Interactive Metronome Training for Children with ADHD: A Systematic Review

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Abstract

Importance: Interactive Metronome Training (IMT) is used in occupational therapy practice to improve motor and cognitive skills in children with neurodevelopmental conditions. However, the research related to the use and effectiveness of IMT is sparse.

Objective: To identify, evaluate, and synthesize the current literature concerning Interactive Metronome Training to determine the efficacy of using it as a treatment method to address attention and coordination in children with ADHD.

Data Sources: A literature search occurred between May 5, 2025, and May 9, 2025. Follow up searches were conducted on May 19, 2025. Databases included Medline, Academic Search Complete, and CINAHL Complete using Hawai'i Pacific University's online library databases. Search terms included interactive metronome training, attention deficit-hyperactivity disorder (ADHD), and children as well as combinations of these terms.

Study Selection and Data Collection: This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines. Published studies on Interactive Metronome Training for children with ADHD were included in the systematic review. Data from presentations, non-peer reviewed literature, and dissertations were excluded.

Findings: Six studies were included in this systematic review. Two of the studies were level IV studies and four were level II studies according to the American Occupational Therapy Association's Levels of Evidence. The outcomes of these studies indicate that IMT has the potential to be an effective therapy tool for children with disabilities due to its' positive impacts on behavior, motor control, speed, and coordination.

Conclusion and Relevance: Interactive Metronome Training may be effective in improving motor function, coordination, and behavior in children with various neurodevelopmental challenges.

What This Systematic Review Adds: There are limited high quality studies that evaluate IMT for children with ADHD. This systematic review provides a starting point for evaluating the efficacy of IMT to treat children with ADHD in OT practice. More research is needed to determine the overall effectiveness of this treatment method.

Key Words: Interactive Metronome Training (IMT), ADHD, Children Mia Collins, OTS; Kyla Genenbacher, OTS; Rachel Santiago, OTS

Attention Deficit Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders in children, comprised of inattention, impulsivity, and hyperactivity interfering with daily functioning and development (Li et al., 2023). In many cases, ADHD is treated with medication and used in combination with behavior therapy. There are many different treatment options, and finding the one that works best is crucial. According to the Centers for Disease Control and Prevention (CDC), for children under the age of six diagnosed with ADHD, it is recommended to try parent training in behavior management before introducing medication. For children six and older, medication is recommended in combination with behavior therapy (CDC, 2024). However, there are non-pharmacological interventions to consider. Unlike medications, non-pharmacological interventions do not pose any side effects. One such intervention is Interactive Metronome Training (IMT).

Interactive Metronome (IM) is a computer-based program designed to improve timing, attention, coordination, and regulation in individuals with cognitive and physical disabilities (Cleveland Clinic, n.d.). IMT helps address cognitive and motor functions, which are areas often impaired in those diagnosed with ADHD. By engaging in a variety of synchronized movements and exercises to a computer-generated beat that provides visual and auditory feedback, participants can improve their timing, attention, coordination, and cognitive skills.

Various practice settings are using IMT, but there is a lack of high-quality research on the effectiveness of the use of interactive metronome training, specifically with pediatric populations diagnosed with ADHD. However, there is anecdotal support from parents and teachers. This systematic review provides a starting point for evaluating the efficacy of IMT for children with ADHD in OT practice. More research is needed to determine the overall

effectiveness of this treatment method. The objective of this systematic review was to identify, evaluate, and synthesize the literature on the effectiveness of IMT for children with ADHD.

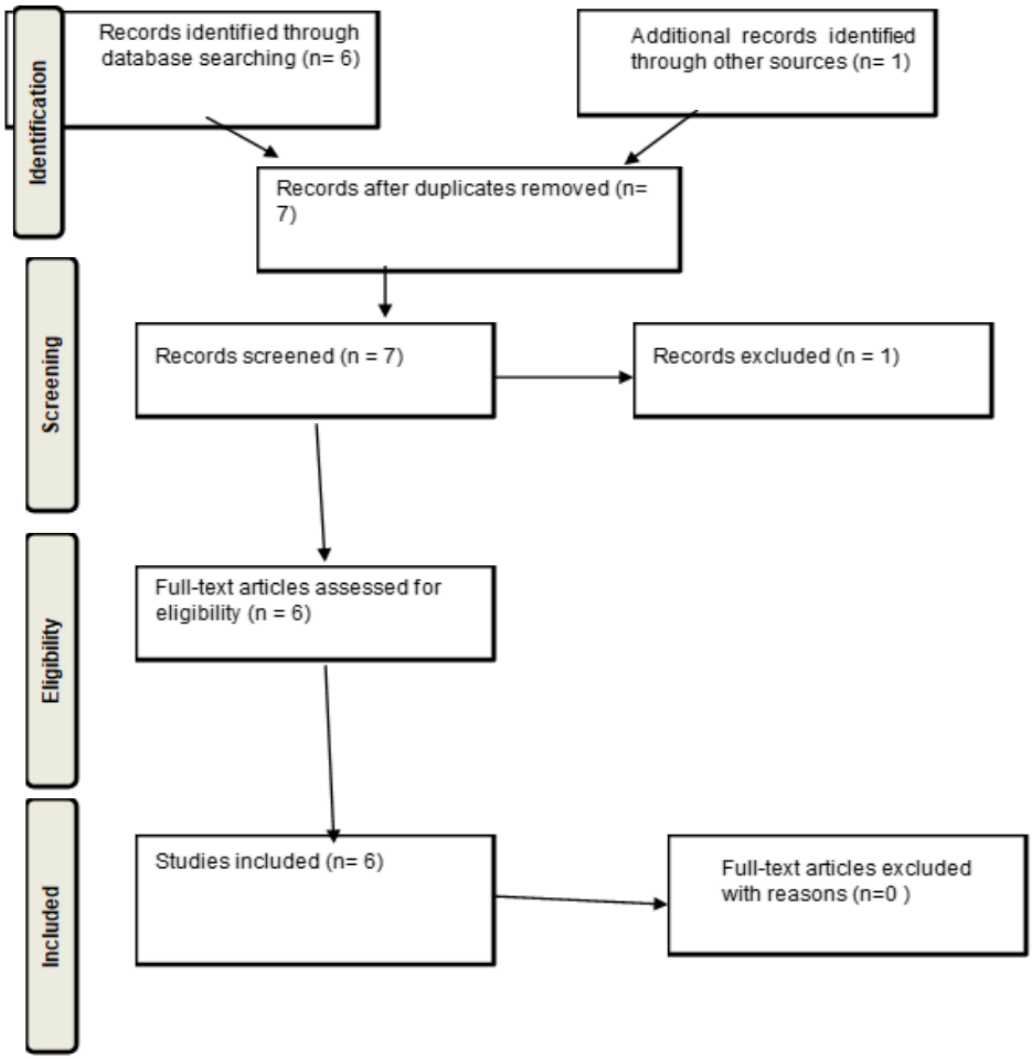
Method

The systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and incorporated recommended processes for conducting a systematic review. The guiding research question for this systematic review was: Does interactive metronome training (IMT) improve attention and coordination in children with ADHD?

A broad search of the literature occurred between May 5, 2025, and May 9, 2025. An additional search was conducted May 19, 2025, to ensure all relevant research was included. The inclusion criteria for studies in this systematic review were as follows: peer-reviewed, published in English, and dated between 2001-2023. Exclusion criteria, in addition to those studies that did not meet the inclusion criteria, included articles that were systematic reviews, scoping reviews, dissertations, and presentations. A search for relevant literature was completed using electronic databases: Medline, Academic Search Complete, and CINAHL Complete through Hawai'i Pacific University's online library databases. Search terms included *interactive metronome training*, *attention deficit-hyperactivity disorder (ADHD)*, and *children*, as well as combinations of these terms. Appendix A provides an extensive list of all search terms used for this systematic review. The initial search included six articles related to the research topic (Figure 1). Three independent reviewers completed the screening and selection of the studies, assessed their quality, and extracted the data.

Figure 1

Flow Diagram



Results

Six studies met the inclusion criteria. The articles were assessed according to their risk of bias, level of evidence, and quality. This systematic review included six studies that contained relevant information on the topic. The information from these articles was divided into three themes related to IMT being associated with positive changes in behavior and motor skills and the need for more research to support the benefits of this intervention. An evidence table is

provided in Appendix B. The Cochrane risk-of-bias guidelines were used to assess each article and are provided in Appendix C.

Positive Changes in Attention and Focus

Five of the six studies on the topic discussed the efficacy of Interactive Metronome Training to promote positive changes in attention and focus. Three of these studies were Level II studies and two were Level IV studies (see Appendix B). All studies provided evidence that IMT may be effective and potentially beneficial.

Specifically, Barthscherer and Dole (2005) examined the use of IMT for attention and motor coordination challenges of a 9-year-old boy. A seven-week training program was conducted utilizing IMT. The child participated in 1-to-1.5-hour sessions three days a week with at least a day of rest between. The child showed positive behavior changes as reported by the child's parents and on clinical measures. His father reported he was more cooperative with television time limits and seat selection for car rides (Barthscherer & Dole, 2005). After the treatment, the child also showed more obedience to rules in the house. Specifically, his mother shared that she had a rule that he had to read to his sister every day, but this task usually ended in an argument. After the IMT, his mother reported that his cooperation with reading and duration improved (i.e., he was reading for 15-20 minutes without difficulty) (Barthscherer & Dole, 2005).

Shank and Harron (2015) explored the use of IMT on cognitive and motor skills. This study looked at how a computer-based IMT program could help kids with motor and cognitive challenges. The children completed approximately 14 one-hour sessions over 8.5 weeks. Before and after the training, their timing, hand skills, and self-control were measured based on parent

feedback. The results showed clear improvements in all areas, even though the children did not practice those specific skills directly, suggesting the training may help both cognition and movement work better together. By moving in sync with the beat, the children enhanced their coordination, timing, and concentration.

Teicher et al. (2023) studied an in-home based program involving children with ADHD that combined Brain Balance exercises and IMT, done five times a week for 15 weeks. Out of the 39 children who started the program, only 16 finished the program. Those who completed it showed a decrease in ADHD symptoms based on the parent ratings. Results suggested better focus and reduced hyperactivity, similar to the effects of low-dose ADHD medication. These results suggest that the program may be beneficial, but a larger, more controlled study is needed.

Shaffer et al. (2001) explored the effects of IMT on motor and cognitive skills in children with ADHD. There was a total of 56 participants split into three treatment groups (IM, video game and control group). The video game participants were randomly assigned to administrators who received six hours of training on both IM and video games. There were five easily accessible PC-based nonviolent video games used as a treatment placebo. Each game encompassed various skills like hand-eye coordination, advanced mental planning, and multiple task sequencing. The participants had a total of 15 video game training sessions, once a day for one hour between a 3-to-5-week period. The participants in the video game treatment showed more improvement in sensory processing tasks, impulsiveness, and hyperactivity than children in the control group. However, the video game group showed a decrease in performance in select areas such as modulation and control of aggression, consistency of concentration, reaction time, and overall attention. IM training produced the most improved results compared to the control and video game group. This study suggests that IM training can improve attention, motor, and

perceptual-motor functioning; cognitive and academic performance; and control of aggression in children with ADHD.

Park and Choi (2017) evaluated aspects of cognition following IMT. They found that both children who participated in the study showed improvements in attention, timing, and processing speed. Only one of the two children improved working memory following IMT. The children's parents/legal caregivers and teachers were asked about the children's improvement in daily activities following IMT. They reported that the children exhibited less distractedness following the intervention. The teachers also reported improvement in the children's attention span and participation following the intervention. After receiving the IM intervention, there was significant improvement in cognitive skills, specifically working memory and processing speed. A previous study supports the results showing that IM interventions enhanced overall brain function which strengthened neural network processing (Park & Choi, 2017). This study supports the effectiveness of IM training to improve motor skills (timing) and cognitive skills (attention, processing speed, and working memory) in children with ADHD.

Limitations of these studies include having small sample sizes that did not allow for confidence in the findings. The largest sample size presented among these studies was just 56 participants (Shaffer, 2000) with one study having a sample size of only one child (Bartscherer & Dole, 2005). Three studies included only boys (Bartscherer & Dole, 2005; Park & Choi, 2017; Shaffer et al., 2001), and two studies had more male participants than female (Shank & Harron, 2015; Teicher et al., 2023). One study used nonviolent computer video games as an alternate treatment for comparison (Shaffer et al., 2001). The approaches to measuring treatment also varied with only three of the studies using the Long Form Assessment (LFA) test of IM (Bartscherer & Dole, 2005; Park, 2017; Shank & Harron, 2015). All the studies varied in the

amount of time that each participant received the intervention ranging from 15 hours total (Shaffer et al., 2001) to an extensive program completed 5 times a week for 15 weeks (Teicher et al., 2023).

Need for Further Research

All six studies on the topic of Interactive Metronome Training indicated a need for further research to confirm the findings. Four of these studies were Level II studies and two were Level IV studies (see Appendix B). All studies provided evidence that IMT may be effective and potentially beneficial. Specifically, Cosper et al. (2009) looked at the impacts of IMT as an intervention for 12 children who had been diagnosed with attention deficit hyperactivity disorder (ADHD) as well as either pervasive developmental disorder or developmental coordination disorder. The researchers concluded that more research is needed to determine the range of applications of IM (Cosper et al., 2009).

Bartscherer and Dole (2005) evaluated an IM intervention and how it impacted a specific child. Their research showed that the intervention itself can be applied safely with a positive association with behavior changes. Regarding future research, they shared that more rigorous studies are needed to clarify the relationship with IM training and behavioral and motor changes.

Shank and Harron's (2015) study involved children with various cognitive and motor challenges. They participated in IM training, which involved performing movements in rhythm with a beat to improve timing and coordination. According to parent reports, the children experienced notable improvements not only in hand function and timing, but also in behavior—particularly in areas such as self-control and attention. These researchers indicated that future

research should include longitudinal studies to determine if the changes from IM are sustained over time (Shank & Harron, 2015).

According to Teicher et al. (2023), metronome training has shown some benefits for children with neurodivergence, like ADHD, but more research is needed. The children were less hyper and more focused following IM training, but the study had limitations. Over half the children didn't finish the program, and not all children showed improvement. More research is needed to understand how the training works in different practice settings and why some children do not finish the program.

The study by Shaffer et al. (2001) also indicated more research should be done, including replications of their study on a larger, more diverse population (e.g., with girls and children from different socioeconomic backgrounds). Additional studies should explore variations of training sessions such as session length, number of sessions, overall repetitions, timing goals, and follow-up duration to observe stability of treatment. More research will help therapists better understand the neurological relationship of motor regulation and how IM training influences these processes. Other researchers identified the need for more research using rigorous study designs with larger and more diverse samples to examine the therapeutic effects of IM (Park & Choi, 2017; Shaffer et al., 2001; Teicher et al., 2001).

Impact on Speed, Coordination, and Motor Control

All six studies on the topic also examined the efficacy of Interactive Metronome Training to improve motor control. Four of these studies were Level II studies and two were Level IV studies (see Appendix B). All studies provided evidence that IMT may be effective and potentially beneficial to enhance children's speed, coordination, and motor control.

This theme was highlighted in the study performed by Bartscherer and Dole (2005) using the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). The child who participated in this study demonstrated gains in timing accuracy throughout the course of the intervention. Cosper et al. (2009) also discovered that the use of IM as an intervention may improve motor control and reaction time with children with ADHD. While the children did not have significant changes in attention or inhibitory control, they did improve in visual choice reaction time and visuomotor control after IM training (Cosper et al., 2009). In the study by Shank and Harron (2015), IMT improved deficits in speed, coordination, and motor control for children with neurodivergence. Assessments conducted before and after the intervention—including the Interactive Metronome Long Form Assessment, the Jebsen Taylor Test of Hand Function, and parent questionnaires—showed significant improvements in timing skills, hand function, and self-regulatory behaviors (Shank & Harron, 2015). The findings support the idea that strengthening timing and coordination through IM may be especially beneficial for children with neurodivergent conditions.

Interactive Metronome Training also helped improve speed, coordination, and motor control in children with neurodivergence in the study by Teicher et al. (2023). Children with ADHD completed a 15-week at-home program combining Brain Balance and IM exercises. Parents reported improvements in focus and behavior. The training had effects similar to low-dose ADHD medication in areas like attention and problem-solving. While more research is needed, the results suggest IMT can help with motor and cognitive skills in neurodivergent children. Parents reported a decrease in ADHD symptoms in their children, especially in attention, with clear improvements in all areas according to the Conners' Parent Rating Scale (CPRS), a behavior rating scale (Teicher et al., 2023).

Boys with ADHD who did the Interactive Metronome program had greater improvements in attention, controlling their movements, understanding and using language, reading, and managing their anger compared to boys who either played video games or didn't receive any treatment (Shaffer et al., 2001). The studies varied among what the IM intervention targeted and the components measured (e.g., attention, motor control, language, cognition and learning (Shaffer et al., 2001). Another study looked specifically at hand function (Shank & Harron, 2015), and how IM affected the brain balance center (Teicher et al., 2023).

The variance in the focus of each study is a limitation of the findings. There were also differences between the studies among the diagnosis of the participants. Some studies only looked at participants diagnosed with ADHD (Park & Choi, 2017; Shaffer et al., 2001; Teicher et al., 2023) while others included children with a variety of neurodevelopment disorders (Bartscherer & Dole, 2005; Cosper et al., 2009; Shank & Harron, 2015).

Discussion

The results of this systematic review suggest that Interactive Metronome Training may be effective in improving cognition, behavior, speed, coordination, and motor control for children with varying neurodevelopmental challenges. Attention is dependent on executive function and timing which are associated with the functioning of the frontal lobe (Park & Choi, 2017). IM is a tool that can help improve motor skills and cognitive function. The articles in this review assessed children with varying diagnoses including ADHD, which is the most prevalent neurodevelopmental disorder beginning in childhood. This condition is marked by an ongoing and disruptive lack of attention, hyperactivity, and impulsivity, and frequently diagnosed among children in the United States (Li et al., 2023). This review examined the research on the use of IMT as an intervention strategy for children with ADHD.

IMT may address deficits in speed, coordination, and motor control in children with various neurodevelopment disorders. Some of the studies' outcome measures included the Nine-Hole Peg Test, and the Evaluation Tool of Children's Handwriting, which were utilized as outcome measures. Study outcomes demonstrated positive results with the use of Interactive Metronome Training, which differed from the participants' baseline performance. Despite the findings of this systematic review, there is still a need for further research.

While further researcher utilizing larger sample sizes and inclusion of females is needed, this review shows that Interactive Metronome Training can be a valuable intervention to improve motor and cognitive skills. IM training is a non-pharmacological intervention that can be used to complement traditional therapeutic treatments, thereby enhancing the outcomes for children with neurodevelopmental disorders.

Strengths and Limitations

Strengths of the systematic review include use of PRISMA guidelines/flow diagram and a team of researchers for consensus in selecting articles, thereby reducing potential bias. Some limitations in the systematic review process include existing limitations within the studies selected, low number of articles located, possible failure to identify relevant articles, and subjective grouping of articles into themes.

Implications for Occupational Therapy Practice

This review found that Interactive Metronome Training may help children with ADHD and other developmental challenges improve focus, behavior, coordination, and motor skills. IMT is a non-pharmacological option that can be used along with other therapies to support

children's development. Reports from parents and teachers after children's participation in IMT indicated the children were more focused, followed rules better, and were less distracted in daily activities. While the results are promising, more research is needed. Most of the studies were small, mostly involving boys, and used different outcomes to measure impact of IMT. Future studies should include more rigorous study designs, larger sample sizes, a mix of boys and girls, and use the same outcomes to track progress.

Conclusion

Interactive Metronome Training is used in occupational therapy practice to improve cognitive and motor function in children with neurodevelopmental challenges. However, the research related to the use and effectiveness of IMT is sparse. Studies included within this systematic review provide evidence that IMT may be effective in improving motor function, coordination, and behavior in children with various neurodevelopmental conditions. Additional research is necessary with larger and more diverse samples to examine the benefits of IMT with children with ADHD and other neurodevelopmental challenges.

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Appendix A

Search Terms

interactive metronome training
AND
adhd or attention deficit hyperactivity disorder or attention deficit-hyperactivity disorder
AND
pediatric or child or children or infant or adolescent

Appendix B

Evidence Table for Interactive Metronome Training for Children with ADHD

Evidence Table for Interactive metronome training for children with ADHD					
Author/Year	Level of Evidence Study Design Risk of Bias	Participants Inclusion Criteria Study Setting	Intervention and Control Groups	Outcome Measures	Results
Bartscherer & Dole (2005)	Level 4 Case Report Moderate risk of bias	*Participants* N = 1 (M age 9) *Inclusion Criteria* NA *Study Setting* In participants home	*Intervention: Interactive Metronome (IM) (n=1), sessions 3 times per week, 15-20 sessions over the course of* weeks with at least one day of no training in between sessions. Control Groups: NA	Fine and gross motor skills: Bruininiks-Oseretsky Test of Motor Proficiency (BOTMP) Coordination with interactive metronome training (IMT): Interactive metronome long-form test (IM LFT)	This case provides clinical evidence that interactive metronome training can be used safely and was tolerated well by the child. It was shown to have a an association with positive changes in behaviors by the participants parents.
Cosper et. Al. (2009)	Level 2B Quasi-experimental with a single group pre-test posttest High risk of bias	*Participants* N = 12 (Age 6 years 5 months to 13 years 5 months, 10 boys and 2 girls) *Inclusion Criteria* Diagnosed with a neurodevelopmental disorder, aged 6 years 5 months to 13 years 5 months Study Setting Outpatient treatment	*Intervention: IMT* (n=12), 15 1hr sessions, facilitated by an Occupational Therapist with registered interactive metronome training. Treatments included the use of headphones and motion-sensory trigger buttons. Protocols were followed based on the Interactive Metronome manual.	Motor Coordination: Bruininks–Oseretsky Test of Motor Proficiency-Short Form Sustained Attention: Gordon Diagnostic System's (GDS)	This study suggests that IM is a reasonably effective technique for treatments to improve some areas of motor control and reaction time for children with mixed neurodevelopmental disorders in regard to attentional and motor coordination.

		at Medical College of Georgia's Rehabilitation Center	*Control Group:* N/A		
Park & Choi, 2017	Level 4 Case Report Moderate Risk of Bias	*Participants:* N = 2 (M; 4 y/o & 6 y/o) *Inclusion Criteria:* Children diagnosed with ADHD *Study Setting:* Child private center (outpatient)	*Intervention:* Pre and posttest were performed. Standard 15 session IM protocol, each session lasting 40 mins, twice a week. Subjects used headphones which delivered a computer-generated tone, and a trigger detected any contact/motion. *Control Groups:* N/A	Timing: Each tap on the trigger was measured using milliseconds(ms)and the millisecond average was recorded Attention: Super Right On (SRO%) which measures percentage of hits within 15ms Pretest and posttest K-WPPSI-IV for measuring working memory and processing speed index.	This study shows there was an increase in attention span and improved motor skills following the IM intervention. Showed less distractedness and increased participation in class following the intervention. The IM intervention improved both working memory and processing speed. This study supports the effectiveness of IM training for improving cognitive functions of children diagnosed with ADHD.
Shaffer et al., 2001	Level 2 RCT with control group pretest posttest Moderate Risk of	*Participants:* N=56 (M; 6-12.5 y/o) *Inclusion Criteria:*	*Intervention 1:* IM group (N=19) had 15 sessions for 1 hour each over a 3-to-5-	Wechsler Digit Span subtest WRAT 3 reading subtest	This study indicates that boys with ADHD that received the IM intervention

	Bias	6-12 y/o boys diagnosed with ADHD living in the greater metropolitan area where the study was conducted. *Intervention Setting:* Did not explicitly say	week period. Used two sets of headphones and two contact-sensing triggers. Each session includes 4 to 8 exercises each session. *Intervention 2:* Video game group (N=19) IM group had 15 sessions for 1 hour each over a 3-to-5-week period. Used five commonly available PC-based nonviolent video games. Participant played against computers and each new level achieved; the game became more difficult. *Control Group: (N=18)*	4 TOVA test: - Omissions - Response time - Variability - Response Time Variability Total Standard deviation and ADHD total score	improved significantly in areas of attention, motor control, language processing, reading, and ability to regulate aggression than the participants who received video game intervention and control group. The video game group improved more than the control group but showed a decrease in select areas such as modulation/control (reaction times, concentration and overall attention).
Shank, T. M., & Harron, W. (2015).	Level 2B Prospective cohort study	*Participants:* N = 48 (41 Male / 7 Female). *Inclusion Criteria:* Children with mixed motor and cognitive diagnoses	*Intervention 1:* Pre-Post-timing as measured by the IM Long Form Assessment (LFA). *Intervention 2:* Hand function as	*Fine Motor Skills:* Bruininks Oseretsky Test of Motor Proficiency & Nine-Hole Peg Test	The study suggest the following: 1) a short regimen of therapist-led IM training is likely to significantly, positively change functional hand skill

		Intervention Setting: Outpatient setting	measured by the Jebsen Taylor Test of Hand Function (JTTHF) *Intervention 3:* Combined Cognitive Training and Exercise (n = 24)	*Sensory*: Sensory Integration and Praxis Test, the Sensory Profile, and the Evaluation Tool of Children's Handwriting	in a pediatric population as measured by the JTTHF; 2) a short regimen is likely to significantly, positively change a participant's internal timing abilities; and 3) parents report statistically significant changes in a variety of their children's behaviors after IM training.
Teicher, M. H., et. Al. (2023).	Level 2B Prospective cohort study	*Participants:* N = 39 (Either sex 8-14yrs). *Inclusion Criteria:* meet DSM- IV criteria for ADHD or be typical developing controls (TDCs) with no lifetime history of psychiatric disorders *Intervention Setting:* Brain Balance Center laboratory	*Intervention 1:* Phase 1 - Individuals with ADHD, had them run through a course of treatment and compared differences in parent and clinician ratings, Quotient measures and neuropsychological test performance on the Cambridge Neuropsychological Test Automated Battery (CANTAB) *Intervention 2:* Phase 2 - Typical developing control (TDC) group and	*Cognitive Phase 1*: Efficacy of Brain Balance@ exercises *Cognitive Phase 2:* Temporal training on the Interactive Metronome 15-weeks of 5 times per week BB/IM training (up to 75 sessions) which were presented as a series of online web-based training exercises Conner's Parent Rating Scale – Revised and the ADHD Rating Scale	*Significant Findings*: Training with Brain Balance / Interactive Metronome appeared to have clinical and neuropsychological effects similar to low doses of methylphenidate though it appeared to be less effective than moderate or high doses. *Nonsignificant Findings:* None

			assessed neuropsychological test performance on tasks from the Inquisit-5 millisecond test library		
Note. Acronyms used: IMT- Interactive metronome training IM- Interactive metronome IM LFT- Interactive metronome long-form test K-WPPSI-IV: Korean-Weschler Preschool and Primary Scale of Intelligence-IV LFA: Long Form Assessment					

Appendix C

Risk-of-Bias Table

Risk-of-Bias Table for Randomized Controlled Trial (RCT) and Non-RCT (Two or More Group Design)										
	Selection Bias (Risk of bias arising from randomization process)			Performance Bias (effect of assignment to intervention)		Detection Bias		Attrition Bias	Reporting Bias	Overall risk-of-bias (low, moderate, high
Citation	Random Sequence Generation	Allocation Concealment (until participants enrolled and assigned)	Baseline difference between intervention groups	Blinding of Participants During the Trial	Blinding of Study Personnel During the Trial	Blinding of Outcome Assessment: Self-reported outcomes	Blinding of Outcome Assessment: Objective Outcomes (assessors aware of intervention received?)	Incomplete Outcome Data (data for all or nearly all participants	Selective Reporting (results being reported selected on basis of the results?)	
(Shaffer et al., 2001)	-	+	+	+	+	-	+	-	-	Moderate Risk
Shank, T. M., & Harron, W. (2015).	-	-	+	-	-	-	-	-	-	High Risk
Teicher, M. H., et. Al. (2023).	-	-	+	+	-	-	-	-	-	High Risk

Note. Categories for risk of bias are as follows: Low risk of bias (+), unclear risk of bias (?), high risk of bias (–). Scoring for overall risk of bias assessment is as follows: 0–3 minuses, low risk of bias (L); 4–6 minuses, moderate risk of bias (M); 7–9 minuses, high risk of bias (H).

Citation. Table format adapted from Higgins, J. P. T., Sterne, J. A. C., Savović, J., Page, M. J., Hróbjartsson, A., Boutron, I., . . . Eldridge, S. (2016). A revised tool for assessing risk of bias in randomized trials. Cochrane Database of Systematic Reviews 2016, Issue 10 (Suppl. 1), 29–31. https://doi.org//10.1002/14651858.CD201601

Risk of Bias for Before-After (Pre-Post) Studies with No Control Group (One Group Design)												
Citation	Study question or objective clear	Eligibility or selection criteria clearly described	Participants representative of real-world patients	All eligible participants enrolled	Sample size appropriate for confidence in findings	Intervention clearly described and delivered consistently	Outcome measures pre-specified, defined, valid/reliable, and assessed consistently	Assessors blinded to participant exposure to intervention	Loss to follow-up after baseline 20% or less	Statistical methods examine changes in outcome measures from before to after intervention	Outcome measures were collected multiple times before and after intervention	Overall risk of bias assessment (low, moderate, high risk)
Bartscherer & Dole (2005)	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	Moderate Risk
Cosper et al. (2009)	Y	Y	Y	N	N	Y	Y	N	Y	Y	N	Moderate Risk
(Park & Choi, 2017)	Y	Y	Y	Y	N	Y	Y	N	N	Y	N	Moderate Risk

Note. Y = yes; N = no; NR = not reported. Scoring for overall risk of bias assessment is as follows: 0–3 N, Low risk of bias (L); 4–8 N, Moderate risk of bias (M); 9–11 N, High risk of bias (H).

Citation. Table format adapted from National Heart Lung and Blood Institute. (2014). Quality assessment tool for before–after (pre–post) studies with no control group. Retrieved from https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools