

Music Therapy in Neurology : An Integrated Medicine For Brain Diseases (ASD & CP) And Brain Injuries

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Integrated Medicine combines conventional medical approaches with complementary therapies to treat the whole person - mind, body and spirit. Among the most powerful of these complementary approaches in music therapy particularly Neurologic music therapy uses evidence based musical interventions to promote neuroplasticity and rehabilitation in patients with neurological diseases and brain injuries. The neurologic music therapist uses standardised techniques to assess nonmusical goals such as speech, physical movement, cognition and other functional abilities. Music can be used to help build new connections in the brain called(neuropathways) thus improving brain function and allowing one to lead a more productive and functional life.

The role music therapy has undergone some interesting changes since early 1990's. Driven by new insights and from the research into music and brain function, Neurologic music therapy has been formed as new branch of music therapy. The advent of modern research techniques in cognitive neuroscience, such as brain imaging and brain wave recordings, have enabled us to study humans's higher cognitive brain functions in vivo. A highly complex picture of brain processes involved in the creation and perception of music has emerged. Brain research involving music has shown that music has distinct influence on the brain by stimulating psychologically complex cognitive, affective, sensorimotor process. Furthermore, biomedical researchers have not only found that music is a highly structured auditory language involving complex perception, cognition, and motor control in the brain but that this sensory language can also effectively be used to retain and re-educate the injured or affected brain.

Science Behind Music and Brain

Music engages multiple regions simultaneously including Auditory cortex (processing sound), Motor cortex(movement and coordination), Limbic system(emotion and memory), Prefrontal cortex(attention and decision making). Through this extensive network, music can influence neurochemical systems(dopamine, serotonin, endorphins), autonomic regulation(heart rate, blood pressure) and neuroplasticity(the brain's ability to reorganise and

form new neural connections).

Since 2006 two professors of University South Florida - Neuroscientist Kiminobu Sugaya and world renowned violinist Ayako Yonetani- teaching at Bennett Honours College have been doing great research on music and brain. Their study 'music and brain' explores how music impacts brain function and human behaviour including improving cognitive and motor skills, spatial-temporal learning and neurogenesis, which is brain's ability to produce neurone.

1. Frontal Lobe

Used in thinking, decision making and planning. How: Front lobe is most important to being a human. We have big front lobe compared to animals. "By listening to music we can enhance its functions", Sugaya says.

2. Temporal lobe

What: processes what we hear. How: We use language centre to appreciate music, which spans both sides of the brain, though language and words are interpreted in the left hemisphere while music and sounds are interpreted in the right hemisphere", Yonetani says.

3. Broca's Area

What: enables us to produce speech. How : "We use this part of the brain to express music", Yonetani says. "Playing a musical instrument may improve your ability to communicate better".

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4. Wernicke's Area

What : comprehends written and spoken language. “ We use this part of the brain to analyse and enjoy music”. Yonetani says.

5. Occipital Lobe

What : Process what we see. How: “Professional musicians use occipital cortex, which is the visual cortex, when they listen music, while lay persons use temporal lobe - the auditory and language centre. This suggests that musicians might visualise a music score when they are listening to a music”, Sugaya Says.

6. Nucleus Accumbens

What: “Seeks reward and pleasure and plays big role addiction - as it releases the neurotransmitter dopamine. How: “Music can be a drug - a very addictive drug. Because it is also acting on the same part of the brain as illegal drugs”, Sugaya says. “Music improves dopamine in the Nucleus Accumbens similar to cocaine”.

7. Cerebellum

What : Coordinates movement and stores physical memory. How: “An Alzheimer's Patient, even if he doesn't recognise his wife, could still play piano which he learned when he was young. Because playing has become a musical memory. Those memories in the cerebellum never fades out.”, says Sugaya.

8. Hippocampus

what: considered as the central processing unit of the brain, it is one of the first regions of the brain to be affected by the Alzheimer's disease leading to confusion and memory loss. “Music may increase neurogenesis in the Hippocampus allowing the production of new neurones and improving memory”, Yonetani Says.

9. Hypothalamus

What: Maintains body's status quo links endocrine and nerve system and produces essential hormones and chemicals that regulate sleep, thirst, appetite, mood, heart rate and body temperature, growth and sex drive. How: “If you play Mozart/ soothing raga, blood pressure and heart rate can reduce”, Sugaya says.

10. Amygdala

Processes and triggers emotions. How: “Music an control your fear and make you ready to flight and increase pleasure” Yonetani says.

11. Corpus Callosum

What: Enables the left and right hemisphere of the brain to communicate, allowing for coordinated body movement as well as complex thoughts that requires logic and intuition. How: As a musician you want to have right side and left side of the brain in coordination, they talk each other. Sugaya says, “This allows

pianist to translate notes on a sheet”.

Neurologic music therapy(NMT)

Neurologic music therapy is a research based system of music interventions used for sensorimotor, cognitive, and speech/language training in neurological rehabilitation. Developed by Dr.Micheal Thaut and colleagues in the 1990s in Colorado,USA, NMT is grounded in neuro science and supported by evidence from neuroimaging and clinical trails. It uses music's rhythmic and temporal structure to drive brain reorganisation. It is based on the concept of entrainment - the synchronisation of biological rhythms with external rhythmic cues. It also focuses on functional outcomes rather than musical ability.

Neurologic Music Therapy Experiments at Chetana, Thrissur

Experiments conducted at Chetana Music College and Chetana Sangeetha Naty Academy in Thrissur have provided astonishing results for humanity. Chetana Student Puja Ramesh has become the first autistic girl in India to do a Karnatic Music Classical concert. After completing B.A. Music she began to speak and her self image, social interaction has remarkably improved. At present she has also completed M.A music and performs both light music and classical music professionally. After the continuous learning and practice of music her autism has come down from peak to low. This year she has been received best differently abled students(music) award. Through Neurologic Music Therapy, Pooja's autism has been now reduced to 55%. Her improvement can be evaluated from three major levels such as Cognitive Skills, Sensory motor coordination and language and speech capacities.

Another Chetana student, Kiran T.A., affected by cerebral palsy, is the first music student in India to perform Karnatic music concert. Instances of the miraculous successes of Neurologic Music Therapy are numerous. The right side of the brain is known as the musical brain, while the left side is associated with intelligence, language, and muscle movements in the human body. When the stem cells in the right brain (musical brain) are stimulated musically, the musical abilities are enhanced, and new neurons are produced in

the left brain through neuroplasticity, thereby improving cognitive ability, speech, muscle control, self-confidence, and social interaction. Scientific training in this manner is being conducted in Thrissur at Chetana through Neurologic Music Therapy. Melodic Intonation Therapy is a powerful therapeutic tradition for providing comfort to patients who are affected by stroke. Thus, today music serves as a divine medicine, bringing peace, joy, and physical and mental well-being to the humans.

Clinical Domains and Techniques in NMT

Domain	NMT techniques
A. Sensory Motor	Rhythmic Auditory Stimulation (RAS) Patterned Sensory enhancement (PSE) Therapeutic Instrumental Performance (TIMP)
B. Speech/ Language	Melodic Intonation Therapy (MIT) Rhythmic speech cueing (RSC), Vocal Intonation Therapy (VIT)
C. Cognitive	Musical attention control training (MACT) Musical Mnemonics training (MMT) Musical Executive function training (MEFT)

Evidence and applications in Integrated medicine

Mechanisms of healing

Neuroplasticity:

Music Stimulates the brain's capacity to reorganise neural networks after injury.

Rhythmic Entrainment:

Synchronisation of movement and brain activity with musical rhythm improves motor control.

Emotional regulation:

Music modulates limbic system activity, reducing stress hormones.

Social and cognitive engagement:

Group music - fosters social connection, motivation, and cognitive stimulation.

Integration into clinical practice

Hospitals and rehabilitation centres now incorporate NMT as part of multidisciplinary teams (physiotherapists, speech -language pathologists, vocologists, neurologic music therapists and psychologists). Neurologic music therapy programmes are recognised by the American music therapy Association (AMTA)

and endorsed by the academy of neurological music therapy. Holistic healthcare models view music therapy as a bridge between physiological healing and emotional well being.

How Indian Ragas are beneficial for Neurological music therapy

Indian ragas(melodic frame works) and Talas(rhythmic circles) are highly effective tools for implementing NMT with children who have Autism spectrum disorder (ASD) and Cerebral Palsy (CP). Because their unique structure directly addresses key neurological deficits. Indian Ragas, rooted in the ancient science of Nada Yoga(the Yoga of sound) and often referred to as Raga chikilsa (Raga Therapy), offer unique benefits for neurological rehabilitation due to their intricate structure and deeply researched emotional associations. Here are key ways Indian Ragas are beneficial for neurological music therapy.

Mechanisms of Neurological benefit

Brainwave modulation studies using EEG (Electroencephalogram) have shown that listening to specific ragas can modulate brain wave frequencies. For instance, slow, meditative ragas often encourage alpha brain waves, which are associated with relaxed, calm, and meditative state, aiding in stress and anxiety reduction.

In contrast, faster-paced ragas can increase beta brain wave activity enhancing alertness, focus, and concentration.

Alpha and theta band activity increases have been found to be associated with relaxation and focussed attention, which is crucial for cognitive rehabilitation.

Emotional and Mood regulation

Each raga is meticulously crafted to evoke a specific Rasa (aesthetic emotion or mood) such as serenity (eg: raga Yaman), calm (eg: Behag), or even a pensive mood (eg: raga thodi).

This predictable emotional structure allows therapist to select rags that specifically target and help regulate the emotional states of patient (eg: reducing agitation, anxiety, or depression), which is vital for neurological disorders.

Enhancing Cognitive functions(Neuroplasticity):

1. The complex melodic and rhythmic patterns of ragas (the Pallavi-Anupallavi-Charanam) provide a rich auditory stimulus that engages multiple brain regions.
2. This structured complexity can activate the auditory cortex, hippocampus (memory and learning), and prefrontal cortex (executive function), potentially fostering neuroplasticity-the brain's ability to reorganise itself by forming new neural connections.
3. Specific ragas have been linked to improving attention, concentration, and short-term memory in conditions like cognitive impairment and dementia.

Physiological regulation:

1. Ragas can influence autonomic nerve system (ANS) serene ragas, for instance, lower heart rate and blood pressure, activating the parasympathetic nervous system(the 'rest' and 'digest').
- Ragas have shown potential for therapeutic use in variety of neurological and psychological conditions. In essence, the precise, emotionally-charged and complex structure of Indian ragas makes them a powerful, culturally resonant tool in NMT. They provide sophisticated form of auditory stimulation that can be specifically tailored to target distinct neurological functions and emotional states, bridging ancient wisdom with modern neuroscience.

How Pranayama helps to improve brain function in autism and cerebral palsy

Pranayama derived from Sanskrit words “Prāna” (life force or breath) and “Āyāma”(control or regulation), is a core component

of yoga therapy. It involves conscious regulation of breathing patterns - altering the rate, depth and rhythm of respiration to influence physical and mental states. In Integrative medicine pranayama is recognised as neurophysiological tool that can modulate brain function through automatic balance, improved oxygenation, and neural network regulation. These mechanisms make it particularly beneficial for neurodevelopment disorders such as autism and cerebral palsy.

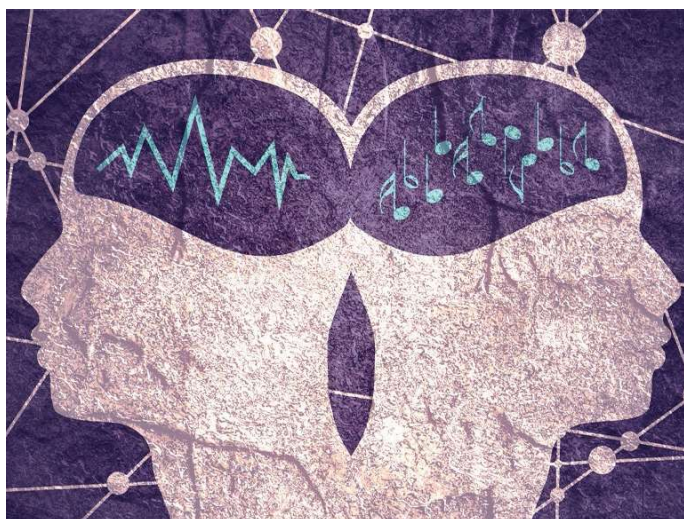
In autism spectrum disorder (ASD) children with autism often have impaired sensory integration and attention control, dysfunctional autonomic nervous system (ANS) balance (sympathetic over activation) and elevated stress and anxiety levels, reduced social and emotional reciprocity. In the case of Children with cerebral palsy typically exhibit motor control impairments due to brain injury, poor coordination and spasticity, Difficulty with speech, attention and emotional regulation, reduced cerebral oxygenation and muscle stiffness. Pranayama addresses many of these dysfunction by influencing brain oxygenation, neurochemical balance and neural connectivity.

Mechanisms of Action: How pranayama affects brain

Physiological effect	Mechanism
Improved oxygenation and cerebral blood flow.	Deep, slow breathing increases Oxygen supply and improves Cerebral perfusion
Automatic Nerve System Regulation	Balances parasympathetic and Sympathetic activity via vagus nerve
Vagal Stimulation	Controlled exhalation and humming (as in brahmari pranayama) activates Vagus nerve.
Reduction of Oxidative stress	Controlled breathing reduces Cortisol and stress hormone levels
Neuroplasticity enhancement	Rhythmic breathing promotes Synchronised neural oscillations and GABA release
Improved motor control	In CP, rhythmic breathing helps relax spastic muscles and improve proprioception

Types of Pranayama useful for ASD and CP

1. **Anuloma-viloma Pranayama(Alternate nostril breathing)**
Balances the two brain hemispheres and regulates autonomic function. Helps to improve focus, reduce anxiety and stabilise emotions.
2. **Brahmari Pranayama(Humming bee breath)**
The humming sound stimulates the vagus nerve and limbic system. Calms the mind, enhances auditory processing, and reduce hyperactivity, particularly beneficial for children with sound sensitivity or emotional dysregulation.
3. **Deep Diaphragmatic breathing (Abdominal breathing)**
Increases oxygen exchange and improve postural control. Supports speech development and respiratory coordination in CP
4. **Ujjayi Pranayama (Victorious breath)**
Promotes mindfulness and body awareness. Can improve attention span and concentration in ASD.
5. **Kapalabhati (Skull Shining breath)**
Stimulates brain centres but should be practiced only under supervision, as it involves force breathing



Pranayama acts as a bridge between body and mind, modulating neural, emotional and physiological systems. For children with autism and Cerebral palsy, it serves as a non-invasive, low-cost, and integrative therapeutic tool that enhances cognitive function, emotional balance, motor coordination and overall quality of life. Through regular, guided practice, pranayama can significantly support the goals of integrated neurorehabilitation.

Conclusion

Music's therapeutic power is both ancient and scientifically validated. In integrated medicine, Neurologic music therapy exemplifies how art and science can merge to foster recovery, emotional balance, and quality of life. Through rhythm, melody, and harmony music becomes not just a cultural expression - but a powerful, evidence based tool for healing the human brain and spirit.

Neurologic music therapy provides a powerful, scientifically validated, and highly engaging therapeutic modality within the spectrum of integrative medicine for children with ASD and CP. By leveraging the comprehensive, multimodal activation of the brain by music, Neurologic music therapy induces beneficial neuroplastic changes that translate to measurable improvements in communication, motor control, and cognitive functions.

Future research should continue to employ advanced neuro imaging techniques (like fMRI) to further delineate the specific neural mechanisms underlying neurological music therapy - induced functional connectivity changes in these populations, thereby optimising the clinical application of this promising intervention.

References:

- Thaut, M.H. & Hoemberg V.(Eds). (2014) Handbook of Neurologic Music Therapy. Oxford University Press.
- Thaut, M.H.(2005) Rhythm,Music and the Brain: Scientific and clinical applications. Rutledge.
- Wigram, T.& De Becker, J.(1999). Music re-connects neural net works. In Namah Journal - Early work linking music to neuroplasticity and emotional well-being.
- Faber, J., et al.(2018). The effects of Music on the brain and cognitive function. Neuroscience & Biobehavioural reviews.
- Goleman, D., & Davidson, R.J.(2017). Altered Traits: Science reveals How Meditation Changes Your Mind, Brain and Body.
- Ramaswamy, M.R., et al. (2024) Therapeutic use of music in neurological disorders: A concise narrative review.
- Sacks, Oliver(2007) . Musicophilia: Tales of Music and the brain. Knopf