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Music and Music Therapy Is a Medicine for Stress

Gayatri Devi Ramalingam, G. Sridevi, Jothi Priya Amirtham, Preetha Santhakumar and S. Saravanakumar

Abstract

Stress is a feeling of emotional or physical tension. It can be triggered by any event or thought that causes you to feel dissatisfied, angry, or anxious. The body's response to a challenge or demand is known as stress. The importance of developing cost-effective stress reduction interventions is high due to the difficulty of reducing or preventing stress without professional help and the large demand for non-pharmacological stress reduction interventions. Music therapy is the clinical application of musical therapies to improve a client's quality of life based on scientific evidence. Music therapists use both active and receptive music experiences to help clients improve their health in cognitive, motor, emotional, communicative, social, sensory, and educational domains by using music and its many facets, which include physical, emotional, mental, social, aesthetic, and spiritual domains. Nowadays, stress is increasingly widespread among all individuals all over the world, and people are more aware of it than ever before. This chapter may assist the general public in gaining a broad understanding of the role of music therapy in stress management, as well as assisting individuals in self-recovery.

Keywords: music, stress, therapy, brain, neurotransmitters

1. Introduction

"Stress" is a term used to describe the impacts of anything that disrupts physiological equilibrium. The "stressor" is the actual threat to an organism, and the "stress response" is the organism's response to the stressor. *Selye* recognised that strong, sustained stress reactions could lead to tissue damage and disease, despite the fact that stress responses evolved as adaptive mechanisms [1]. The two types of stress are acute and chronic. Acute stress lasts for a few days or weeks, whereas chronic stress lasts for weeks or months. At the time of stress, the autonomic nervous system gets activated to protect the body from it. When instant fight-or-flight is possible, autonomic and hormonal activities accelerate, maximising the opportunities for physical exertion [2]. There are two important types of stereotypy. Individual variances in stress reactions to the same scenario exist, despite the fact that different conditions tend to evoke diverse patterns of stress responses. The term "response stereotypy" refers to the tendency to demonstrate a consistent pattern of stress responses across a variety of stressors. Situational stereotypy refers to the degree to which distinct contexts stimulate diverse patterns of physiological response [3]. Some people exhibit stress responses linked with active coping in a

range of contexts, whereas others exhibit stress responses more associated with unconcerned attention.

Humans are particularly susceptible to the negative consequences of chronic stressors, presumably because of their strong ability for symbolic cognition, which can evoke persistent stress reactions to a wide range of stressful living and working environments. Psychosocial stressors and chronic disease have a complicated interaction. Anxiety and mood disorders, aggressive dyscontrol issues, hypo-immune dysfunction, medical morbidity, structural alterations in the CNS, and early death are all linked to exposure to strong and chronic stressors during childhood [4]. Acute stress disorder (ASD) and post-traumatic stress disorder (PTSD) are the two most common trauma disorders. Injury, property damage, loss of finances, grief, and a perceived stress threat are all factors linked to the development of PTSD and mental health disorders [5]. A traumatic incident involving actual or threatened death or significant harm, and symptom clusters including re-experience of the traumatic event are common elements of both of these diseases [6]. Other stress-related repercussions have been documented, including a rise in smoking habit, substance abuse, crashes, insomnia, and anorexia. People who live in more stressful circumstances such as populations with greater divorce rates, business failures, major hazards smoke more and have a higher lung cancer and COPD incidence [7]. Stress from life events and chronically stressful environments have also been connected to increased alcohol use. There is additional evidence that the relationship between personality and environmental adversity is bidirectional. Following the perception of an acute stressful event, changes in the neurological, circulatory, endocrine, and immunological systems occur. These changes are a normal feature of the stress response, and they are generally adaptive, at least in the short term [8].

2. Music interference

Music interventions can be defined as intentional music activities if they engage hearing to pre-taped music provided by clinician or healthcare professionals, if the involvement is self-administered by the person or if the intervention involves music creating or singing without the involvement of a professional musician or a therapeutic context. Specific aspects of music are thought to have an impact on the stress-relieving benefits of music therapies. Song lyric composition, interpretation of selected song lyrics, and identification of song names or lyrics that depict stresses and coping mechanisms are all examples of music therapy techniques for linguistic self-expression. One of the most important modifiers of music-related excitation and relaxation is the pace of the song. Music with a slow tempo (60–80 beats per minute), such as meditation music, has been linked to lower heart rates and increased calm [9]. When instrumental music is used instead of music with lyrics, the effects of music treatments on stress reduction are generally larger [10]. According to several studies, music with lyrics is more provocative and stimulating than calming. Through the possible calming effects, the use of music with lyrics may increase the good benefits of music therapies on stress reduction. Furthermore, some research compared the stress responses of people who listened to live music vs. those who listened to pre-recorded music, with live music showing to be the most stress-relieving [11, 12]. Several studies have found that listening to music has a favourable impact on stress-related outcomes. Listening to relaxing music before, during, and after medical operations has been linked to decreased cortisol levels, which has been linked to a reduction in tension and/or anxiety in medical settings [12–15]. Background music had a considerable impact on behavioural expressions of tension in specific parts of the body, as well as pain-related verbalizations.

Patients' verbal comments of music's usefulness in promoting relaxation were backed up by the behavioural measure. Other stress-reduction studies could benefit from behavioural observations of tension, and they could be used as a credible dependent measure [16].

3. Music therapy or music-relaxed therapy

Music is a vital component in improving one's ability to express oneself, reducing anxiety, treating physiological disorders, effectively managing time, learning coping techniques, and overall life quality. Music therapy (MT) is a goal-oriented and purposeful practise in which therapists use musical expression and the memories, emotions, and experiences it evokes to work with individuals or groups. MT is one of the oldest treatment techniques, and it has been used to treat diseases in various cultures. Music elements such as rhythm, melody, and harmony are used therapeutically in MT. Active and receptive music therapy are the two primary forms of music therapy. Playing simple instruments, dancing, or singings are common forms of active music therapy. This type of exercise promotes physical stimulation, which can be beneficial to one's health. Receptive music therapy is a type of music therapy that includes a period of time spent listening to music mindfully, usually with specially curated recorded or live music [17].

According to studies, music has a positive effect on hormones such as serotonin, dopamine, adrenaline, and testosterone, which are important in the development of mental disorders and regulate our emotional state; it also regulates physiological functions such as blood pressure and breathing [18]. The use of a person's reactions and associations to music in music therapy is used to promote positive improvements in mood and general well-being [19]. Music therapy can include making music with various instruments, singing, dancing to music, or simply listening to it. Music therapy makes use of music's therapeutic properties to help people feel better. It may be used instead of other forms of therapy such as counselling or cognitive behavioural therapy (CBT). Music therapists use a person's reactions and associations to music to promote healthy attitude and mental mindset adjustments. Unconscious emotions are triggered by musical action, and music has a strong connection with them.

The choice of music to employ for stress relief is a personal and unique option. Some people may consider themselves late for work in peak hour traffic, clenching the driving wheel and mumbling curses while tuning the radio to classical music to help them relax. Some could find themselves in the same scenario, but instead choose to shout their favourite pop song loudly. In either case, the decision is yours to make. The first step in de-stressing and reducing stress is to select music, which is one component of the circumstance over which you have influence.

The next stage is to start singing. This is even more personal than music choice, yet it is crucial because it necessitates deep diaphragmatic breathing. Deep breathing, often called abdominal or diaphragmatic breathing which is described in **Figure 1**. As a result, deep breathing and singing can assist to induce relaxation and protect the body from the negative effects of stress.

Music is a soothing therapy that relieves tension and aids in the retrieval of long-forgotten memories [20]. This indicates that music therapy lowered students' tension, implying that students can develop the open-mindedness required in musical therapy. This is due to the fact that the therapy experiences were creative and reflective abilities were maintained. In the course of therapeutic change, open-mindedness is essential and vital. According to findings, music therapy is useful in lowering anxiety, schizophrenia, physically or mentally challenged individuals, and

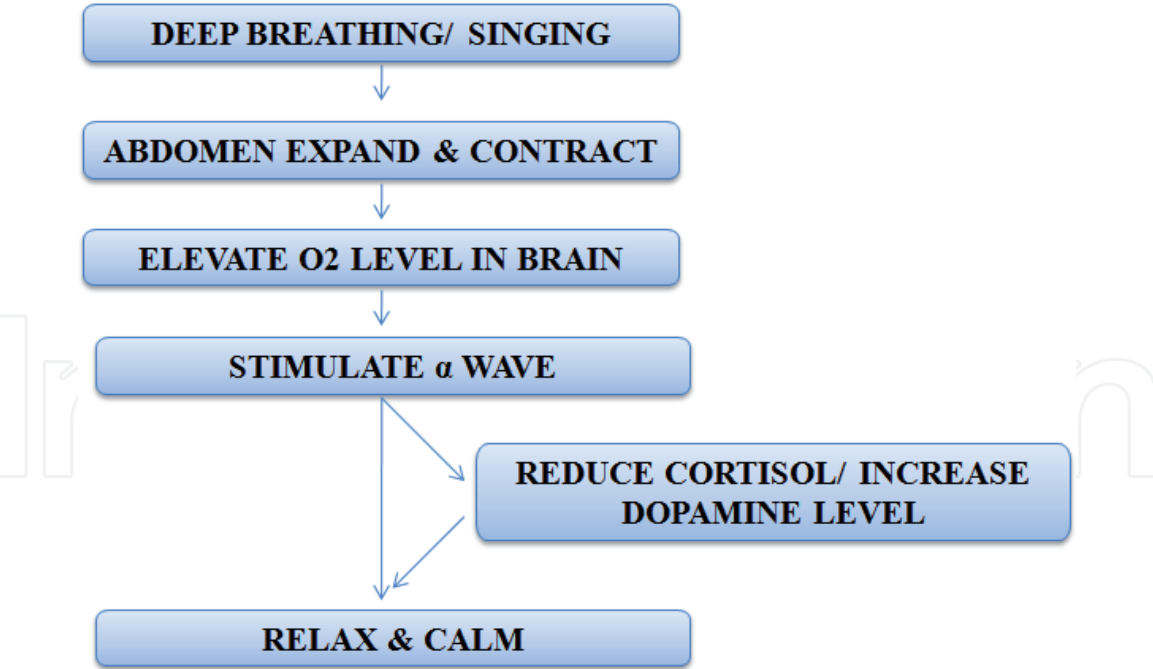


Figure 1.
Mechanism of deep breathing.

school-related stress, among other psychological symptoms [21]. Music therapy’s effectiveness addresses emotional issues, naturally increases neurochemicals, rehabilitates individuals with stress and mental illness, improves motor control and well-being, directs physiologic effects through the autonomic nervous system, regulates motor and emotional responses, and positively modifies the release of psychological stress hormones responsible for coordinating the functions of immunity, respiration, and neurology [22]. Music therapy combined with relaxation techniques has been shown in previous research to reduce cognitive stresses of all types, including mild, moderate, and severe stresses [21]. From the previous findings, music can treat all kinds of stress.

4. Music causes neurologic changes in body

Music, which is thought to be a soothing influence at all stages of life, can elicit a wide range of feelings, which can be pleasant or negative depending on the genre of music. Music has been shown in numerous studies to produce major changes in the neurological systems of the brain, as well as changes in brain waves such as beta, theta, alpha, and delta [23]. Music as medicine methods targets specific brain functions and addresses deficiencies that may arise as a result of many of these neurological disorders. Music, rather than being viewed solely as cultural phenomena, should be viewed as a vibration stimulus that causes cognition and memory, according to Siebert et al. [24]. The human brain is programmed to recognise music and respond to rhythm, repetition, tones, and songs. The auditory nerve sends electrical signals from music and other sounds to the temporal lobe’s auditory cortex [25]. According to research employing magnetic resonance imaging and positron emission tomography scans, neural networks in various areas of the brain are responsible for decoding and interpreting various aspects of music. Pitch perception, which is the foundation of melody, chords (multiple pitches that sound at the same time), and harmony, requires a small area of the right temporal lobe (two or more melodies at the same time) [26]. Another neighbouring facility

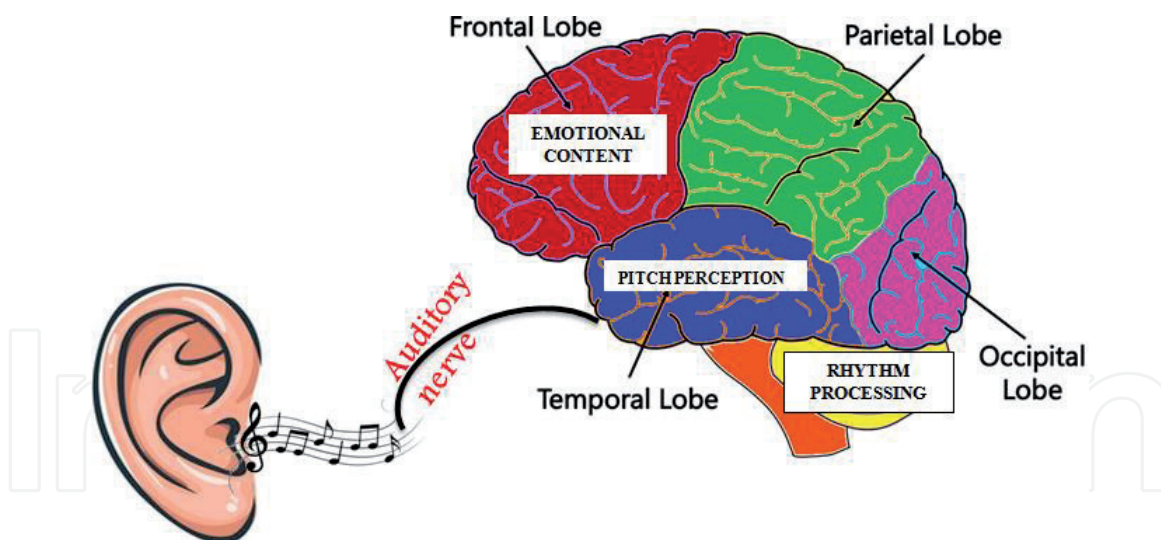


Figure 2.
Recognition of music in brain.

is in charge of deciphering timbre, which is the property that allows the brain to differentiate between different instruments playing the same note [27]. The frontal lobes perceive the emotional content of music, whereas the cerebellum processes rhythm (**Figure 2**). Music that is loud enough to cause “spine tingling” can activate the reward region of the brain, just as enjoyable stimuli such as alcohol or chocolate. Although any healthy human brain is capable of performing all of the complicated processes required to detect music, artists’ brains are more finely tuned.

Playing music is more difficult and time-consuming than simply listening to it, although listening to music has been shown to increase cognitive function in the elderly, as well as quality of life and cognition in dementia patients. Depression, anxiety, maniacal states, and thinking and perception abnormalities are the most frequent mental disorders in neurology. Alexithymia, concern, and locus of control are other mental symptoms that can be found in people with neurological diseases [28]. After specific strokes, listening to music can help with cognitive recovery, mood elevation, and muscle function. Singing has been shown to aid in the recovery of speech in aphasic patients. Music-based training can improve gait and balance in senior adults who are at danger of falling; in Parkinson’s disease patients, fast, rhythmic music improves gait velocity, cadence, and stride length [28, 29].

One issue in assessing musical illnesses is determining what constitutes a “normal musical brain.” While aphasia schedules might legitimately presume a degree of homogeneity in education, where the majority of people are taught to a particular level, the same cannot be said for music. An early study based on differences in melody discrimination depending on whether they were delivered to the left or right ear revealed that musicians and non-musicians have different brain lateralization [30]. A number of neuroimaging studies have revealed structural variations in the auditory [31], motor, somatosensory, superior parietal, callosal, and cerebellar areas of musicians’ brains [32]. Longitudinal studies have shown that even brief periods of musical instruction result in functional brain remodelling; however, the extent to which these changes last after training is uncertain [32, 33].

Absolute pitch (AP) musicians have different brain organisation than those [34, 35] who do not have the skill, according to studies. Increases in leftward asymmetry in the PT linked with AP have been shown in structural studies utilising both region-of-interest techniques and whole-brain interrogation with voxel-based morphometry [34]. People without AP show activity in right inferior frontal areas, which might be interpreted as a form of working memory for pitch, whereas AP

sufferers engage left dorsolateral frontal areas, which might be seen as associative analysis [34, 35]. The question of whether structural and functional differences in skilled performers are the result of musical training or whether such differences may contribute to an individual's decision to learn music, or to persist in learning music when others may give up, is critical to the interpretation of such differences. The demonstration that the size of the structural difference generally coincides with the age of commencement of musical instruction or the degree of practice supports the thesis that these distinctions originate from, rather than enable, skill development. Only longitudinal studies in which variations in brain structure can be evaluated in the same individuals as learning progresses will be able to unambiguously demonstrate the nature vs. nurture effects [36].

Adolescents were able to relax, increase their identity, improve their emotional problem, reduce their stress, develop and sustain communication, and improve their mental focus, as well as their intellectual and mental growth, using music therapy applications. Listening to music may cause the brain to produce alpha waves, which cause relaxation, or it may boost endorphin release, which causes other physiological responses such as a fall in BP and pulse [37]. Adolescents that abuse substances love rap, hip hop, techno, and dance music [38]. There is additional evidence that rock and metal music, in particular, can have a disastrous impact on young people.

5. Music causes endocrinological changes in body

Music was generally agreed to lower cortisol levels, whether through direct engagement or listening to recorded music. Only a couple research found the reverse trend, but in both cases, the music group's growth was less than the control group [39]. Both relaxing and stimulating music reduced cortisol levels, whereas few studies stated that only a drop for relaxing music and an increase for stimulating music. This was reflected in the study's measurements of GH and ACTH, as well as a comparable response from epinephrine, which increased when exposed to stimulating music but remained unaltered when exposed to calming music. These findings suggest that hormones are sensitive to musical stimulus [40]. When participants listened to soothing recorded music, oxytocin levels increased more than the other hormones examined. Bittman et al. revealed an increase in the dehydroepiandrosterone (DHEA) to cortisol ratio when participants participated in group drumming, whereas Conrad et al. observed a decrease in the DHEA to cortisol ratio and a rise in growth hormone when patients listened to relaxing recorded music [41, 42]. Migneault et al. reported that when participants chose their own recorded music, testosterone levels elevated in men but dropped in women [43].

6. Link between stress, memory, and music therapy

Memory is one of the CNS's most significant functions, and it is divided into sensory, short-term, and long-term memory. Stress has been proven to create functional and structural alterations in the hippocampal area of the brain. Chronic stress, which results in a rise in plasma cortisol level, reduces the number of dendritic branches and neurons in the hippocampus, as well as structural abnormalities in synaptic terminals and impaired neurogenesis [44, 45]. Declarative memory impairments can be caused by high levels of stress hormones [46]. Stress has a

negative impact on learning as well. After a stressful event, the memory-building process is frequently reinforced [47].

Physiologically, music can also increase the heart rate and hormone levels of patients with cognitive impairment [48]. In addition, playing musical instruments can delay the onset of cognitive decline in the future and reduce the risk of dementia. Therefore, music seems to be a necessity for patients with dementia [49]. Singing is also commonly used to help people with dementia. They discovered that sad music was the most efficient for recalling personal experiences, particularly distant ones. This revealed that the emotional content of music played a significant influence in the dementia recall memory process [50]. In addition to medicine for dementia, there is a growing trend in research using a multimodal stimulation intervention, which combines several different cognitive stimulations. Ozdemir and his colleagues created multimodal stimulations for mild AD patients, including MT with a light tempo instrument, painting lifeless alive drawings, and orientation to time-place-person. This study found that multi-domain stimulation enhanced MMSE scores while lowering Geriatric Depression Scale and Beck Anxiety Scale scores [51].

A vast amount of research indicates that music therapy improves behaviour, anxiety, mood, and memory in dementia patients. Short-term music therapy has been demonstrated to be useful in reducing mood symptoms such as depression and anxiety, while longer-term music therapy has also been proved to be quite effective. Another research revealed that personalised music therapy has therapeutic benefits on anxiety and depression.

7. Stress and music therapy for Alzheimer disease

Progressive cognitive impairment reduces the stress threshold. As a result, under stressful circumstances, patients may exhibit agitation or aggressive behaviour [52]. Music therapy helps people become more tolerant of stressful environmental cues that can cause these symptoms [53]. Music-related feelings appear to be preserved in people with Alzheimer disease (AD). Brain regions involved in music recognition are mostly unaffected by Alzheimer's disease, and music may help persons with the disease remember their own lives better. According to the literature, music improves the encoding of verbal information in both healthy older people and Alzheimer's sufferers [54]. Music therapy, a combination of "therapist" and "listening to music", has the greatest effect on patients with Alzheimer's disease in the early stages, as contrasted to the ones used alone. The increases in 17-estradiol and testosterone levels seen in Alzheimer's patients with declining hormones show that music therapy may help to slow or even stop the progression of Alzheimer's disease. Music therapy is thought to restore normal hormone levels, reduce nerve cell damage, and protect nerve cells, halting progression. For healthy elderly people, music therapy could be an effective Alzheimer's disease prevention strategy [55].

Perceptual-motor issues are common in people with Alzheimer's disease, and they may become restless at particular times of the day. Exercise can help them feel less restless. People feel better when they are physically active. Exercising to music promotes the use of various body parts, improves circulation, promotes attention, and aids in the release of tension and extra energy. Perhaps most importantly, music is a pleasurable, uplifting, and sociable experience [56]. When compared to the waitlist control group, individuals who received music therapy with a relaxation programme had considerably lower stress levels. Music therapy and relaxation programmes were also proven to have a favourable effect.

8. Conclusion

When paired with standard of care, music therapy is a viable and effective treatment for a wide range of diseases. It works as an anxiolytic and can also help with stress relief. Music is a strong medium that we may use in our daily lives to improve our quality of life as we age. Maintaining wellness through active music creation is a terrific compliment to proper nutrition and exercise, regular doctor appointments, having a positive mindset, and engagement in religion or spirituality.

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References

- [1] Selye H. The stress of life. Revised Edition 1984. New York: McGraw-Hill; 1956
- [2] Trumper M. Bodily Changes in Pain, Hunger, Fear and Rage: An Account of Recent Researches into the Function of Emotional Excitement. *Psychology Clinical*. 1930;**19**(3):100-101
- [3] Lacey JI, Lacey BC. Verification and extension of the principle of autonomic response-stereotypy. *The American Journal of Psychology*. 1958;**71**(1):50-73
- [4] Shaw JA. Children exposed to war/terrorism. *Clinical Child and Family Psychology Review*. 2003;**6**(4):237-246
- [5] McNally RJ. Psychological mechanisms in acute response to trauma. *Biological Psychiatry*. 2003;**53**(9):779-788. DOI: 10.1016/s0006-3223(02)01663-3
- [6] Vahia VN. Diagnostic and statistical manual of mental disorders 5: A quick glance. *Indian Journal of Psychiatry*. 2013;**55**(3):220-223
- [7] Colby JP Jr, Linsky AS, Straus MA. Social stress and state-to-state differences in smoking and smoking related mortality in the United States. *Social Science & Medicine*. 1994;**38**(2):373-381
- [8] Selye H. Stress in Health and Disease. Boston: Butterworth-Heinemann; 2013
- [9] Bernardi L. Cardiovascular, cerebrovascular, and respiratory changes induced by different types of music in musicians and non-musicians: the importance of silence. *Heart*. 2005;**92**(4):445-452. DOI: 10.1136/hrt.2005.064600
- [10] Good M, Picot BL, Salem SG, Chin C-C, Picot SF, Lane D. Cultural differences in music chosen for pain relief. *Journal of Holistic Nursing*. 2000;**18**(3):245-260. DOI: 10.1177/089801010001800306
- [11] Arnon S, Shapsa A, Forman L, Regev R, Bauer S, Litmanovitz I, et al. Live music is beneficial to preterm infants in the neonatal intensive care unit environment. *Birth*. 2006;**33**(2):131-136
- [12] Baker F, Uhlig S, editors. *Voicework in Music Therapy: Research and Practice*. London: Jessica Kingsley Publishers; 2011
- [13] Chanda ML, Levitin DJ. The neurochemistry of music. *Trends in Cognitive Sciences*. 2013;**17**(4):179-193. DOI: 10.1016/j.tics.2013.02.007
- [14] Nilsson U. The anxiety- and pain-reducing effects of music interventions: A systematic review. *AORN Journal*. 2008;**87**(4):780-807. DOI: 10.1016/j.aorn.2007.09.013
- [15] Thaut MH, Hoemberg V, editors. *Handbook of Neurologic Music Therapy*. Oxford: OUP; 2014
- [16] Hanser SB. Music therapy and stress reduction research. *Journal of Music Therapy*. 1985;**22**(4):193-206. DOI: 10.1093/jmt/22.4.193
- [17] Stegemann T, Geretsegger M, Phan Quoc E, Riedl H, Smetana M. Music Therapy and Other Music-Based Interventions in Pediatric Health Care: An Overview. *Medicines (Basel)*. 2019;**6**(1):25
- [18] Dowson B, McDermott O. Approaches to measuring the impact of music therapy and music activities on people living with dementia. In: Baird A, Garrido S, Tamplin J, editors. *Music and Dementia: From Cognition to Therapy*. 1st ed. New York: Oxford

- University Press; 2019. pp. 171-196. DOI: 10.1093/oso/9780190075934.003.0009
- [19] Lindsay M. Music therapy in dementia care Aldridge David (Ed) Music therapy in dementia care 256pp Jessica Kingsley 9781853027765 1853027766. Nursing Standard. 2001;**15**:29. DOI: 10.7748/ns2001.06.15.41.29.b1
- [20] Mohammad NR. Effect of music therapy on stress: Is it really effective? International Journal of Emergency Mental Health and Human Resilience. 2015;**17**(2):446. DOI: 10.4172/1522-4821.1000192
- [21] Raglio A. Effects of music and music therapy on mood in neurological patients. World Journal of Psychiatry. 2015;**5**(1):68. DOI: 10.5498/wjp.v5.i1.68
- [22] Ezegebe BN, Ede MO, Eseadi C, Nwaubani OO, Akaneme IN, Aye EN, et al. Effect of music therapy combined with cognitive restructuring therapy on emotional distress in a sample of Nigerian married couples. Medicine. 2018;**97**(34):e11637. DOI: 10.1097/md.00000000000011637
- [23] Musacchia G, Khalil A. Music and Learning: Does Music Make You Smarter?. Frontiers for Young Minds. 2020;**8**:81
- [24] Siebert M, Markowitsch HJ, Bartel P. Amygdala, affect and cognition: Evidence from 10 patients with Urbach-Wiethe disease. Brain: A Journal of Neurology. 2003;**126**(Pt. 12):2627-2637
- [25] Radstaak M, Geurts SA, Brosschot JF, Kompier MA. Music and psychophysiological recovery from stress. Psychosomatic Medicine. 2014;**76**(7):529-537. DOI: 10.1097/psy.0000000000000094
- [26] Stewart L, von Kriegstein K, Warren JD, Griffiths TD. Music and the brain: Disorders of musical listening. Brain. 2006;**129**(10):2533-2553. DOI: 10.1093/brain/awl171
- [27] Münte TF, Kohlmetz C, Nager W, Altenmüller E. Neuroperception. Superior auditory spatial tuning in conductors. Nature. 2001;**409**(6820):580
- [28] Hemming L et al. Alexithymia and its associations with depression, suicidality, and aggression: An overview of the literature. Frontiers in Psychiatry. 2019;**10**:203
- [29] de Bruin N et al. Walking with music is a safe and viable tool for gait training in Parkinson's disease: The effect of a 13-week feasibility study on single and dual task walking. Parkinson's Disease. 2010;**2010**:483530
- [30] Spiegel MF, Watson CS. Performance on frequency-discrimination tasks by musicians and nonmusicians. The Journal of the Acoustical Society of America. 1984;**76**(6):1690-1695. DOI: 10.1121/1.391605
- [31] Schneider P et al. Morphology of Heschl's gyrus reflects enhanced activation in the auditory cortex of musicians. Nature Neuroscience. 2002;**5**(7):688-694. DOI: 10.1038/nn871
- [32] Gaab N et al. Functional anatomy of pitch memory—An fMRI study with sparse temporal sampling. NeuroImage. 2003;**19**(4):1417-1426. DOI: 10.1016/s1053-8119(03)00224-6
- [33] Hutchinson S. Cerebellar volume of musicians. Cerebral Cortex. 2003;**13**:943-949. DOI: 10.1093/cercor/13.9.943
- [34] Luders E et al. A voxel-based approach to gray matter asymmetries. NeuroImage. 2004;**22**(2):656-664. DOI: 10.1016/j.neuroimage.2004.01.032
- [35] Zatorre RJ et al. Functional anatomy of musical processing in listeners with

- absolute pitch and relative pitch. Proceedings of the National Academy of Sciences. 1998;**95**(6):3172-3177. DOI: 10.1073/pnas.95.6.3172
- [36] Amunts K et al. Motor cortex and hand motor skills: Structural compliance in the human brain. Human Brain Mapping. 1997;**5**(3):206-215. DOI: 10.1002/(sici)1097-0193(1997)5:3<206::aid-hbm5>3.0.co;2-7
- [37] Yildirim D, Özbek A. Erken Dönem Ekonomi Eğitimi ve Finansal Sosyalleşiminin Finansal Okuryazarlık Düzeyine Etkisi. Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi. 2021;**23**(2):694-710. DOI: 10.32709/akusosbil.860749
- [38] Önal A, Ögel K, Eke C. Dikkat Eksikliği ve Hiperaktivite Belirtileri Bulunan Ergenlerde Madde Kullanımı ve Aile Özellikleri Üstüne Kesitsel Bir Çalışma. Klinik Psikofarmakoloji Bulteni-Bulletin of Clinical Psychopharmacology. 2011;**21**(3):225-231. DOI: 10.5455/bcp.20110627104419
- [39] Escher J et al. Music during gastroscopy. Schweizerische Medizinische Wochenschrift. 1993;**123**(26):1354-1358
- [40] Fancourt D, Ockelford A, Belai A. The psychoneuroimmunological effects of music: A systematic review and a new model. Brain, Behavior, and Immunity. 2014;**36**:15-26. DOI: 10.1016/j.bbi.2013.10.014
- [41] Bittman BB et al. Composite effects of group drumming music therapy on modulation of neuroendocrine-immune parameters in normal subjects. Alternative Therapies in Health and Medicine. 2001;**7**(1):38-47
- [42] Conrad C et al. Overture for growth hormone: Requiem for interleukin-6?*. Critical Care Medicine. 2007;**35**(12):2709-2713. DOI: 10.1097/00003246-200712000-00005
- [43] Migneault B et al. The effect of music on the neurohormonal stress response to surgery under general anesthesia. Anesthesia & Analgesia. 2004;**98**(2):527-532. DOI: 10.1213/01.ane.0000096182.70239.23
- [44] Sapolsky RM et al. Hippocampal damage associated with prolonged glucocorticoid exposure in primates. The Journal of Neuroscience: The Official Journal of the Society for Neuroscience. 1990;**10**(9):2897-2902
- [45] Woolley CS, Gould E, McEwen BS. Exposure to excess glucocorticoids alters dendritic morphology of adult hippocampal pyramidal neurons. Brain Research. 1990;**531**(1-2):225-231
- [46] Steckler T, Kalin NH, JMH R, editors. Handbook of Stress and the Brain Part 1: The Neurobiology of Stress. Amsterdam: Elsevier; 2005
- [47] Schwabe L et al. Stress effects on memory: An update and integration. Neuroscience & Biobehavioral Reviews. 2012;**36**(7):1740-1749. DOI: 10.1016/j.neubiorev.2011.07.002
- [48] Baird A, Garrido S, Tamplin J, editors. Music and Dementia: From Cognition to Therapy. London: Oxford University Press; 2019
- [49] Verghese J et al. Leisure activities and the risk of dementia in the elderly. New England Journal of Medicine. 2003;**348**(25):2508-2516. DOI: 10.1056/nejmoa022252
- [50] Vanstone AD, Cuddy LL. Melody, memory, and engagement in Alzheimer's disease. In: Baird A, Garrido S, Tamplin J, editors. Music and Dementia: From Cognition to Therapy. New York: Oxford University Press; 2019. pp. 67-87. DOI: 10.1093/oso/9780190075934.003.0004
- [51] Ozdemir L, Akdemir N. Effects of multisensory stimulation on cognition, depression and anxiety levels of

mildly-affected Alzheimer's patients.
Journal of the Neurological Sciences.
2009;**283**(1-2):211-213. DOI: 10.1016/j.
jns.2009.02.367

[52] Smith M et al. History,
development, and future of the
progressively lowered stress threshold:
A conceptual model for dementia care.
Journal of the American Geriatrics
Society. 2004;**52**(10):1755-1760.
DOI: 10.1111/j.1532-5415.2004.52473.x

[53] Volicer L, Hurley AC. Management
of behavioral symptoms in progressive
degenerative dementias. The Journals of
Gerontology Series A: Biological
Sciences and Medical Sciences.
2003;**58**(9):M837-M845. DOI: 10.1093/
gerona/58.9.m837

[54] Simmons-Stern NR, Budson AE,
Ally BA. Music as a memory enhancer in
patients with Alzheimer's disease.
Neuropsychologia. 2010;**48**(10):
3164-3167. DOI: 10.1016/j.
neuropsychologia.2010.04.033

[55] Fukui H, Arai A, Toyoshima K.
Efficacy of music therapy in treatment
for the patients with Alzheimer's
disease. International Journal of
Alzheimer's Disease. 2012;**2012**:531646.
DOI: 10.1155/2012/531646

[56] Petersson G, Nyström M. Music
therapy as a caring intervention:
Swedish musicians learning a new
professional field. International Journal
of Music Education. 2011;**29**(1):3-14.
DOI: 10.1177/0255761410389659