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Music: The Journey from Neural Entertainment to Therapy

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Abstract

Music has been intricately linked to humanity since times immemorial. Initially believed to be a pleasurable activity, there has been a paradigm shift in understanding of this mysterious entity. During ancient times music was thought to enhance ones physical, mental, spiritual and social health. This applied also to unborn child as is evident in the garbhasanskaras from ancient Indian texts. Last decade has witnessed fierce research in providing objective validation of this age old myth. Researchers have concluded that in addition to providing neural entertainment, music also has restorative and healing powers. So impressive are the results that a new branch of therapeutics has emerged called Neurologic Music Therapy. Reviewing the current body of evidence, an attempt has been made to get to the origin of music and trace its evolution and entry into therapeutics from the perspective of Neurosciences. In spite of scientifically tempered enthusiasm and technological back up there are many questions which remain unanswered. The Indian Music Industry which is currently worth 10 Billion Rupees is set to double its revenues by 2019. Why "The Gangham style" from Korea or the "Kolaveri di" from India goes on to have millions of "likes" worldwide, remains a mystery. Precise localization of the neural substrate of music at anatomical, physiological and molecular level still remains unclear. Neuroscience seems to be poised to unravel the mystery of music. Only time will tell whether sound will become music or vice versa.

Keywords: Music; Neurologic music therapy

Introduction

The Term Music is derived from the Greek word Mousike which was one of the goddesses inspiring culture in Greek mythology [1]. The Wikipedia defines music as a cultural expression consisting of a combination of sound and silence. While Aigul et al. defined music as a dynamic entity which depicts a nations creative power [2]. The statement "Music is the universal language of mankind" itself was derived from the Prose Collection Outre-Mer: A Pilgrimage Beyond the Sea by Henry Wadsworth Longfellow, who emphasized the power of music to romantically enable people to communicate with each other.

Music is probably as old as mankind. In fact music comes even before the baby babbles or speaks. The Garbhasanskaras are a set of tenets laid down by ancient scripture which teach the pregnant mother as to how to educate the fetus in the womb. Here too listening to music has been described to be beneficial for the mother as well as the fetus [3]. Across numerous cultures of world, we have mothers interacting with her infants by singing lullabies or play songs [4].

Infants in return respond positively [5].The common rhythmic rocking movements accompanying these songs is said to increase the infants social affiliative behavior [6,7]. The Indian schooling system followed the Vedic principle incorporating the Guru Shishya tradition. In this tradition, the pupils depended on oral learning (shruti) as the mode of instruction, with careful attention paid to the correct pronunciation and commitment to memory, leading to intellectual emancipation. Attention was paid to- sound (dhvani), words (shabda) and verses (chanda). All these aspect have an element of music hidden somewhere within it [8].

Since ancient times our ancestors were aware of the cognitive enhancing effect of music. It's only in the last two decades that we have been able to gather scientific evidence validating the same. Music has been proven to enhance many of the known cognitive skills. Reading and literacy skills seem to be primarily enhanced by music [9-11]. Spatial-temporal reasoning [12,13], Mathematical abilities [14,15]. Children with attention deficit/hyperactivity disorder, when exposed to music do well in mathematical skills. Other cognitive domains like emotional intelligence, Recall of autobiographical and episodic information also show a definite enhancement [16,17]. Prenatal music experiments in rat pups demonstrate an increase of neurogenesis in the hippocampus and enhanced spatial learning ability [18].

The shift from entertainment to healing

Pythagoras from Greece during 550 B.C, considered music, a higher form of medical therapy compared to other therapeutic modalities during his times. Music was also described as an ancient method for healing. In the year 550 B.C. Famous German classical composer, Peter Huebner based on Pythagorean concept came up with The Medical Resonance Therapy Music (MRT-Music) [19].

The scientific documentary evidence of role of music as a therapeutic agent slowly started taking shape during second world war, A survey Conducted by The US Surgeon General during that period showed that music could be employed in several beneficial ways. These were (a) to expedite exercising; (b) as physical modality in post-operative exercise for orthopedic, plastic, or lung cases; (c) in educational activities (studying music, notation, or some kind of instrument, playing in an orchestra, playing chamber music or singing in a chorus): (d) for re socialization; and (e) to aid in neuro-psychiatric treatment [20].

The military divided its employment of music into three categories: active participation (considered the most beneficial), passive participation (second in benefits derived), and audio-reception. Harriet Ayer Seymour , then in her seventies, along with her students, helped hundreds of shell-shocked American at Pennsylvania State University on veterans to regain their mental health .Seymour during her stint in treating war victims once commented "We know that the right music will change fear into faith, and despair into courage, because we have seen it happen" [21].

Music for entertainment and recreation, though never considered "music therapy" during World War II, was certainly seen then as having restorative powers. The military along with the Walter Reed General Hospital under the guidance of Frances Paperte conducted a scientific study to establish the curative powers of music. This landmark study established the roe of music therapy in military medicine and provided an added stimulus for researchers to carry out more research in establishing music as an aid to medicine. In 1950 the National Association of Music Therapy was established in US [20].

A neurologists focus on music is based on studying disorders of musical deficits. To name a few it includes amusia, musicogenic epilepsy or singing in aphasia. They have further focused on neurological disorders afflicting the professional musician, like musicians dystonia. The last decade has witnessed increased interest and progress in adoption music as a therapeutic modality in neurological rehabilitation. Many novel music-based methods have been developed not only to improve cognitive deficits but also treat language, emotional, and social deficits. The therapeutic effect of Music is being increasingly tried and proven in a wide range of neurological illness extending to include children and adolescents [22].

Music: the neuroscientists perspective

Music shares the same dopaminergic releasing reward systems as those involved in eating, sex, and recreational drug use. Särkämö and colleagues following 20 years of research outlined the regions in brain which are implicated in musical activities. Norman-Haignere and colleagues have identified a specific region of the brain which responds to very selectively to music. These regions are separate from those involved in non-musical behavior. These findings support the theory of evolution of a distinct neural population going hand in hand with the evolution of humans [23]. These centers have been shown in the schematic diagram (Figures 1&2).

Fachner has proposed three ways in which neuroscience methods are used for research in music therapy: (a) *in situ* studies, where music therapy sessions are conducted and underlying neurological processes are explored simultaneously. (b) *Empirical comparisons* where various imaging, biomarker and behavioral parameters are compared, before and after, any intervention. (c) *Approximations*, where one correlates a specific music intervention and its response to the functional mechanism in brain [24].

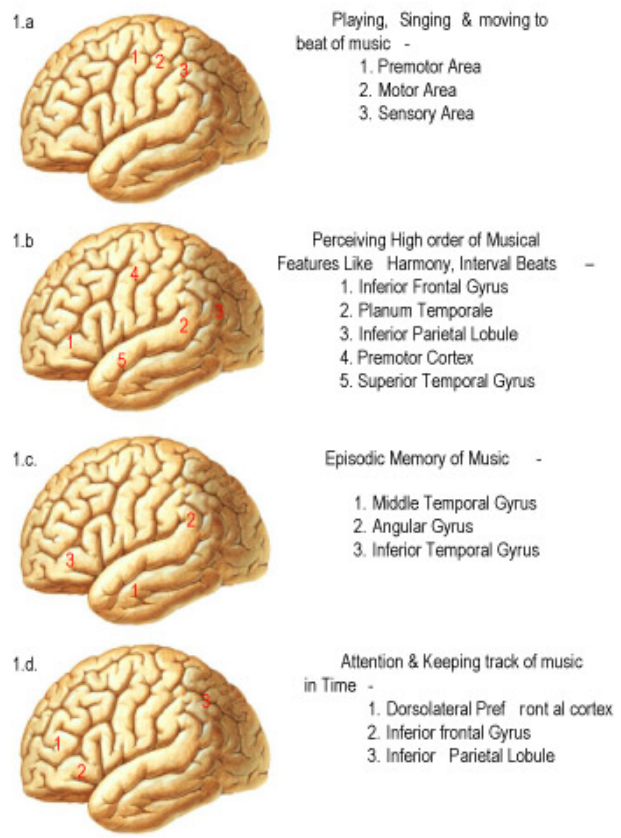

Figure 1: Key Areas of Brain (Lateral View) Processing Music.

Music therapy: neuromonitoring and research

The commonest modalities of neuroimaging relevant to music therapy include functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG).Of the two, EEG in considered more sensitive. Positron emission tomography (PET), monitors the metabolic processes through the detection of gamma rays emitted by a radio-active tracer, and diffusion tensor imaging (DTI), exploits the principle of diffusion process of water molecules in brain to reveal its architectural details [25]. Chanda and Levitan's through their research have shown that various chemicals can be modulated by music. They include dopamine, cortisol, serotonin and oxytocin [26]. These neurochemicals indirectly bring about behavioural changes. Musical activities play a role in modulating host behaviour through: neurotransmitters, hormones, cytokines, lymphocytes, and immunoglobulins .Research in this field as on date remains inconclusive [27].

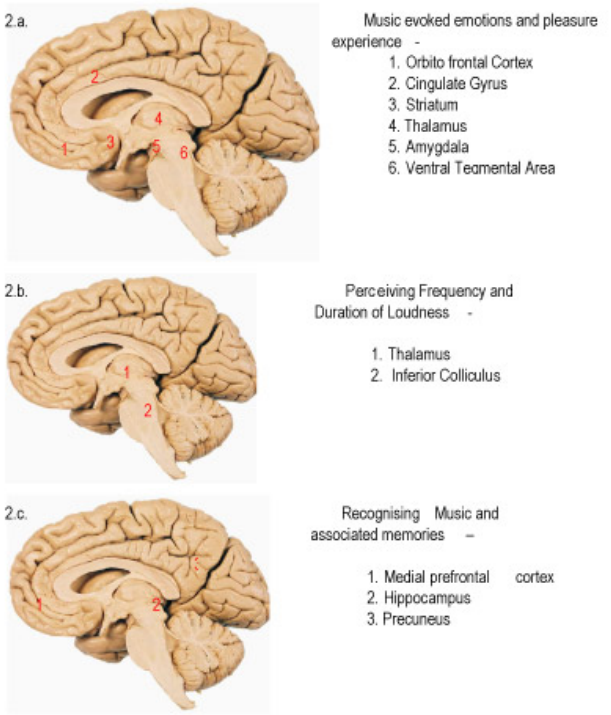

Figure 2: Key brain areas (Medial View) processing music.

Music: relation to emotion

The limbic and paralimbic sturctures of brain are involved in initiation, generation, maintenance, modulation and termination of emotions, fMRI has shown that music has an effect on these centers. Depression, anxiety and post-traumatic stress disorder (PTSD) predominantly involve these areas [28]. According to Koelsch deeper understanding of how music effects these areas will translate into establishing music therapy as an accepted treatment modality for these difficult to treat psychiatric disorders.

Music and interpersonal relationships

Babioni and colleagues showed that when musicians perform in group there is synchronous activity in the heart rate, frontal and central regions of their brains [29]. Keeler and colleagues in 2015 demonstrated changes in oxytocin and adrenocorticotropic hormone (ACTH) in group singers which translates to reduced stress levels and increase in social bonding [30].

Music and neuroplasticity

Neuroplasticity of brain implies establishment of new neural pathways. Musical activity has a potential role in effecting neuroplasticity by establishing new circuitry within the brain. This aspect of Music therapy holds immense potential in treatment and rehabilitation of patients with a wide range of neurological disorders.

Application of neurologic music therapy

The current body of literature shows promising potential of Music therapy in the following disorders-

Stroke

Music listening promotes behavioural recovery and brings about neuroanatomical changes in the sroke afflicted brain [31]. Lin C and colleagues have demonstrated in their studies, the definitive role of music in reducing the recurrence of childhood epilepsies by reducing the epileptiform discharges [32]. The antiepileptic effect of Mozart's sonata was been earlier shown by group of scientists from Taiwan [33].

In addition, lot of encouraging work is being done on establishing the role of Music Therapy in Dementia, Disorders of Consciousness, Cancer and Palliative Care, Autistic Spectrum Disorders. In dementia certain areas of brain like the caudal anterior cingulate and ventral pre-supplementary motor area, seem to be activated in the neural encoding of long-known music. Music intervention can thus help in establishing connections between music, autobiographical moments and self-expression in dementia patients. In patients with Autistic spectrum Disorder music therapy improves attention, communication and neuroplasticity. Studies done on Disorders of consciousness so far have shown that music therapy may have a role in prognostication and rehabilitation of patients.

In Cancer patient needing Palliative care, Music therapy addresses the psychological and spiritual needs of the patient as well as the care giver. Studies have shown that the psychosocial and affective needs are better addressed by music therapy as compared to pharmacotherapy. Physiological data has proven that improvisatory music therapy modulates emotional arousal in patients with dementia. Studies on Alzheimer's patients have shown that stimulating the somatosensory system by way of music therapy produces significant improvement in behavioral and cognitive scales [34-38]. With an increase in ageing population these conditions are going to increase. Hence Music therapy offers a promising role in multimodality management of such conditions.

Limitations

In spite of untiring research and technological revolution we have been unable to unravel the Mystery of music and its entire spectrum of effects on the mind soul and body. To validate the fact we have The "Gangam style" originating from Korea or " Kolaveri di " sung by an amature Indian singer going on to capture Heart of millions across the Globe including even those who do not understand the language. The 2011 estimates show that the music industry of the world is worth around 168 Billion Dollars. KPMG which is one of the top auditors in the world provide an estimate that the Indian Music industry in 2014 was 9.8 Billion Rupees worth and is all set to double to 18.9 Billion Rupees by 2019. These figures only prove the pleasure and addiction value that music has on the human brain. Neuroscience still is unable to pinpoint that factor or substrate which tells us what kind of music will produce a predictive neurochemical response.

Conclusion

Standard research methods in Neuroscience hinges on standardization and replicabilty. The same cannot be done as each individual has a unique mental makeup and cognitive milieu. Further we may not have true controls. However we need to draw conclusions

form empirical comparisons augmented with behavioral and clinical measures. In future, technology will provided the added impetus to join the missing dots .Music therapy and neuroscientific collaboration has a great potential in offering a more holistic approach in treating various neurologic disorders. Every neuroscientist in clinical practice would have thought or practiced music therapy for his patient without knowing of its actual spectrum of action. Ansell has very rightly pointed out that while conducting any type of research in music one should acknowledge the contribution of musically inclined people involved in the practice of music in real life.

Conflicts of interest

None to Declare

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