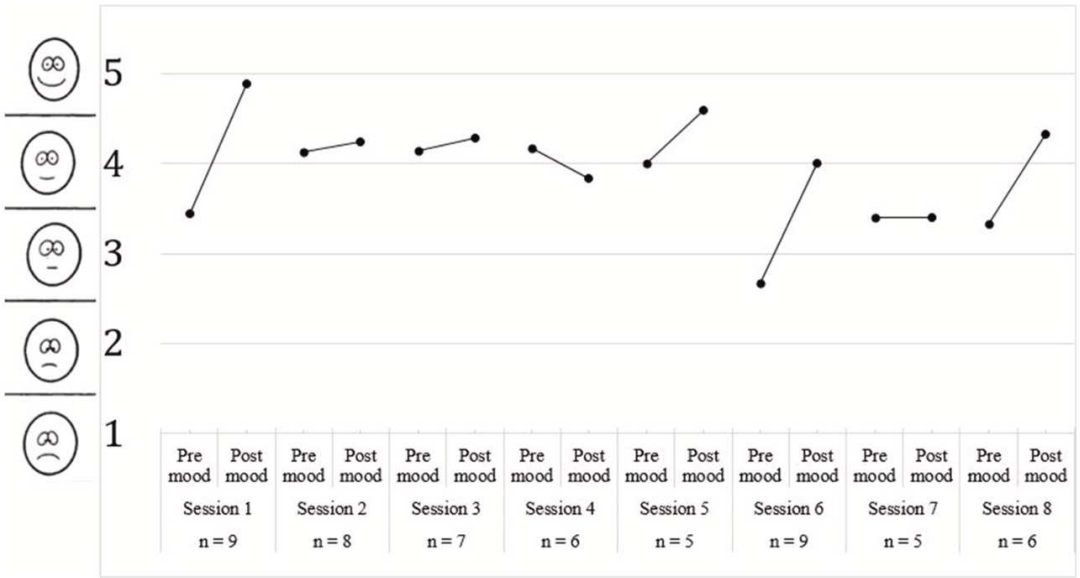


Figure 15. Pre - and post-session emotional wellbeing (WONCA chart). Gulliver, A., et al. (2021)

In addition, the program encourages social interaction and builds ties with the local community. This includes activities that create an atmosphere of cooperation, such as singing together. Social interaction is crucial for the positive impact of the program.

The researchers moreover collected criticism from family/community individuals. They found the program valuable and successful. As a result, inhabitants felt superior and the general environment within the domestic was more positive.

The Music Engagement Program (MEP) was examined and found to have a positive effect on patients with Alzheimer's disease and dementia. The program was compelling in progressing the enthusiastic well-being of these patients and decreasing indications of sadness. Disposition and social intuitiveness too moved forward, making a sense of community and support among patients. Input from staff and family individuals affirmed the viability of the program, but there are concerns about supportability and the requirement for continuous back. They recommend that music can be an imperative helpful intercession in elderly care homes. Be that as it may, assist investigation is required to look at the long-term impacts of music treatment and to create successful execution procedures.

Cognitive reserve (CR) is the brain's ability to improvise and find alternative ways of functioning when faced with age-related changes or neurological damage. It is a theoretical construct that explains why some people can retain cognitive function despite the same level of brain pathology as others who experience significant cognitive decline.

The two main types of cognitive capacity are: neural reserve, which refers to the structural capacity of the brain (e.g. gray matter volume); and neural compensation, which refers to additional neural resources to maintain cognitive capacity in the face of cognitive decline.

An article by Wolff, L., et al., explores how cognitive function is preserved in the face of age-related decline and neurocognitive disorders, particularly Alzheimer's disease and dementia. CR is influenced by a number of factors such as education, occupational complexity and participation in stimulating activities. The authors focus specifically on music as a potential contributor to CR, emphasizing activities such as playing instruments, singing

and dancing. The authors emphasize that more research is needed to better understand the link between music practice and CR and to explore the mechanisms by which music promotes cognitive health across the lifespan. The authors acknowledge the challenges posed by the diversity of music production and the need to address current research gaps to fully understand the relationship between music and cognitive reserve.

The article notes that music can have a positive effect on cognitive reserve. Since activities like singing and playing musical instruments require certain cognitive functions. Music can also preserve and prolong neurocognitive functions for a longer period.

Cognitive reserve is very important for an elderly person who is faced with dementia and Alzheimer's, and music can help not to worsen cognitive functions for as long as possible, and accordingly only improve the quality of life.

It has been said more than once that music has a positive effect on the treatment of dementia and Alzheimer's, but what mechanisms are involved to give a positive effect. According to theory, two mechanisms of neuroplasticity and neurogenesis are involved here. Neuroplasticity and neurogenesis are accompanied throughout life and it is believed that plasticity decreases with age.

Usually in the studies or in music interventions used the music that relates to individuals or familiar to them to have better effect rather than random song. But are there any positive outcomes on the background music?

Bottrioli, S., et al (2014) conducted a study that focused on the effect of background music on cognitive functions. The aim of the study is the effect of various types of background music on declarative memory and data processing speed in the elderly. In particular, it compares the effects of optimistic music (Mozart's "Eine Kleine Nachtmusik") and gloomy music (Mahler's "Adagietto 5th Symphony") in order to assess their impact on

cognitive functions, thereby eliminating gaps in the literature and giving an idea of the potential benefits of music for the cognitive functioning of an aging population.

Participants were 65 non musicians, and ages range from 60 to 84 years. This study used upbeat and downbeat music. They had vocabulary tasks, depression questionnaires, mood questionnaires, and asked for episodic and semantic memory.

The findings showed that upbeat music is associated with fast tempo and enhances processing speed. In memory performance, both upbeat and downbeat have a positive influence on memory. The downbeat improves the semantic and episodic memory while upbeat increases the processing speed.

Participants evaluated Mozart's music as more emotional and happier rather than Mahler's music. Mahler's music was perceived as sadder. This supports the arousal and mood hypothesis, upbeat is a positive mood and high arousal. However, downbeat is a negative emotion. Nevertheless, both music have a positive influence on cognitive functions.

The familiar music has better outcomes in music interventions, because individuals have personal experience and memories that relate with familiar music. In contrast, unfamiliar music does not have the same effect.

The study Arroyo-Anlló EM et al. (2013) found that familiar music stimulation significantly improved the sense of self (SWB) of patients with Alzheimer's disease (AD). Patients listening to familiar music showed stabilization or improvement in several aspects of self-perception, including personal identity and emotional state, whereas the control group listening to unfamiliar music showed deterioration in most aspects of self-perception. Furthermore, cognitive function was preserved in the group exposed to familiar music, as evidenced by stable scores on the cognitive assessment, while the control group showed cognitive decline. This Study Suggests that familiar music may promote emotional

engagement and social interaction, reduce agitation and improve quality of life for both patients and their families. Overall, it is suggested that familiar music is an effective therapeutic tool to enhance the self-consciousness and emotional well-being ofAlzheimer's patients.

In the study two groups in each 20 participants with Alzheimer disease. Participants did self conscious questionnaire cognitive test MMSE and Frontal assessment short test in pre intervention stage and post intervention. So one group that is experimental listened to the familiar song in a passive manner, while the control group listened to the unfamiliar song. The sessions were three times a week and each around 2-4 minutes.

In the result (Table 1) , the experimental group that listened to familiar music highly improved self-consciousness (SC) in Alzheimer's disease. The participants who listened to familiar music were more stable in personal identity. Whereas, the control group who listened to the unfamiliar music declined the most SC facts. Moreover, the familiar music enhances cognitive functioning and more effectively forms SC and emotional well-being AD patients.

Aspects of self-consciousness (SC) questionnaire	Experimental AD group		t	P	Control AD group		t	P	P^a
	Mean (SD) Pre-	Mean (SD) Post-			Mean (SD) Pre-	Mean (SD) Post-			
A1: personal identity	3.08 (1.73)	3.48 (2.00)	−2.63	.023	3.26 (1.48)	2.84 (1.42)	2.21	.044	.019
A2: anosognosia	2.03 (2.31)	2.14 (1.96)	−0.67	NS	1.99 (2.44)	1.03 (2.63)	2.46	.027	.042
A3: affective state	0.8 (0.07)	0.93 (0.56)	−2.34	.031	0.79 (0.1)	0.77 (0.41)	0.11	NS	.02
A4: body' representation	1.9 (0.23)	1.99 (0.17)	−2.19	.049	1.72 (0.32)	1.88 (1.54)	−2.29	.049	NS
A5: prospective memory	0.65 (2.1)	0.63 (2.4)	0.23	NS	0.7 (1.91)	0.3 (3.1)	2.71	.019	.04
A6: introspection	0.75 (1.54)	0.74 (1.65)	0.22	NS	0.8 (1.63)	0.61 (2.34)	2.27	.048	NS
A7: moral judgments	0.9 (0.42)	1.3 (2.21)	−2.38	.037	0.91 (0.61)	0.64 (0.98)	2.36	.045	.034
Total score of SC	10.11 (2.44)	11.21 (3.14)	−2.07	.056	10.17 (2.1)	8.07 (1.8)	2.44	.038	.016

[a] *P* values referred to comparison of pre/post-intervention differences between the experimental and control AD groups.

Table 1. Means and standard deviation of good answers for each aspect of self-consciousness test produced by the experimental and control AD groups in the pre- and post-interventions phases. Arroyo-Anlló EM et al. (2013)

The familiar music makes SC stable and helps to preserve cognitive functioning. The study supports that in music interventions for AD patients need to use familiarity for

individual music for improving cognitive functions, emotional well-being, quality of life and social interactions. Overall, familiar music is a valuable fact when applying music interventions for AD patients.

Conclusion

Researching the connection between music, emotions and memory opens up deep and amazing aspects of the influence of sound art on the human psyche and perception of the world. For centuries, music has consistently accompanied humanity, having a significant impact on people's emotional states and memories. This phenomenon is not only important for the cultural heritage and identity of various peoples, but also has deep significance in psychology, neurobiology, music therapy and other fields of scientific research.

Modern neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) can help us understand which parts of the brain are activated when listening to music and how this activation relates to emotional and cognitive processes. For example, music has been shown to activate the limbic system, including the amygdala and hippocampus, strengthening the link between musical impressions and emotional memories.

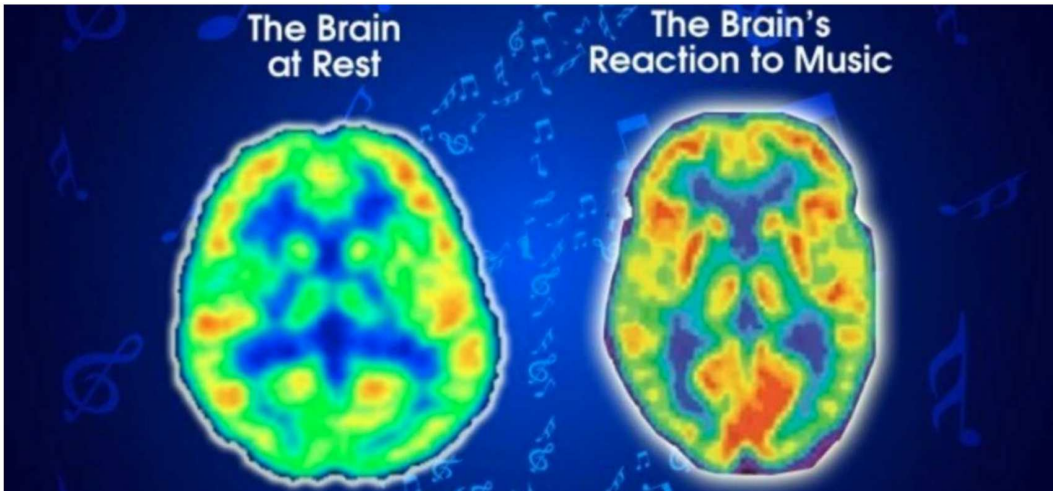
This thesis aimed to explore the topic of music-evoked emotional memories in more detail. The topic of music in psychology is vast and has not been fully explored. There are still topics that scientists have not solved to this day. However, what we have now clearly shows us how important music is in human life. Music is not just entertainment or part of

cultural development in society. Music has extensive effects on a person's cognitive processes and can improve the quality of life.

The effect of music within the treatment of patients with dementia and Alzheimer's disease underlines the significance of music treatment as an effective and promising strategy within the comprehensive care of these patients. Music treatment has the potential to move forward cognitive working and passionate well-being, as well as cultivate a positive environment for interaction and socialization. Later research has shown that music treatment is a fundamental asset in modern healthcare settings due to its wide range of applications and its flexibility to the requirements of each person.

In the context of behavioral science, music can also play an important role in the regulation of human behavior. For example, songs can inspire creative skills, encourage physical activity or contribute to the formation of certain social norms and values.

Music also has a strong influence on emotions, making people happy, sad, lethargic or joyful. People tend to listen to music that matches their emotional state in order to feel relaxed. Figure 15 shows the differences between brain activity at rest and music activity.



A number of studies have proven that music triggers emotional memories through cognitive functions. Memories in which there was an emotional response using music that matches with the emotion experienced at the moment are recalled much more clearly and

quickly than all others. Cheerful music makes it easier to experience complex memories, and structured music helps you remember information better. On the contrary, irregular music makes it difficult to encode memory.

The studies have also shown that familiar songs trigger more memories and do so more spontaneously. It turns out that a favorite song may be a more effective memory trigger than our favorite movie or book: all because we are more likely to re-listen to songs we like than revisit movies or reread novels.

The impact of music in the treatment of patients with dementia and Alzheimer's disease underlines the importance of music therapy as an effective and promising method in the comprehensive care of these patients. Music therapy has shown the potential to improve cognitive functioning and emotional well-being, as well as foster a positive environment for interaction and socialization. Recent research has shown that music therapy is an irreplaceable resource in contemporary healthcare settings due to its wide range of applications and its adaptability to the needs of each individual patient.

Music treatment is a fundamental portion of a comprehensive approach to treating dementia and Alzheimer's illness. This approach not as it progresses the mental and physical wellbeing of the understanding, but moreover makes a difference to decrease the burden on the patient's adored ones and caregivers. Music treatment is presently effectively practiced in different healthcare facilities, nursing homes and recovery centers and encompasses a positive effect on the lives of numerous individuals enduring from dynamic neurological diseases.

There are diverse procedures and approaches to music treatment, checking tuning in to music, effectively making music, singing, playing disobedient and act of suddenness. Each of these techniques can be reasonable depending on the patient's current condition and response to melodic boosts. For outline, singing and effectively participating in melodic

works out can fortify cognitive capacities and social interaction, while tuning in to loosening up music can diminish uneasiness and extend levels.

One of the most curiously viewpoints of music treatment is its effect on cognitive work in patients with dementia. In spite of the slow loss of memory and cognitive capacities in dementia patients, music can lead to progressed memory incitement and phonetic reactions by enacting memorized melodies and verses. Usually since music actuates distinctive districts of the brain that prepare melodic and etymological boosts, such as the hippocampus and frontal lobes.

The emotional state of patients with dementia and Alzheimer's illness too progresses essentially under the impact of music treatment. Music has the capacity to inspire positive feelings, decrease sentiments of uneasiness and discouragement, and diminish hostility and negative feelings. This can be especially vital considering that numerous patients involve periodic enthusiastic changes and feel separated from the world around them.

Music that is familiar to the patient may elicit more positive responses than unfamiliar music. It is assumed that 'familiar territory', i.e. what is known, will be more comforting than what is unfamiliar. Familiar music is predictable and therefore reassuring and comforting and is likely to be known and understood in unfamiliar environments, possibly after living in one's own home (e.g. in a nursing home - author's note). Unfamiliar music may be less successful as it requires more processing and analysis by the brain. When listening to new music (especially by musicians), the brain is often busy analyzing the instruments, assessing the overall quality, searching for melodies and interpreting lyrics. In people with Alzheimer's disease, these skills are probably no longer present or at a very low level.

The field of examination on the impacts of music on energetic memory and human mental well-being has various basic challenges and headings for future investigation. In show

disdain toward critical headways in this field, various questions remain unanswered, requiring support to examine and the advancement of unused procedures.

One of the foremost critical challenges is to get the more profound instruments by which music influences the human brain and mind. Neuroscientific inquire about has appeared that music enacts different parts of the brain, counting the limbic framework, which controls feelings and memory. Be that as it may, the particular atomic and neural instruments of this impact are not however completely caught on. Investigate in this heading may shed light on more exact ways of applying music treatment to diverse categories of patients, counting those enduring from dementia and other neurological disorders.

Another important area is the development of new music therapy methods tailored to the individual needs of the patient. This includes not only the selection of specific pieces of music, but also the development of individualized programs that take into account the cultural, social and psychological characteristics of each individual. Understanding which types of musical stimuli are most effective in improving cognitive and emotional functioning will improve music therapy outcomes and expand its use in clinical practice.

There's still much to consider in this field to move forward people's cognitive working and their by and large living environment. For example, different apps and online stages can offer coordinated music treatment into the standard and extend the populace of individuals who can benefit from it.

In conclusion, continuous research into the impacts of music on enthusiastic memory is an imperative challenge for science and medication. Tending to these issues will extend our information of music's potential as a therapeutic instrument and create unused approaches to utilizing music to improve the quality of life for many individuals.

References

1. Schäfer T, Sedlmeier P, Städtler C, Huron D. The psychological functions of music listening. Front Psychol. 2013 Aug 13;4:511. doi: 10.3389/fpsyg.2013.00511. PMID: 23964257; PMCID: PMC3741536.

2. Ferreri, Laura & Bigand, Emmanuel & Bugaiska, Aurélia. (2015). The positive effect of music on source memory. Musicae Scientiae. 19. 10.1177/1029864915604684.

3. Fennell AM, Bugos JA, Payne BR, Schotter ER. Music is similar to language in terms of working memory interference. Psychon Bull Rev. 2021 Apr;28(2):512-525. doi: 10.3758/s13423-020-01833-5. Epub 2020 Dec 2. PMID: 33269465; PMCID: PMC7710156.

4. Dingle GA, Sharman LS, Bauer Z, Beckman E, Broughton M, Bunzli E, Davidson R, Draper G, Fairley S, Farrell C, Flynn LM, Gomersall S, Hong M, Larwood J, Lee C, Lee J, Nitschinsk L, Peluso N, Reedman SE, Vidas D, Walter ZC, Wright ORL. How Do Music Activities Affect Health and Well-Being? A Scoping Review of Studies Examining Psychosocial Mechanisms. Front Psychol. 2021 Sep 8;12:713818. doi: 10.3389/fpsyg.2021.713818. PMID: 34566791; PMCID: PMC8455907.

5. Bowling DL. Biological principles for music and mental health. Transl Psychiatry. 2023 Dec 4;13(1):374. doi: 10.1038/s41398-023-02671-4. PMID: 38049408; PMCID: PMC10695969.

6. Welch Graham F. , Biasutti Michele , MacRitchie Jennifer , McPherson Gary E. , Himonides Evangelos. Editorial: The Impact of Music on Human Development and Well-Being. 2020 Frontiers in Psychology. doi:10.3389/fpsyg.2020.01246

7. Fennell AM, Bugos JA, Payne BR, Schotter ER. Music is similar to language in terms of working memory interference. Psychon Bull Rev. 2021 Apr;28(2):512-525. doi: 10.3758/s13423-020-01833-5. Epub 2020 Dec 2. PMID: 33269465; PMCID: PMC7710156.

8. Amy M. Belfi, Brett Karlan & Daniel Tranel (2016) Music evokes vivid autobiographical memories, Memory, 24:7, 979-989, DOI: 10.1080/09658211.2015.1061012

9. Janata P. The neural architecture of music-evoked autobiographical memories. Cereb Cortex. 2009 Nov;19(11):2579-94. doi: 10.1093/cercor/bhp008. Epub 2009 Feb 24. Erratum in: Cereb Cortex. 2010 Jan;20(1):254-5. PMID: 19240137; PMCID: PMC2758676.

10. Barrett FS, Grimm KJ, Robins RW, Wildschut T, Sedikides C, Janata P. Music-evoked nostalgia: affect, memory, and personality. Emotion. 2010 Jun;10(3):390-403. doi: 10.1037/a0019006. PMID: 20515227.

11. Jakubowski, K., & Ghosh, A. (2021). Music-evoked autobiographical memories in everyday life. Psychology of Music, 49(3), 649-666.https://doi.org/10.1177/0305735619888803

12. Kaiser AP, Berntsen D. The cognitive characteristics of music-evoked autobiographical memories: Evidence from a systematic review of clinical investigations. Wiley Interdiscip Rev Cogn Sci. 2023 May-Jun;14(3):e1627. doi: 10.1002/wcs.1627. Epub 2022 Oct 12. PMID: 36223919.

13. Demorest SM, Morrison SJ, Stambaugh LA, Beken M, Richards TL, Johnson C. An fMRI investigation of the cultural specificity of music memory. Soc Cogn Affect Neurosci. 2010 Jun;5(2-3):282-91. doi: 10.1093/scan/nsp048. Epub 2009 Dec 24. PMID: 20035018; PMCID: PMC2894677.

14. Schaefer HE. Music-Evoked Emotions-Current Studies. Front Neurosci. 2017 Nov 24;11:600. doi: 10.3389/fnins.2017.00600. PMID: 29225563; PMCID: PMC5705548.

15. Francesca Talamini, Greta Eller, Julia Vigl et al. Music-evoked emotions affect memory for emotional pictures, 29 November 2021, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-1110303/v1]

16. Juslin PN, Västfjäll D. Emotional responses to music: the need to consider underlying mechanisms. Behav Brain Sci. 2008 Oct;31(5):559-75; discussion 575-621. doi: 10.1017/S0140525X08005293. PMID: 18826699.

17. Jäncke L. Music, memory and emotion. J Biol. 2008 Aug 8;7(6):21. doi: 10.1186/jbiol82. PMID: 18710596; PMCID: PMC2776393.

18. Salakka I, Pitkäniemi A, Pentikäinen E, Mikkonen K, Saari P, Toiviainen P, Särkämö T. What makes music memorable? Relationships between acoustic musical features and

music-evoked emotions and memories in older adults. PLoS One. 2021 May 14;16(5):e0251692. doi: 10.1371/journal.pone.0251692. PMID: 33989366; PMCID: PMC8121320.

19. Talamini, F., Eller, G., Vigl, J. et al. Musical emotions affect memory for emotional pictures. Sci Rep 12, 10636 (2022). https://doi.org/10.1038/s41598-022-15032-w

20. Barrett FS, Grimm KJ, Robins RW, Wildschut T, Sedikides C, Janata P. Music-evoked nostalgia: affect, memory, and personality. Emotion. 2010 Jun;10(3):390-403. doi: 10.1037/a0019006. PMID: 20515227.

21. Arroyo-Anlló EM, Díaz JP, Gil R. Familiar music as an enhancer of self-consciousness in patients with Alzheimer's disease. Biomed Res Int. 2013;2013:752965. doi: 10.1155/2013/752965. Epub 2013 Sep 11. PMID: 24106716; PMCID: PMC3784147.

22. McClay M, Sachs ME, Clewett D. Dynamic emotional states shape the episodic structure of memory. Nat Commun. 2023 Oct 17;14(1):6533. doi: 10.1038/s41467-023-42241-2. PMID: 37848429; PMCID: PMC10582075.

23. Bleibel M, El Cheikh A, Sadier NS, Abou-Abbas L. The effect of music therapy on cognitive functions in patients with Alzheimer's disease: a systematic review of randomized controlled trials. Alzheimers Res Ther. 2023 Mar 27;15(1):65. doi: 10.1186/s13195-023-01214-9. PMID: 36973733; PMCID: PMC10041788.

24. Gulliver A, Pike G, Banfield M, Morse AR, Katruss N, Valerius H, Pescud M, McMaster M, West S. The Music Engagement Program for people with Alzheimer's disease and dementia: Pilot feasibility trial outcomes. Eval Program Plann. 2021 Aug;87:101930. doi: 10.1016/j.evalprogplan.2021.101930. Epub 2021 Mar 3. PMID: 33711690.

25. Wolff L, Quan Y, Perry G, Forde Thompson W. Music Engagement as a Source of Cognitive Reserve. Am J Alzheimers Dis Other Demen. 2023 Jan-Dec;38:15333175231214833. doi: 10.1177/15333175231214833. PMID: 37993973.

26. van der Steen JT, van Soest-Poortvliet MC, van der Wouden JC, Bruinsma MS, Scholten RJ, Vink AC. Music-based therapeutic interventions for people with dementia. Cochrane Database Syst Rev. 2017 May 2;5(5):CD003477. doi: 10.1002/14651858.CD003477.pub3.

Update in: Cochrane Database Syst Rev. 2018 Jul 23;7:CD003477. PMID: 28462986; PMCID: PMC6481517.

27. Matziorinis AM, Koelsch S. The promise of music therapy for Alzheimer's disease: A review. Ann N Y Acad Sci. 2022 Oct;1516(1):11-17. doi: 10.1111/nyas.14864. Epub 2022 Jul 18. PMID: 35851957; PMCID: PMC9796133.

28. Aldridge, D. (1996a) Music therapy research and practice in medicine

29. Casby JA, Holm MB. The effect of music on repetitive disruptive vocalizations of persons with dementia. Am J Occup Ther. 1994 Oct;48(10):883-9. doi: 10.5014/ajot.48.10.883. PMID: 7825703.

30. World Health Organisation (WHO). World Health Organisation. Summary: World report on disability 2011 (6099570705). 2011. Retrieved from:https://apps.who.int/iris/handle/10665/44575.

31. Lyu J, Zhang J, Mu H, Li W, Champ M, Xiong Q, et al. The effects of music therapy on cognition, psychiatric symptoms, and activities of daily living in patients with Alzheimer's disease. J Alzheimer's Dis. 2018;64(4):1347–58.

32. Pongan E, Tillmann B, Leveque Y, Trombert B, Getenet JC, Auguste N, et al. Can musical or painting interventions improve chronic pain, mood, quality of life, and cognition in patients with mild Alzheimer's disease? Evidence from a randomized controlled trial. J Alzheimer's Dis. 2017;60(2):663–77.

33. Gómez Gallego M, Gómez García J. Music therapy and Alzheimer's disease: Cognitive, psychological, and behavioural effects. Neurologia. 2017;32(5):300–8. https://doi.org/10.1016/j.nrl.2015.12.003.

34. Sakamoto M, Ando H, Tsutou A. Comparing the effects of different individualized music interventions for elderly individuals with severe dementia. Int Psychogeriatr. 2013;25(5):775–84.

35. World Health Organisation (WHO). World Health Organisation. Demen‐tia. 2022. Retrieved from: https://www.who.int/en/news‐room/fact‐sheets/ detail/dementia.

36. Koelsch S. Music-evoked emotions: principles, brain correlates, and implications for therapy. Ann N. Y Acad Sci. 2015;1337:193–201.

37. Narme P, Clément S, Ehrlé N, Schiaratura L, Vachez S, Courtaigne B, et al. Efficacy of musical interventions in dementia: evidence from a randomized controlled trial. J Alzheimer's Dis. 2014;38(2):359–69.

38. Thompson WF, Schellenberg EG, Husain G. Arousal, mood, and the Mozart effect. Psychol Sci. 2001;12(3):248–51. https://doi.org/10.1111/1467‐9280.00345.

39. Tyng CM, Amin HU, Saad MNM, Malik AS. The Influences of Emotion on Learning and Memory. Front Psychol. 2017;8:1454. https://doi.org/10.3389/ fpsyg.2017.01454.

40. Innes KE, Selfe TK, Brundage K, Montgomery C, Wen S, Kandati S, et al. Effects of meditation and music‐listening on blood biomarkers of cellular aging and Alzheimer's disease in adults with subjective cognitive decline: An exploratory randomized clinical trial. J Alzheimer's Dis. 2018;66(3):947–70.

41. Folstein MF, Folstein SE, McHugh PR. "Mini‐mental state": a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189–98.

42. Platel H, Baron J‐C, Desgranges B, Bernard F, Eustache F. Semantic and episodic memory of music are subserved by distinct neural networks. Neuroimage. 2003;20(1):244–56.

43. Jacobsen J‐H, Stelzer J, Fritz TH, Chételat G, La Joie R, Turner R. Why musical memory can be preserved in advanced Alzheimer's disease. Brain. 2015;138(8):2438–50.

44. Popa LC, Manea MC, Velcea D, Şalapa I, Manea M, & Ciobanu AM. Impact of Alzheimer's dementia on caregivers and quality improvement through art and music therapy. Healthcare (Basel). 2021;9(6). https://doi.org/10.3390/ healthcare9060698

45. Bartlett, D. L. (1996). "Physiological responses to music and sound stimuli," in Handbook of Music Psychology, 2nd Edn, ed D. A. Hodges (St. Louis, MO: MMB Music), 343–385.

46. Bicknell, J. (2007). Explaining strong emotional responses to music: sociality and intimacy. J. Conscious. Stud. 14, 5–23.

47. Blood, A. J., and Zatorre, R. J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. Proc. Natl. Acad. Sci. U.S.A 98, 11818–11823. doi: 10.1073/pnas.191355898

48. Boehnke, K., and Münch, T. (2003). “Jugendsozialisation und Medien. Helfen Medien und Musik beim Erwachsenwerden?” in Neue Medien im Alltag. Nutzung, Vernetzung,

49. Interaktion, eds E. Keitel, K. Boehnke, and K. Wenz (Lengerich: Pabst Science Publishers), 203–227.

50. Boer, D. (2009). Music Makes the People Come Together: Social Functions of Music Listening for Young People Across Cultures. Department of Psychology. Victoria University of Wellington, Wellington. Available online at: http://researcharchive. vuw.ac.nz/bitstream/handle/10063/ 1155/thesis.pdf?sequence=1

51. Brown, J. D., Campbell, K., and Fischer, L. (1986). American adolescents and music videos: why do they watch. Int. Commun. Gaz. 37, 19–32. doi: 10.1177/001654928603700104

52. Brown, S. (2006). “How does music work? Toward a pragmatics of musi- cal communication,” in Music and Manipulation: On the Social Uses and Social Control of Music, eds S. Brown and U. Volgsten (New York, NY: Berghahn Books), 1–30.

53. Bryson, B. (1996). “Anything but heavy metal”: symbolic exclusion and musical dislikes. Am. Soc. Rev. 61, 884–899. doi: 10.2307/2096459

54. Bullough, E. (1921). Recent work in experimental aesthetics. Br. J. Psychol. 12, 76–99.

55. Campbell, C., Connell, S., and Beegle, A. P. (2007). Adolescents’ expressed meanings of music in and out

56. of school. J. Res. Music Educ. 55,

57. 220–236.

Chamorro-Premuzic, T., and Furnham,

58. A. (2007). Personality and music: can traits explain how people use music in everyday life. Br. J. Psychol. 98, 175–185. doi: 10.1348/000712606X111177

59. Coleman, J. S. (1961). “Psychological effects of the social system,” in The Adolescents Society: The Social Life of the Teenager and its Impact on Education, ed J. S. Coleman (Oxford: Free Press of Glencoe), 220–243.

60. Cook, J. D. (1986). Music as an inter- vention in the oncology setting. Cancer Nurs. 9, 23–28.

61. Blood AJ, Zatorre RJ: Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. Proc Natl Acad Sci USA 2001, 98:11818-11823.

62. Blood AJ, Zatorre RJ, Bermudez P, Evans AC: Emotional responses to pleasant and unpleasant music correlate with activity in paralimbic brain regions. Nat Neurosci 1999, 2:382-387.

63. Samson S, Peretz I: Effects of prior exposure on music liking and recognition in patients with temporal lobe lesions. Ann NY Acad Sci 2005, 1060:419-428.

64. Gaab N, Gaser C, Schlaug G: Improvement-related functional plasticity following pitch memory training. Neuroimage 2006, 31:255- 263.

65. Darwin, C. (1871). The Descent of Man, and Selection in Relation to Sex. London: John Murray.

66. Darwin, C. (1872). The Expression of the Emotions in Man and Animals. London: John Murray.

67. Walker Kennedy, S. (2010). An Exploration of Differences in Response to Music Related to Levels of Psychological Health in Adolescents. Toronto, ON: University of Toronto.

68. Wells, A., and Hakanen, E. A. (1997). "The emotional use of popular music by adolescents," in Mass Media and Society, eds A. Wells and E. A. Hakanen (Greenwich: Ablex Publishing Corporation), 217–228.

69. Wilson, T. D. (2002). Strangers to Ourselves: Discovering the Adaptive Unconscious. Cambridge, MA: Harvard University Press.

70. Merriam, A. P. (1964). The Anthropology of Music. Evanston, IL: Northwestern University Press.

71. Miller, G. (2000). "Evolution of human music through sexual selection," in The Origins of Music, eds N. L. Wallin, B. Merker, and S. Brown (Cambridge: The MIT Press), 329–360.

72. Platel H: Functional neuroimaging of semantic and episodic musical memory. Ann NY Acad Sci 2005, 1060:136-147.

73. Platel H, Baron JC, Desgranges B, Bernard F, Eustache F: Semantic and episodic memory of music are subserved by distinct neural networks. Neuroimage 2003, 20:244-256.

74. Eschrich S, Münte TF, Altenmüller EO: Unforgettable film music: the role of emotion in episodic long-term memory for music. BMC Neurosci 2008, 9:48.

75. Schendel ZA, Palmer C: Suppression effects on musical and verbal memory. Mem Cognit 2007, 35:640-650.

76. Chan AS, Ho YC, Cheung MC: Music training improves verbal memory. Nature 1998, 396:128.

77. Misenhelter, D., and Kaiser, K. (2008). Social functions of music in music education. J. Artistic Creat. Educ. 2, 61–74.

78. Mithen, S. (2006). The Singing Neanderthals: The Origins of Music, Language, Mind, and Body. Cambridge: Harvard University Press.

79. Schellenberg, E. G., Nakata, T., Hunter, P. G., and Tamoto, S. (2007). Exposure to music and cognitive performance: tests of children and adults. Psychol. Music 35, 5–19. doi: 10.1177/0305735607068885

80. Schellenberg, E. G., and Weiss, M. W. (2013). "Music and cognitive abilities," in The Psychology of Music 3rd Edn, ed D. Deutsch (Amsterdam: Elsevier), 499–550.

81. Polzella, D. J., and Schoeling, S. (2004). "Effects of familiar background music on working memory and motor tracking," in Poster session presented at the meeting of the Psychonomic Society (Minneapolis, MN).

82. Radloff, L. S. (1977). The CES-D scale: a self-report depression sale for research in the general population. Appl. Psychol. Meas. 1, 385–401. doi: 10. 1177/014662167700100306

83. Riener, C. R., Stefanucci, J. K., Proffitt, D. R., and Clore, G. (2011). An effect of mood on the perception of geographical slant. Cogn. Emot. 25, 174–182. doi: 10. 1080/02699931003738026

84. Sacks, O. (2006). The power of music. Brain 129, 2528–2532. doi: 10.1093/ brain/awl234

85. Alzheimer's Disease International. (2018). World Alzheimer Report 2018 - The state of the art of dementia research (pp. 1–48). London: New frontiers, Publishing.

86. Aspden, T., Bradshaw, S. A., Playford, E. D., & Riazi, A. (2014). Quality-of-life measures for use within care homes: A systematic review of their measurement properties. Age and Ageing, 43, 596–603.

87. Baird, A., & Samson, S. (2015). Music and dementia. Progress in Brain Research, 217, 207–235.

88. Goris, E., Ansel, K., & Schutte, D. (2016). Quantitative systematic review of the effects of non-pharmacological interventions on reducing apathy in persons with dementia. Journal of Advanced Nursing, 72(11), 2612-262.

89. Gulliver, A., Pike, G., Banfield, M., Morse, A. R., Katruss, N., Pescud, M., et al. (2019). Evaluation of the Music Engagement Program for people with Alzheimer's disease and dementia: Study protocol for a pilot trial. Contemporary Clinical Trials Communications, 15, Article 100419

90. Resnick, B., Gruber-Baldini, A. L., Pretzer-Aboff, I., Galik, E., Buie, V. C., Russ, K., et al. (2007). Reliability and validity of the evaluation to sign consent measure. The Gerontologist, 47, 69–77.

91. Ridder, H., & Gummesen, E. (2015). The use of extemporizing in music therapy to facilitate communication in a person with dementia: An explorative case study. The Australian Journal of Music Therapy, 26, 3–25.

92. Koelsch, S. (2014). Brain correlates of music-evoked emotions. Nature Reviews Neuroscience, 15, 170–180.

93. Korner, A., Lauritzen, L., Abelskov, K., Gulmann, N., Brodersen, A. M., Wedervang, T., et al. (2006). The geriatric depression scale and the Cornell Scale for Depression in Dementia. A validity study. Nordic Journal of Psychiatry, 60.

94. van der Steen, J. T., van Soest-Poortvliet, M. C., van der Wouden, J. C., Bruinsma, M. S., Scholten, R. J., & Vink, A. C. (2017). Music-based therapeutic interventions for people with dementia. The Cochrane Database of Systematic Reviews, 5, Article CD003477.

95. West, S. (2009a). The Australian National University Music Education Programme: Developing a new approach to ongoing engagement in music making for all ages. International Journal of Community Music, 2, 241–254.

96. West, S. (2009b). Passing it on: Disseminating and evaluating the theory and practice of the music education program. The Second International Conference on Music Communication Science. Publishing.

97. Wongpakaran, N., & Wongpakaran, T. (2013). Cornell Scale for Depression in Dementia: Study of residents in a northern thai long-term care home. Psychiatry Investigation, 10, 359–364.

98. Jeon, Y. H., Li, Z. C., Low, L. F., Chenoweth, L., O'Connor, D., Beattie, E., et al. (2015). The clinical utility of the Cornell Scale for Depression in Dementia as a routine assessment in nursing homes. The American Journal of Geriatric Psychiatry : Official Journal of the American Association for Geriatric Psychiatry, 23, 784–793.

99. Alzheimer's Association. 2023 Alzheimer's disease facts and figures. Alzheimers Dement. 2023;19(4):1598-1695. doi:10. 1002/alz.13016

100. Gustavsson A, Norton N, Fast T, et al. Global estimates on the number of persons across the Alzheimer's disease continuum. Alzheimers Dement. 2023;19(2):658-670. doi:10.1002/alz.12694.

101. Herholz SC, Herholz RS, Herholz K. Non-pharmacological interventions and neuroplasticity in early stage Alzheimer's disease. Expert Rev Neurother. 2013;13(11):1235-1245. doi:10. 1586/14737175.2013.845086.

102. Brancatisano O, Thompson WF. 41C3Seven Capacities of music that underpin its therapeutic value in dementia care. In: Music and Dementia: From Cognition to Therapy. Oxford: Oxford University Press; 2019.

103. Sa¨rka¨mo¨T. Cognitive, emotional, and neural benefits of musical leisure activities in aging and neurological rehabilitation: A critical review. Ann Phys Rehabil Med. 2018;61(6):414-418. doi:10.1016/j.rehab.2017.03.006.

104. Baird A, Samson S. Music and dementia. Prog Brain Res. 2015; 217:207-235. doi:10.1016/bs.pbr.2014.11.028.

105. Cuddy LL, Sikka R, Vanstone A. Preservation of musical memory and engagement in healthy aging and Alzheimer's disease. Ann N Y Acad Sci. 2015;1337:223-231. doi:10.1111/nyas.12617.

106. Stern Y. What is cognitive reserve? Theory and research ap- plication of the reserve concept. J Int Neuropsychol Soc. 2002; 8(3):448-460. doi:10.1017/S1355617702813248.

107. Page MJ, Moher D, Bossuyt PM, et al. PRISMA 2020 expla- nation and elaboration: Updated guidance and exemplars for reporting systematic reviews. BMJ. 2021;372:n160. doi:10. 1136/bmj.n160.

108. Merten N, Fischer ME, Dillard LK, Klein BEK, Tweed TS, Cruickshanks KJ. Benefit of musical training for speech perception and cognition later in life. J Speech Lang Hear Res. 2021;64(7):2885-2896. doi:10.1044/2021_JSLHR-20- 00588.

109. Grassi M, Meneghetti C, Toffalini E, Borella E. Auditory and cognitive performance in elderly musicians and nonmusicians. PLoS One. 2017;12(11):e0187881. doi:10.1371/journal.pone. 0187881.

110. Zendel BR, Alain C. Musicians experience less age-related decline in central auditory processing. Psychol Aging. 2012; 27(2):410-417. doi:10.1037/a0024816.

111. Hanna-Pladdy B, Gajewski B. Recent and past musical activity predicts cognitive aging variability: Direct comparison with general lifestyle activities. Front Hum Neurosci. 2012;6:198. doi:10.3389/fnhum.2012.00198.

112. Wilson RS, Boyle PA, Yang J, James BD, Bennett DA. Early life instruction in foreign language and music and incidence of mild cognitive impairment. Neuropsychology. 2015;29(2):292-302. doi:10.1037/neu0000129.

113. Arafa A, Eshak ES, Shirai K, Iso H, Kondo K. Engaging in musical activities and the risk of dementia in older adults: A longitudinal study from the Japan gerontological evaluation study. Geriatr Gerontol Int. 2021;21(6):451-457. doi:10.1111/ggi.14152.

114. Romeiser JL, Smith DM, Clouston SAP. Musical instrument engagement across the life course and episodic memory in late life: An analysis of 60 years of longitudinal data from the Wisconsin Longitudinal Study. PLoS One. 2021;16(6): e0253053. doi:10.1371/journal.pone.0253053.

115. Salthouse TA. Mental exercise and mental aging: Evaluating the validity of the “use it or lose it” hypothesis. Perspect Psychol Sci. 2006;1(1):68-87.

doi:10.1111/j.1745-6916.2006.00005.x. Lee DH, Seo SW, Roh JH, et al. Effects of cognitive reserve in Alzheimer's disease and cognitively unimpaired individuals. Front Aging Neurosci. 2021;13:784054.

116. Baird A, Umbach H, Thompson WF. A nonmusician with severe Alzheimer's dementia learns a new song. Neurocase. 2017;
23(1):36-40. doi:10.1080/13554794.2017.1287278.

117. Perry G, Polito V, Thompson WF. Exploring the physiological and psychological effects of group chanting in Australia: Re- duced stress, cortisol and enhanced social connection. J Relig Health. In press.

118. Hunsberger HC, Pinky PD, Smith W, Suppiramaniam V, Reed
MN. The role of APOE4 in Alzheimer's disease: Strategies for future therapeutic interventions. Neuronal Signal. 2019;3(2): NS20180203. doi:10.1042/NS20180203.

119. Foster, N. A., & Valentine, E. R. (2001). The effect of auditory stim- ulation on autobiographical recall in dementia. Experimental Aging Research, 27, 215–228. PMID: 11441644.

120. Irish, M., Cunningham, C. J., Walsh, J. B., Coakley, D., Lawlor, B. A., Robertson, I. H., & Coen, R. F. (2006). Investigating the enhancing effect of music on autobiographical memory in mild Alzheimer's dis- ease. Dementia and Geriatric Cognitive Disorders, 22, 108–120. PMID: 16717466.

121. Bottiroli S, Rosi A, Russo R, Vecchi T and Cavallini E (2014) The cognitive effects of listening to background music on older adults: processing speed improves with upbeat music, while memory seems to benefit from both upbeat and downbeat music. Front. Aging Neurosci. 6:284. doi: 10.3389/fnagi.2014.00284

122. Ferreri, L., Aucouturier, J. J., Muthalib, M., Bigand, E., and Bugaiska, A. (2013). Music improves verbal memory encoding while decreasing prefrontal cortex activity: an fNIRS study. Front. Hum. Neurosci. 7:779. doi: 10.3389/fnhum.2013. 00779

123. Ferreri, L., Bigand, E., Perrey, S., Muthalib, M., Bard, P., and Bugaiska, A. (2014). Less effort, better results: how does music act on prefrontal cortex in older adults during verbal encoding? An fNIRS study. Front. Neurosci. 8:301. doi: 10. 3389/fnhum.2014.00301

124. N. A. Foster and E. R. Valentine, "The effect of auditory stimulation on autobiographical recall in dementia," Experimental Aging Research, vol. 27, no. 3, pp. 215–228, 2001.

125. B. Jennings and D. Vance, "The short-term effects of music ther- apy on different types of agitation in adults with Alzheimer's," Activities, Adaptation & Aging, vol. 26, no. 4, pp. 27–33, 2002.

126. C.Holmes,A.Knights,C.Dean,S.Hodkinson,andV.Hopkins, "Keep music live: music and the alleviation of apathy in dementia subjects," International Psychogeriatrics, vol. 18, no. 4, pp. 623–630, 2006.

127. S. Gue´tin, F. Portet, M. C. Picot et al., "Effect of music therapy on anxiety and depression in patients with Alzheimer's type dementia: randomised, controlled study," Dementia and Geriatric Cognitive Disorders, vol. 28, no. 1, pp. 36–46, 2009.

128. E. Go¨tell, S. Brown, and S.-L. Ekman, "The influence of caregiver singing and background music on vocally expressed emotions and moods in dementia care," International Journal of Nursing Studies, vol. 46, no. 4, pp. 422–430, 2009.

129. P.Laukka,T.Eerola,N.S.Thingujam,T.Yamasaki,and.Beller, "Universal and culture-specific factors in the recognition and performance of musical affect expressions," Emotion, vol. 13, no. 3, pp. 434–449, 2013.

130. P.J.Rentfrow,L.R.Goldberg,andD.J.Levitin,"The Structure Of musical preferences: a five-factor model," Journal of Personality and Social Psychology, vol. 100, no. 6, pp. 1139–1157, 2011.

131. Arroyo-Anlló EM, Díaz JP, Gil R. Familiar music as an enhancer of self-consciousness in patients with Alzheimer's disease. Biomed Res Int. 2013;2013:752965. doi: 10.1155/2013/752965. Epub 2013 Sep 11. PMID: 24106716; PMCID: PMC3784147.

132. Chen L. Influence of music on the hearing and mental health of adolescents and countermeasures. Front Neurosci. 2023 Aug 3;17:1236638. doi: 10.3389/fnins.2023.1236638. PMID: 37600009; PMCID: PMC10434992.

133. Vasilev, M. R., Kirkby, J. A., and Angele, B. (2018). Auditory distraction during Reading: a Bayesian Meta-analysis of a continuing controversy. Perspect. Psychol. Sci. 13, 567–597. doi: 10.1177/1745691617747398