Interactive Metronome

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Today's Objectives

- Demonstrate knowledge of how the Interactive Metronome impacts on timing and rhythm.
- Understand the treatment effects of using the Interactive Metronome.
- Be aware of how the Interactive Metronome is incorporated into an occupational therapy program and impacts on the performance of children's daily occupations.
Interactive Metronome

- What IM is
- Relevant research
- What IM does
- Underlying brain structures
- Treatment effect
- Who should do IM
- IM in my occupational therapy practice
- My take on IM
- Case studies
- Questions
What is the Interactive Metronome?

- Computer-based training program
- Assessment tool and training tool
- Child wears headphones and hears the computerized metronome beat
- Child taps a hand or foot trigger at the same time as the beat
- Guide sounds assist child in fine-tuning movements
- Visual feedback can also be provided
What is IM?

- Offers opportunity to practice rhythmic, repetitive movements in a smoothly timed and coordinated manner
- Improves child's ability to plan and sequence the timing of his/her movements
- Improves ability to maintain focus over extended amounts of time without interruption
- Facilitates the unconscious processing of thought and movement
Relevant Research

- IM invented by music engineer James Cassily
- Private studies found fine/gross/visual motor improvements in coordination with children with autism
- IM came to the attention of Dr. Stanley Greenspan
Effect of Interactive Metronome Training on Children with ADHD

- Published in the April/May 2001 issue of the American Journal of Occupational Therapy
- Peer-reviewed, double-blind, placebo-controlled study of 56 boys aged 9-12 diagnosed with ADHD
- Statistically significant improvement in attention and concentration, coordination, control of aggression/impulsivity, reading, and language processing
- (Shaffer, Jacokes, Cassily, Greenspan, Tuchman, Stemmer, 2001).
Motor Control Study

- Comparison of IM trained special education students to a control group
- Students who received IM training demonstrated significant improvements in motor control and motor coordination as measured by the Bruininks-Oseretsky and SIPT Motor Accuracy Test
- Parents also reported improvements in their children's ability to attend to tasks, read, write, and general behavior
- (Stemmer 1996)
Reading Study

- 86 children ranging from first to fourth grade completed pre- and post-test measures of reading achievement.
- The experimental group participated in 4 weeks of IM training.
- Their post-test scores on select measures of reading were significantly higher than the non-treatment control group’s scores at the end of the 4 weeks.
- (Taub, McGrew, Keith, 2007 *Psychology in the Schools*)
What Does IM Do?

- Provides REPETITION
- REPETITION
- REPETITION
- REPETITION
- REPETITION
- REPETITION
- REPETITION
Four Neurological Functions That Occur During Every IM Beat:

1. The child attends to and concentrates on the beat
2. Sensory integration occurs
3. Performance of functional motor control
4. Synchronization

- For every beat that occurs there is a neurological loop doing these 4 functions at once.
IM Improves Mental Timing

- Mental timing is a foundation of learning and memory
- Underlying theory of IM is that motor planning processes of organizing and sequencing are based on an internal sense of rhythmicity
- Rhythm provides the foundation of timing upon which the child can organize and sequence the actions that make up a motor plan
IM Integrates sight, sound, and physical movement to improve:

- **Working Memory** – ability to store information and ideas
- **Attention** – ability to focus on information and tasks and ignore distractions
- **Processing** – rate at which the child is able to accurately perceive and manipulate information
- **Sequencing** – placing of detailed information in its accustomed order
- **Motor Coordination** – combination of purposeful body movements working together
Underlying Brain Structures

- Timing Structures of the Brain
  - Dorsolateral Prefrontal Cortex
  - Basal Ganglia
  - Cingulate Gyrus
  - Cerebellum

- Motor Cortex Areas
  - Supplementary Motor Area
  - Premotor Cortex
  - Primary Motor Cortex

- Frontal Lobe
Dorsolateral Prefrontal Cortex

- Involved in timing, motor planning, and speech
- Highest cortical area responsible for motor planning, organization, and regulation
- Associated with executive functions – planning, organizing, strategizing, initiating, monitoring, evaluation, modifying, changing, and shifting (requiring flexibility)
- Executive attention
Basal Ganglia

- Involved in timing, voluntary motor coordination, attention, working memory, executive functions

- Rich interconnections between cortical and subcortical structures including the cerebellum

- Significantly involved in motor planning, sensory performance, and sensorimotor integration
Cingulate Gyrus

- Involved in timing, executive functions, and emotion modulation
- Anterior Cingulate is associated with motivation, persistence, and on-line monitoring of performance
- May serve a role in executive attention function, self-monitoring of performance, inhibiting automatic responses, and complex decision making
Cerebellum

- Associated with movement, balance, and posture
- Involved in coordinated motor skill acquisition
- Seems to be involved in timing, learning, memory, and coordinating cognitive functions
Motor Cortex Areas

- Supplementary Motor Area is implicated in the planning of motor actions and bi-manual control. In contrast to the Premotor Cortex, the SMA has been implicated in actions that are under internal control, such as the performance of a sequence of movements from memory (as opposed to movements guided by a visual cue).
- Premotor Cortex is active when learning new/novel sequences.
- Primary Motor Cortex is responsible for directing movement in response to the environment.
Frontal Lobe

- Plays a major role in the planning and execution of movements
- The Frontal Lobes are involved in motor function, problem solving, spontaneity, memory, language, initiation, judgment, impulse control, and social and sexual behavior
- Responsible for action
- Actively involved in mental time keeping
- Executive functions – attention, planning, strategizing, organizing, flexibility, monitoring, evaluation, and change
Treatment Effect of IM

- Drives Neural Plasticity
- Improves Cognitive Efficiency
Drives Neural Plasticity

- Neural plasticity refers to strengthening or weakening of nerve connections or adding new nerve cells based on outside experience.
- Participating in IM creates conditions that lead to the growth of neural networks.
- In order to make neuronal growth there must be repetition and engagement.
- Plastic changes to the brain occur without conscious awareness and are always available.
Improves Cognitive Efficiency

- Dr. Kevin McGrew, Ph.D. - studied the synchronized metronome tapping effect
- Hypothesized that IM is impacting on a child's executive functioning
- Executive functioning needs working memory to carry out its various functions
- Working memory is being taxed during IM
- Controlled executive attention - “focus” occurs during IM
- Improved focus improves the cognitive efficiency of a child's brain
Hypothesized Improvements in Cognitive Efficiency

- Increased ability to sustain and selectively divide attention for longer periods of time
- Increased ability to filter or screen out distractions
- Increased ability to inhibit impulsive responding
- Increased ability to self-regulate/monitor mental operations
Appropriate Candidates for IM

- Children with motor planing and sequencing problems, speech and language delays, motor and sensory disorders, learning deficits, and various cognitive and physical difficulties
- Labels – ADD/ADHD, Autism Spectrum Disorder, Aspergers Syndrome, Sensory Processing Disorder, Dyspraxia, Cerebral Palsy
- Children who display deficits that seem to be related to difficulties with timing and rhythm
IM In My OT Practice

- IM program is typically 15-20 OT sessions
- Ideally done as a treatment intensive (3 times week/5-7 weeks)
- 2000 repetitions per treatment session
- Typical age of children is between 6-12, but not limited
DTA Interactive Metronome Program
Parent Questionnaire

- Coordination skills – success with sports, clumsiness, bumping into objects, catch/kick/throw, balance

- Ability to use both sides of the body together – jumping jacks, tie shoelaces, ride a bike

- Organizational skills – need constant reminders, chores/routine tasks need assistance, organization of belongings

- Writing skills – quality, ability to line up digits, fit letters/words within provided lines of paper
DTA Interactive Metronome Program
Parent Questionnaire

- Attention to task – ability to finish a task in the same sitting it was begun, distractibility, completion of homework, teacher report
- Ability to complete a sequence of events – activities of daily living, morning routine, ability to follow 2-3 step verbal directions
- Play skills – turn taking, ability to build or construct, complexity of play activities, ability to play alone, ability to play with unfamiliar objects
IM In My OT Practice

- Tap into child's motivation to participate in IM
- Therapeutic use of self – the planned use of personality, insights, perceptions, and judgments as part of the therapeutic process
- My background in Sensory Integration
- Each IM treatment session is fundamentally the same, but no two IM sessions look the same
- Goal is to have the child feeling good about their participation in IM and the improvements they see in their IM scores as well as their daily occupations
What I See

- Definite refinement of timing and sequencing
- Child gets a sense of rhythm, pattern, organization of the movements of his/her body
- Helps connect child to his/her body
- Often child unwinds to the IM beat – inner calm is generated from repetition of synchronous activities
- Grading of movement around the body midline
- Look more fluid and seem more focused
What I See

- Definite improvement in attention
- Improvement with bilateral motor coordination
- Huge improvement in endurance/stamina
- I don't believe that IM is the best treatment tool to address auditory processing problems, but it seems to support
- Changes stick
- Success breeds success
Jared

- 10 ½ years old
- Concerns: difficulties blocking out distractions and staying focused and disorganization; diagnosis of ADHD
- 21 sessions
- Initial IM Long Form Assessment score of 210 ms. (considered severe deficiency); post IM training score of 46 ms. (considered above average)
- Jared showed improvement in his ability to make decisions and choices, complete a sequence of events, independently work on homework, coordination, ability to handle frustrations and challenges, sleep
Steven

- 9 ½ years old
- Concerns: difficulties sustaining attention to task and completing classroom assignments, focusing on the task at hand, coordinating his body, and sequencing the steps needed to complete new and complex activities; diagnosis of Sensory Processing Disorder
- 24 sessions
- Initial IM Long Form Assessment score of 94 ms. (considered below average), post IM training score of 41 ms. (considered above average)
- Steven demonstrated functional gains in coordination skills, use of both sides of his body together, attention to task, organizational and sequencing skills, play with peers
Evan

- 7 ½ years old
- Concerns: difficulties blocking out distractions and sustaining attention to tasks, balance, coordination skills, and using both sides of his body together in a coordinated fashion; diagnosis of Autism.
- 21 treatment sessions
- Initial IM Long Form Assessment score of 113 ms (considered below average); post IM training score of 45 ms. (considered above average)
- Evan demonstrated improved motor coordination, bilateral motor coordination, balance, attention, play skills, patience