Course Objectives

- Unit I. Learn Basic Brain Information
- Unit II. Music in the Brain; Why Music Works
- Unit III. Considerations for Populations
  - a. Rehabilitation
  - b. Habilitation

Rhythmic/Musical Cues

- Motor training
  - Intrinsic and volitional
  - Cognitive training

Music/Rhythm Can:

- Rhythm can entrain movement
- Music can be used to show movement information (spatial, force) - to better organize movement!
- Music is invokes extended networks, using unimpaired areas relearn tasks
- Music is emotional, motivational

Rehabilitation

- Evidence of entrainment in:
  - Parkinson’s Disease
  - Cerebral Vascular Accident
  - Traumatic Brain Injury
  - Spinal Cord Injury
**Parkinson’s**

- Major deficit in basal ganglia (substantia nigra)
  - On-beat synchronization mechanism is maintained
  - Motor timing differences with syncopation (Stegemoller 2009)
  - Difference in beat determination (Grahn et al. 2009)

**Parkinson’s**

- A Meta-Analysis of Music aided Movement Therapy for Parkinson’s
  - Found significant effect sizes for:
    - Balance Scale
    - Timed Up and Go Test
    - Stride Length
  - No Significance for:
    - Quality of life, freezing, Unified Parkinson’s Rating Score

**Parkinson’s**

- Rhythm may also help with:
  - Freezing (Arias, 2010).
  - Turning (Nieuwboer, 2009).
  - Increased step amplitude (Arias, 2008).
  - Mental singing (Satoh & Kuzuhara, 2008).

**What This Means**

- Persons with damage to Basal Ganglia:
  - Can rehab motor patterns with rhythm
  - Likely “bypass” damaged areas of the brain by engaging areas not impacted by Parkinsons

**Cerebral Vascular Accident**

- Motor movement improvements dependent on area of insult
  - Evidence of entrainment in gait (Roerdink et al. 2009, 2007; Thaut et al. 2007)
  - Evidence of entrainment in volitional motor movement (Malcolm et al. 2009; Whitall et al. 2010)
  - Auditory stimulation worked better than Bobath training in measures of velocity, stride length, and cadence (Thaut, 2007).

**CVA - Volitional**

- Music assisted therapy (MAT) improved fine and gross motor skills, including movement speed, precision, and smoothness (Altenmuller, 2009).
  - Music-supported therapy improves motor patterns and facilitates cortical plasticity (Amengual et al., 2013; Grau-Sanchez et al. 2013)
  - Improved in their activities of daily living (Schneider, 2007).
**Traumatic Brain Injury**

- Injury varies; insult to cortical areas
  - Improvements in gait training (Hurt et al. 1998)

**What this means**

- Rhythm may be useful for rehab acquired brain injury:
  - For gait rehabilitation
  - Upper body rehabilitation

**Spinal Cord Injury**

- Incomplete Spinal Cord Injury
  - Motor and sensory are dependent on location of insult
  - Signs of entrainment that differed based on injury (de l'Etoile, 2008)
  - Findings that visuotemporal cue may work best (Amatachaya et al. 2009)

**Cerebral Palsy**

- Rhythmic cues:
  - Ameliorated anterior tilt of the pelvis and hip flexion
  - Aggravated internal and external rotation
  - Bobath:
    - Improved internal and external rotations of hip joints

  Kim, Kwak et al, 2012

- External rhythmic cues:
  - Lessening tilt of pelvis and hip flexion
  - Improvement of the Gait Deviation Index with RAS
  - Improvement in side-to-side asymmetry of step length

Kim, Kwak et al. 2011

**Cerebral Palsy**

- Keyboard playing:
  - Improved manual dexterity
  - Improved velocity of finger movement

Chong, Cho, Jeong & Kim, 2013
What this means

• Rhythm can be used for improvements with multiple neurological difficulties
  • Wittwer et al. 2013 - Evidence for CVA, not for others
  • Evidence of some contraindications

Clinical Practice

• Steady Rhythm
  • Metronome or body beat
  • Use appropriate tempo for skill function
  • Consideration of competing stimuli
  • Music imbedded with strong patterns
  • Motivational elements

Clinical Practice

• Where is the work?
  • ADD music to the work
    • Decrease the perception of work, increase cortical and motor efficiency
    • Use neurologic principals to better function
  • Eliminate music - do you still have function?

Clinical Practice

• In Rehabilitation:
  • Consider the rhythmic stimulus
  • Use cortical plasticity for “good”
  • Provide the brain with patterned information to ease processing
  • Remember points about perception-action mediation and entrainment principles
  • Consider the limitation of our research, apply the best logic

Overview of NMT

• Neurologic Music Therapy:
  • Is a music therapy methodology based on applied and clinical research
  • Strives to help clinicians maintain evidence-based medicine (EBM)
  • The RF Unkefer Academy of NMT has over 800 certified members; 129 Fellows

NMT Techniques

• Rhythmic Auditory Stimulation (RAS)
• Therapeutic Instrument Music Performance (TIMP)
• Patterned Sensory Enhancement (PSE)
Habilitation

Similar to Rehab...

- Consider neurological side of diagnoses:
  - Example - Autism
    - Multiple brain areas implicated in autism
    - Local over-connectivity, long-range under-connectivity
  - Fragile X Syndrome
    - Slowed neural transmission times

Neural development

- Rapid development
- Reflexive to skill
- Synaptic pruning
- Critical/sensitive windows
- Experience
- Entrainment

Entrainment?

- Perception = taking in, organizing, and interpreting sensory information.
- Motor development = changes in children’s ability to control their body’s movements
- Perceptual-motor development = the developing ability of the young to integrate their perception and motor processes to achieve optimal motor responses to their environment

Entraining to a stimulus

- Motor synchronization abilities in children increase with chronological development
- Seven-year-old children synchronized finger tapping to auditory stimulus with 77% accuracy.
- Eleven-year-olds performed at 98% accuracy for the same task.

Meaning...

- Rhythm can still work in children!
  - Beat matching isn’t typically developed till adolescence
  - Studies show that neurons DO synchronize to external auditory stimulus (Davies et al. 2009)
Cognitive Research

- Less clinical research in cognitive and social realm
- Difficulty studying populations
- Difficulty with measurement of skills
- Need for pilot studies and clinical research

How Music Can Help in Cognition

- Music thought to help with cognitive flexibility
- Music involves attention function
- Music performance involves executive function
- Rhythmic patterns can synchronize with internal oscillators

Hedge, 2014

Evidence of Improvements in:

- Visual Neglect (see Thaut & McIntosh, 2014**)
- Executive Function (TBI; Thaut et al. 2009; Hedge, 2014**; Mueller, in review)
- Memory (MS; Thaut, 2008)
- Emotional Regulation (TBI; Thaut et al., 2009) (OA; Chu et al., 2014)
- Cognitive Functioning (OA; Hars et al., 2014)

Techniques

- Music Neglect Training (MNT)
- Music Attention Control Training (MACT)
- Music Executive Functioning Training (MEFT)

Music Attention Control Training

Goal:

To practice focused, sustained, selective, divided, and alternating attention functions

Diagnostics:

- Autism Spectrum, ADHD, CVA, TBI, Psychiatric Disorders, Dementia/Alzheimer’s

Attention Control

- Basic Research:
  - Activations in the prefrontal areas with large (conscious) perturbations in rhythmic consistency

Stephan et al 2002, Neuroimage
**Clinical Research - TBI**

- MACT with Adults with Traumatic Brain Injury
- Eight Participants
- Ages: $M = 27$; Range = 24-74
- Single Case Design: Reversal
- Paced Auditory Serial Addition Test (PASAT): Clinical Assessment for Attention (CAT)

Abiru et al. (in press)

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**Clinical Research - ASD**

- MACT with Adolescents with Autism Spectrum Disorders
- Nine Participants
- Ages: $M = 16.25$; Range = 12-20
- Pre-test –post-test design
- Two sessions a week for four weeks
- Test of Everyday Attention – Child

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**Attention Training Protocol**

- Music Attention Control Training - sustained
  - Client hears stimulus and demonstrates behavior
  - Stimulus is changed and client changes behavior
- Music Attention Control Training – selective
  - Client hears stimulus and with imbedded cue
  - Upon hearing the imbedded cue, the client’s behavior changes.

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**Results**

- TEA-CH Ten Subtests
  - No significant effects for:
    - Sustained
    - Divided Attention
  - Significant effects for:
    - Selective
    - Switching

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**Selective Attention**

- "Sky Search" $^{*p = .004}$
- "Map Search" $^{*p = .04}$

**Switching Attention**

- "Creature Count" $^{*p = .024}$
- "Opposite World" $^{*p = .039}$
**Executive Functioning**

Goal: To practice executive function skills
- Organization
- Problem solving
- Decision making
- Reasoning
- Comprehension

Diagnostics:
- TBI, CVA, Psychiatric Disorders, Neurologic Disorders with executive function deficits

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**Basic Research**

- Music activates the known networks and areas for executive functions including:
  - Prefrontal cortex,
  - Orbitofrontal cortex,
  - Cingulate cortex,
  - Temporal poles/frontal polar region,
  - Cortico-cerebellar loop
  - Dorsal premotor cortex (Koelsch, 2009; Ramnani and Passingham, 2001; Zatorre et al., 2007).

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**Clinical Research**

- MEFT with adults with TBI, CVA, seizures, and brain tumor
- Thirty-one participants
- Ages: M = 50
- Quasi Experimental Design; Control = 14 Treatment = 21
- Wechsler Adult Intelligence Scale (Attention), Auditory Verbal Learning Test (Memory), Brief Symptom Inventory (Emotional), and Multiple Affect Adjective Check List (Emotions). Thaut et al. (2009).

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**Confidence in Executive Functioning Ability**

**Child Research**

- Musical cuing was utilized to learn sequential information, such as counting and phone numbers. Information embedded in a musical structure was found to be easier to recall. (Wolfe 1993)
- Children are able to easily attend to musical stimuli. Music aided in decreasing distractibility, thereby increasing attention and memory. (Morton 1990).
- Children engaged in music for more than 1 year show increased gamma-band response activity (brainwaves associated with memory, attention, and integration of multisensory experiences)
  - Could lead to enhanced executive function and learning (Trainor et al. 2009)

**Reading Skills**


**Bottom Line**

- Music can change the brain in very little time
- Music is not only motivating, but promotes neural synchrony
- Music can engage nonmusical areas, as well as extended areas of the brain.
  - Children with disabilities may have differential neural response to music vs. nonmusical stimuli. Example: Lai et al. 2012
- Music can provide a scaffold for learning nonmusical information

**Music Therapy**

- Music is:
  - Rhythmic
  - Highly predictable
    - Structure, anticipation, organization
  - Motivating & fun
  - Organizing
  - Multi-sensory

**Clinical Practice**

- Let the music do the work
- With children, use the music but "hide the peas in the potatoes"
- Consider the rhythmic/musical template - are you supporting the work?

**In Conclusion**

- Music is a powerful medium in the brain
- Rhythm appears to be a key to organization in the brain
- Music can facilitate functional goals due to shared/extended networks
- Additional factors including emotional responses and motivation make this an excellent medium for therapy