

# Role of Music Therapy in Neurological Practice

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## ABSTRACT

Music has marked its presence since the evolution of human society and has occupied our day-to-day life. It has also contributed in forming society and civilizations. Advancement in technology and portability of multimedia devices have made the access to music a common norm. It has various purposes like social cohesion, emotional expressions, interpersonal communication, recreation. It has a great bonding power and is important in terms of social dynamics. As it has an effect on society, so does it have an effect on an individual's mind and body as well. Music intervention is convenient, inexpensive, user controlled and seems to be influencing the physiological system in a positive way if rightly used, this therapy and its intervention is applied now-a-days in various ailments and disease states as an adjuvant therapy. Vast research is going on to find the right music that could have the desired therapeutic effect where the physiology is deranged from the normal. Effect of music on pain modulation, exercise performance, Cardiac and Autonomic functions, Heart rate variability, emotions, anxiety, stress and entrainment of biological rhythms are well evaluated. Its application in enhancing higher functions like memory tasks and learning are also known. The evident physiological implications of music on various physiological parameters are being elaborated.

**Keywords:** Music intervention, Pain modulation, Parallel processing, Motivational Hypothesis, Reward value, Memory function

## INTRODUCTION

Music can be defined as sound that convey emotions and has some sort of rhythmical pattern and controlled variation in the pitch. Anthropological evidence points out that Homo Sapiens and Homo Neanderthalensis were having all requirements for vocalization. As per Montague, music has four evident purposes: Dance, Ritual, entertainment and social cohesion. [1] It has also been regarded as a factor for social cohesion. It can convey emotions of sadness or happiness even with a neutral expression from the subject who is vocalizing. Evolution of music as a phenomenon encompass equal role of biology and culture in its development. Cultural neuroscience is an emerging field that can be a tool for studying relationship between brain and culture. [2] With these qualities, the music has tremendous capacity to influence human physiology and leads to changes in various physiological parameters. Music regarded as an enjoyable activity which

itself also allow for the expression of personal inner states and feelings. [3] As per Rene Dubois, music is considered one of the 'cultural invariants. Cultural invariant are the universal characteristics of human culture like food, clothing, shelter, art and music. [4] These universal invariants have underlying biological mechanisms like genetic influences. Among all cultures singing is common, as is the singing of lullabies and dancing to music. [5]

## PAIN SENSATIONS AND MUSIC

Pain sensations are conveyed to brain by various neural circuits from the tissue to the spinal cord then to the brain. One major system is the limbic system which receives the pain input and is involved in the affective-motivational modulation of pain. This limbic system is also affected by listening to music. [6] As the cortex and limbic system has influence on pain this may be the possible reason for decreased pain sensitivity while listening to music.

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The valence of music is the positive-ness or negative-ness conveyed through it. Similarly, it is the valence of music (pleasant Vs. unpleasant) which is more crucial than the mood (happy Vs. sad) in pain modulation. Also, the valence is important determinant of hypoalgesic effect of music. [7] Further there is also a role of "Gate control theory" operating at the level of spinal cord. According to this theory the nociceptive transmission is reduced or decreased when touch receptors in the area of pain source are also stimulated. The large diameter touch fibers suppress or close the gate of pain transmission owing to activity of interneurons present in Spinal grey matter. There could be a possible influence of the DPMS on this "Gate Control Theory". [8] As listening music distracts the mind, there results a selective attention mediated by the thalamus which alerts prefrontal cortex towards the acoustic sound stimuli than towards the pain input thus leading to pain inhibition. [9,10] Reduced muscular tension and activity associated with listening a soothing music and further sympathetic activation from hypothalamus leads to release of endogenous opioids. The endogenous opioids are mediators of analgesic effect and also have an affective component.

## PARALLEL PROCESSING, SYNCHRONIZATION AND MOOD MOTIVATION

Music can evoke extra-musical associations which may be instrumental to help pursue on going physical activity. This hypothesis is called Motivational or mood hypothesis. As per this hypothesis, it is believed that music induces change in CNS arousal. Since the music or rhythm can be associated with particular memory for the specific situation. This arousal can bring about feelings of relaxation, anger, longing, happiness, which in the case of exercise can lead to changes in performance. [11,12] This hypothesis is particularly also useful for reducing pre-performance anxiety and to provide motivation to the trained athletes. Similarly, the ergogenic effect of music listening associated with moderate and high intensity exercise, can be assigned the dissociative cognitive strategy which allows shifting attention away from subjective awareness of discomfort. With increasing intensity of exercise, perceived ratings of exertion also increase and shortly subject may feel fatigued. Exposure to environmental or external sensory cues like music, colors, videos can divert attention from perceived exertion and discomfort and help subject remained engaged in the task. As brain perceives the music input, it unconsciously synchronizes the motor movements of particular cyclic exercise with music tempo (i.e., beats per minute of music syntax). [13] Similarly, synchronization hypothesis is also explanatory for

pacings strategy adopted by the performer. As one performs certain exercise, this pacing strategy is adopted at conscious or unconscious level so as to allow him to finish the task in stipulated or at the most in minor time. This also allows the performer to maintain the task and prevent the fall of performance. The parallel processing hypothesis states that, listening music diverts attention of listener towards it, allowing individual to respond less to the signs of fatigue during exercise. (Distraction effect). This is due to parallel information processing model, as per this model information from different afferent pathways are processed simultaneously. Cerebral cortex processes the afferent information like fatigue sensation and incoming music in such manner to decide which input needs to be given priority depending on its importance. Similarly, the brain adopts a dissociative cognitive strategy that enables a shift in attention away from the subjective experiences of discomfort or pain. [14]

## MUSIC AND EMOTIONS

Alike dopaminergic system, music can evoke the emotional sensations of euphoria and craving and the reward value of music is encoded in the activity of Nucleus Accumbens (NA) that has a reciprocal functional connectivity with auditory and frontal areas (Cortical working memory loop). This connectivity is strengthening as a function of musical reward. Further it is also suggested that listening to music might have a strong indirect  $D_2$  agonist effect (on account of Dopamine release in the NA). Anhedonia is the lack of ability to experience pleasure from normally pleasant stimuli and is observed in many psychiatric illnesses. Reduced reactivity and connectivity of mesolimbic and related structures is associated with anhedonia. [15] Indeed, the singing differs from simple speech. Positron Emission Tomography (PET) scanning observed relative increase in activity in several cortical areas and putamen of the left hemisphere during speaking versus singing. While relative increases in activity of several cortical areas of right hemisphere, cerebellum and Nucleus Accumbens was evident in PET imaging studies. Also, the word production in songs is associated with increased activity in regions within right hemisphere that are not exact opposite areas of contralateral left cerebral hemisphere viz. peri-sylvian language areas and involvement of multiple neural networks is there in different aspects of singing. [16] During peak emotional arousal while listening music, endogenous Dopamine release in striatum was evident which was studied using neuron specific  $^{14}C$  Raclopride. [17] Further the study of time course of Dopamine release using fMRI (Functional Magnetic Resonance Imaging) sug-

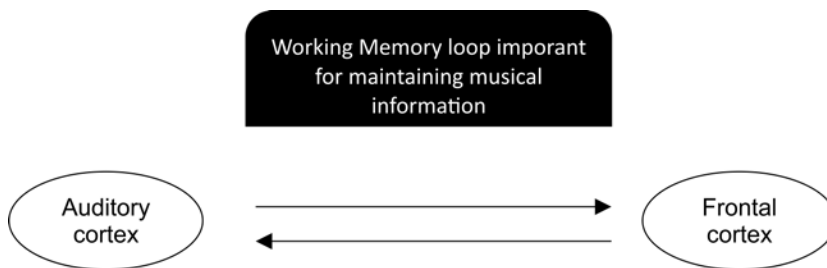


FIGURE 1. Working memory loop for music processing

gested a ‘functional dissociation’. During anticipation of emotional response, Caudate nucleus was found to have increased activity while it is the Nucleus Accumbens which shows increase activity during the peak of emotional response to music.

## MUSIC AND ITS REWARD VALUE

Organisms seek the stimuli which are imparting certain pleasure or are of incentive salience and which instill the curiosity. Reward is that property of a stimulus which is the attractive and motivational and induces appetitive or approach behavior. [18] As music allows expression and simultaneously regulation of emotions, it has influence over mood and pleasure evoking response. The study of neural mechanism of music evoked emotions was found to be valuable in understanding the basis of human emotions. Cortical loops involved in working memory play role in maintaining music information which on exposure leads to expectancies. [19] (Figure 1).

Music is regarded as an art form which is intentionally organized with sound and silence as its medium and basic elements comprising of sound, melody, harmony, rhythm, texture, structure or form and expression. [20]

## CONCLUSIONS

Many attempts were done to define music with different views and perspectives. With the unknown origin of music, it is true that music has been intricately linked with each and every human civilization and traditions and has impact upon humans. The scope of these findings is of huge multitude. The physiological effects of music on mood, behavior, memory are notable. In modern days, use of music therapy and music intervention as a healing force for alleviating illness and distress is practiced. Holistic healing, ordered social life, soul forming has been reported as applications of music since long time.

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