Improving Movement, Communication, and Cognitive Functioning with Neurologic Music Therapy (NMT)

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Disclosure

I, Meredith Sharpe, have no financial interests or relationships to disclose.

Music and Music Therapy

"Music is a product of the human brain. However, the brain that engages in music is also changed by engaging in music." (Thaut et al., 2014, p. 3)

Music

- Music in nature
- Music as part of the human experience
- Thinking of music's elements
- Music **stimulates** many areas of the brain, making cross hemispheric connections
- **Shares neural networks** with non-musical functions

Music Therapy

- Designs therapeutic music exercises to target **non-musical goals** to **optimize** the function of stimulated brain regions
- Research and evidenced based
- Certified professional
- Neurologic Music Therapy

Thaut, M.H., McIntosh, G.C., and Hoemberg, V. (2014). Neurologic music therapy: from social science to neuroscience. In M.H. Thaut & V. Hoemberg (Eds.), *Handbook of neurologic music therapy* (1st ed., pp. 1-6). Oxford University Press.

Music and Movement

- **Rhythm** (pulse, pattern, tempo)
  - Motor system very sensitive to the arousal of the auditory system
    - Responds automatically to temporal information relayed to the brainstem (automatic finger or foot tapping, infant's breathing pattern)
  - **Entrainment**
    - "*a temporal locking process in which one system's motion or signal frequency entrains the frequency of another system*"[1]
    - body's internal pulse aligns with an external pulse, begin to internalize pulse
    - potential to organize sensory processes, improving attention, language, motor planning, and arousal level [2]

[1]Thaut MH, McIntosh GC, Hoemberg V. Neurobiological foundations of neurologic music therapy: rhythmic entrainment and the motor system. Front Psychol. 2015 Feb 18;5:1185. doi: 10.3389/fpsyg.2014.01185. PMID: 25774137; PMCID: PMC4344110.

[2]Berger, D. (2002). *Music therapy, sensory integration and the autistic child.* Philadelphia, PA: Jessica Kingsley.

Music and Movement Continued

Element	Connection to Movement
Rhythm and Tempo	• Rhythm as a communicator of time • Neural impulses from auditory rhythm project directly into motor structures • Entrainment of motor responses organizes movements
Melody	• Melodic contour supports the direction of a movement
Dynamics	• Dynamic levels drive movement sizes and intensity
Harmony	• Harmonic consonances and dissonances simulate feelings of tension and release

Application: NMT and Movement

Research:

- Improvements in gait in Parkinson's Disease[1]
  - Stride length, swing time & cadence
- Gait velocity in Huntington's Disease[2]
- Overall hand and arm performance in Cerebral Palsy[3]
- Decrease in stereotypical motor stimming in ASD[4]

[1]Benoit, C. E., Dalla Bella, S., Farrugia, N., Obrig, H., Mainka, S., & Kotz, S. A. (2014). Musically cued gait-training improves both perceptual and motor timing in Parkinson's disease. *Frontiers in human neuroscience*, *8*, 494.[2]Wittwer JE, Webster KE, Hill K. Rhythmic auditory cueing to improve walking in patients with neurological conditions other than Parkinson's disease—what is the evidence? Disabil Rehabil. 2013;35(2):164–76.[3] Marrades-Caballero, Santonja-Medina, ·Sanz-Mengibar, Santonja-Medina. (2018) .Neurologic music therapy in upper-limb rehabilitation in children with severe bilateral cerebral palsy: a randomized controlled trial. European Journal of Physical and Rehabilitation Medicine, 54(6):866-872[4]Srinivasan, S. M., Park, I. K., Neelly, L. B., & Bhat, A. N. (2015). A comparison of the effects of rhythm and robotic interventions on repetitive behaviors and affective states of children with Autism Spectrum Disorder (ASD). *Research in autism spectrum disorders*, *18*, 51-63.

Application: Rhythmic Auditory Stimulation (RAS)-Initial, No music

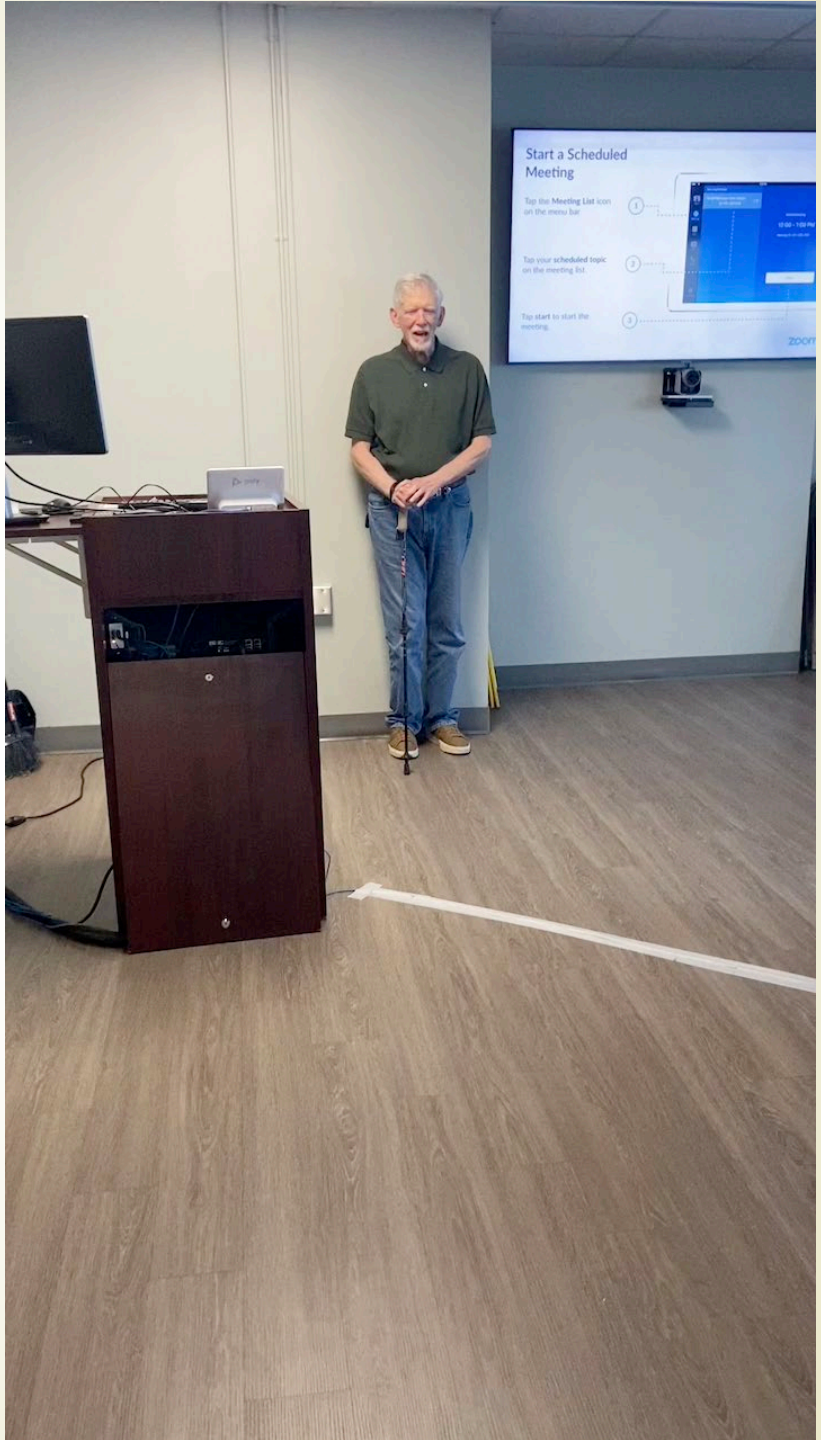
1. ~80 bpm there
2. ~85 bpm back

Application: Rhythmic Auditory Stimulation (RAS)-With music

1. 95 bpm-able to entrain

Application: Rhythmic Auditory Stimulation (RAS)-After, no music

1. ~95 bpm-able to internalize



Application: Other NMT Interventions

- Patterned Sensory Enhancement (PSE)
- Therapeutic Instrumental Music Performance (TIMP)[1]

- Explorations in hand-writing and rhythm/music for Parkinson's
  - *"It's making the hand-writing a little better, but it's making me not stop. So, the point of it is to keep the flow, and my writing is larger, like I like it."*
    -Pt. with Parkinson's
- Adding rhythm/music to vestibular exercises

1Mertel, K. (2014). Therapeutic Instrument Playing (TIMP). In Thaut, M. H., & Hoemberg, V. (Eds.). (2014). *Handbook of neurologic music therapy.* Oxford University Press.

Testimonials

- *"As a professional musician, music educator and composer, I truly know the value of using music to help heal the body. I've used many different types of PT, OT and Neuro balance therapy for long-term rehabilitation from multiple sclerosis and vestibular dysfunction.*

  My personal experience with Neuro music therapy and the techniques I've learned have been exciting, unique and remarkable!

  Practicing slow movements with a metronome beat to specific music has helped me retrain my body and brain! It feels like an internal beat in my head that helps keep my balance and postural stability.

  Even when I don't have the music and beat available, I imagine it in my head before I start walking, and while I'm walking, I feel that " click track" going on in my brain. It's remarkable! I'm getting stronger and have more mobility. My balance is improving."

  -Pt. with MS and vestibular dysfunction

- *"I started attending Music Therapy weekly…and I am very happy to say that I thoroughly enjoy the sessions. I am slowly learning to balance my steps using music interventions in a manner that I never imagined. I seem to be accomplishing new goals and I'm feeling motivated again."*

  -Pt. recovering from a stroke

Music and Communication

Singing and speaking have different but also overlapping neural pathways.

- Rhythm in speech and singing--left hemisphere function
- Rhythm in singing adds right hemispheric function
- Control of pitch and melodic patterns are predominately right hemispheric functions
- Reading musical notation and reading language are closely related in the brain

Non-verbal communication patterns can be mirrored and practiced in musical improvisation experiences

- Eye contact, turn taking
- Emotional expression, tone, intention of thoughts
- Agreement/Validation through mirroring
- Disagreement/Independent thought through modulation or changing pattern

Application: NMT and Communication

- **Research:**
- Significant improvement in aphasia quotient, naming, and repetition with Music Therapy[1]
- Enhances recovery of cognitive abilities post-stroke[2]
- Supports maintenance of vocal abilities in Parkinson's Disease[3]
  Volume, quality, and glottal function
- Fluency in patients with Alzheimer's Disease[4]
- Acquisition of speech sounds and word approximations, articulation of words and phrases in children with ASD[5]

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[2]Xu, C., He, Z., Shen, Z., & Huang, F. (2022). Potential Benefits of Music Therapy on Stroke Rehabilitation. *Oxidative medicine and cellular longevity*, *2022*, 9386095. https://doi.org/10.1155/2022/9386095

[3]Matthews, R. Acoustic, respiratory, cognitive and wellbeing comparisons of two groups of people with Parkinson's disease participating in voice and choral singing group therapy (VCST) versus a music appreciation activity. *Mov. Disord.* **2018**, *3* (Suppl. 2), 33

[4]Lyu, J., Zhang, J., Mu, H., Li, W., Champ, M., Xiong, Q., ... & Li, M. (2018). The effects of music therapy on cognition, psychiatric symptoms, and activities of daily living in patients with Alzheimer's disease. *Journal of Alzheimer's Disease*, *64*(4), 1347-1358.

[5]Wan CY, Bazen L, Baars R, Libenson A, Zipse L, Zuk J, et al. (2011) Auditory-Motor Mapping Training as an Intervention to Facilitate Speech Output in Non-Verbal Children with Autism: A Proof of Concept Study. PLoS ONE 6(9): e25505. https://doi.org/10.1371/journal.pone.0025505

Example

Patient Background

- 66 yr. old female
- hx. of left MCA stroke followed by PNES, PBA
- Aphasia and apraxia
- Participated in ST, PT, OT, and EMDR
- Began MT approximately 2 years after her stroke
- On-going short-term ST clinics through LSU
- Regular practice at home

NMT Interventions and Progress

- **Melodic Intonation Therapy (MIT)**
  - Sing or intone functional phrases with a steady pulse, Musical prosody models normal speech inflections

- **Oral Motor and Respiratory Exercises (OMREX)**
  - Stimulate muscles used with breathing, phonation, articulation, and resonance; improve sound sequencing and motor planning

- **Therapeutic Singing**
  - Overall practice to strengthen vocal mechanisms that produce sound

- **Re-Assessment**

Testimonials

- *"When I first found music therapy, I know that it's working. The first time, I will never forget, it's right there (pointing to lower lungs for deeper breathing to support voice). It's the combined music and speech that worked for me. It is miraculous how music uses all the brain. It's a big difference. A whole body experience. I learned to say my name, my birthday, all sorts of things. For me, I feel empowered…meaning, 'I got this.' A long time ago I used to say, 'why me'. I don't anymore. I know I have a disability, but music therapy has empowered me."*

  -Patient with Broca's Aphasia due to stroke

- *"After my stroke, I became depressed. I had speech impairments. Music therapy has helped with everything…attitude, encouraged me to take part in therapy, made me cognizant of what is going on around me. I can read and write now. I can sing songs. It has helped me talk with family and friends."*

  -Patient with Apraxia and Aphasia due to stroke

Music and Cognition

- Studies have shown that rhythmic patterns drive attention and focus
- Shared neural pathways between attention and memory in both musical and non-musical cognition
- Associating musical patterns with certain responses can work on improving sustained attention
- The practice of recognizing changes in music can enhance auditory processing
- Improvisation—Lateral prefrontal cortex shuts down (conscious self-monitoring, self-inhibition, and evaluation of what is correct or incorrect), medial prefrontal cortex turns on (autobiographical narrative abilities and sense of self)

Application: NMT and Cognition

- Improved frontal lobe function in Parkinson's' Disease[1]
- Improved long term memory storage and retrieval in MS[2]
- Improved global cognitive state, long and short-term memory in patients with MCI[3]
- Evoke white matter neuroplasticity in TBI[4]
  - Improved executive function

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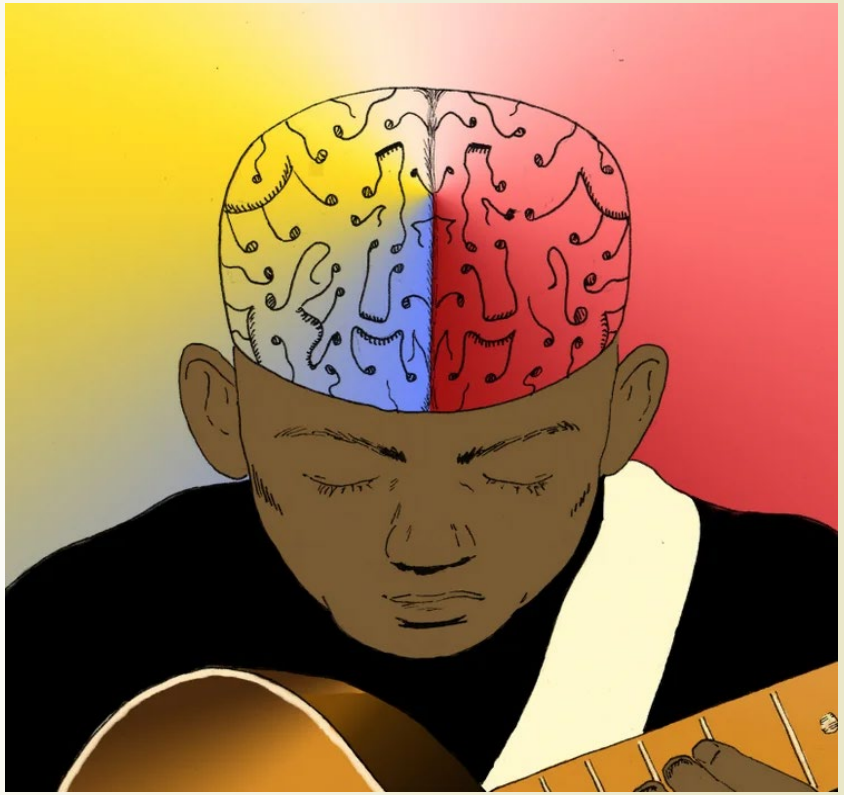
[1] Spina, E., Barone, P., Mosca, L. L., Lombardi, A., Longo, K., Iavarone, A., & Amboni, M. (2016). Music therapy for motor and nonmotor symptoms of Parkinson's disease: a prospective, randomized, controlled, single-blinded study. *J Am Geriatr Soc*, *64*(9), e39.[2]Impellizzeri, F., Leonardi, S., Latella, D., Maggio, M. G., Cuzzola, M. F., Russo, M., ... & Calabrò, R. S. (2020). An integrative cognitive rehabilitation using neurologic music therapy in multiple sclerosis: A pilot study. *Medicine*, *99*(4).[3] Domínguez-Chávez, C. J., Murrock, C. J., Guerrero, P. I. C., & Salazar-González, B. C. (2019). Music therapy intervention in community-dwelling older adults with mild cognitive impairment: A pilot study. *Geriatric Nursing*, *40*(6), 614-619..[4]Sihvonen, A. J., Siponkoski, S. T., Martínez-Molina, N., Laitinen, S., Holma, M., Ahlfors, M., ... & Särkämö, T. (2022). Neurological music therapy rebuilds structural connectome after traumatic brain injury: Secondary analysis from a randomized controlled trial. *Journal of clinical medicine*, *11*(8), 2184.

Application: NMT Interventions

- **Musical Attention Control Training (MACT)**
  - Structured music experiences (actively playing or listening) in which musical elements cue certain responses to work on different levels of attention
- **Musical Executive Function Training (MEFT)**
  - Structured improvisation and composition exercises that practice executive function skills such as organizing, decision making, planning
- **Associative Mood and Memory Training (AMMT)**
  - Uses music (often familiar music) to enhance memory by stimulating access to long-term memories that are associated with positive mood; this positive mood can then possibly allow for learning of new information
- **Music in Psychosocial Training and Counseling (MPC)**
  - Active music making or listening experiences to help improve mood, positively express emotions, enhance self-awareness, manage stress levels, and inspire social connections



Testimonials

- *"I have noticed when I have attended with him, how his mood changes (more positive) and how engaged he becomes with singing, playing the instruments, following patterns, and making up songs for pictures he couldn't find the words to describe! It brought tears to my eyes the very first visit, just to see my dad so happy and the enjoyment he seemed to be experiencing."*

  -Daughter of Patient with Alzheimer's

- *"Before ____ began Music Therapy, it was incredibly difficult to structure his life because he just wasn't interested in doing anything but sit in a chair. Now he practices several times a week, often for hours at a time. He listens to music with new alertness as well…the music gives him a way to connect in a way he'd lost with me and with others."*

  -Wife of a Patient with Alzheimer's

- *"Music therapy helped me release emotions, and songwriting opened up things that I didn't know were closed. It opened lines of communication with my family and brought us closer together."*

  -Pt. with history of TBI and stroke

- *"After participating in music therapy, I can move through the tough things. I can make space for what the instrument has for me. I strum through difficulty. The impact on my MS has been absolutely breathtaking. My heart is healing. After one of my first sessions, I was able to complete three projects that night, which previously was very difficult due to my MS. The music is a continuous resource."*

  -Pt. with MS

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Thank you!