

ADHD
Effect of Interactive Metronome rhythmicity training on children with ADHD by Shaffer et al. 2001

- n = 56 boys age 6-12 yrs
- Randomly assigned to:
 - n=19 experimental group: 15 sessions of IM training
 - n=19 placebo control group: played videogames
 - n=18 control group: participated recess
- IM group demonstrated statistically significant improvements on 53 of 58 tests ($p \leq 0.0001\%$)**

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

AJOT
The American Journal of Occupational Therapy

im360

7

ADHD
Effect of Interactive Metronome rhythmicity training on children with ADHD by Shaffer et al. 2001

58 tests/subtests

- Attention & concentration
- Clinical functioning
- Sensory & motor functioning
- Academic & cognitive skills

IM group improved on...

- Attention to task
- Processing speed & response time
- Attaching meaning to language
- Decoding for reading comprehension
- Sensory processing (auditory, tactile, social, emotional)
- Reduced impulsive & aggressive behavior

im360

8

ADHD
Effects of Brain Balance Exercises and Interactive Metronome on Children with Attention Deficit Hyperactivity Disorder are Similar to the Effects of Stimulant Medication by Martin H Telcher, PhD, MD 2020

BRAIN BALANCE EXERCISES

IM-HOME TRAINING

McLean HOSPITAL
HARVARD MEDICAL SCHOOL AFFILIATE

HARVARD MEDICAL SCHOOL

im360

9

ADHD
Effects of Brain Balance Exercises and Interactive Metronome on Children with Attention Deficit Hyperactivity Disorder are Similar to the Effects of Stimulant Medication by Martin H Telcher, PhD, MD 2020

33 Subjects:

- EXPERIMENTAL: n=16 children 8-14 years of age with confirmed diagnosis of ADHD who received IM/BB
- CONTROL: n=8 typically developing age-matched controls
- CONTROL: n=19 closely matched children with confirmed diagnosis of ADHD who only received morning light therapy for daytime sleepiness (phototherapy produces a stimulant effect)

Outcome Measures:

- Conner's Parent Rating Scale (CPRS-R) to assess ADHD symptoms
- DSM-IV Rating Scale (ADHD-RS)
- Quotient ADHD System for objective evaluation of hyperactivity, inattention and impulsivity
- Neuropsychological tests:
 - Tower of London
 - Macworth Clock
 - Corsi Block Tapping Test
- fMRI to examine resting-state functional connectivity

im360

10

BRAIN BALANCE EXERCISES

IM-HOME TRAINING

Mondays, Wednesdays, and Fridays two times a day

- Primitive Reflex
- Symmetrical Tonic: Neck Reflex
- Asymmetrical Tonic: Neck Reflex
- Spinal Galant Reflex
- Core Exercises
- Gait-Aerobic Exercises
- Spinning Exercises
- Optikentic
- Gaze Stability
- Convergence
- Slow Tracking Exercises
- Saccade Exercises
- IM-Home Exercise

Tuesday and Thursday over 30 sessions
Each session has at least 1500 reps and is between 18 - 25 minutes in length

WELCOME TO LEVEL 1: WEEKS 1 - 3 of YOUR BRAIN BALANCE & IM-HOME TRAINING

WEEK	SESSION	DATE	TIME	LOCATION	STATUS	STATUS
1	Session 1	10/20/20	10:00 AM	McLean Hospital	OK	OK
	Session 2	10/27/20	10:00 AM	McLean Hospital	OK	OK
	Session 3	11/3/20	10:00 AM	McLean Hospital	OK	OK
2	Session 4	11/10/20	10:00 AM	McLean Hospital	OK	OK
	Session 5	11/17/20	10:00 AM	McLean Hospital	OK	OK
	Session 6	11/24/20	10:00 AM	McLean Hospital	OK	OK
3	Session 7	12/1/20	10:00 AM	McLean Hospital	OK	OK
	Session 8	12/8/20	10:00 AM	McLean Hospital	OK	OK
	Session 9	12/15/20	10:00 AM	McLean Hospital	OK	OK

im360

11

ADHD
Effects of Brain Balance Exercises and Interactive Metronome on Children with Attention Deficit Hyperactivity Disorder are Similar to the Effects of Stimulant Medication by Martin H Telcher, PhD, MD 2020

Compared to controls, the children who received IM/BB demonstrated:

- Decrease in ADHD Symptoms by an average of 7.4 points ($p < .0002$) on *Connors Parent Rating Scale* with large therapeutic effect size on oppositional behavior, inattention and hyperactivity
- 7-point reduction in Total *ADHD Rating Scale of the DSM-IV* ($p < .02$) with large therapeutic effect size on reducing hyperactivity & medium effect size on reducing inattention
- Rate-dependent effect on ADHD symptoms on the *Quotient ADHD System* similar to that seen with medication (i.e., ADHD medication has a tendency to calm and focus a child who is impulsive, distractible & hyperactive while providing stimulation for a child who is sluggish or drowsy). The children demonstrated increased ability to sit still which is often seen with low dose methylphenidate.
- Greater planning and less impulsivity on *Tower of London*
- Greater attentiveness and impulse-control on *Macworth Clock*

im360

12

ADHD

Effects of Brain Balance Exercises and Interactive Metronome on Children with Attention Deficit Hyperactivity Disorder are Similar to the Effects of Stimulant Medication by Martin H Teicher, PhD, MD 2020

Several pre-treatment fMRI neurobiological differences between ADHD and typically developing children were normalized following IM/BB:

- Connections between critical brain regions involved in purposeful focusing and attention shifting
- Abnormal connectivity within the salience network that contributed to distractibility
- Cortical network associated with language, music processing, time estimation and prediction
- Cerebellar connections responsible for visual memory and comprehension
- Cerebellar volume responsible for emotional regulation and vestibular and visual information and involved in balance, vestibular reflexes, and eye movements impacting level of hyperactivity, postural control and balance

"...it appears that IM/BB reduced these (neurobiological) differences to the point that they were no longer statistically significant."

interactive metronome

13

ADHD

Effects of Brain Balance Exercises and Interactive Metronome on Children with Attention Deficit Hyperactivity Disorder are Similar to the Effects of Stimulant Medication by Martin H Teicher, PhD, MD 2020

Additional neurobiological outcomes of IM/BB included:

- Connectivity of the hippocampus was greatly improved, associated with *visual-spatial working memory*, a skill that is often impaired with ADHD
- Greater balancing and connectivity of the salience network, which is associated with *sustained and selective attention*
- Increased reciprocal connectivity between the default (mind-wandering) mode network and the salience (purposeful focusing) network resulting in *improved planning and anticipation, focused attention, and decreased tendency to become distracted*
- Increased connectivity between the supplemental motor area (SMA) and the medial prefrontal cortex, important for *action monitoring and continuous performance cognitive control*
- Normalization of connectivity between regions of the brain known to contribute to *hyperactivity, thus decreasing this undesirable behavior*

interactive metronome

14

ACADEMIC RESEARCH

interactive metronome

15

Academics

Timing in Child Development by Kuhlman & Schweinhart 1999

HIGHSCOPE.

- n = 585 (ages 4-11)
- Significant correlation between IM timing and academic performance
 - Reading
 - Mathematics
 - Oral Language
 - Written Language
 - Attention
 - Motor Coordination and Performance

interactive metronome

16

Academics

Timing in Child Development by Kuhlman & Schweinhart 1999

Timing was better:

- As children age
- If achieving academically (California Achievement Test)
- If taking dance & musical instrument training
- If attentive in class

Timing was deficient:

- If required special education
- If not attentive in class

interactive metronome

17

Reading Achievement

Improvements in Interval time tracking and effects on reading achievement by Taub et al. 2007

JAP Institute for Applied Psychometrics

- n=86 elementary students age 7-10
- 18 IM training sessions over 4 weeks
- Results:
 - ~ 250 ↑ in timing
 - Most gains seen in those who had very poor timing to begin with
 - 18-20% growth in critical pre-reading skills (phonics, phonological awareness, & fluency)

IM is addressing ...

- Efficiency of working memory
- Cognitive processing speed & efficiency
- Executive functions, especially executive-controlled attention (FOCUS) & ability to tune-out distractions
- Self-monitoring & self-regulation (META-COGNITION)


interactive metronome

18

Reading Disorders

Reading Intervention Using Interactive Metronome in Children With Language and Reading Impairment: A Preliminary Investigation by Ritter et al. 2012

- n = 49 age 7 – 11 yrs
- Concurrent oral & written language impairments
- Reading disability & lower to middle class SES
- Control**
 - Reading intervention 4 hours per day, 4 times per week for 4 weeks
- Experimental**
 - 15 min of IM training per session prior to same reading intervention
- IM group demonstrated significantly greater gains in reading rate, fluency & comprehension




Measure	Improvement over Control Group
Reading Naturally	3.67 times
DIBELS-6 (literacy skills)	3.29 times
GORT 4 – rate	4.31 times
GORT 4 – fluency	1.8 times
GORT 4 – comprehension	2.6 times

interactive metronome

19

Mathematics

Effects of Improvements in Interval Timing on the Mathematics Achievement of Elementary School Students by Taub et al. 2015



- n=86 children ages 7-9
- n=49 experimental group: received 18 sessions of IM training (50 min each over 4 weeks)
- n=37 control group: participated in recess
- IM group demonstrated greater accuracy on math problem solving and completed math problems faster than the control group

Growth in math achievement in the experimental (IM training) group was above and beyond the expected growth for that age group for that period of time

interactive metronome

20

AUTISM MARKERS RESEARCH

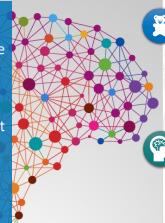


interactive metronome

21

Autism Spectrum

Disrupted neural synchronization in toddlers with autism by Dinstein et al. 2011



Autism has been hypothesized to arise from the development of abnormal neural networks that exhibit irregular synaptic connectivity and abnormal neural synchronization.

Toddlers with autism exhibited significantly weaker interhemispheric synchronization (i.e., weak “functional connectivity” across the two hemispheres)

Disrupted cortical synchronization appears to be a notable characteristic of autism neurophysiology that is evident at very early stages of autism development.


interactive metronome

22

Autism Spectrum

The Impact of multisensory integration deficits on speech perception in children with autism spectrum disorders by Stevenson et al. 2014


- Children with autism spectrum disorders have trouble integrating simultaneous auditory & visual sensory information due to impaired temporal processing.
- Perceiving the timing of incoming sensory information is paramount to the ability to perceptually bind stimuli across sensory modalities.
- This timing deficit hampers development of social, communication, language & literacy skills.



interactive metronome


23

SENSORY PROCESSING & AUDITORY PROCESSING RESEARCH



interactive metronome

24



Sensory Processing Disorder

The Effects of a Sensory Integration Programme with Applied Interactive Metronome Training for Children with Developmental Disabilities: A Pilot Study by Kim et al. 2012

- n = 10 children diagnosed with delayed development (20%), autism (10%), mental retardation (10%), speech delay (30%), ADHD (20%), and Down's syndrome (10%)
- pre-post measures:
 - Short Sensory Profile
 - Conner's Teachers Rating Scale
 - DeGangi-Berk Test

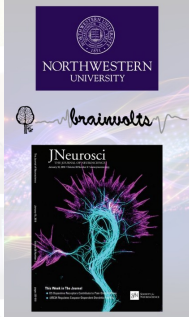
25

Sensory Processing Disorder

The Effects of a Sensory Integration Programme with Applied Interactive Metronome Training for Children with Developmental Disabilities: A Pilot Study by Kim et al. 2012

- Significant improvements on Short Sensory Profile ($p < .05$)
 - tactile sensitivity
 - gustatory/olfactory sensitivity
 - motor sensitivity
 - high/low response
 - hearing filtering
 - low endurance
 - visual/auditory sensitivity
 - and Short Sensory Profile Total Score
- Significant improvement on Conner's Teachers Rating Scale ($p < .05$)
 - Increased attention
 - decreased hyperactivity
- Significant improvement on DeGangi-Berk Test ($p < .05$)
 - postural control
 - bilateral integration
 - reflex integration
 - and DeGangi-Berk Total Score

26



Auditory Processing & Literacy

The Ability to Move to a Beat is Linked to the Consistency of Neural Responses to Sound by Tierney & Kraus 2013

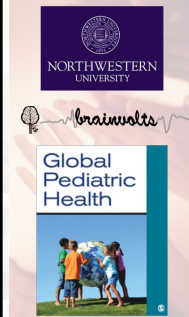
Auditory & motor systems use shared neural pathways.

The ability to tap in sync with an auditory beat is directly correlated with

- consistency of auditory brainstem response to sound
- degree of neural jitter (noise in the system)
- ability to read
- phonological awareness
- fine & gross motor skills

Children with speech, language and reading disorders have much more difficulty clapping in sync with a steady beat than children who are developing these skills normally.

27



Auditory Processing & Literacy

How Rhythmic Skills Relate and Develop in School-Age Children by Bonacina et al. 2019

EXPERIMENT:


n=68 children, ages 5-8 were assessed on 4 different tasks to evaluate the taxonomy of rhythmic skills fundamental for the development of language and literacy:

- Drumming to an isochronous (steady pacing) beat
- Remembering and repeating rhythmic patterns
- Drumming to the beat of music (identifying the beat within the music)
- Clapping in sync with a steady beat with visual feedback for millisecond timing (IM)

28

Auditory Processing & Literacy

How Rhythmic Skills Relate and Develop in School-Age Children by Bonacina et al. 2019



Quotes by lead researcher, Nina Kraus, PhD

"Struggling with certain rhythmic skills can reflect underlying language and/or perceptual impairment."

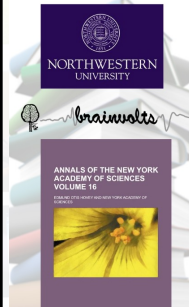
"A more thorough understanding of the development and interconnection of different rhythmic abilities in early childhood can crucially help in sculpting such interventions to the specific needs of each individual."

"Interactive Metronome is unique in that it is the only intervention to date that simultaneously impacts all of the vital rhythms for the development of language and literacy."

29

Auditory Processing & Literacy

Clapping in time parallels literacy and calls upon overlapping neural mechanisms in early readers by Bonacina et al. 2018




- n=64 children ages 5-7
- Evaluated:
 - synchronization abilities
 - neurophysiological responses to speech in noise
 - literacy skills
- Results:
 - Children with lower variability in synchronizing have higher phase consistency, higher stability, and more accurate envelope encoding—all neurophysiological response components linked to language skills.

30

Auditory Processing & Literacy

Clapping in time parallels literacy and calls upon overlapping neural mechanisms
In early readers by Bonacina et al. 2018



Quotes by lead researcher, Nina Kraus, PhD


"...performing the same task with visual feedback [Interactive Metronome] reveals links with literacy skills, notably processing speed, phonological processing, word reading, spelling, morphology, and syntax."

"These results suggest that rhythm skills and literacy call on overlapping neural mechanisms, supporting the idea that rhythm training may boost literacy in part by engaging sensory-motor systems."

31

Auditory Processing & Literacy

Incorporation of Feedback during Beat Synchronization is an Index of Neural Maturation and Reading Skills by Woodruff Carr et al. 2016



- Adolescents who were able to clap in sync with an auditory beat during Interactive Metronome (IM) assessment scored higher on reading-related tests
- Adolescents who demonstrated better rhythm (consistency) during IM...
 - performed better on tests of phonological memory and reading sub-skills
 - demonstrated greater cortical maturation for auditory processing

"Synchronization employing feedback [via IM] may prove useful as a remedial strategy for individuals who struggle with timing-based language learning impairments."

32


TRAUMATIC BRAIN INJURY RESEARCH



33

Traumatic Brain Injury

Effects of Interactive Metronome® Therapy on Cognitive Functioning After Blast-Related Brain Injury: A Randomized Controlled Pilot Trial by Nelson et al. 2013



- n=46 active-duty soldiers with mild-moderate blast-related TBI
- Experimental:
 - Treatment as Usual (OT, PT, ST)
 - 18 sessions of IM training @ frequency of 3 sessions per week
- Control:
 - Treatment as Usual (OT, PT, ST)

34

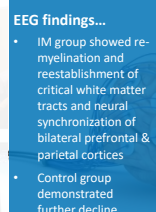
ASSESSMENT	SKILLS MEASURED	OUTCOME
DKEFS: Color Word Interference	Attention, response inhibition	Cohen's d= .804 LARGE p=.0001
RBANS Attention Index	Auditory attention, auditory memory & processing speed	Cohen's d= .511 LARGE p=.004
RBANS Immediate Memory Index	Auditory attention, auditory memory & processing speed	Cohen's d= .768 LARGE p=.0001
RBANS Language Index	Confrontation naming, verbal fluency, & processing speed	Cohen's d= .349 MED p=.0001
WAIS-IV Symbol Search	Processing speed, short-term visual memory, visual-motor coordination, cognitive flexibility, visual discrimination, speed of mental operations, & psychomotor speed	Cohen's d= 0.478 MED p=.0001
WAIS-IV Coding	Visual attention, processing speed, short-term visual memory, visual perception, visual scanning, visual - motor coordination, working memory, & encoding	Cohen's d= .630 LARGE p=.0001
WAIS-IV Digits Sequencing	Auditory attention, working memory, cognitive flexibility, rote memory & learning	Cohen's d= .588 LARGE p=.021
DKEFS Trails: Motor Speed	Motor speed, executive functions	Cohen's d= .790 LARGE p=.015
DKEFS Trails: Letter Sequencing	Processing speed, working memory, and executive functions	Cohen's d= .626 LARGE p=.0001

IM group demonstrated substantial improvement on 21 of 26 neuropsychological measures

35

Traumatic Brain Injury

Effects of Interactive Metronome Therapy on Cognitive Functioning After Blast-Related Brain Injury: A Randomized Controlled Pilot Trial by Nelson et al. 2013



EEG findings...

- IM group showed re-myelination and reestablishment of critical white matter tracts and neural synchronization of bilateral prefrontal & parietal cortices
- Control group demonstrated further decline

IM training substantially improved...

- Auditory and visual attention
- Processing speed
- Working memory
- Response inhibition
- Executive functions


36

Traumatic Brain Injury

Effects of Interactive Metronome® Therapy on Cognitive Functioning After Blast-Related Brain Injury: A Randomized Controlled Pilot Trial by Nelson et al. 2013

"The addition of IM therapy to SRC [standard rehab care] appears to have a positive effect on neuropsychological outcomes for soldiers who have sustained mild-to-moderate TBI and have persistent cognitive complaints after the period for expected recovery has passed."

Lonnie Nelson, PhD



37

MOTOR AND NEUROLOGICAL DYSFUNCTION RESEARCH




38

Fine Motor Skills/Praxis

Validity of Long Form Assessment In Interactive Metronome as a Measure of Children's Praxis by Kim et al. 2015.

- Study validated use of IM Long Form Assessment (LFA) as a measure of praxis in children
- n=25 children ages 6-11 with and without ADHD
- Significant difference in timing & rhythm (LFA) between children with and without ADHD ($p < .05$)
- High correlations found between IM LFA scores & performance on Bruininks-Oseretsky Test of Motor Proficiency-2 (hand control, fine motor, hand, balance)




39

Developmental Coordination Disorder

Timing abilities among children with developmental coordination disorders (DCD) in comparison to children with typical development by Rosenblum & Regev 2013

- n=42 children ages 7-12
 - EXPERIMENTAL: n=21 with DCD
 - CONTROL: n=21 typically developing
- Study revealed much slower motor response times in children with DCD
- IM timing scores accurately predicted handwriting performance
- "...strongly recommend IM as an evaluation and intervention tool for children with DCD"




40

Cerebral Palsy

The Effects of Interactive Metronome on Bilateral Coordination, Balance, and Upper Extremity Function for Children with Hemiplegic Cerebral Palsy: Single-Subject Research by Jung & Kim 2012

- Single subject
- ABA study design
- Child with hemiplegic CP demonstrated significant improvement in bilateral coordination and balance following 12 sessions of IM training twice weekly




41

Cerebral Palsy

Short- and long-term effects of synchronized metronome training in children with hemiplegic cerebral palsy: A two case study by Johansson et al. 2012

- n=2 children with hemiplegic CP
 - 17-year-old female
 - 13-year-old male
- 12 sessions of IM over 4 weeks
- Unilateral & bimanual upper limb movements assessed via kinematic analysis
 - pre & post
 - 6 months post



42

Cerebral Palsy

Short- and long-term effects of synchronized metronome training in children with hemiplegic cerebral palsy: A two case study by Johansson et al. 2012

- Both children demonstrated smoother and shorter bimanual movement trajectories, especially for the affected side.
- One child exhibited increased smoothness of the non-affected side.
- Noticeable improvement in motor learning occurred immediately post training and was maintained at 6 months post training.

"IM training incorporates many of the factors that have been described to be important in the induction of plastic changes in the brain and, thus, appears to be a promising intervention method for persons with sensori-motor deviations."

interactive metronome

43

Hemiplegia

Computer-Based Rhythm and Timing Training in Severe, Stroke-Induced Arm Hemiparesis by Beckelheimer et al. 2011

- n = 2 (68 & 75 yrs)**
 - 68-year-old male: 23 years post ischemic stroke with R hemiplegia
 - 77-year-old male: 2 years post ischemic stroke with L hemiplegia
 - Both with minimal active movement of affected arm/hand prior to study

UNIVERSITY OF Cincinnati
THE AMERICAN JOURNAL OF Occupational Therapy

interactive metronome

44

Hemiplegia

Computer-Based Rhythm and Timing Training in Severe, Stroke-Induced Arm Hemiparesis by Beckelheimer et al. 2011

Intervention:

- 30 min of IM training
- 25 min of traditional OT targeting practice of meaningful functional movement based upon patient goal-selection

Results:

- ↑ ability to grasp, pronate, and supinate arm & hand
- ↑ ability to perform ADLs
- ↑ self-efficacy
- ↑ self-report of quality of life

"IM does not require active, distal movement to be effective (most other technologies do)."

"IM training is easily incorporated into traditional treatment where patients can practice functional movement."

Quotes by lead researcher, Sarah C. Beckelheimer

interactive metronome

45

Upper Extremity Function

Effects of Interactive Metronome training on upper extremity function, ADL and QOL in stroke patients Ga-Hui Yu et al. 2017

- n=30 adults, 6 months post-CVA**
 - EXPERIMENTAL:**
 - n=15
 - IM training for 15 weeks
 - CONTROL:**
 - n=15
 - Completed bilateral arm exercises independently for same time period
- IM group demonstrated greater improvement in:**
 - Finger control
 - Self-care ADLs
 - feeding, toileting, dressing & transfers
 - most notable change in dressing
- Overall motor function**
- Quality of life**

KONYANG UNIVERSITY
Kwangju University · 1991

Neurorehabilitation

interactive metronome

46

Parkinson's Disease

Computer-Based Motor Training Activities Improve Function in Parkinson's Disease: a Pilot Study by Togasaki

n=36 individuals with mild-moderate Parkinson's

- Control Group:** rhythmic movement and clapping to music, metronome, or playing videogames
- Experimental:** Interactive Metronome training x 20 hours (rhythmic movement + feedback for timing)

Parkinson's Institute and Clinical Center

"In this controlled study computer directed rhythmic movement training was found to improve the motor signs of parkinsonism."

interactive metronome

47

Balance & Gait

The only true way to practice walking is to walk...

The smooth transition between phases of the gait cycle is an integrated activity that is difficult to learn through practice of individual parts.

- Goals for gait training with IM in-motion trigger:**
 - improve biomechanics
 - alter gait speed
 - increase stride length...

interactive metronome

48



49

Healthy Aging Fall Risk

Effects of the Interactive Metronome on Memory Process and Balance with Aging Adult 60+ Population by Leonard G. Trujillo 2015

- n= 9 healthy aging adults age 60 – 80 years
- IM training
 - 12 IM sessions over 8 weeks*
 - 6-week break
 - 6 IM sessions over 4 weeks*
- *max 275 reps per session, upper extremity exercises only while seated
- Cognitive & balance tests administered:
 - Pre-intervention
 - After initial 12 sessions
 - After 6-week break
 - At conclusion of study



50

Healthy Aging Fall Risk

Effects of the Interactive Metronome on Memory Process and Balance with Aging Adult 60+ Population by Leonard G. Trujillo 2015

Assessment	Overall Improvement
Modified IM Long Form Assessment	77%
Short Form Test	31%
Math Fluency (WJIII)	23%
Reading Fluency (WJIII)	12%
Decision Speed (WJIII)	5%
Visual Matching (WJIII)	4%
The d2 Test of Attention	16%
Four Step Square Test	88% *
The 9 Hole Peg Test	3%

Most notable effect on Four Step Square Test despite ONLY UPPER EXTREMITY EXERCISES, indicating improved...

- Balance
- Motor speed
- Decreased fear of falling

Results of Math Fluency, Reading Fluency & d2 Test of Attention indicate increased ...



- Attention
- Cognitive speed

51

Fall Risk Reduction

Interactive Metronome addresses fall risk reduction by improving:

- Attention in distractions
- Executive functions, including impulse control
- Cognitive & motor speed
- Motor control & coordination
- Weight-shifting, balance & dynamic gait

52

Ongoing Research

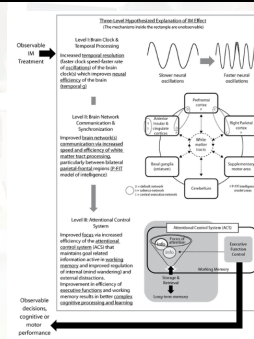
www.interactivemetronome.com




53

Research Supports "The IM Effect" Principle:

1. IM increases the speed & synchronization of neural oscillations ... improving neural efficiency
2. IM increases the speed & efficiency of white matter tract processing resulting in increased brain network communication ... particularly between parietal & frontal regions
3. IM increases the efficiency of the attentional control system, working memory & executive functions for better focus, more complex cognitive processing & learning.

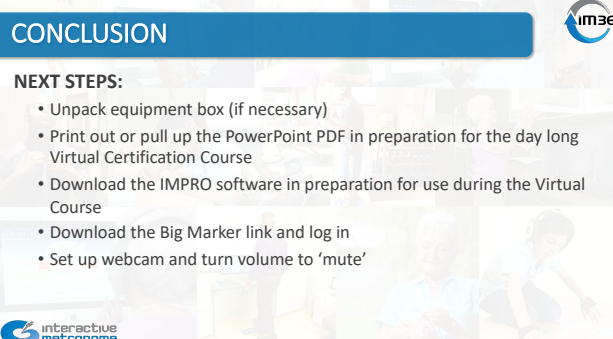


54

CONCLUSION

NEXT STEPS:

- Unpack equipment box (if necessary)
- Print out or pull up the PowerPoint PDF in preparation for the day long Virtual Certification Course
- Download the IMPRO software in preparation for use during the Virtual Course
- Download the Big Marker link and log in
- Set up webcam and turn volume to 'mute'



interactive metronome

55

Research Review

ADHD

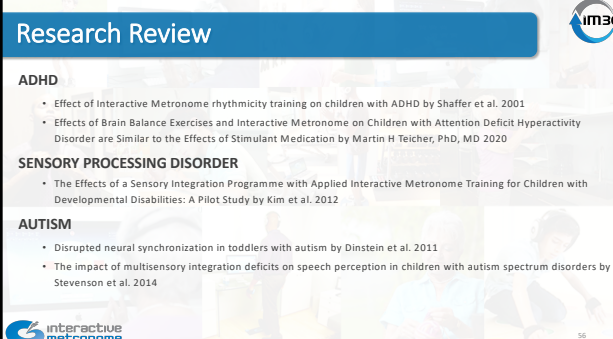
- Effect of Interactive Metronome rhythmicity training on children with ADHD by Shaffer et al. 2001
- Effects of Brain Balance Exercises and Interactive Metronome on Children with Attention Deficit Hyperactivity Disorder are Similar to the Effects of Stimulant Medication by Martin H Teicher, PhD, MD 2020

SENSORY PROCESSING DISORDER

- The Effects of a Sensory Integration Programme with Applied Interactive Metronome Training for Children with Developmental Disabilities: A Pilot Study by Kim et al. 2012

AUTISM

- Disrupted neural synchronization in toddlers with autism by Dinsteinst et al. 2011
- The impact of multisensory integration deficits on speech perception in children with autism spectrum disorders by Stevenson et al. 2014



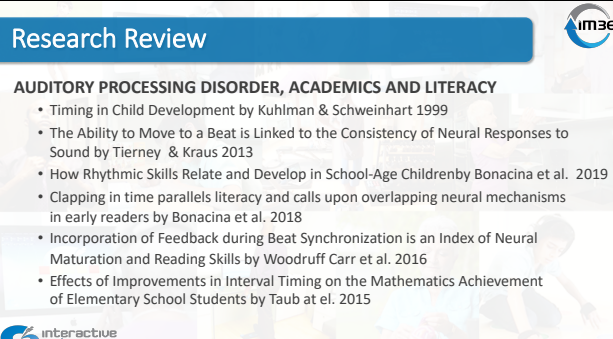
interactive metronome

56

Research Review

AUDITORY PROCESSING DISORDER, ACADEMICS AND LITERACY

- Timing in Child Development by Kuhlman & Schweinhart 1999
- The Ability to Move to a Beat is Linked to the Consistency of Neural Responses to Sound by Tierney & Kraus 2013
- How Rhythmic Skills Relate and Develop in School-Age Children by Bonacina et al. 2019
- Clapping in time parallels literacy and calls upon overlapping neural mechanisms in early readers by Bonacina et al. 2018
- Incorporation of Feedback during Beat Synchronization is an Index of Neural Maturation and Reading Skills by Woodruff Carr et al. 2016
- Effects of Improvements in Interval Timing on the Mathematics Achievement of Elementary School Students by Taub et al. 2015



interactive metronome

57

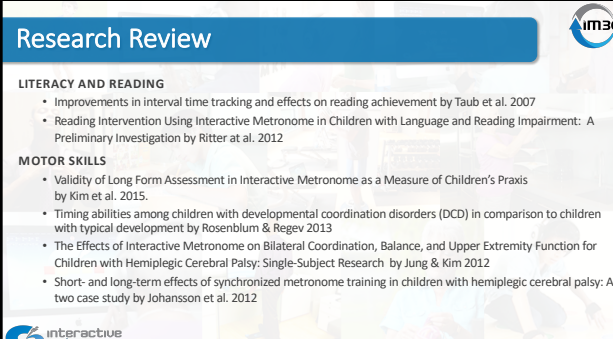
Research Review

LITERACY AND READING

- Improvements in interval time tracking and effects on reading achievement by Taub et al. 2007
- Reading Intervention Using Interactive Metronome in Children with Language and Reading Impairment: A Preliminary Investigation by Ritter et al. 2012

MOTOR SKILLS

- Validity of Long Form Assessment in Interactive Metronome as a Measure of Children's Praxis by Kim et al. 2015.
- Timing abilities among children with developmental coordination disorders (DCD) in comparison to children with typical development by Rosenblum & Regev 2013
- The Effects of Interactive Metronome on Bilateral Coordination, Balance, and Upper Extremity Function for Children with Hemiplegic Cerebral Palsy: Single-Subject Research by Jung & Kim 2012
- Short- and long-term effects of synchronized metronome training in children with hemiplegic cerebral palsy: A two case study by Johansson et al. 2012



interactive metronome

58

Research Review

TRAUMATIC BRAIN INJURY

- Effects of Interactive Metronome® Therapy on Cognitive Functioning After Blast-Related Brain Injury: A Randomized Controlled Pilot Trial by Nelson et al. 2013

HEMIPLEGIA & CVA

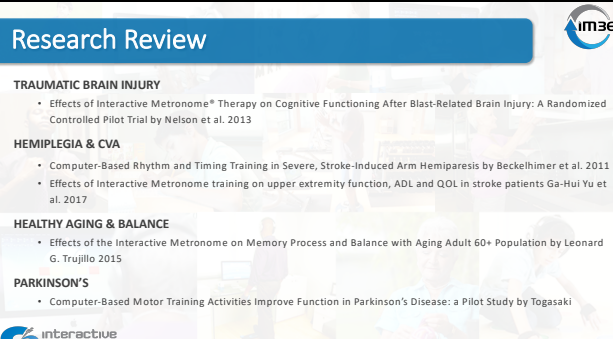
- Computer-Based Rhythm and Timing Training in Severe, Stroke-Induced Arm Hemiparesis by Beckelheimer et al. 2011
- Effects of Interactive Metronome training on upper extremity function, ADL and QOL in stroke patients Ga-Hui Yu et al. 2017

HEALTHY AGING & BALANCE

- Effects of the Interactive Metronome on Memory Process and Balance with Aging Adult 60+ Population by Leonard G. Trujillo 2015

PARKINSON'S

- Computer-Based Motor Training Activities Improve Function in Parkinson's Disease: a Pilot Study by Togasaki



interactive metronome

59