

# A brief survey on music intervention in western and non-western (Indian) music

## Abstract

Given that deaths nowadays are mostly caused by heart attacks, cancer, hypertension, diabetes etc., which have more to do with our fast and tensed lifestyle, rather than communicable diseases (most of whose cure have been found), music medicine and music therapy have emerged as a useful supplement to medicine. The present article makes a survey on music intervention in western and non-western (Indian) music.

**Keywords:** music medicine, music therapy, {western, non-western} music, raga

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## Introduction

The idea of deriving therapeutic benefits from music is not new. Scientists through their studies have revealed the healing powers of music in controlling blood pressure, negative emotions and stress.

### State of the art

Aldridge<sup>1</sup> provides a good source of literature on therapeutic music intervention. Cochrane database of Systematic Review "Music interventions for acquired brain injury"<sup>2</sup> also concluded "Music interventions may be beneficial for gait, the timing of upper extremity function, communication outcomes, and quality of life after stroke. These results are encouraging, but more high-quality randomized controlled trials are needed on all outcomes before recommendations can be made for clinical practice."<sup>3</sup>

In India,<sup>4</sup> [needs to be explored] provides some resources and information about raga therapy although scientific research in Indian music especially from a therapeutic angle is still at a beginner's stage. Some more information about music therapy in the context of Indian music is also available.<sup>5</sup> A good account of research findings about the neurobiological foundation of rhythm and the brain with a thrust on how music and rhythm can affect both musical and non-musical brains can be found in Thaut.<sup>6</sup> Clair and Bright showed significance of music on the reduction of depression and anxiety induced in strokes patients during recovery.<sup>3</sup> Hurkmans J et al.,<sup>7</sup> have conducted a systematic review on music therapy for aphasia and after reviewing 15 studies concluded that "measurable improvement was reported in studies where musical components were used in the treatment of neurological language and speech disorders. However, the methodological quality of studies was rated low." Mayer M et al.<sup>8</sup> stated in the review reports that the evidence surrounding agents targeting dopamine pathways (amantadine, bromocriptine and levodopa), sensory stimulation, music therapy and median nerve electrical stimulation show some degree of benefit in improving consciousness, but further research is necessary.

Prevalence of post-stroke depression is significantly high (32.9-35.9%) as compared to the prevalence of depression in general population (10%).<sup>9</sup> Rhythmic auditory stimulation (RAS) may be beneficial for improving gait parameters in stroke patients.<sup>10</sup> Dong et al. reported that the frequency of anxiety after stroke varies from study to study ranging from 21% to 28% (see also Leppävuoriet al., 2003). Brad et al.<sup>10</sup> stated that music therapy has power to stimulate brain functions involved in emotion, cognition, speech and sensory perception used in rehabilitation phase. The study by Koelsch et al.<sup>11</sup> reported that unpleasant music showed activation of the limbic and paralimbic systems (which are known as the center of feelings) through functional MRI in a study on the mechanism of music therapy, but pleasant music stimulated the inferior frontal gyrus and Rolandic operculum which reflect working memory. Steven et al.<sup>12</sup> explored the future prospect of Traumatic brain injury (TBI). In western countries, music supported therapy (MST) has been developed recently to improve the use of the affected upper extremity after stroke.<sup>13</sup> Schneider et al.<sup>14</sup> reported that music supported therapy yielded significant improvement in fine as well as gross motor skills with respect to speed, precision and smoothness of movements. Music is a multimodal stimulus that activates many brain structures related to sensory processing, attention, and memory, and can stimulate complex cognition and multisensory integration.<sup>15-17</sup> The modular view of music processing with music-specific neuronal regions and networks is challenged by the alternative view that there is a significant overlap between neuronal structures used for language and music processing. There are evidences for shared neural processing resources between the phonological/semantic aspects of language and the melodic/harmonic aspects of music.<sup>18-21</sup>

Daily listening to self-selected music may improve verbal memory and attention after stroke.<sup>22</sup> Significant improvements in speech-in-noise perception have been obtained in adult individuals with no prior music training with a training program that incorporated cognitively based listening exercises to improve speech-in-noise perception.<sup>23</sup> According to Rojo et al.,<sup>24</sup> Music-Supported Therapy

(MST) is found to be a useful neuro-rehabilitation tool in patients with chronic stroke and leads to neural reorganization in the sensory motor cortex. Forsblomet al.<sup>25</sup> and Sarkamo et al.<sup>26</sup> demonstrated that music listening during the early post-stroke stage can enhance cognitive recovery and prevent negative mood.<sup>27</sup> Sarkamo & Soto<sup>22</sup> found that listening to pleasant music can have a short-term facilitating effect on visual awareness in patients with visual neglect, which is associated with functional coupling between emotional and attention area of brain regions. Second, daily music listening can improve auditory and verbal memory, focused attention, and mood as well as induce structural gray matter changes in the early post-stroke stage.

A pilot study conducted by Magee & Davidso<sup>28</sup> showed that, in terms of composed-anxious, energetic-tired, and agreeable-hostile mood states, there was a significant difference between pre and post music therapy intervention in a positive direction. Most of the available literatures on the use of music therapy in medicine are predominantly western, although the use of music as a therapeutic medium is found in most of the cultures.

Mossler et al.<sup>29</sup> searched the Cochrane Schizophrenia Group Trials Register (December, 2010) and supplemented this by contacting the authors of relevant study, hand searching of music therapy journals and manual searches of reference lists and suggested that music therapy improves global state and may also improve mental state and functioning if a sufficient number of music therapy sessions are provided. Sunder et al.,<sup>30</sup> concluded that Indian music therapy is an integration of ancient healing practices and musical traditions coupled with the recent modifications, derived from the modern day practice and the knowledge gained by current clinical studies undertaken.

The encoding of pitch along musical scales is an essential component. The implications of the existence of such special-purpose cortical processes are that the human brain might be hardwired for music. This valuable resource of evidence is suggestive of the existence of neural networks in brain, which are dedicated to music.<sup>31</sup>

Music therapy showing significant results are present in the stroke and Parkinson's disease rehabilitation and authors have suggested the need of more rigorous studies based on clear procedures and strong methodological research criteria.<sup>32</sup> The authors gave special attention to the perception of components of music processing, music structure, laterality effects, cultural issues, links between music and movement, emotional processing, expertise, and the amusias and served to demonstrate the important role that music can play in forming broad theories of higher order cognitive processes such as music in humans.<sup>33</sup> Fujioka et al.,<sup>34</sup> demonstrated that music supported therapy in stroke rehabilitation changes in neuromagnetic beta band oscillation. Friedman et al.,<sup>35</sup> observed that the incorporation of music into rehab-training, significantly improved both objective measures of hand motor performance and self-ratings of motivation for training in the single session.

Satoh<sup>36</sup> stated that future studies need to be conducted to establish evidence of the positive effects of music therapy on neurological and neuropsychological symptoms in the paper.<sup>37</sup> There is a need for nursing professionals in this area to better understand the role a music therapist may play and how they can assist clients in using music in a therapeutically beneficial way and educate nurses about music therapy and provide evidence for the therapeutic use of music in the rehabilitation setting for victims of stroke.<sup>38</sup> Sarkamo et

al.,<sup>22</sup> through their study revealed that deficits in both basic auditory encoding and higher domain-general cognitive processing underlie acquired amusia after middle cerebral artery (MCA) stroke, and furthermore that their relative contribution to amusia depends on the location of the cerebral damage.

Most of the studies support the efficacy of Music Therapy and other musical interventions on mood, depressive syndromes, and quality of life on neurological patients.<sup>39</sup> In humans, music listening activates a wide-spread bilateral network of brain regions related to attention, semantic processing, memory, motor functions, and emotional processing. Zimmerman & Lahav<sup>40</sup> highlighted the key multisensory regions within the brain and discussed their role in the context of music learning and rehabilitation.

Listening to rhythm activates motor and premotor cortices.<sup>15,41,42</sup> Myskja et al.<sup>43</sup> stated that music has been an element in medical practice throughout history. Bengtsson et al.<sup>42</sup> used functional magnetic resonance imaging (fMRI) to identify brain area involved in auditory rhythm perception. They found that dorsal premotor cortex (PMD), Supplementary motor area (SMA), PreSMA, and lateral cerebellum were more active when participants listen to rhythm sequences compared to random sequences. Other findings indicate that through learning music the auditory, motor and learning areas of the brain grow larger and interact more efficiently.<sup>44</sup>

Music therapy has proved especially useful for patients suffering from stroke, Parkinson's disease. It retrains auditory perception, attention, memory, and executive control.<sup>45</sup> Kim<sup>46</sup> developed a music therapy protocol to enhance swallowing training for stroke patients with dysphasia. Music therapy now a days are used to improve communication, linguistic development, emotional response, and behavioral adjustment in patients with autism.<sup>47</sup> Improvement in the sound field, and mood was observed in patients with traumatic brain injury.<sup>47</sup> Also it has been reported that music therapy significantly decreased anxiety and blood pressure in patients who underwent transurethral resection of the prostate [TURP].<sup>49</sup> According to Buffum et al.<sup>49</sup> music therapy could reduce anxiety in patients undergoing angiography. Moreover it has been established that music therapy reduced anxiety in patients who received mechanical ventilation respiration.<sup>50</sup>

Sarkamo et al.<sup>26</sup> found that the recovery in the domains of verbal memory and focused attention improved significantly more in the music group than in the language and control groups. According to Rudin et al.<sup>51</sup> music therapy allowed patients to calmly undergo examinations by reducing stress and acting as painkiller during endoscopy.

According to Sarkamo et al.<sup>26,51</sup> music listening was found to enhance verbal memory and focused attention, prevent depressed and confused mood, and increase the amplitude of the frequency magnetic mismatch negativity (MMNm) in the right hemisphere whereas audio book listening had no effect on cognition or mood but increased duration and frequency magnetic mismatch negativity (MMNm) amplitudes in the right hemisphere. As shown by these studies, music therapy enhanced the function of verbal memory of stroke patients.

Kim et al.<sup>43</sup> concluded that the Music therapy has a positive effect on mood in post-stroke patients and may be beneficial for mood improvement with stroke and they also found that Beck

Anxiety Inventory (BAI) and Beck Depression Inventory (BDI) scores showed a greater decrease in the music group than the control group after music therapy, but only the decrease of BDI scores were statistically significant ( $p=0.048$ ). Several Studies on healthy subjects showed that Music listening evokes widespread activation of many frontal, temporal, parietal, and sub-cortical areas related to attention, working memory, semantic and episodic memory, and emotional processing rather than being an endeavour of the auditory cortices alone.<sup>52-55</sup> Dafer et al.<sup>56</sup> stated that early diagnosis and successful intervention of post-stroke depression improves clinical outcome and should be considered as a key to better stroke care. In this regard, our research<sup>58-60</sup> could be a valuable contribution demanding further study on the effects of Hindustani ragas to Cerebrovascular Accident (CVA) and Diffused Head Injury (DHI) patients.

Remark: The main difference between music medicine and music therapy is that in music medicine music intervention is achieved with pre-recorded music which is fixed. There is no provision of manipulating with the music. For music therapy, we need a music lab through which we can manipulate the music, like increasing or decreasing its tempo, change the note duration and microtonal pitch ("shruti" in Indian music) etc. The idea is to provide the optimum benefits to the patient with a given piece of music.

### Therapeutic benefits of Hindustani ragas (non-western music)

Ayurveda tells that our body is dominated by three factors -*Kapha* (Phlegm), *Pitta* (Bile) and *Vata* (Wind). These factors stay in equilibrium in healthy condition but they work in a cycle of rise and fall during 24 hours in a day. Each raga has a characteristic mood or emotional content which can affect our physiological and psychological changes taking place during the 24hour period. Symphonies of raga have a definite soothing effect on the mind (psyche) as well as on the body (soma). Repeated listening to the particular raga at a particular time being chosen for a particular disease produces a network of sound vibration. Giving one (musical) stimulus leads to contraction of the muscles and nerves of the affected part which get relaxed during the interval between successive (musical) stimuli. When a tissue of the affected area contracts, musical notes make the blood flow out from that particular area. Likewise, during relaxation, a state of reduced pressure is created in that area whereby the blood from the adjacent area will flow there. The process is repeated and the blood flow in that part is enhanced resulting in quick healing. Energy from URF (universal energy field) to HEF (human energy field) transmitted by the strokes of the different tones of raga affects the CNS (central nervous system) because the roots of the auditory nerves are more widely distributed and have more connections than any other nerves in the body. Musical beats are closely related to heart beat. Music having 70-75 beats per minute equivalent to the normal heart beat of 72 per minute has a very soothing effect. Likewise rhythms which are slower than 72 beats per minute create a positive suspense on the mind and body since the mind body complex anticipates that the music will speed up and this restored vital energy gives a deep relaxation to the body. Rhythms which are faster than the heart rate as in Pop music excite and rejuvenate the body.<sup>4,5</sup>

Both Hindustani and Carnatic classical music consider ragas as depicting specific moods. An appropriate mood is to be evoked in the listener's mind before initiating the musical treatment.

The therapeutic use of music as a supplementary medicine is growing now a day across the world which is effective in our fast and tensed lifestyle where music is now being considered as the best tranquilizer of anxiety, tension and hypertension. It should be kept in mind that deaths nowadays are caused mostly by diseases having to do with our lifestyle (e.g. heart problems, hypertension, diabetes etc.) whereas earlier they were caused more by communicable diseases. However, music as a therapy is only a supplement to medical treatment and not a substitute. Unfortunately, despite the rich tradition and emotional content of ragas, Indian music so far as therapeutic aspects are concerned is seriously under-researched. In that perspective, our contribution briefed in section 1.3 bears some definite relevance.

### Our contribution

Our study was not involved in experimenting with different types of music; rather it focused only on some Hindustani ragas (North Indian ragas) whose impact was studied on some sampled patients with CVA (cerebrovascular accident) and DHI (diffuse head injury). Since head injury and cerebrovascular accident affect the central nervous system (CNS), it is not surprising that musical stimuli such as those generated by ragas with rich melody and high emotional content can have a positive effect on such patients, given that music also affects the CNS. Music, apart from being a therapy for a disease, also helps in organizing one's thoughts and generates a feeling of satisfaction thereby countering frustrations in life. Music by itself or in combination with other media such as dance offer unlimited scope for experience for the sensory deprived, caused by coma, injury or degenerative diseases. There is a growing awareness that ragas could be a safe supplement for many medical interventions. Interested readers are referred to our work published in several journals.<sup>57-59</sup> Our most cited paper is Singh & Chakraborty, et al.<sup>55</sup> in which the objective was to study the impact of Hindustani ragas on the cognitive functions of the right and left cerebral hemispheres, especially of the parieto-occipital lobe, in patients with cerebrovascular accident and diffuse head injury. Our team is presently investigating the therapeutic role of Hindustani music on migraine patients.

### A few grains of salt

Prof. (Dr.) Soubhik Chakraborty adds: "A question I am often asked in several conferences is which music heals. I do not support the idea that any music heals so long as the listener likes it. We like junk food. Do they do us any good? Similarly if you select music rich in rhythm and poor in melody and if you listen to such music with increased volume, you will end up exciting your sympathetic nervous system causing more harm than good. One should always select melodious music that is soothing to the sympathetic nervous system. From my personal experience, raga Pilu works well in depression and also in nausea and therefore a choice raga to be investigated in psychiatry and pregnancy respectively, raga Yaman in pain and hence our choice raga in migraine, raga Ahir Bhairav in fever, raga Darbari in breathing difficulties and raga Bihag in sleep disturbance. But more work is required for their substantiation.

While working with a medical team on patients with brain injury at Rajendra Institute of Medical Sciences (RIMS), Ranchi we encountered an interesting problem. Most of the patients were from a poor educational and musical background. Although classical music has depth due to the emotional richness of the ragas, one should also have the receiving capacity in order to derive the therapeutic benefits

thereof. On the other hand, the Bollywood songs, many of which are based on ragas and are composed by veteran composers such as S.D. Burman, Madan Mohan, Salil Choudhury, Shankar Jaikishan, Kalyanji Anandji, Roshan, Naushad etc. are very popular among the common mass. We thought it would be an excellent idea to first play the raga based songs first so that the brain gets acclimatized with the raga mood before playing the corresponding raga recordings. Further, the songs were broadly grouped into two categories: non-raga Pradhan songs (songs in which the raga is present but not very prominent) and the raga Pradhan songs (songs in which the raga is not only present but very prominent). First the non-raga Pradhan songs would be played, then the raga Pradhan songs would be played and finally the corresponding raga would be played. The idea worked wonderfully and the patients were able to obtain the desired results as confirmed by the mini mental state examination (MMSE) report. Using similarity analysis of melodies, an attempt was also made to quantify the amount of raga in a song so that the songs could be graded from low to high raga content. But this work is still in progress.”

### Concluding remarks

It is felt that a great deal of research is needed in the field of raga therapy before it is formalized into a definite prescription for the patients. Till then a balanced approach to the role and effect of raga therapy seems to be necessary. In India, music therapy has not received as much attention as in the west. The Medical Council of India has so far not recognized music therapy as a branch of modern medicine, necessitating all the more effort for using an appropriate music scientifically.<sup>4</sup> India is very much lagging behind in such pursuits, despite the rich traditions in raga in Indian classical music (both Hindustani and Carnatic). Our research will hopefully substantiate the existing facts about music medicine and music therapy. With Indian Music Therapy Association about to be formed this very year and the first IMTA conference scheduled to be held in New Delhi on Dec 1-2, 2018, there is definitely hope for better days to come. So we close this paper on this positive note.

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### Conflicting interests

The authors hereby declare that they do not have any conflict of interests.

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### Ethical approval

This research was approved by the Ethical Committee at Rajendra Institute of Medical Sciences, Ranchi.

### References

1. Aldridge D. An Overview of Music Therapy Research. *Complementary Therapies in Medicine*. 1994;2:204–216.
2. Magee WL, Clark I, Tamplin J, et al. Music interventions for acquired brain injury. *Cochrane Database Syst Rev*. 2017;1:CD006787.
3. Kim DS, Park YG, Choi JH, et al. (2011). Effects of music therapy on mood in stroke patients. *Yonsei Med J*. 2011;52(6):977–981.
4. Sairam TV. Raga Therapy. NADA centre for music therapy. 2004.
5. Rammohan GV. Music Therapy: The Present Scenario. In: Raju MV, editor. *Health Psychology and Counselling*. New Delhi: Discovery Publishing House Pvt. Ltd; 2009.
6. Thaut MH. *Rhythm, music and the brain: Scientific Foundations and Clinical Applications*. New York: Taylor and Francis; 2005.
7. Hurkmans J, de Bruijn M, Boonstra AM, et al. Music in the treatment of neurological language and speech disorders: A Systematic review. *Aphasiology*. 2012;26(1):1–19.
8. Mayer M, Megyesi J, Meythaler J, et al. Acute management of acquired brain injury Part III: an evidence-based review of interventions used to promote arousal from coma. *Brain Inj*. 2010;24(5):722–729.
9. Robinson RG. Post stroke depression: prevalence, diagnosis, treatment, and disease progression. *Biol Psychiatry*. 2003;54(3):376–387.
10. Bradt J, Magee WL, Dileo C, et al. Music therapy for acquired brain injury. *Cochrane Database of Systematic Reviews*. 2010;7(7):CD006787.
11. Koelsch S, Fritz T, Cramon DY, et al. Investigating emotion with music: an fMRI study. *Hum Brain Mapp*. 2006;27(3):239–250.
12. Steven R Flanagan, Joshua B Cantor, Teresa A Ashman. Traumatic brain injury: future assessment tools and treatment prospects. *Neuro psychiatr Dis Treat*. 2008;4(5):877–892.
13. Rodriguez-Fornells A, Rojo N, Amengual JL, et al. The involvement of audio-motor coupling in the music-supported therapy applied to stroke patients. *Ann N Y Acad Sci*. 2012;1252:282–93.
14. Schneider S, Schönle PW, Altenmüller E, et al. Using musical instruments to improve motor skill recovery following a stroke. *J Neurol*. 2007;254(10):1339–1346.
15. Zatorre RJ, Chen JL, Penhune VA. When the brain plays music: auditory-motor interactions in music perception and production. *Nat Rev Neurosci*. 2007;8(7):547–558.
16. Koelsch S. A neuroscientific perspective on music therapy. *Ann NY Acad Sci*. 2009;1169:406–416.
17. Thaut MH, Gardner JC, Holmberg D, et al. Neurologic music therapy improves executive function and emotional adjustment in traumatic brain injury rehabilitation. *Ann NY Acad Sci*. 2009;1169:406–416.
18. Platel H, Baron JC, Desgranges B, et al. Semantic and episodic memory of music are subserved by distinct neural networks. *Neuro image*. 2003;20(1):244–256.
19. Patel AD. *Music, Language, and the Brain*. New York: Oxford University Press; 2008.
20. Koelsch S, Kasper E, Sammler K, et al. Music, language and meaning: brain signatures of semantic processing. *Nat Neurosci*. 2004;7(3):302–307.
21. Patel AD, Iversen JR. The linguistic benefits of musical abilities. *Trends Cogn Sci*. 2007;11(9):369–372.

22. Särkämö T, Soto D. Music listening after stroke: beneficial effects and potential neural mechanisms. *Ann N Y Acad Sci.* 2012;1252:266–2681
23. Song JH, Skoe E, Banai K, et al. Training to improve hearing speech in noise: biological mechanism. *Cereb Cortex.* 2012;22(5):1180–1190.
24. Rojo N, Amengual J, Juncadella M, et al. Music-supported therapy induces plasticity in the sensorimotor cortex in chronic stroke: a single-case study using multimodal imaging (fMRI-TMS). *Brain Inj.* 2011;25(7–8):787–793.
25. Forsblom A, Laitinen S, Särkämö T, et al. Therapeutic role of music listening in stroke rehabilitation. *Ann N Y Acad Sci.* 2009;1169:426–430.
26. Särkämö T, Tervaniemi M, Laitinen S, et al. Music listening enhances cognitive recovery and mood after middle cerebral artery stroke. *Brain.* 2008;131(Pt 3):866–876.
27. Sarkamo T, Soto D. Music listening after stroke: beneficial effects and potential neural mechanisms. *Ann N Y Acad Sci.* 2012;1252:266–2681.
28. Magee WL, Davidson JW. The effect of music therapy on mood states in neurological patients: a pilot study. *J Music Ther.* 2002;39(1):20–29.
29. Mössler K, Chen X, Heldal TO, et al. Music therapy for people with schizophrenia and schizophrenia-like disorders. *Cochrane Database of Systematic Reviews.* 2017;5:CD004025.
30. Sunder, Sumathy. *Music Therapy Today.* 2007:3.
31. Isabelle Peretz. Brain Specialization for Music. *Neuro scientist.* 2002;8(4):372–380.
32. Raglio A. The efficacy of music and music therapy in the neuro motor rehabilitation. *G Ital Med Lav Ergon.* 2012;34(1):85–90.
33. Levitin DJ, Tirovolas AK. Current advances in the cognitive neuroscience of music. *Ann N Y Acad Sci.* 2009;1156:211–231.
34. Fujioka T, Ween JE, Jamali S, et al. Changes in neuromagnetic beta-band oscillation after music-supported stroke rehabilitation. *Ann N Y Acad Sci.* 2012;1252:294–304.
35. Friedman N, Chan V, Zondervan D, et al. Music Glove: motivating and quantifying hand movement rehabilitation by using functional grips to play music. *Conf Proc IEEE Eng Med Biol Soc.* 2011;2011:2359–2363.
36. Satoh M. Music therapy for dementia and higher cognitive dysfunction: a review. *Brain Nerve.* 2011;63(12):1370–1377.
37. Kim DS, Park YG, Choi JH, et al. Effects of music therapy on mood in stroke patients. *Yonsei Med J.* 2011;52(6):977–981.
38. Knight AJ, Wiese N. Therapeutic music and nursing in post stroke rehabilitation. *Rehabil Nurs.* 2011;36(5):200–4, 215.
39. Raglio A, Attardo L, Gontero G, et al. Effects of music and music therapy on mood in neurological patients. *World J Psychiatry.* 2015;5(1):68–78.
40. Zimmerman E, Lahav A. The multisensory brain and its ability to learn music. *Ann N Y Acad Sci.* 2012;1252:179–184.
41. Chen MC, Tsai PL, Huang YT, et al. Pleasant music improves visual attention in patients with unilateral neglect after stroke. *Brain Inj.* 2013;27(1):75–82.
42. Bengtsson SL, Ullén F, Ehrsson HH, et al. listening to rhythms activates motor and premotor cortices. *Cortex.* 2009;45(1):62–71.
43. Myskja A, Lindbaek M. Examples of the use of music in clinical medicine. *Tidsskr Nor Laegeforen.* 2000;120(10):1186–1190.
44. Schlaug G. Music, musicians, and brain plasticity. In: Hallam S, Cross I, Thaut MH, editors. *The Oxford Handbook of Music Psychology.* Oxford: Oxford University Press; 2008:197–208.
45. Haslam C, Cook M, et al. Striking a chord with amnesic patients: Evidence that song facilitates memory. *Neurocase.* 2002;8(6):453–465.
46. Kim SJ. Music therapy protocol development to enhance swallowing training for stroke patients with dysphagia. *J Music Ther.* 2010 Summer;47(2):102–119.
47. Wigram T, Gold C. Music therapy in the assessment and treatment of autistic spectrum disorder: clinical application and research evidence. *Child Care Health Dev.* 2006;32(5):535–542.
48. Baker F, Wigram T, Gold C. The effects of a song-singing programme on the affective speaking intonation of people with traumatic brain injury. *Brain Inj.* 2005;19(7):519–528.
49. Yung PM, Chui-Kam S, French P, et al. A controlled trial of music and pre-operative anxiety in Chinese men undergoing transurethral resection of the prostate. *J Adv Nurs.* 2002;39(4):352–359.
50. Buffum MD, Sasso C, Sands LP, et al. A music intervention to reduce anxiety before vascular angiography procedures. *J Vasc Nurs.* 2006;24(3):68–73.
51. Lee OK, Chung YF, Chan MF, et al. Music and its effect on the physiological responses and anxiety levels of patients receiving mechanical ventilation: a pilot study. *J Clin Nurs.* 2005;14(5):609–620.
52. Rudin D, Kiss A, Wetz RV. Music in the endoscopy suite: a meta-analysis of randomized controlled studies. *Endoscopy.* 2007;39(6):507–510.
53. Särkämö T, Pihko E, Laitinen S, et al. Music and speech listening enhance the recovery of early sensory processing after stroke. *J Cogn Neurosci.* 2010;22(12):2716–2727.
54. Janata P, Tillmann B, Bharucha JJ. Listening to polyphonic music recruits domain-general attention and working memory circuits. *Cogn Aff Behav Neurosci.* 2002;2(2):121–140.
55. Patel AD. Language, music, syntax and the brain. *Nat Neurosci.* 2003;6(7):674–681.
56. Koelsch S, Siebel WA. Towards a neural basis of music perception. *Trends Cogn Sci.* 2005;9(12):578–584.
57. Koelsch S. Towards a neural basis of music-evoked emotions. *Trends Cogn Sci.* 2010;14(3):131–137.
58. Dafer RM, Rao M, Shareef A, et al. Poststroke depression. *Top Stroke Rehabil.* 2008;15:13–21.
59. Singh SB, Chakraborty S, Jha KM. Assessment of Level of Recovery of Cognitive Impairment in the Cerebrovascular Accident and Head Injuries Cases: Therapeutic Impact of North Indian Ragas. In: SY stad, et al. editors. Springer-Verlag, Berlin Heidelberg; 2012:44–52.
60. Singh SB, Chakraborty S, Jha KM, et al. Impact of Hindustani Ragas on Visual Acuity, Spatial Orientation and Cognitive Functions in Patients With Cerebrovascular Accident and Diffuse Head Injury. *Music and Medicine.* 2013;5(2):67–75.
61. Singh SB, Chakraborty S, Jha KM, et al. Repeated Measure Analysis in Raga Therapy: A Case Study on Head Injury Patients. *Research Journal of Pharmaceutical, Biological and Chemical Sciences.* 2013;4(1):420–428.
62. Singh SB, Chakraborty S, Jha KM, et al. Impact of Hindustani Ragas on CVA and DHI Patients: An Application of Linear Mixed Model. *International Journal of Advanced Science, Engineering and Technology.* 2013;2(1):97–103.
63. Singh SB, Chakraborty S, Jha KM, et al. Music and Medicine: Healing Brain Injury Through Ragas. *CBH Publications;* 2016:108.