

Title: There is limited evidence (2b) supporting the use of metronome training to address attention and academic performance in school aged children experiencing attention deficits.

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CLINICAL SCENARIO:

Client Population:

- Children, 6-13 years old, with attention deficits, some with additional features of hyperactivity, coordination disorder, or developmental disorder.

Treatment Context:

- Metronome training was delivered on a one-on-one basis in an out-patient setting.

Problem/Condition this intervention addresses:

- Metronome training is used to address inattention, cognitive deficits, poor academic performance, and motor coordination in children with attention deficits. This CAT, however, is limited to attention and academic performance. Attention deficits affect executive functions such as, the ability to hold information in short-term memory, organize and plan, and transition between tasks. These skills are required for success in academic performance (Attention deficit, 2012)

Intervention:

- Metronome training is a computer-based program, such as Interactive Metronome™, that provides auditory and visual cues to the participant. Participants wear a headphone and listen to a recurring metronomic beat. As they listen to the beat, they engage in physical movements such as clapping hand-to-hand with a sensor on one palm or stepping on a sensor with the foot. The training attempts to reduce the mean negative synchronization error during normal tracking of the regularly occurring metronome beat (clapping before or past the beat). During training, participants receive feedback through an auditory guidance system as they progress through the simple, interactive physical movements. The auditory feedback system provides audible cues that indicate whether the participant responded before, at, or past the regularly occurring auditory metronomic beat (Leisman et al., 2010).

Science behind the intervention:

- Children with ADHD show deficits in areas of executive functioning as a result of under stimulation of the pre-frontal region of the brain (Roberds, 2005). Two complementary approaches describe how metronome training addresses attention deficits.

-Neuronal pathways of the pre-frontal and striatal areas of the brain that regulate timing and motor planning are also involved with attention. Therefore, interventions aimed at strengthening motor planning, sequencing, timing, and rhythmicity may have a role in improving the capacity to attend and perform academically (Shaffer et al., 2001).

- Attention is required for a person to respond to sensory stimuli, such as a visual or auditory cue, with an appropriately timed motor response, such as finger tapping (Repp & Keller, 2004). Metronome training prompts the user to attend to and synchronize their motor response to visual and audible cues (Gorman, n.d.). It uses repetition of sensorimotor feedback to elicit cortical reorganization of motor and attention pathways (Diamond, 2003). Therefore when practicing motor response in metronome training, it is believed the user automatically practices attention as well.

Why is this intervention appropriate for occupational therapy?

- Metronome training is a preparatory method that addresses client factors and performance skills in the OT framework. Improving the client factors and performance skills is intended to increase occupational performance of education and play. Specific client factors include mental functions of attention and thought. Performance skills of temporal organization and knowledge are also addressed (American Occupational Therapy Association, 2008)

FOCUSED CLINICAL QUESTION:

- Patient/Client Group: School aged children experiencing attention deficits
- Intervention: Metronome training
- Comparison Intervention: No treatment
- Outcomes: Increased attention and academic performance

SUMMARY:

- Is metronome training effective in increasing attention and academic performance when compared to no treatment for school aged children experiencing attention deficits?
- Ten databases were searched and a total of nine articles were found to be relevant to the PICO question. Two of the articles were Level 2b, three were Level 4, and four Level 5 according to the Canadian Levels of Evidence. An article at Level 2b was omitted from CAT inclusion due to ambiguous data presentation. After this omission, the three articles selected represent the highest level of evidence available and the clearest report of results.
- These articles provide limited evidence to support the use of metronome training to improve attention and academic performance in school aged children experiencing attention deficits.

CLINICAL BOTTOM LINE:

There is limited evidence (2b) supporting the use of metronome training to address attention and academic performance in school aged children experiencing attention deficits.

Limitation of this CAT: This critically appraised paper (or topic) has been reviewed by occupational therapy graduate students and the course instructor.

SEARCH STRATEGY:

Table 1: Search Strategy

Databases Searched	Search Terms	Limits used	Inclusion and Exclusion Criteria
Cinahl Plus with Full Text	"Interactive Metronome and ADHD"	And	None Used
Cochrane Central Register of Controlled Trials	"Synchronized metronome and ADHD"		
Alt Health Watch	"Interactive Metronome and children and attention"		
OVID	"Interactive Metronome"		
OT Seeker	"Coordination training and attention"		
PEDRO	"Metronome training"		
Education Full Text (EBSCOhost)			
Education Research Complete (EBSCOhost)			
Education Databases via EBSCOhost			
PsychInfo			

RESULTS OF SEARCH:

Table 2: Summary of Study Designs of Articles Retrieved

Level	Study Design/ Methodology of Articles Retrieved	Total Number Located	Data Base Source	Citation
Level 1a	Systematic Reviews or Metanalysis of Randomized Control Trials	0		
Level 1b	Individualized Randomized Control Trials	0		

Level 2a	Systematic reviews of cohort studies	0		
Level 2b	Individualized cohort studies and low quality RCT's (PEDRO < 6)	2	PsychInfo PsychInfo	Leisman, G. & Melillo, R. (2010) Shaffer, R.J., Jacokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Stemmer, P. J. (2001)
Level 3a	Systematic review of case-control studies	0		
Level 3b	Case-control studies and non-randomized controlled trials	0		
Level 4	Case-series and poor quality cohort and case-control studies	3	Alt Health Watch OVID Alt Health Watch	Bartscherer, M.L. & Dole, R.L. (2005) Cosper, S.M., Lee, G.P., Peters, S.B., & Bishop, E. (2009) Leisman, G., Melillo, R., Thum, S., Ransom, M., Orlando, M., Tice, C., & Carrick, F. (2010)
Level 5	Expert Opinion	4	Cinahl Plus with Full Text Alt Health Watch PsychInfo PsychInfo	Hermansen, M.S. & Miller, P.J. (2008) Koomar, J., Burpee, J.D., DeJean, V., Frick, M.J. & Fischer, D.M. (2001) Roberds, J.A. (2005) Solis-Smith, L.A. (2004)

STUDIES INCLUDED:

Table 3: Summary of Included Studies

	Study 1: Shaffer et al. (2001)	Study 2: Cosper, Lee, Peters & Bishop (2009)	Study 3: Leisman et al. (2010)
Design and PEDRO rating	Randomized Control Trial 5/10 PEDRO rating	Case Series	Case Series
Population	56 males Ages: 6y to 12y Diagnosis: ADHD	10 males, 2 females Ages: 6y5m to 13y5m Diagnosis:	94 males, 28 females Ages: 6y to 12y Diagnosis: ADD or ADHD

		ADHD w/PDD or ADHD w/DCD	
Intervention Investigated	Interactive Metronome (IM) Training™: 15 one hour sessions over 3-5 weeks	Interactive Metronome (IM) Training™: 1 hour session per week for 15 weeks	Synchronized metronome training: 1 hour session, 3 times per week for 12 weeks.
Comparison Intervention	Control group: no intervention Treatment group #2: video games	No control group	No control group
Dependent Variables	Attention & concentration Clinical functioning Academic & cognitive skills	Motor Coordination Sustained Attention	Academic performance ADHD behaviors
Outcome Measures	Test of Variables of Attention Conners' Rating Scales-Revised Wechsler Intelligence Test for Children Achenbach Child Behavior Checklist The Sensory Profile Bruininks-Ostretsky test for Motor Efficiency Wide Range Achievement Test Language Processing Test	Bruininks–Oseretsky Test of Motor Proficiency- Short Form (BOT-SF) Gordon Diagnostic System's Continuous Performance Test	Wechsler Individual Achievement Tests Brown Attention Deficit Disorder Scales
Results	IM treatment group showed significant improvements on 53/58 variables. There were also significant differences from pretreatment to posttreatment in attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior.	Significant improvements seen in some aspects of motor coordination measured by the BOT-SF: battery composite score and 1 of 8 components (visuomotor). Significant improvement in 1 of 3 attention measures (reaction time).	Significant improvement in ADHD behaviors were reported by the parents. Significant changes from pre to post- treatment on sensory motor performance were seen. Significant changes were found in spelling, written expression, and listening comprehension.
Effect Size	Data not available for calculation.	N/A	N/A

Conclusion	This study concluded that IM training can improve: aspects of attention, motor, and perceptual-motor functioning; cognitive and academic performance; and control of aggression in children with major attentional problems.	This study showed that IM training in kids with attention and motor coordination deficits has the potential to improve reaction time and visual motor coordination. IM training did not improve sustained, focused attention or decrease impulsivity.	This pilot study determined that the effects of metronome training on sensory motor performance and attention is promising. A larger-scale clinical trial to explore the effect of metronome training on academic performance is justified.
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IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

Is metronome training effective in increasing attention and academic performance when compared to no treatment for school aged children experiencing attention deficits?

Overall Conclusions:

The three studies in this CAT addressed the use of metronome training to improve attention and academic performance. The construct of attention was measured as a client factor as well as a component of academic performance. Attention, or the ability to direct one's thought to a specific stimuli while suppressing non-relevant stimuli, was directly measured by both Shaffer et al. (2001) and Cosper et al. (2009) but produced conflicting results. Shaffer et al. (2001) provided a more intense treatment regime with three to five hours per week as compared to Cosper et al. (2009) providing only one hour of treatment a week. The Shaffer et al. (2001) treatment group improved significantly on global attention as compared to the control group. In contrast, Cosper et al. (2009) measured the specific attentional components of vigilance, errors of commission and reaction time and found significant improvement only in reaction time. Reaction time may be more of a measure of motor control than attention. Leisman et al. (2010) used parental report to document a posttest improvement in ADHD symptoms but did not provide results specific to attention or report if the change was statistically significant.

Academic performance of participants was assessed by measuring spelling, reading comprehension and writing skills, language processing, listening comprehension, and mathematical reasoning. Both studies that measured academic performance (Shaffer et al., 2001; Leisman et al., 2010) found statistically significant improvements. Shaffer et al., (2001) found that both reading and language processing showed a significant difference between control and experimental groups at post-test. Leisman et al. (2010) found that there was a significant difference in spelling, word reading, written expression, and listening comprehension within the experimental group from pre-test to post-test. Although treatment time varied between studies from 15 (Shaffer et al., 2001) to 36 hours (Leisman et al., 2010), this did not produce different outcomes related to academic performance. Effect size was not reported in any of the articles and could not be calculated using the available data.

There are additional variations between studies that impacted the results of this CAT. The three studies used different outcome measures that measured different dependent variables related to attention and academic performance. The Shaffer et al. (2001) article is co-authored by James F. Cassily, the inventor of Interactive Metronome™, which may present a bias in the results. No blinding of any type was reported by Cosper et al. (2009) or Leisman et al. (2010). Shaffer et al. (2001) was the only RCT available in current research and has a PEDRO rating of 5/10, the other two articles were case series involving no control group. The two case series reviewed should not be considered equal to the RCT as they provide a lower level of evidence. Follow-up testing to determine long-term effects

of metronome training was not performed in any of the three studies. The studies reviewed in this CAT did not report any adverse effects of metronome training.

In conclusion, due to the variation between studies and lack of rigor in study designs, this CAT provides limited evidence (2b) supporting the use of metronome training to address attention and academic performance in school age children experiencing attention deficits.

Boundaries:

A total of 190 participants were studied, with only 30 of them being females. The general population consists of two to four times more boys with ADHD than girls; therefore boys were overrepresented in this CAT (WebMD, 2011). Participant age ranged from 6 years to 13 years, 5 months. All participants had some form of attention deficit disorder, some with additional features of hyperactivity, coordination disorder, or developmental disorder although time since diagnosis was not specified. Leisman et al. (2010) and Shaffer et al. (2001) excluded children with severe emotional problems and limited intellectual ability. In addition, Leisman et al. (2010) excluded children with vision and hearing impairments, those who use English as a second language, and those diagnosed with Pervasive Developmental Disorder (PDD). Cosper et al. (2009) did not specify any exclusion criteria and contrary to Leisman et al (2010), included two children with PDD. Of the 190 participants, 134 reported that no changes to medication occurred during the course of treatment.

Implications for practice:

Research from this CAT concludes that a more intensive intervention provided better outcomes related to attention. Differences in effect size, however, cannot be quantified. When using a standardized assessment to measure academic performance, metronome training shows an improvement in outcomes irrespective of treatment intensity. Evidence shows that treatment is effective in improving attention and academic performance when provided in a one on one, outpatient setting.

More research at a higher level of rigor needs to be conducted in order to form a stronger conclusion on whether or not metronome training is an effective treatment for children experiencing attention deficits. The precise connection between attention and academic performance is currently unknown. Therefore, from an occupational therapist perspective, outcome measures that target the occupation of academic performance, rather than the client factor of attention, would be valuable.

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