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Movement Interventions for Children with Autism and Developmental Disabilities: An Evidence-Based Practice Project

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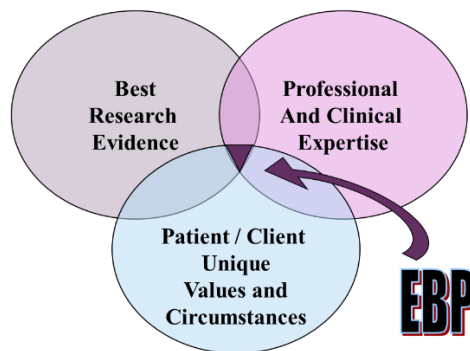
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Introduction

Evidence Based Practice

Evidence based practice is defined as the integration of knowledge from professional and clinical expertise, patient/client unique values and circumstances, and best research evidence (Straus, Richardson, Glasziou, & Haynes, 2005). The EBP courses in the St. Catherine University occupational therapy programs emphasizes skill building in finding, analyzing, and synthesizing research.

A definition of Evidence-Based Practice (EBP)



(Straus, Richardson, Glasziou & Haynes, 2005)



The EBP Project

Occupational therapy graduate students at St. Catherine University complete an EBP project in partial fulfillment of the requirements for a course on Evidence-Based Practice.

The EBP Process

- Begins with a practice dilemma
- Dilemma is framed as an EBP question and PICO
P (population/problem) I (intervention) C (comparison group) O (outcome(s) of interest)
- Background learning
- Search for the best evidence
- Initial appraisal and critical appraisal of the evidence
- Summary of themes from the evidence
- Recommendations for practice
- Next steps – implementation in practice

Practice Dilemma

The practice dilemma for these projects centered on children with developmental disabilities, particularly those with autism spectrum disorder.

In the past couple of decades we have seen the enormous growth in the number of individuals with ASD and the types and costs of services provided to them and their families (Centers for Disease Control and Prevention, 2016):

- Autism spectrum disorder: 1 in 68 children
- U.S. annual costs for children with ASD in 2011
 - \$11-60 billion
- Cost of autism medical care and therapies per year
 - Medical care for children with ASD on Medicare: \$10,000
 - Intensive behavioral interventions: \$40,000-60,000

Occupational therapy is a primary provider for children with autism spectrum disorder and their families. There are expectations that the interventions occupational therapy uses are evidence-based. There are growing questions about Comprehensive Treatment Models that are being used with children with ASD.

Comprehensive Treatment Models for ASD and Developmental Disabilities

A number of governmental agencies and expert review groups have begun to examine those interventions that are most costly and time intensive. These have been described as comprehensive treatment models (rather than focused interventions) because of the unique characteristics related to some of these features (Wong et al., 2013). AOTA, the Department of Human Services, and others receive a lot of questions from practitioners and families about some of these interventions that have been used in practice and thus, it seemed appropriate to conduct a review of the research evidence.

- Comprehensive Treatment Models “consist of a set of practices designed to achieve a broad learning or developmental impact on the core deficits of ASD” and “are characterized by
 - organization (i.e., around a conceptual framework),
 - operationalization (i.e., procedures manualized),
 - intensity (i.e., substantial number of hours per week),
 - longevity (i.e., occur across one or more years), and
 - breadth of outcome focus (i.e., multiple outcomes such as communication, behavior, social competence targeted)” (p. 3)
- Focused Intervention Practice: “address a single goal or skill” (p. 3)

Table 1.

Interventions Reviewed in the Evidence Based Practice Projects

General Category	Specific Interventions
Listening Therapies	Auditory Integration Therapy The Listening Program Therapeutic Listening
Movement Therapies	Brain Gym Interactive Metronome Makoto Therapy
Reflex Integration Therapies	Masgutova Method (MNRI) Reflex Integration Rhythmic Movement Training
Sensory/Manipulative Therapies	Wilbarger Therasuit Craniosacral therapy

Appraisal of Best Research

After searching and finding evidence available from library databases and alternative sources, students conducted an initial appraisal to evaluate the quality and relevance of the evidence and select the best research for further review. Then they conducted critical appraisals of the best formal reviews of primary research (e.g., systematic reviews, meta-analyses) and/or primary/original research studies using the AOTA CAP form (American Occupational Therapy Association, 2016). One of the steps in the CAP process is to evaluate the strength or level of the research design and the types of conclusions that are possible from each design.

Initial Appraisal

- Quality of the evidence
 - type of evidence
 - research design
 - investigator qualifications
 - journal/publication/website
- Relevance of the evidence
 - PICO

Critical Appraisal

- Reviews of primary research
 - systematic reviews, meta-analysis
 - review process and approach
 - consistent and inconsistent findings
- Primary research studies AOTA CAP
 - Level 1: randomized controlled trials
 - Level 2: two groups, nonrandomized/cohort and case control
 - Level 3: nonrandomized, pretest/posttest and cross-sectional
 - Level 4: single subject
 - Level 5: case report

Expert Review Groups

Students also explored the conclusions and recommendations of expert review groups when available (see Tables 1-4). The Wisconsin Treatment Intervention Advisory Committee in particular has made determinations on a number of the interventions that students reviewed.

- Wisconsin Treatment Intervention Advisory Committee
- Evidence-Based Practices for Children, Youth, and Young Adults with Autism Spectrum (UNC)
- Association for Science in Autism Treatment (ASAT) Disorder
- Cochrane Collaboration
- U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services
- National Autism Center
- American Academy of Pediatrics
- Others

Wisconsin Determination Levels (Wisconsin Department of Health Services, 2016).

After reviewing all of the evidence, students made their own recommendations using the Wisconsin determination levels.

- Level 1- Well Established or Strong Evidence
(DHS 107 - Proven & Effective Treatment)
- Level 2 – Established or Moderate Evidence
(DHS 107 - Proven & Effective Treatment)
- Level 3 – Emerging Evidence
(DHS 107 – Promising as a Proven & Effective Treatment)
- Level 4 – Insufficient Evidence (Experimental Treatment)
- Level 5 – Untested (Experimental Treatment) and/or Potentially Harmful.

References

- American Occupational Therapy Association. (2016). AOTA'S evidence exchange: Guidelines to critically appraised paper (CAP) worksheet. Retrieved from <https://www.aota.org/~media/Corporate/Files/Practice/EvidenceExchange/CAP%20Guidelines%20for%20Evidence%20Exchange.pdf>
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All EBP Projects are available at <http://sophia.stkate.edu/>.

Final EBP Question and PICO

Are the comprehensive treatment models (CTM) Makoto Therapy, Brain Gym, and Interactive Metronome effective interventions for improving occupational performance including improving executive function, academic performance, and physical coordination in children and adolescents with Autism Spectrum Disorder (ASD)?

	Keywords	More Broad And Narrow Keywords	Keyword Synonyms, abbreviations, and spelling variants
P Patient / Population / Problem	Autism Cognition Coordination Children/adolescents with Autism Spectrum Disorder (ASD)	Developmental Disorders Children with disabilities Autism Spectrum Disorder (ASD) Neurodevelopmental Disorders	Autistic Balancing Processing ASD Youth, kids Students
I Intervention	Occupational Therapy, Brain Gym, Interactive Metronome, Makoto Arena Therapy	Rehabilitation Movement Education Therapeutic Exergame Fitness arena Active video games	OT Movement Therapy Participate
C Comparison	Current Protocol for treatment Control group		
O Outcome	Reaction Time Participation Occupational Performance Performance in School Motor coordination Focus/attention Hand/eye coordination Cross body movement	Function Coordination Education/ learning Balance Executive Function Movement Exercise Activity	Distractibility Leisure Play

Executive Summary.

After a comprehensive 7-week search and analysis of library databases and other internet resources, and thorough appraisal and synthesis of evidence, we recommend that neither Interactive Metronome, Brain Gym®, nor Makoto Therapy should be used in clinical practice for occupational therapy until further research is conducted. Much of the research found does not directly address these therapies as interventions for children and adolescents with autism spectrum disorder (ASD). Therefore, we place Interactive Metronome and Makoto Therapy at a level four for the Wisconsin Determination Levels, meaning “Authorities agree no emerging evidence base for the procedure” due to lack of research with children and adolescents with ASD, and flaws in current research (WI Department of Health Services, 2014). We place Brain Gym® as level five, meaning “there are no published studies supporting the proposed treatment package” due to lack of research involving children and adolescents with ASD and no reputable evidence-based research (WI Department of Health Services, 2014).

Because current research on Interactive Metronome, Brain Gym®, and Makoto Therapy fails to address children and adolescents with autism spectrum disorder, presents multiple flaws in research design, and does not measure occupational outcomes such as occupational performance, we recommend that these interventions should not be used as comprehensive treatment models in occupational therapy. We recommend that more occupational-based, methodologically-sound research involving youth with ASD be conducted before implementing these interventions in occupational therapy practice.

Reference

Wisconsin Department of Health Services (2014). Treatment Intervention Advisory Committee. Retrieved from <https://tiac.wisconsin.gov/index.htm>

Interactive Metronome Therapy

Executive Summary

Final EBP question and PICO.

Are the comprehensive treatment models (CTM) Makoto Therapy, Brain Gym, and Interactive Metronome effective interventions for improving occupational performance including improving executive function, academic performance, and physical coordination in children and adolescents with Autism Spectrum Disorder (ASD)?

	Keywords	More Broad And Narrow Keywords	Keyword Synonyms, abbreviations, and spelling variants
P Patient / Population / Problem	Autism Cognition Coordination Children/adolescents with Autism Spectrum Disorder (ASD)	Developmental Disorders Children with disabilities Autism Spectrum Disorder (ASD) Neurodevelopmental Disorders	Autistic Balancing Processing ASD Youth, kids Students
I Intervention	Occupational Therapy, Brain Gym, Interactive Metronome, Makoto Arena Therapy	Rehabilitation Movement Education Therapeutic Exergame Fitness arena Active video games	OT Movement Therapy Participate
C Comparison	Current Protocol for treatment Control group		
O Outcome	Reaction Time Participation Occupational Performance Performance in School Motor coordination Focus/attention Hand/eye coordination Cross body movement	Function Coordination Education/ learning Balance Executive Function Movement Exercise Activity	Distractibility Leisure Play

Themes.*Description of Interactive Metronome.*

Interactive Metronome training is a movement-based intervention used across various age groups. This intervention uses computer technology to promote coordination and timing. IM training a computer to assess timing by using a variety of buttons, mats, and sensors to detect movement (Interactive Metronome, n.d.). IM training has been used for children with developmental and learning disabilities, such as ADHD, autism, and cerebral palsy (Shaffer et al., 2000. p. 156). IM training claims to improve, “motor planning and sequencing, fine and gross motor skills, attention, sensory integration, self-monitoring and impulse control, balance, and bilateral coordination,” and other functions (Interactive Metronome, n.d., n.p.). Typically, an individual participates in 15-20, 1-hour treatment session over 3-5 weeks. (Patino, 2014). The equipment required for Interactive Metronome costs approximately \$1600 while the training to become a provider is \$149 (Interactive Metronome, n.d.).

Developers, Researchers and Company.

Interactive Metronome was developed in the 1990's. Currently, there are over 20,000 certified Interactive Metronome providers in Canada, and in the United States (Interactive Metronome, n.d.). There were articles on Interactive Metronome, or relating to Interactive Metronome that were found. Outcomes show varying reviews on the effectiveness of Interactive Metronome. The people who did research on Interactive Metronome had other research articles that had been published in the past. Most of the researchers had credentials from Universities, and had obtained a higher education with an advanced degree such as a Doctoral degree. Other researcher's credentials were not reported, or were not found. One article that was found was cited by 0 people, and it was about the treatment of children with severe head injuries (Mulligan & Hanzlik,

1991). The author has a Doctor's degree, and is a professor, so there are reliable credentials. Most of these research studies and articles on Interactive Metronome were cited at least once by other sources. Being cited by others shows that these research studies were useful, and relevant to others. The organization that sells this intervention is the company it was developed by, called Interactive Metronome (Interactive Metronome, n.d.).

Quality and Quantity of Evidence.

Sixteen articles were selected for a more comprehensive review. Of the sixteen articles, ten were studies specifically on children. Of the six studies not focused on children, only one specifically used interactive metronome (Nelson et. al, 2013). The studies not focused on children investigated sensory stimulation, perceptual abilities, and cognitive functioning (Conklyn et. al, 2013; Kim et. al, 2012; Letts et. al, 2011; Padilla, 2016). Two systematic reviews were also found (Letts, 20011; Padilla, 2016) along with one conceptual/theoretical article outlined the rationale for interactive metronome clinical in occupational therapy practice (Koomar, 2001). The remainder of the peer-reviewed articles were primary research studies. Our research focused primarily on experimental studies. Only two articles were determined to have both high quality and high relevance (Koomar, 2001; Nelson et. al 2013). Interactive metronome was not listed under any expert review group, as shown in Table 1. Of the sixteen articles reviewed, nine related directly to interactive metronome.

Current Evidence.

In general, the three best articles we reviewed had small sample sizes and were not generalizable to the population (Kim, Bo & Yoo, 2012; Cospers, Lee, Peters & Bishop, 2009; Shaffer et al., 2001). According to one study, "The objective of this study was to evaluate the effects of a SI group intervention programme involving interactive metronome training. This study not only

focused on the three traditional senses, tactile, vestibular, and proprioceptive, but additionally on the auditory sense from interactive metronome” (Kim, Bo & Yoo, 2012). This was a level III, nonrandomized study. The results of the study claim that Interactive Metronome and sensory integration combined revealed improvements in tactile, vestibular, auditory, and proprioceptive senses. However, they did not provide a control group to compare SI and Interactive metronome.

Another study by Shaffer et al. (2001), sought to assess the effects of Interactive Metronome training on the motor and cognitive abilities of children with ADHD. The researchers used an experimental pretest, posttest design randomizing the participants into either control, interactive metronome, or video game groups (Shaffer et al., 2001). The participants were all male (Shaffer et al., 2001). Participants in the Interactive Metronome group reported declines in aggressive behavior and improvements in attention, concentration, cognition, and academic skills (Shaffer et al., 2001). Although the results of this study supported the use of interactive metronome in children with ADHD, the study had limitations hindering its ability to be generalized to different populations (Shaffer et al., 2001).

Cosper et al. (2009) did research to determine the effectiveness of Interactive Metronome on 12 children with ADHD (Cosper, Lee, Peters, & Bishop, 2009). This study was done to see if children would become more focused, pay attention, and if their motor control and coordination would get better. There was a pretest and posttest given to the participants, to examine improvements made after doing the Interactive Metronome (Cosper, Lee, Peters, & Bishop, 2009). The children were tested for motor control, coordination, running speed, balance, strength, response speed, and visuomotor control in the pre and posttests (Cosper, Lee, Peters, & Bishop, 2009). This study on Interactive Metronome had evidence that suggests that Interactive Metronome is an effective technique to increase certain aspects of motor control, and reaction

time for children with developmental disorders. The strengths of this study were that the researchers did a pretest and posttest, and used different tests to determine the effectiveness of Interactive Metronome. The weaknesses included the sample size of the study, because there were only 12 children, who were mostly boys, and Caucasian. Cautions in using this study in practice include the fact that it was only compared to one other study on Interactive Metronome, and the sample size was small (Cosper, Lee, Peters, & Bishop, 2009).

The current research does not assess the effects of Interactive Metronome training on children with autism. In addition, the characteristics measured were not applied to occupational performance. More research needs to be conducted on Interactive Metronome training from an occupation-based approach.

EBP Summary: The research on Interactive Metronome training is limited. Much of the research is questionable due to lack of control groups and small sample sizes. Interactive metronome is not generalizable to the population because the characteristics of the samples had little variation in gender and race. Of the studies we identified, only nine were directly related to interactive metronome. Of the nine studies directly related to Interactive Metronome training, they had limited to moderate relevance to the population of interest, children with autism. On the Treatment Intervention Advisory Committee scale, Interactive Metronome would fall under category 4, which states “no emerging evidence base for procedure,” (Wisconsin Department of Health Services, n.d.). Interactive Metronome training should not be used as a comprehensive treatment method in individuals with autism without further research.

Expert Review Table.

Table 1.

Summary of Evidence and Recommendations by Expert Review Groups for Interactive Metronome

Review Organization	Summary and Recommendations	Citation and Source
Wisconsin Treatment Intervention Advisory Committee	Not Reviewed	Wisconsin Department of Health Services Autism and Other Developmental Disabilities Treatment Intervention Advisory Committee (2016). https://tiac.wisconsin.gov/summary-determinations-regarding-level-evidence.htm
Evidence-Based Practices for Children, Youth, and Young Adults with Autism Spectrum Disorder	Not Reviewed	Wong, C., Odom, S. L., Hume, K. Cox, A. W., Fettig, A., Kucharczyk, S., ... Schultz, T. R. (2013). <i>Evidence-based practices for children, youth, and young adults with Autism Spectrum Disorder</i> . Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, Autism Evidence-Based Practice Review Group. http://autismpdc.fpg.unc.edu/sites/autismpdc.fpg.unc.edu/files/2014-EBP-Report.pdf
Association for Science in Autism Treatment (ASAT)	Not Reviewed	Association for Science in Autism Treatment (n.d.) Treatments in alphabetical order. (http://www.asatonline.org/for-parents/learn-more-about-specific-treatments/treatments-in-alphabetical-order/)
Cochrane Collaboration	Not Reviewed	Cochrane Collaboration (2016). http://www.cochrane.org/
U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services.	Not Reviewed	U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services. (2010). Autism spectrum disorders (ASDs) services final report on environmental scan. Retrieved from http://www.impaqint.com/sites/default/files/files/Autism_Spectrum_Disorders.pdf
National Autism Center	Not Reviewed	National Autism Center (2015). National Standards Project, Phase 2. Retrieved from http://www.nationalautismcenter.org/national-standards-project/phase-2/
American Academy of Pediatrics	Not Reviewed	Myers, S. M., & Johnson, C. P. (2007). Management of children with autism spectrum disorders. <i>Pediatrics</i> , 120(5), 1162-1182. http://pediatrics.aappublication.org/content/pediatrics/120/5/1162.full.pdf

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- Letts, L., Minezes, J., Edwards, M., Berenyi, J., Moros, K., O'Neill, C., & O'Toole, C. (2011). Effectiveness of interventions designed to modify and maintain perceptual abilities in people with alzheimer's disease and related dementias. *The American Journal of Occupational Therapy*, 65(5), 505-13. Retrieved from
<http://pearl.stkate.edu/login?url=http://search.proquest.com/docview/893425449?accountid=2687>

Nelson, L.A., Macdonald, M., Stall, C., Pazdan, R., (2013). Effects of interactive metronome therapy on cognitive functioning after blast-related brain injury: a randomized controlled pilot trial.

Neuropsychology Epub. (6)675-79. doi:10.1037/a0034117.

Padilla, R., Anna, D.; Effectiveness of Sensory Stimulation to Improve Arousal and Alertness of People in a Coma or Persistent Vegetative State After Traumatic Brain Injury: A Systematic Review.

(2016) *American Journal of Occupational Therapy*, 70(3):7003180030p1- 7003180030p8. doi:

10.5014/ajot.2016.021022.

Patino, E. (2014) *FAQs about interactive metronome training*. Retrieved from Understood website:

<https://www.understood.org/en/learning-attention-issues/treatments-approaches/alternative-therapies/faqs-about-interactive-metronome-training>

Shaffer, R. J., Jacokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Jr, S. P. (2001). Effect of interactive metronome training on children with ADHD...including commentary by koomar J,

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Wisconsin Department of Health Services (n.d.) *Summary of determinations regarding level of evidence*.

Retrieved from Treatment Intervention Advisory Committee Website:

<https://tiac.wisconsin.gov/tiacfiles/pdf/txtreview-documentation.pdf>

Background Learning and Evidence Searches

Table of resources.

Table 2.

Journals and Website Information Examining the use of Interactive Metronome

Title/Name	Brief Description	Source
FAQs About Interactive Metronome Training (2014)	<p>Readable, informative website providing comprehensive information on Interactive Metronome training.</p> <p>Content includes what training is, claimed benefits, time commitment, who provides it, who it claims to help</p> <p>Consumer-oriented</p> <p>https://www.understood.org/en/learning-attention-issues/treatments-approaches/alternative-therapies/faqs-about-interactive-metronome-training</p>	<p>Understood: For Learning and Attention Issues</p> <p>https://www.understood.org/en</p>
Interactive Metronome	<p>Readable website summarizing information on who may benefit, and the claimed benefits.</p> <p>Consumer-oriented</p> <p>http://www.cfneurology.com/services/interactive-metronome/</p>	<p>Carolina Functional Neurology</p> <p>http://www.cfneurology.com/services/interactive-metronome/</p>
Effect of Interactive Metronome Training on Children with ADHD (2000)	<p>A practitioner-oriented research study examining the benefits of Interactive Metronome training on children with ADHD. The article contains a literature review explaining the claimed and studied benefits of Interactive Metronome training for individuals with various levels of ability.</p>	<p>American Journal of Occupational Therapy</p> <p>http://ajot.aota.org/index.aspx</p>
The Effects of a Sensory Integration Programme with applied interactive metronome	<p>A clinician-oriented research article which assesses the reliability of interactive metronome training. The article highlights the issues of children with functional disabilities in hopes to support the hypothesis that interactive metronome</p>	<p>Hong Kong Journal of Occupational Therapy</p>

training for children with developmental disabilities: A pilot study	positively influences the performance of children with developmental disabilities.	http://www.sciencedirect.com/science/article/pii/S1569186112000216
Reading Intervention Using Interactive Metronome in Children With Language and Reading Impairment: A Preliminary Investigation	A practitioner-oriented research study. Examines the effects of Interactive Metronome when integrated with a traditional language and reading intervention. This study focuses on reading achievement for students. Interactive Metronome may be useful for promoting reading rate/fluency, and comprehension for children with impairments.	Sage Journals: Hammill Institute on Disabilities http://cdq.sagepub.com/content/34/2/106.full.pdf+html

Background learning paper one.

This EBP project will focus on describing Interactive Metronome training. Background learning focused Interactive Metronome training, claimed benefits, target population for training, and length of training, and professionals who provide the service.

Interactive Metronome (IM) training is a therapy that uses computer technology to promote coordination and timing. IM training uses a variety of buttons, mats, and sensors to detect movement (Interactive Metronome, n.d.). IM training also uses a computer to gauge and assess timing, so the participant can see their feedback on the screen as they use the program (Interactive Metronome, n.d.). The button trigger equipment is worn on the participant's hand and is activated when the participant hits the button against a surface. The tap mat is activated when the participant makes contact with it using either hands or feet. The in-motion switch is typically worn around the ankles and detects movement as the person does an activity. There is also a program, IM-Home, which is designed so a participant can use it outside of therapy.

Interactive Metronome training claims to be beneficial for people with varying levels of abilities and both children and adults. IM training has been used for children with developmental and learning disabilities as well as athletes looking to “improve motor control, focus, and athletic performance,” (Shaffer et al., 2000. p. 156). In individuals with developmental or learning disabilities, timing can be a challenge for them (Interactive Metronome, n.d.). IM training claims to improve timing and other cognitive functions required for movement (Interactive Metronome, n.d.).

Interactive Metronome training claims to be beneficial for cognitive function. IM training claims to improve, “motor planning and sequencing, fine and gross motor skills, attention, sensory integration, self-monitoring and impulse control, balance, and bilateral coordination,”

and other functions (Interactive Metronome, n.d., n.p.). Ho, Bo, Yoo (2012, p. 26) states that, “the interactive metronome provides accurate real-time guide sounds to indicate users’ temporal accuracy during performance in a series of prescribed movements. The tonally and spatially changing guide sounds enable users to correct their rhythms and timing errors deliberately.” It is suggested that the ability to do these things effectively allows a person to live more independently (Interactive Metronome, n.d.).

Many professionals have used Interactive Metronome training in their practice settings. IM training is provided by occupational, physical and speech therapists, chiropractors, educators, neurologists and various other health professionals (Interactive Metronome, n.d.). Typically, an individual participates in 15-20, 1-hour treatment session over 3-5 weeks. (Patino, 2014).

This background summary of Interactive Metronome training describes interactive metronome training, how it is used, the claimed benefits, who it is used for and the characteristics of treatment in a therapy session. Professionals are currently using this treatment and thus, it is important to understand what the therapy entails prior to determining its validity.

References

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Effect of interactive metronome training on children with ADHD including commentary by koomar J, burpee JD, DeJean V, frick S, kawar MJ, fischer DM. *American Journal of Occupational Therapy*, 55(2), 155-166.

Kim, H. H., Bo, G. H., & Yoo, B. K. (2012). The effects of a sensory integration programme with applied interactive metronome training for children with developmental disabilities: a pilot study. *Hong Kong Journal of Occupational Therapy*, 22(1), 25-30.

Patino, E. (2014) *FAQs about interactive metronome training*. Retrieved from

<https://www.understood.org/en/learning-attention-issues/treatments-approaches/alternative-therapies/faqs-about-interactive-metronome-training>

Background learning paper two.

In occupational therapy, practitioners are constantly searching for new select interventions strategies to improve the overall performance, participation, and well-being of their clients. Interactive Metronome (IM) has been proposed as an intervention that is appropriate for pediatric occupational therapy settings. However, in order to do no harm onto our clients, it is crucial to ensure that the activities they participate in sufficiently achieve what they claim to do. The following background learning will focus on gathering information on Interactive Metronome, including the definition, populations it supposedly serves, and the characteristics of the technology.

Interactive Metronome is a computer system that targets timing by giving positive or negative feedback to the participant to gradually improve their hand or foot rhythm with the beat of the computer system (Patino 2015). The computer program requires a set of headphones as well as a hand or foot trigger to measure rhythm of the participant (Bartscherer & Dole 2005). According to the Interactive Metronome official website, the cost of the technology is approximately \$1600 and the training to be a provider costs \$149.

The claimed key to success for this device is the focus on timing. Research argues that trained timing to a rhythm has many positive effects on the brain, particularly in the developmental years. Some of the claimed improvements include planning skills, maintaining focus, and increasing the speed of processing (Patino 2015). Despite the theory that rhythm provides many benefits, specifically to children with disabilities, there is not enough concrete evidence to prove that interactive metronome effectively aids children with cognitive or learning issues.

Individuals with a wide range of conditions and disabilities have used Interactive Metronome. Many specific studies reflect on the results with varying conditions. For example, a study conducted focused on 56 boys with ADHD in hopes to examine the effectiveness on Interactive Metronome on facilitating a variety of positive behaviors for the children within the study (Shaffer et. al. 2001). While cognitive disabilities are a popular area of research for facilitators of Interactive Metronome, there is also a claim that individuals with physical disabilities may also benefit (McBride 2011). Current studies with relatively small participant groups claim that Interactive Metronome may decrease aggression for those traumatized by physical injuries, although further research will be needed to support the claim (McBride, 2011). This same theory also applies to the overall improvement for children with language disorders, despite small control groups leading to inconclusive results (McBride 2011).

Interactive Metronome and the population of participants leads us to understand the implications of technology. Several studies describe the implications of computer equipment required for the study to be conducted. Basic equipment includes a computer program, headphones, and hand or foot buzzers that are tapped to correlate with the rhythm provided through the headphones. The objective is to hit the foot or hand trigger as closely to the beat as possible. Varying tones give the user feedback as to how closely they hit the trigger with the beat (Bartscherer & Dole 2005). The discussion portion of this article discusses a possible fallback of the technology. The example provided highlights a key learning problem: Children who have less coordination may have similar results on an isometric metronome test as children with a diagnosis of a motor disorder. While there are few reliable sources that explain the technology behind Interactive Metronome, there is well-supported research on computer programs being a successful therapy for children with disabilities (Halton, 2008).

This background summary of Interactive Metronome introduces the therapeutic strategy. An understanding of the definition, commonly targeted populations, and technology implications are important to understanding the evidence and providing a clear understanding of its validity. After understanding this content, we may begin researching the validity by applying the knowledge of evidence-based practice and its implication in determining the legitimacy of a study.

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Background learning paper three.

This Evidence Based Practice project will focus on interventions conducted for people with disorders using Interactive Metronome for recovery. Background learning on this topic explored definitions of Interactive Metronome, what types of clients benefit from Interactive Metronome, and studies on children who participated in Interactive Metronome treatments and interventions.

Interactive Metronome is the only known research based intervention program that puts together music metronome with computer technology to improve a person's sense of rhythm, sequencing, and timing (Trayford, 2016). Interactive Metronome teaches the client to learn how to process, and plan information more accurately, and efficiently (Trayford, 2016). A metronome is a device that creates a ticking like sound to help people keep track of a beat (Patino, 2014). Interactive Metronome training is a therapy that is computer-based, and helps guide and teach people how to match various beats (Patino, 2014). This therapy consists of up to 20 sessions that last one hour each, and is spread over a three to five week period. IM therapists say the effects of this treatment are permanent, and long lasting (Patino, 2014).

Interactive Metronome (IM) works by training the brain to work more accurately. In IM training, children are asked to tap their feet, and clap their hands along with a beat that is being played by a computer (Patino, 2014). They wear headphones during this process, and the computer gives them feedback on how they are doing. The goal of this process is to be able to increase the ability to match various beats over repeated sessions (Patino, 2014). Interactive Metronome therapists suggest that in order to stimulate the growth of important connections in the brain, a person should be able to concentrate while keeping a beat. The connections made are what help the brain to work more accurately and effectively. Children are able to learn the skills

they need to concentrate, understand information they are given, read, move, and control impulsive, or aggressive behavior (Patino, 2014).

Interactive Metronome (IM) is a treatment for clients with learning and attention deficits, and is an effective intervention for people of all ages and ability levels. Interactive Metronome is suggested to be a beneficial and effective treatment, because the outcomes are permanent and patients will not lose what they have learned from it (Patino, 2014). IM helps with many conditions that include auditory processing disorder, ADHD, Dyslexia, language based learning issues, nonverbal learning disabilities, and sensory processing issues (Trayford, 2016). People who may benefit from Interactive Metronome training include those with behavioral disorders, developmental disabilities that impair learning, speech and language disorders, balance and movement disorders, dementia, brain injury and stroke, limb amputation, and spinal cord injury (Patino, 2014). Interactive Metronome is also used for people who are musicians and athletes, to increase their current level of performance, by working on the brain's timing mechanism (Patino, 2014).

Interventions using Interactive Metronome with children are described in the literature. In one study, Interactive Metronome training appears to have a beneficial impact on motor ability, control, attention, and academic skills in boys with ADHD (Shaffer, Jacokes, Cassily, et al., 2001). In another study, the findings were that there was a significant effect on the concentration, coordination, sensory processing, and motor control in the study group of children with disabilities treated with IM (Kim, Bo, Yoo, 2012). In another study, there was a control group and a group receiving IM. Both groups saw gains made, but the IM group's outcomes were significantly better. Interactive Metronome training may be able to increase the reading rate

and comprehension of children with language and reading impairments (Ritter, Colson, Park, 2013).

This background summary of Interactive Metronome explains that IM training is an alternative drug free therapy for children with ADHD (Attention Deficit Hyperactivity Disorder). It has shown potential for being effective, and administrators of this treatment suggest that the outcomes are significant and permanent, making Interactive Metronome a highly effective treatment. There is currently not enough evidence to demonstrate whether Interactive Metronome training is effective or not effective. Clients and their family members should ask questions and do their own research before starting this alternative drug free method of therapy.

References

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- Shaffer, R., Jacokes, L., Cassily, J., Greenspan, S., Tuchman, R., Stemmer, P. (2001). Effect of Interactive Metronome Training on Children with ADHD. *American Journal of Occupational Therapy*, 55, 155-162. doi: 10.5014/ajot.55.2.155
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Evidence searches.

PubMed/MEDLINE

Preparing for Search Process:

- Interactive metronome was not in MeSH headings. I did a keyword search using “Interactive Metronome” to gather ideas for MeSH headings that might be used to classify IM. The following are the relevant IM-related headings that I found:
 - Therapy, Computer-Assisted/instrumentation*
 - Motor Skills Disorders/rehabilitation*
 - Physical Therapy Modalities/rehabilitation*
 - Acoustic Stimulation/instrumentation*
 - Occupational Therapy/methods*
 - Occupational Therapy/instrumentation*
 - Occupational Therapy/rehabilitation*
- I searched autism under MeSH headings and found “Autism Spectrum Disorder”
 - More broadly I may search with “developmental disabilities” (MeSH)
- Final List of Terms: “Interactive Metronome” (Keyword), “Therapy, Computer-Assisted/instrumentation*” (MeSH), “Motor Skills Disorders/rehabilitation*” (MeSH), “Physical Therapy Modalities/rehabilitation*” (MeSH), “Acoustic Stimulation/instrumentation*” (MeSH), “Occupational Therapy/methods*” (MeSH), “Occupational Therapy/instrumentation*” (MeSH), “Occupational Therapy/rehabilitation*” (MeSH), “Autism Spectrum Disorder” (MeSH), “Developmental Disabilities” (MeSH)
- I will use a combine keyword “interactive metronome” and a one of the MeSH headings related to IM with “OR”.
- I will combine intervention keywords/MeSH headings and the population MeSH terms with “AND”.
- I will begin by using no filters to search for journal articles.

Summarizing Strategic Search Process:

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Therapy, Computer-Assisted/instrumentation* [MeSH] AND Autism Spectrum Disorder [MeSH]	3/0	11/14/16
None Years: Unlimited	(Interactive Metronome [keyword]) OR Therapy, Computer-Assisted/instrumentation* [MeSH] AND Developmental Disabilities [MeSH]	11/0	11/14/16
None Years: Unlimited	(Interactive Metronome[keyword]) OR Motor Skills Disorders/rehabilitation* [MeSH] AND Autism Spectrum Disorder [MeSH]	6/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Motor Skills Disorders/rehabilitation* [MeSH] AND Developmental Disabilities [MeSH]	47/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Physical Therapy Modalities/rehabilitation*[MeSH] AND Autism Spectrum Disorder [MeSH]	13/0	11/14/16

None Years: Unlimited	(Interactive Metronome [Keyword]) OR Physical Therapy Modalities/rehabilitation*[MeSH] AND Developmental Disabilities [MeSH]	113/- Try to narrow	11/14/16
None Years: 10years	(Interactive Metronome [Keyword]) OR Physical Therapy Modalities/rehabilitation*[MeSH] AND Developmental Disabilities [MeSH]	56/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Acoustic Stimulation/instrumentation*[MeSH] AND Autism Spectrum Disorder [MeSH]	0/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Acoustic Stimulation/instrumentation*[MeSH] AND Developmental Disabilities [MeSH]	0/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Occupational Therapy/methods* [MeSH] AND Autism Spectrum Disorder [MeSH]	20/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Occupational Therapy/methods* [MeSH] AND Developmental Disabilities [MeSH]	69/0	11/14/16

None Years: Unlimited	(Interactive Metronome [Keyword]) OR Occupational Therapy/instrumentation* [MeSH] AND Autism Spectrum Disorder [MeSH]	1/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Occupational Therapy/instrumentation* [MeSH] AND developmental disabilities [MeSH]	12/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) OR Occupational Therapy/rehabilitation* [MeSH] AND autism spectrum disorder [MeSH]	0/0	11/14/16
None Years: Unlimited	(Interactive Metronome[Keyword]) OR Occupational Therapy/rehabilitation* [MeSH] AND Developmental Disabilities [MeSH]	0/0	11/14/16
None Years: Unlimited	Interactive Metronome [Keyword] AND Autism Spectrum Disorder [MeSH]	0/0	11/14/16
None Years: Unlimited	(Interactive Metronome [Keyword]) AND Developmental Disabilities [MeSH]	0/0	11/14/16
None Years: Unlimited	Interactive Metronome [Keyword]	14/5 Johansson, Domellöf , Rönqvist 2012 Cosper, Lee, Peters, Bishop, 2009 Bartscherer, Dole, 2005 Koomar et al., 2001 Shaffer et al., 2001	11/14/16

OT Organizations

- I searched each organization's website using keywords "interactive metronome"

AOTA	AOTF	WFOT
Hits: 14	Hits: 47	Hits: 19
Relevant: 0	Relevant: 0	Relevant: 0

Summary of 5 Best Articles or Credible Resources:

Johansson, A. M., Domellof, E., & Ronnqvist, L. (2012). Short- and long-term effects of synchronized metronome training in children with hemiplegic cerebral palsy: A two case study. *Developmental Neurorehabilitation, 15*(2), 160-169.

doi:10.3109/17518423.2011.635608 [doi]

Background: Children with cerebral palsy (CP) require individualized long-term management to maintain and improve motor functions. The objective of this study was to explore potential effects of synchronized metronome training (SMT) on movement kinematics in two children diagnosed with spastic hemiplegic CP (HCP). Method: Both children underwent 4-weeks/12 sessions of SMT by means of the Interactive Metronome (IM). Optoelectronic registrations of goal-directed uni- and bimanual upper-limb movements were made at three occasions; pre-training, post completed training and at 6-months post completed training.

Results: Significant changes in kinematic outcomes following IM training were found for both cases. Findings included smoother and shorter movement trajectories in the bimanual condition, especially for the affected side. In the unimanual condition, Case I also showed increased smoothness of the non-affected side. Conclusions: The observed short- and long-term effects on the spatio-temporal organization of upper-limb movements need to be corroborated and extended by further case-control studies.

Cosper, S. M., Lee, G. P., Peters, S. B., & Bishop, E. (2009). Interactive metronome training in children with attention deficit and developmental coordination disorders. *International Journal of Rehabilitation Research.Internationale Zeitschrift Fur Rehabilitationsforschung.Revue Internationale De Recherches De Readaptation, 32*(4), 331-336. doi:10.1097/MRR.0b013e328325a8cf [doi]

The objective of this study was to examine the efficacy of Interactive Metronome (Interactive Metronome, Sunrise, Florida, USA) training in a group of children with mixed attentional and motor coordination disorders to further explore which subcomponents of attentional control and motor functioning the training influences. Twelve children who had been diagnosed with attention deficit hyperactivity disorder, in conjunction with either developmental coordination disorder (n=10) or pervasive developmental disorder (n=2), underwent 15 1-h sessions of Interactive Metronome training over a 15-week period. Each child was assessed before and after the treatment using measures of attention, coordination, and motor control to determine the efficacy of training on these cognitive and behavioral realms. As a group, the children made significant improvements in complex visual choice reaction time and visuomotor control after the training. There were, however, no significant changes in sustained attention or inhibitory control over inappropriate motor responses after treatment. These results suggest Interactive Metronome training may address deficits in visuomotor control and speed, but appears to have little effect on sustained attention or motor inhibition.

Bartscherer, M. L., & Dole, R. L. (2005). Interactive metronome training for a 9-year-old boy with attention and motor coordination difficulties. *Physiotherapy Theory and Practice*, 21(4), 257-269.

The purpose of this case report is to describe a new intervention, the Interactive Metronome,¹¹ for improving timing and coordination. A nine-year-old boy, with difficulties in attention and developmental delay of unspecified origin underwent a seven-week training program with the Interactive Metronome.¹ Before, during, and after training timing, accuracy was assessed with testing procedures consistent with the Interactive Metronome¹ training protocol. Before and after training, his gross and fine motor skills were examined with the Bruininiks-Oseretsky Test of Motor Proficiency (BOTMP). The child exhibited marked change in scores on both timing accuracy and several BOTMP subtests. Additionally his mother relayed anecdotal reports of changes in behavior at home. This child's participation in a new intervention for improving timing and coordination was associated with changes in timing accuracy, gross and fine motor abilities, and parent reported behaviors. These findings warrant further study.

Koomar, J., Burpee, J. D., DeJean, V., Frick, S., Kawar, M. J., & Fischer, D. M. (2001).

Theoretical and clinical perspectives on the interactive metronome: A view from occupational therapy practice. *The American Journal of Occupational Therapy: Official Publication of the American Occupational Therapy Association*, 55(2), 163-166.

No abstract.

Shaffer, R. J., Jacokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Jr, S. P. (2001).

Effect of interactive METRONOME training on children with ADHD...including
commentary by Koomar J, Burpee JD, DeJean V, Frick S, Kavar MJ, Fischer DM.
American Journal of Occupational Therapy, 55(2), 155-166.

Objective. The purpose of this study was to determine the effects of a specific intervention, the Interactive Metronome[®], on selected aspects of motor and cognitive skills in a group of children with attention deficit hyperactivity disorder (ADHD).

Method. The study included 56 boys who were 6 years to 12 years of age and diagnosed before they entered the study as having ADHD. The participants were pretested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hr. of Interactive Metronome training exercises were compared with a group receiving no intervention and a group receiving training on selected computer video games.

Results. A significant pattern of improvement across 53 of 58 variables favoring the Interactive Metronome treatment was found. Additionally, several significant differences were found among the treatment groups and between pretreatment and posttreatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior.

Conclusion. The Interactive Metronome training appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD.

Preparing for Search Process:

- PSYCInfo does not provide any mesh headings. However, it does provide a list of key words.
- There were two terms provided for occupational therapy. Searching with the term “therapy” brought up more search results.
- Searching a specific diagnosis along with interactive metronome brought up more search results as well, although little could be find regarding autism.
- A sample search run through PSYCInfo is as follows:
 - [www.stkate.edu>library>PSYCinfo](http://www.stkate.edu/library/PSYCinfo)
 - advanced search>interactive metronome AND development
 - Check box for “peer reviewed”
 - 4 search results>select one of four
- This type of search was replicated to find five suitable articles. Many different key words were searched using the “advanced search” format.
- Each search brought up a range from 4 to 13 hits. Each article was skimmed to determine its validity to the assignment. The number of applicable articles was provided in the table and the abstract of the best five have been provided.

Filters/Years	Keywords	Total Yield/Relevant Hits	Date
Advanced Search Years: Unlimited	Interactive metronome Development	4 of 1 (Roseblum & Regev, 2004)	November 16, 2016
Peer Reviewed Years: Unlimited	Attention Interactive metronome	13 of 2 (Koomar, Burpee, DeJean, Frick, Kumar, 2001) (Solis-Smith, 2004)	November 16, 2016
Scholarly Journals Years: Unlimited	Timing ability coordination, Childhood development	11 of 2 (Rosenblum 2013) (Koomar, Burpee, DeJean, Frick, Kavar 2001)	November 16, 2016
Advanced Search Years: Unlimited	Cerebral Palsy Metronomes Perceptual motor process	6 of 2 (Johanson, Domeloff, Ronnqvist, 2012) (Solis-smith 2004)	November 16, 2016
None: Years: Unlimited	Interactive metronome Videogames Motor and cognitive skills	15 of 4 (Shaffer, Jacokee, Cassily, Greenspan, 2001) (Koomar, Burpee, DeJean, Frick, Kavar, 2001) (Johansson, Domeloff, Ronnqvist, 2012) (Solis-Smith, 2004)	November 16, 2016

Summary of 5 Best Articles or Credible Resources:

Koomar, J., Burpee, J. D., DeJean, V., Frick, S., Kavar, M. J., & Fischer, D. M. (2001).

Theoretical and clinical perspectives on the interactive metronome®: A view from occupational therapy practice. *American Journal of Occupational Therapy*, 55(2), 163-166.

Comments on the article by R. J. Shaffer et al (see record 2001-14946-002) on the effect of Interactive Metronome® training on children with attention deficit hyperactivity disorder (ADHD). The research provides important evidence that an updated interactive version of the metronome may be helpful in improving timing and rhythmicity related to motor planning and sequencing. Emerging clinical experience, together with the study of Shaffer et al, suggests that the Interactive Metronome may have potential usefulness in a wide range of clinical conditions and, therefore, may complement existing interventions currently being used by occupational therapists to address these areas. (PSYCIInfo Database Record (c) 2016 APA, all rights reserved)

Shaffer, R. J., Jacokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Stemmer, P. J.,

Jr. (2001). Effect of interactive metronome® training on children with ADHD. *American Journal of Occupational Therapy*, 55(2), 155-162.

Determined the effects of the Interactive Metronome® on selected aspects of motor and cognitive skills in a group of children with attention deficit hyperactivity disorder (ADHD). The study included 56 boys who were 6–12 years of age and diagnosed before they entered the study as having ADHD. The Ss were pretested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hrs of Interactive Metronome training exercises were compared with a group receiving no intervention and a group receiving training on selected computer games. A significant pattern of improvement across 53 of 58 variables favoring the Interactive Metronome treatment was found. Several significant differences were found among the treatment groups and between pretreatment and posttreatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior. The Interactive Metronome training appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD. (PSYCInfo Database Record (c) 2016 APA, all rights reserved)

Solis-Smith, L. (2004). *The effects of the interactive metronome training on attention and*

cognitive abilities of children and adolescents Available from PsycINFO. (620642107; 2004-99022-301).

The ability to attend develops early in life and is a vital part of the capacity to learn, concentrate, think, interact with others and master basic academic skills. Conversation, communication and healthy social interaction all depend on being able to pay attention to another person and to one's own internal states simultaneously. Since the mid-1960's, counseling models continue to grow. Although the superiority of many paradigms may be shown with an occasional study, the majority of the results indicate that no meaningful difference exists. In the small body of research found, the Interactive Metronome (IM) training protocol demonstrated an impact on the basic functional human capacities. However, there has not been a study of IM data that explores the attention and cognitive possibilities in a therapeutic setting. This study reviewed pre and posttest data of the Integrated Visual and Auditory Continuous Performance Test (IVA-CPT) and the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) to determine the cumulative effect of the Interactive Metronome training on the cognitive abilities of clients in a counseling setting. The archival data comprised a sample of twelve clients. There were five females and seven males. Given that the IVA and the WISC-III pretest and posttest were part of the baseline versus intervention comparisons, it cannot be assumed that the pre and post IM measures were associated with changes in the IVA or the WISC-III scores. An intensive single-subject quantitative design was used to identify the process of the IM's cumulative effect on indices of attention and other cognitive operations that are important to the engagement in the counseling process. The global score and the full quotient score was used because the composites of scores were more reliable and representative of the true score of the individual subject. A time-series graphical analysis was established using the IM Daily Short Form, task one only. The results showed there was some evidence for a difference in level between the phases. The effect of the IM was further analyzed using the pre and post regression within design. Although there was some evidence of improvement, much of the results indicated the lack of statistical significant improvement in the global combined score of the IVA and the Full Quotient scores of the WISC-III when the IM results were examined. The results could be due to sources of influences of the counseling setting

and the limitations that accompany archival data research. (PSYCInfo Database Record (c) 2016 APA, all rights reserved)

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

Research in Developmental Disabilities, 34(1), 218-227.

Timing ability is essential for common everyday performance. The aim of the study was to compare timing abilities and temporal aspects of handwriting performance and relationships between these two components among children with Developmental Coordination Disorders (DCD) and a control group. Forty two children, 21 diagnosed as DCD and 21 with typical development, aged 7–12, were matched for age, gender and school performed 14 tasks of the interactive metronome (IM) and three functional handwriting tasks on an electronic tablet that was part of a computerized system (ComPET—computerized penmanship evaluation tool). The IM supplies response time, while on-paper and in-air time per written stroke is received from the ComPET. Results indicated significant differences between the groups for both IM and handwriting tasks (ComPET). Linear regression indicated that the mean IM response time explained 37% of variance of the in-air time per stroke during a paragraph-copying task. Furthermore, based on one discriminate function including two measures reflected timing ability, 81% of all participants were correctly classified into groups. Study results strongly recommend consideration of the IM as an evaluation and intervention tool for children with DCD who are faced with timing deficits in their everyday functioning. (PSYCInfo Database Record (c) 2016 APA, all rights reserved)(journal abstract)

Johansson, A., Domellöf, E., & Rönnqvist, L. (2012). Short- and long-term effects of synchronized metronome training in children with hemiplegic cerebral palsy: A two case study. *Developmental Neurorehabilitation, 15(2), 160-169.*

Background: Children with cerebral palsy (CP) require individualized long-term management to maintain and improve motor functions. The objective of this study was to explore potential effects of synchronized metronome training (SMT) on movement kinematics in two children diagnosed with spastic hemiplegic CP (HCP). Method: Both children underwent 4-weeks/12 sessions of SMT by means of the Interactive Metronome (IM). Optoelectronic registrations of goal-directed uni- and bimanual upper-limb movements were made at three occasions; pre-training, post completed training and at 6-months post completed training. Results: Significant changes in kinematic outcomes following IM training were found for both cases. Findings included smoother and shorter movement trajectories in the bimanual condition, especially for the affected side. In the unimanual condition, Case I also showed increased smoothness of the non-affected side. Conclusions: The observed short- and long-term effects on the spatio-temporal organization of upper-limb movements need to be corroborated and extended by further case-control studies. (PSYCInfo Database Record (c) 2016 APA, all rights reserved)(journal abstract)

Preparing for Search Process:

- Google Scholar is an excellent tool for a general search. It is often a starting point for researchers and students because it is easy to navigate and similar to a general google search many of us are familiar with. However, is the resource reliable? I had two goals in my research on google scholar.
- **Goal 1: Have the authors of these articles published other reliable information?**
 - **Google Scholar Summary of Evidence Resource:** In order to determine the research and validity of one specific author, I began by doing a general search of the topic of interest, Interactive Metronome. After finding one research article which efficiently answered my question, I copy and pasted the authors name into a new search window in order to determine if they had any other research posted on google scholar. I also discovered that all articles have the option to select “related articles.” This could bring up articles from the same article or articles on a related topic. When researching the authors, Cosper, Lee, Peters, & Bishop., I was able to find articles they had referenced in the research, but there were no other articles written by them which could be found on google scholar.
- **Goal 2: Can the search be narrowed specifically to Interactive Metronome and children with Autism?**
 - **Google Scholar Summary of Evidence Resource:** My results revealed that google scholar has very limited information on the use of interactive metronome specifically with autism. I began a broad search with the terms “Interactive Metronome and Autism.” The result revealed a few sources about interactive metronome that did not correlate with autism, as well as many sources on autism that did not directly correlate with interactive metronome.

Documenting the Search Process:

- **Goal 1: Have the authors of these articles published other reliable information?** The steps I used to find the Cosper, Lee, Peters & Bishop article were as follows:
 - Step 1: Search scholar.google.com
 - Step 2: Press the down arrow for advanced search
 - Step 3: Go to settings. Select search results>library links>St. Catherine University (Find Library and Save)
 - Step 4: Down arrow again for advanced search
 - Step 5: Search interactive metronome, Cosper.
 - Step 6: All available sources by this author appear on screen.
- **Goal 2: Can the Search be narrowed specifically to Interactive Metronome and children with Autism?** To find an article related specifically to Autism interventions, I followed the following steps”
 - Step 1: Search scholar.google.com
 - Step 2: Press the down arrow for advanced search
 - Step 3: Under “Find article with all words” search, “Occupational Therapy Interventions”
 - Step 4: Under, “With at least one of the Words,” search “interactive metronome.”
 - Step 5: Click the image of the blue magnifying glass to find results.

Summary of 5 Best Articles or Credible Resources:

Shaffer, R., Jacokes, L., Cassily, J., Greenspan, S., Tuchman, R., Stemmer, P. (2001) Effect of Interactive Metronome Training on children with ADHD. *American Journal of Occupational Therapy*, 55, 155-162. doi:10.5014/ajot.55.2.155

Objective. The purpose of this study was to determine the effects of a specific intervention, the Interactive Metronome®, on selected aspects of motor and cognitive skills in a group of children with attention deficit hyperactivity disorder (ADHD).

Method. The study included 56 boys who were 6 years to 12 years of age and diagnosed before they entered the study as having ADHD. The participants were pretested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hours of Interactive Metronome training exercises were compared with a group receiving no intervention and a group receiving training on selected computer video games.

Results. A significant pattern of improvement across 53 of 58 variables favoring the Interactive Metronome treatment was found. Additionally, several significant differences were found among the treatment groups and between pretreatment and posttreatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior.

Conclusion. The Interactive Metronome training appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD. (AJOT, 2001)

Case-Smith, J., & Arbesman, M. (2008). Evidence-based review of interventions for autism used in or of relevance to occupational therapy. *American Journal of Occupational Therapy*, 62(4), 416-429.

Objective.

To assess the effects of a sensory integration programme involving applied interactive metronome training in a group of children with developmental disabilities.

Methods.

Ten children with various developmental disabilities participated in this study. Participants received sensory integration treatment in a group programme with applied interactive metronome training for 45 minutes a day for 4 weeks, exclusive of Saturday and Sunday. The treatments consisted of stimulations of the vestibular and tactile senses, and proprioceptive applied metronome training.

Results.

The effects of the programme were evaluated via measurements of short sensory profile, Corner's teacher rating scale, and DeGangi-Berk test. The data obtained before and after the treatment were analyzed using Wilcoxon's test. The findings of this study were that there were significantly positive effects on sensory processing, concentration, motor control, bilateral coordination, and reflex integration in the study group.

Conclusion.

Our results indicated that the sensory integration programme with applied interactive metronome training might be useful and improved the performance of the children with developmental disabilities. The results demonstrated the efficacy of this new approach. This pilot study provides new insights into the effective treatment of children with developmental disabilities.

(Kim, Bo, Yu, 2012)

Cosper, S. M., Lee, G. P., Peters, S. B., & Bishop, E. (2009). Interactive Metronome training in children with attention deficit and developmental coordination disorders. *International*

Journal of Rehabilitation Research, 32(4), 331-336.

The objective of this study was to examine the efficacy of Interactive Metronome (Interactive Metronome, Sunrise, Florida, USA) training in a group of children with mixed attentional and motor coordination disorders to further explore which subcomponents of attentional control and motor functioning the training influences. Twelve children who had been diagnosed with attention deficit hyperactivity disorder, in conjunction with either developmental coordination disorder ($n=10$) or pervasive developmental disorder ($n=2$), underwent 15 1-h sessions of Interactive Metronome training over a 15-week period. Each child was assessed before and after the treatment using measures of attention, coordination, and motor control to determine the efficacy of training on these cognitive and behavioral realms. As a group, the children made significant improvements in complex visual choice reaction time and visuomotor control after the training. There were, however, no significant changes in sustained attention or inhibitory control over inappropriate motor responses after treatment. These results suggest Interactive Metronome training may address deficits in visuomotor control and speed, but appears to have little effect on sustained attention or motor inhibition.

(Cosper, Peters, Bishop, 2009).

Kim, H. H., Bo, G. H., & Yoo, B. K. (2012). The effects of a sensory integration programme

with applied interactive metronome training for children with developmental disabilities:

a pilot study. *Hong Kong Journal of Occupational Therapy*, 22(1), 25-30.

Occupational therapy practitioners are among the professionals who provide services to children and adults with autism spectrum disorder (ASD), embracing both leadership and supportive roles in service delivery. The study's primary aims were as follows: (1) to identify, evaluate, and synthesize the research literature on interventions for ASD of relevance to occupational therapy and (2) to interpret and apply the research literature to occupational therapy. A total of 49 articles met the authors' criteria and were included in the review. Six categories of research topics were identified, the first 3 of which are most closely related to occupational therapy: (1) sensory integration and sensory-based interventions; (2) relationship-based, interactive interventions; (3) developmental skill-based programs; (4) social cognitive skill training; (5) parent-directed or parent-mediated approaches; and (6) intensive behavioral intervention. Under each category, themes supported by research evidence and applicable to occupational therapy were defined. The

findings have implications for intervention methods, communication regarding efficacious practices to professionals and consumers, and future occupational therapy research. (Case-Smith, Arbesman, 2008).

Scott, J. L. (2010). *The effect of a metronome-based coordination training programme on the fundamental gross motor skills of children with motor development delays* (Doctoral dissertation, Stellenbosch: University of Stellenbosch).

This study investigated the effect of a coordination-training programme on selected fundamental motor skills of children (ages 9 to 12) who were identified as having motor development delays. The group of participants identified included seven boys and one girl. The study followed an A-B-A reversal design. The intervention was a rhythm-based training programme. The dependent variables were the motor abilities of bilateral coordination, balance and upper-limb coordination, assessed using the BOT-2. The results of an ANOVA for dependent groups indicated a significant improvement in bilateral coordination and no change in balance. The improvement in upper-limb coordination was attributed to a familiarisation or learning effect on the test. A descriptive analysis of each child's results revealed high variability in the effect of participation in the programme. The results of this study supported the conclusion that a rhythm-based coordination-training programme may help children with coordination problems improve their bilateral coordination, which will have a positive impact on the performance on many fundamental gross motor skills. (Scott 2010).

Library Database: OT Search**The American Occupational Therapy Association & The American Occupational Therapy Foundation/ OT SEARCH-****Preparing for Search Process**

- A. Subject Headings or Indexing Terms of the Database: OT Search>Library Catalog>Interactive Metronome
- B. Final Concept or Term List for the Database: “Interactive Metronome”, “Rhythm Therapy”, “Training”, “Occupational Therapy”, “Rehabilitation”, “Clinical Perspectives”, “Auditory Interventions”
- C. Database Filters to be tried: None
- D. Boolean Logic Terms to be tried: None

Date	Total Yield/Relevant Hits	Keywords	Filters/Years
11/12/16	4/4 Frick, 2000 Hill, 2011 Koomar, 2001 Shaffer, 2001	“Interactive Metronome”	2000-2011
11/12/16	5/10 Bazyk, 2010 Frick, 2000 Gee, 2014 Mulligan, 1991 Padilla, 2016	“Auditory Interventions”	1990-2016
11/12/16	2/6 Hill, 2011 Vance, 2003	“Rhythm Therapy”	1995-2011

Summary of 5 Best Research Articles

Mulligan, S. E., & Hanzlik, J. R. (1991). The effectiveness of sensory stimulation in the treatment of children with severe head injuries. *The Occupational Therapy Journal of Research*, 11(4), 213-226. Retrieved from

<http://pearl.stkate.edu/login?url=http://search.proquest.com/docview/910974534?accountid=26879>

A single subject design was used with two children with severe head injuries to examine the effects of familiar and unfamiliar auditory and visual stimulation on levels of consciousness. The results indicated that the treatments used in this study did not significantly improve levels of consciousness. To determine whether or not the familiar stimuli was more effective than the unfamiliar; changes in vital signs, including heart and respiratory rates, were examined in response to the stimulation. The results indicated a tendency for one of the subjects to respond more to the familiar stimuli than the unfamiliar; however, the results were not statistically significant. The use of a single subject experimental design for examining the effectiveness of treatments with this population is discussed, as well as implications for therapeutic interventions.

Letts, L., Minezes, J., Edwards, M., Berenyi, J., Moros, K., O'Neill, C., & O'Toole, C. (2011).

Effectiveness of interventions designed to modify and maintain perceptual abilities in people with alzheimer's disease and related dementias. *The American Journal of Occupational Therapy*, 65(5), 505-13.

An evidence-based review was undertaken to answer the question, "What is the evidence for the effect of interventions designed to modify and maintain perceptual abilities on the occupational performance of people with Alzheimer's disease and related dementias?" A systematic search of electronic databases and application of inclusion and exclusion criteria guided the selection of 31 articles. Each article was critically appraised, and the evidence was synthesized. Some interventions use remaining perceptual abilities to enable people to find their way in a facility and decrease attempts at exiting. Preliminary evidence has supported use of visual stimulation and barriers. We found some evidence for the use of auditory stimuli and group therapy that aim to change perceptual abilities. Research with high-level evidence is required to validate these findings. Evidence on the benefits of Snoezelen is not conclusive for occupational performance outcomes; further research to justify its use as an occupational therapy intervention may be warranted.

Koomar, J., Jeannetta D., DeJean, V., Frick, S., Kavar, Fischer, M., (2001). Theoretical and

clinical perspectives on the Interactive Metronome®: a view from Occupational Therapy Practice. *American Journal of Occupational Therapy* 2001;55(2):163-166. doi:

10.5014/ajot.55.2.163.

For many years, occupational therapists have observed motor planning difficulties in a variety of populations, including those with learning disabilities, attention deficit disorder (ADD), central auditory processing disorders, autism, Down syndrome, and cerebral palsy. The research presented by Shaffer et al. (2001) provides important evidence that an updated interactive version of the metronome may be helpful in improving timing and rhythmicity related to motor planning and sequencing. In the study, various measures commonly used by the occupational therapy, psychology, and educational communities showed that improving rhythmicity through Interactive Metronome® training may also bring about improvements in behaviors and skills that are important for occupational performance in many areas. Emerging clinical experience, together with Shaffer et al.'s study, suggest that the Interactive Metronome may have potential usefulness in a wide range of clinical conditions and, therefore, may complement existing interventions currently being used by therapists to address these areas. Further systematic studies are encouraged.

Shaffer, R., Jacokes, L., Cassily, J., Greenspan, S., Tuchman, R., Stemmer, P. (2001). Effect of Interactive Metronome® Training on children with ADHD. *American Journal of Occupational Therapy* 2001;55(2):155-162. doi: 10.5014/ajot.55.2.155.

Objective. The purpose of this study was to determine the effects of a specific intervention, the Interactive Metronome®, on selected aspects of motor and cognitive skills in a group of children with attention deficit hyperactivity disorder (ADHD).

Method. The study included 56 boys who were 6 years to 12 years of age and diagnosed before they entered the study as having ADHD. The participants were pretested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hr of Interactive Metronome training exercises were compared with a group receiving no intervention and a group receiving training on selected computer video games.

Results. A significant pattern of improvement across 53 of 58 variables favoring the Interactive Metronome treatment was found. Additionally, several significant differences were found among the treatment groups and between pretreatment and posttreatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior.

Conclusion. The Interactive Metronome training appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD.

Padilla, R., Anna D., (2016). Effectiveness of sensory stimulation to improve arousal and alertness of people in a coma or persistent vegetative state after traumatic brain injury: a

systematic review. *American Journal of Occupational Therapy*, 70(3):7003180030p1-7003180030p8. doi: 10.5014/ajot.2016.021022.

OBJECTIVE. This systematic review evaluates the effectiveness of sensory stimulation to improve arousal and alertness of people in a coma or persistent vegetative state after traumatic brain injury (TBI).

METHOD. Databases searched included Medline, PSYCInfo, CINAHL, OTseeker, and the Cochrane Database of Systematic Reviews. The search was limited to outcomes studies published in English in peer-reviewed journals between 2008 and 2013.

RESULTS. Included studies provide strong evidence that multimodal sensory stimulation improves arousal and enhances clinical outcomes for people in a coma or persistent vegetative state after TBI. Moderate evidence was also provided for auditory stimulation, limited evidence was provided for complex stimuli, and insufficient evidence was provided for median nerve stimulation.

CONCLUSION. Interventions should be tailored to client tolerance and premorbid preferences. Bimodal or multimodal stimulation should begin early, be frequent, and be sustained until more complex activity is possible.

Evidence Resource(s): OT Seeker**Preparing for Search Process**

- a. OTSeeker is an OT database with articles on experiments, and research that has been done in the field. The name of the database site is the *Occupational Therapy Systematic Evaluation of Evidence*.
- b. To find evidence, I typed into the search bar “Interactive Metronome”, since that is the therapeutic intervention that my subgroup is focusing on for our class project. Only two articles were available, and they are both randomized controlled trials.

Documenting the Search Process/Summarizing Strategic Process

I searched for these articles on November 14th, 2016. The steps taken to find these articles were to go to the OTSeeker website, and type into the search bar key words such as “Interactive metronome”, “auditory interventions”, and “rhythm therapy”. I looked through the results that came up for each of the set of keywords that I typed into the search bar. I found a few articles below that can relate back to interactive metronome therapy interventions.

Summary of 5 Best Research Articles or Credible Resources

Nelson, L.A., Macdonald, M., Stall, C., Pazdan, R., (2013). Effects of interactive metronome therapy on cognitive functioning after blast-related brain injury: a randomized controlled pilot trial. *Neuropsychology Epub*. (6)675-79. doi: 10.1037/a0034117.

OBJECTIVE:

We report preliminary findings on the efficacy of interactive metronome (IM) therapy for the remediation of cognitive difficulties in soldiers with persisting cognitive complaints following blast-related mild-to-moderate traumatic brain injury (TBI).

METHOD:

Forty-six of a planned sample of 50 active duty soldiers with persistent cognitive complaints following a documented history of blast-related TBI of mild-to-moderate severity were randomly assigned to receive either standard rehabilitation care (SRC) or SRC plus a 15-session standardized course of IM therapy. Primary outcome measures were Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) Index Scores. Secondary outcome measures included selected subtests from the Delis-Kaplan Executive Functioning System (Trail Making Test and Color-Word Interference) and the Wechsler Adult Intelligence Scale-Fourth Edition (Symbol Search, Digit-Symbol Coding, Digit Span, and Letter-Number Sequencing) as well as the Integrated Visual and Auditory Continuous Performance Test.

RESULTS:

Significant group differences (SRC vs. IM) were observed for RBANS Attention ($p = .044$), Immediate Memory ($p = .019$), and Delayed Memory ($p = .031$) indices in unadjusted analyses, with the IM group showing significantly greater improvement at Time 2 than the SRC group,

with effect sizes in the medium-to-large range in the adjusted analyses for each outcome (Cohen's $d = 0.511, 0.768, \text{ and } 0.527$, respectively). Though not all were statistically significant, effects in 21 of 26 cognitive outcome measures were consistently in favor of the IM treatment group (binomial probability = .00098).

CONCLUSION:

The addition of IM therapy to SRC 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.”

Kim, S.J., Kwak, E.E., Park, E.S., Cho, S.R. (2012). Differential effects of rhythmic auditory stimulation and neurodevelopmental treatment on gait patterns in adults with cerebral palsy: a randomized controlled trial. *Sage Publications*. 26(10), 904-14. doi: 10.1177/0269215511434648.

Objectives: To investigate the effects of rhythmic auditory stimulation (RAS) on gait patterns in comparison with changes after neurodevelopmental treatment (NDT/Bobath) in adults with cerebral palsy.

Design: A repeated-measures analysis between the pretreatment and posttreatment tests and a comparison study between groups.

Setting: Human gait analysis laboratory.

Subjects: Twenty-eight cerebral palsy patients with bilateral spasticity participated in this study. The subjects were randomly allocated to either neurodevelopmental treatment ($n = 13$) or rhythmic auditory stimulation ($n = 15$).

Interventions: Gait training with rhythmic auditory stimulation or neurodevelopmental treatment was performed three sessions per week for three weeks. Temporal and kinematic data were analysed before and after the intervention. Rhythmic auditory stimulation was provided using a combination of a metronome beat set to the individual's cadence and rhythmic cueing from a live keyboard, while neurodevelopmental treatment was implemented following the traditional method.

Main measures: Temporal data, kinematic parameters and gait deviation index as a measure of overall gait pathology were assessed.

Results: Temporal gait measures revealed that rhythmic auditory stimulation significantly increased cadence, walking velocity, stride length, and step length ($P < 0.05$). Kinematic data demonstrated that anterior tilt of the pelvis and hip flexion during a gait cycle was significantly ameliorated after rhythmic auditory stimulation ($P < 0.05$). Gait deviation index also showed modest improvement in cerebral palsy patients treated with rhythmic auditory stimulation ($P < 0.05$). However, neurodevelopmental treatment showed that internal and external rotations of hip joints were significantly improved, whereas rhythmic auditory stimulation showed aggravated maximal internal rotation in the transverse plane ($P < 0.05$).

Conclusions: Gait training with rhythmic auditory stimulation or neurodevelopmental treatment elicited differential effects on gait patterns in adults with cerebral palsy.

Conklyn, D., Stough, D., Novak, E., Paczak, S., Chemali, K., & Bethoux, F. (2010). A home-based walking program using rhythmic auditory stimulation improves gait performance in patients with multiple sclerosis: a pilot study. *Neurorehabilitation and Neural Repair, 24*(9), 835-842.

Background. Few interventions have been successful in improving gait dysfunction in patients with multiple sclerosis (MS). Rhythmic auditory stimulation (RAS) has demonstrated positive results on gait performance in other neurologically impaired populations. *Objective.* To measure the effects of RAS on quantitative walking parameters in ambulatory patients with MS. *Methods.* Ten MS patients with gait disturbance were randomly assigned to receive RAS versus no intervention for 2 weeks. All participants received RAS for another 2 weeks. Between weekly clinic visits, they were provided with MP3 players containing songs whose tempo was 10% above the participant's spontaneous cadence and were instructed to walk to the music 20 minutes daily. Quantitative gait parameters were measured using the GAITRite system. *Results.* A statistically significant decrease between groups was found for change in double-support time (left, $P = .0176$; right, $P = .0247$), whereas trends with medium to high effect sizes were found for other gait parameters, including walking speed. A pooled within-group analysis showed significant improvement of cadence, stride length, step length, velocity, and normalized velocity after 1 week of treatment. Satisfaction level with RAS was high. *Conclusions.* These results in a convenience sample of MS patients demonstrate the feasibility and safety of RAS when used at home and suggest a potential benefit on gait parameters.

Amato, M.P., Goretti, B., Viterbo, R.G., Portaccio, E., Nicolai, C., Hakiki, B. (2014). Computer-assisted rehabilitation of attention in patients with multiple sclerosis: results of a randomized, double-blind trial. *Sage Journals, 20*(1) 91-8. doi: 10.1177/1352458513501571.

Background: There is controversial information on the efficacy of cognitive rehabilitation in multiple sclerosis (MS).

Objective: The objective of this paper is to test a home-based computerized program for retraining attention dysfunction in MS.

Methods: Relapsing–remitting patients who failed > 2 tests of attention on an extensive neuropsychological battery were randomized to specific or nonspecific computerized training (ST, n-ST), in one-hour sessions, twice a week for three months. Outcome measures included

neuropsychological assessment, depression, fatigue, everyday activities and a visual analogue scale assessing attentive performance (VAS). Assessments were repeated after the interventions and after a further three months. Statistical analysis included the analysis of variance (ANOVA) for repeated measures.

Results: Eighty-eight out of 102 randomized patients completed the study (69 women, age 40.9 ± 11.5 years, disease duration 13.0 ± 8.7 years, Expanded Disability Status Scale score 2.7 ± 1.5). Fifty-five patients were randomized to ST, 33 to n-ST. A benefit of the ST was observed on the Paced Auditory Serial Addition Test ($p < 0.002$). However, patient self-report did not reveal differences between ST and n-ST patient groups.

Conclusion: Although our program trained different attention components, we could detect some improvements exclusively on tasks of sustained attention. Moreover, patient self-perceived results may be independent of the training program.

Appraisal of Evidence

Initial Appraisal of Evidence: Primary Research Studies

Type of Article	Primary Research Study, Qualitative Research Study
APA Reference	Kim, H. H., Bo, G. H., & Yoo, B. K. (2012). The effects of a sensory integration programme with applied interactive metronome training for children with developmental disabilities: a pilot study. <i>Hong Kong Journal of Occupational Therapy</i> , 22(1), 25-30.
Abstract	<p>Summary Objective: To assess the effects of a sensory integration programme involving applied interactive metronome training in a group of children with developmental disabilities. Methods: Ten children with various developmental disabilities participated in this study. Participants received sensory integration treatment in a group programme with applied interactive metronome training for 45 minutes a day for 4 weeks, exclusive of Saturday and Sunday. The treatments consisted of stimulations of the vestibular and tactile senses, and proprioceptive applied metronome training.</p> <p>Results: The effects of the programme were evaluated via measurements of short sensory profile, Corner's teacher rating scale, and DeGangi-Berk test. The data obtained before and after the treatment were analyzed using Wilcoxon's test. The findings of this study were that there were significantly positive effects on sensory processing, concentration, motor control, bilateral coordination, and reflex integration in the study group.</p> <p>Conclusion: Our results indicated that the sensory integration programme with applied interactive metronome training might be useful and improved the performance of the children with developmental disabilities. The results demonstrated the efficacy of this new approach. This pilot study provides new insights into the effective treatment of children with developmental disabilities.</p>
Author	<p>Credentials: School of Rehabilitation Position and Institution: Deagu University, South Korea; Hanlyo University, South Korea Publication History in Peer-Reviewed Journals: 3</p> <p>Kim, H. H., HwangBo, G., Yoo, B. K., & Kim, M. K. (2011). Effects of Vestibule-Oriented Sensory Integration Treatment on the Nystagmus, Visual Perception and Balancing Ability of Children with Developmental Disability. <i>The Journal of the Korea Contents Association</i>, 11(4), 290-302.</p> <p>Jeong, S. J., Lee, H., Hur, E. M., Choe, Y., Koo, J. W., Rah, J. C., ... & Kim, K. (2016). Korea Brain Initiative: Integration and Control of Brain Functions. <i>Neuron</i>, 92(3), 607-611.</p> <p>김현호, 황보각, 유병국, & 김명권. (2011). 전정중심의 감각통합치료가 발달장애아동의 안구진탕, 시지각, 균형능력에 미치는 영향. <i>한국콘텐츠학회논문지</i>, 11(4), 290-302.</p>
Publication	<p>Type of Publication: Scholarly Publisher: Hong Kong Occupational Therapy Association</p>
Date and Citation History	<p>Date of Publication: June 25, 2012 Cited by: 8</p>
Stated Purpose or Research Question	<p>"The objective of this study was to evaluate the effects of a SI group intervention programme involving interactive metronome training. This study not only focussed on the three traditional senses, tactile, vestibular, and proprioceptive, but additionally on the auditory sense from interactive metronome." (P. 26)</p>
Author's Conclusion	<p>"This study demonstrated positive effects of the SI interventions with interactive metronome training used in children with developmental disabilities. We found positive improvements in sensory processing, nervous system functions, and concentration after treatment." (p. 29)</p>
Overall Relevance to PICO	<p>Limited The study did not specify the type of developmental disabilities participants had.</p>
Overall Quality of Article	<p>Moderate: Included a detailed study on Interactive Metronome but was also paired with other types of interventions. It is difficult to conclude if the outcome resulted from IM or another intervention.</p>

Type of Article	Primary Research Study: A-B-A reversal design
APA Reference	Scott, J. L. (2010). <i>The effect of a metronome-based coordination training programme on the fundamental gross motor skills of children with motor development delays</i> (Doctoral dissertation, Stellenbosch: University of Stellenbosch).
Abstract	This study investigated the effect of a coordination-training programme on selected fundamental motor skills of children (ages 9 to 12) who were identified as having motor development delays. The group of participants identified included seven boys and one girl. The study followed an A-B-A reversal design. The intervention was a rhythm-based training programme. The dependent variables were the motor abilities of bilateral coordination, balance and upper-limb coordination, assessed using the BOT-2. The results of an ANOVA for dependent groups indicated a significant improvement in bilateral coordination and no change in balance. The improvement in upper-limb coordination was attributed to a familiarisation or learning effect on the test. A descriptive analysis of each child's results revealed high variability in the effect of participation in the programme. The results of this study supported the conclusion that a rhythm-based coordination-training programme may help children with coordination problems improve their bilateral coordination, which will have a positive impact on the performance on many fundamental gross motor skills.
Author	Credentials: Thesis, Master's Student Position and Institution: The University of Stellenbosch Publication History in Peer-Reviewed Journals: None
Publication	Type of Publication: Scholarly Publisher: Doctoral Dissertation
Date and Citation History	Date of Publication: December 2009 Cited by: 3
Stated Purpose or Research Question	"Within the context of this study, the intervention is aimed at influencing sub-systems within the individual's functional constraints that affect the coordination of the individual and thereby improve the performance of key fundamental movement skills. One of the simplest rhythmic movements that can be performed is tapping in synchrony with a rhythmic beat (Corriveau & Goswami, 2009), so the specific intervention of computer-based interactive metronome training has been selected." (p. 43)
Author's Conclusion	"This result is similar to the results reported by Jacokes (2004) who also found that metronome-based training led to an improvement in bilateral coordination. The retention of improvements was also found in the Jacokes' study after both a three- and a six-month period. This indicates that the immediate improvements realised after rhythmic training may be retained over an extended period of time." (p. 64)
Overall Relevance to PICO	Limited: Strong support on Interactive Metronome positively influencing motor skills. However, there is no research on benefits with ASD.
Overall Quality of Article	Moderate: Thorough description of intervention and its use with motor movement. Not applicable to Autism Spectrum Disorder.

Type of Article	Primary Research Study: Empirical, Quantitative study
APA Reference	Solis-Smith, L. (2004). <i>The effects of the interactive metronome training on attention and cognitive abilities of children and adolescents</i> Available from PSYCInfo. (620642107; 2004-99022-301). Retrieved from http://pearl.stkate.edu/login?url=http://search.proquest.com/docview/620642107?accountid=26879
Abstract	The ability to attend develops early in life and is a vital part of the capacity to learn, concentrate, think, interact with others and master basic academic skills. Conversation, communication and healthy social interaction all depend on being able to pay attention to another person and to one's own internal states simultaneously. Since the mid-1960's, counseling models continue to grow. Although the superiority of many paradigms may be shown with an occasional study, the majority of the results indicate that no meaningful difference exists. In the small body of research found, the Interactive Metronome (IM) training protocol demonstrated an impact on the basic functional human capacities. However, there has not been a study of IM data that explores the attention and cognitive possibilities in a therapeutic setting. This study reviewed pre and posttest data of the Integrated Visual and Auditory Continuous Performance Test (IVA-CPT) and the Wechsler Intelligence Scale for Children-Third Edition (WISC-III) to determine the cumulative effect of the Interactive Metronome training on the cognitive abilities of clients in a counseling setting. The archival data comprised a sample of twelve clients. There were five females and seven males. Given that the IVA and the WISC-III pretest and posttest were part of the baseline versus intervention comparisons, it cannot be assumed that the pre and post IM measures were associated with changes in the IVA or the WISC-III scores. An intensive single-subject quantitative design was used to identify the process of the IM's cumulative effect on indices of attention and other cognitive operations that are important to the engagement in the counseling process. The global score and the full quotient score was used because the composites of scores were more reliable and representative of the true score of the individual subject. A time-series graphical analysis was established using the IM Daily Short Form, task one only. The results showed there was some evidence for a difference in level between the phases. The effect of the IM was further analyzed using the pre and post regression within design. Although there was some evidence of improvement, much of the results indicated the lack of statistical significant improvement in the global combined score of the IVA and the Full Quotient scores of the WISC-III when the IM results were examined. The results could be due to sources of influences of the counseling setting and the limitations that accompany archival data research. (PsycINFO Database Record (c) 2016 APA, all rights reserved)
Author	Credentials: Counselor, Mental Health and Family Therapist. Position and Institution: St. Mary's University Dissertation. Publication History in Peer-Reviewed Journals: None
Publication	Type of Publication: Scholarly Publisher: ProQuest information and learning
Date and Citation History	Date of Publication: 2004 Cited by: 2
Stated Purpose or Research Question	"This study reviewed pre and post-tests data on the Integrated Visual and Auditory Continuous Performance Test (IVA CPT) and the Wechsler Intelligence Scale for children-third edition (WISC III) to determine the cumulative effect of Interactive Metronome training on the cognitive abilities of clients in a therapeutic setting." (p. iii-iv)
Author's Conclusion	"The IM, as a new educational tool, allows for many teaching opportunities. According to the small body of research, the IM as an educational tool has been limited to overt behaviors in educational or behavioral settings, sports performance and peak mental agility. However, there has not been a study of IM data that explores the attention and cognitive abilities that may be linked to a counseling setting.
Overall Relevance to PICO	Poor: The article takes a perspective from a counseling setting rather than an Occupational Therapy setting.
Overall Quality of Article	Moderate: The description of interactive metronome was sufficient. The author is unbiased and concludes that little research supports interactive metronome. However, there is no reference to ASD.

Type of Article	Primary Research Study, Qualitative
APA Reference	Rosenblum, S., & Regev, N. (2013). Timing abilities among children with developmental coordination disorders (DCD) in comparison to children with typical development. <i>Research in Developmental Disabilities, 34</i> (1), 218-227. Retrieved from http://pearl.stkate.edu/login?url=http://search.proquest.com/docview/1324549706?accountid=26879
Abstract	Timing ability is essential for common everyday performance. The aim of the study was to compare timing abilities and temporal aspects of handwriting performance and relationships between these two components among children with Developmental Coordination Disorders (DCD) and a control group. Forty two children, 21 diagnosed as DCD and 21 with typical development, aged 7–12, were matched for age, gender and school performed 14 tasks of the interactive metronome (IM) and three functional handwriting tasks on an electronic tablet that was part of a computerized system (ComPET—computerized penmanship evaluation tool). The IM supplies response time, while on-paper and in-air time per written stroke is received from the ComPET. Results indicated significant differences between the groups for both IM and handwriting tasks (ComPET). Linear regression indicated that the mean IM response time explained 37% of variance of the in-air time per stroke during a paragraph-copying task. Furthermore, based on one discriminating function including two measures reflected timing ability, 81% of all participants were correctly classified into groups. Study results strongly recommend consideration of the IM as an evaluation and intervention tool for children with DCD who are faced with timing deficits in their everyday functioning.
Author	Credentials: Masters of Occupational Therapy Position and Institution: Department of Occupational Therapy, Faculty of Social Welfare & Health Sciences, University of Haifa Publication History in Peer-Reviewed Journals: 94, Substantial
Publication	Type of Publication: Scholarly Publisher: Elsevier
Date and Citation History	Date of Publication: January 2013 Cited by: 14
Stated Purpose or Research Question	“The aim of the study was to compare timing abilities and temporal aspects of handwriting performance and the relationships between these two components among children with DCD and those with TD. Through the study, the preliminary evaluation of the Interactive Metronome 1 for evaluation of timing ability among children with DCD was validated.” (p. 3)
Author’s Conclusion	“Further studies are required to evaluate whether including auditory and visual inputs while training the children to perform everyday tasks (Niemeijer, Smits-Engelsman, Reynders, & Schoemaker, 2003) will indeed improve their performance.” (p. 16)
Overall Relevance to PICO	Poor: Primary purpose of the article was to assess hand-writing through IM rather than focusing on movement and ASD.
Overall Quality of Article	Good: Substantial, credible publishing within the field of Occupational Therapy. The article is recent, well organized, and has a strong number of participants.

Type of Article	Primary Research Study: Case Study
APA Reference	Mulligan, S. E., & Hanzlik, J. R. (1991). The effectiveness of sensory stimulation in the treatment of children with severe head injuries. <i>The Occupational Therapy Journal of Research</i> , 11(4), 213-226. Retrieved from http://pearl.stkate.edu/login?url=http://search.proquest.com/docview/910974534?accountid=26879
Abstract	A single subject design was used with two children with severe head injuries to examine the effects of familiar and unfamiliar auditory and visual stimulation on levels of consciousness. The results indicated that the treatments used in this study did not significantly improve levels of consciousness. To determine whether or not the familiar stimuli was more effective than the unfamiliar; changes in vital signs, including heart and respiratory rates, were examined in response to the stimulation. The results indicated a tendency for one of the subjects to respond more to the familiar stimuli than the unfamiliar; however, the results were not statistically significant. The use of a single subject experimental design for examining the effectiveness of treatments with this population is discussed, as well as implications for therapeutic interventions.
Author	Credentials: PhD Position and Institution: Associate Professor of Occupational Therapy, University of New Hampshire Publication History in Peer-Reviewed Journals: 5
Publication	Type of Publication: Scholarly Publisher: Sage Journals
Date and Citation History	Date of Publication: July/Aug 1991 Cited by: 0
Stated Purpose or Research Question	“The present study was designed to control for the discussed methodological problems. A single subject design was used with two children with severe head injuries to examine the effects of unfamiliar and familiar auditory and visual stimulation on levels of consciousness. Changes in heart and respiratory rates were also examined in response to familiar vs. unfamiliar stimulation.” (p. 215)
Author’s Conclusion	“The results indicated that the treatments used in this study did not significantly improve levels of consciousness. To determine whether or not the familiar stimuli was more effective than the unfamiliar; changes in vital signs, including heart and respiratory rates, were examined in response to the stimulation. The results indicated a tendency for one of the subjects to respond more to the familiar stimuli than the unfamiliar; however, the results were not statistically significant.” (p. 221)
Overall Relevance to PICO	Poor: Does not relate to movement or ASD. The focus is primarily on auditory stimuli and children with severe head injuries.
Overall Quality of Article	Poor: An unsubstantial number of 2 participants were used in the study. It is not cited by any other journal articles, which calls into question its validity. The hypothesis was also not supported by the study.

Type of Article	<i>Primary Research Study</i> Randomized, double-blind trial
APA Reference	Amato, M.P., Goretti, B., Viterbo, R.G., Portaccio, E., Nicolai, C., Hakiki, B. (2014). Computer-assisted rehabilitation of attention in patients with multiple sclerosis: results of a randomized, double-blind trial. <i>Sage Journals</i> . 20(1) 91-8. doi: 10.1177/1352458513501571.
Abstract	<p>Background: There is controversial information on the efficacy of cognitive rehabilitation in multiple sclerosis (MS).</p> <p>Objective: The objective of this paper is to test a home-based computerized program for retraining attention dysfunction in MS.</p> <p>Methods: Relapsing–remitting patients who failed > 2 tests of attention on an extensive neuropsychological battery were randomized to specific or nonspecific computerized training (ST, n-ST), in one-hour sessions, twice a week for three months. Outcome measures included neuropsychological assessment, depression, fatigue, everyday activities and a visual analogue scale assessing attentive performance (VAS). Assessments were repeated after the interventions and after a further three months. Statistical analysis included the analysis of variance (ANOVA) for repeated measures.</p> <p>Results: Eighty-eight out of 102 randomized patients completed the study (69 women, age 40.9 ± 11.5 years, disease duration 13.0 ± 8.7 years, Expanded Disability Status Scale score 2.7 ± 1.5). Fifty-five patients were randomized to ST, 33 to n-ST. A benefit of the ST was observed on the Paced Auditory Serial Addition Test ($p < 0.002$). However, patient self-report did not reveal differences between ST and n-ST patient groups.</p> <p>Conclusion: Although our program trained different attention components, we could detect some improvements exclusively on tasks of sustained attention. Moreover, patient self-perceived results may be independent of the training program.</p>
Author	<p>Credentials: Department of Neurology Position and Institution: University of Florence Publication History in Peer-Reviewed Journals: Anxiety state affects information processing speed in patients with multiple sclerosis. https://www.ncbi.nlm.nih.gov/pubmed/24072658 Emotional and neutral verbal memory impairment in Multiple Sclerosis https://www.ncbi.nlm.nih.gov/pubmed/24713509 https://www.ncbi.nlm.nih.gov/pubmed/24713509</p>
Publication	Type of publication: <i>Scholarly Article Journal</i> Publisher: Sage Journals
Date and Citation History	Date of publication: 2014 Cited By: 29
Stated Purpose or Research Question	The objective of this paper is to test a home-based computerized program for retraining attention dysfunction in MS. (p. 1).
Author's Conclusion	Although our program trained different attention components, we could detect some improvements exclusively on tasks of sustained attention. Moreover, patient self-perceived results may be independent of the training program. (p.1)
Overall Relevance to PICO	Overall Relevance to PICO: <i>Limited</i> Rationale: <i>This article describes a computer program that was supposed to increase attention and cognition of patients, but the outcomes were not significant.</i>
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: The article does not describe a significant difference in results among patients in the control group or the treatment group, and could show that computer programs are ineffective. There is still not enough data to come to a conclusion about the way computer programs could increase a person's cognitive abilities.

Type of article	Primary Research Study, Experimental
APA Reference	Conklyn, D., Stough, D., Novak, E., Paczak, S. (2010). A home-based walking program using rhythmic auditory stimulation improves gait performance in patients with multiple sclerosis: a pilot study. <i>Sage Journals</i> . 24(9) 835-42. Doi: 10.1177/1545968310372139.
Abstract	<i>Background.</i> Few interventions have been successful in improving gait dysfunction in patients with multiple sclerosis (MS). Rhythmic auditory stimulation (RAS) has demonstrated positive results on gait performance in other neurologically impaired populations. <i>Objective.</i> To measure the effects of RAS on quantitative walking parameters in ambulatory patients with MS. <i>Methods.</i> Ten MS patients with gait disturbance were randomly assigned to receive RAS versus no intervention for 2 weeks. All participants received RAS for another 2 weeks. Between weekly clinic visits, they were provided with MP3 players containing songs whose tempo was 10% above the participant's spontaneous cadence and were instructed to walk to the music 20 minutes daily. Quantitative gait parameters were measured using the GAITRite system. <i>Results.</i> A statistically significant decrease between groups was found for change in double-support time (left, $P = .0176$; right, $P = .0247$), whereas trends with medium to high effect sizes were found for other gait parameters, including walking speed. A pooled within-group analysis showed significant improvement of cadence, stride length, step length, velocity, and normalized velocity after 1 week of treatment. Satisfaction level with RAS was high. <i>Conclusions.</i> These results in a convenience sample of MS patients demonstrate the feasibility and safety of RAS when used at home and suggest a potential benefit on gait parameters.
Author	Credentials: MM, MT-BC OH Publication History in Peer-Reviewed Journals: The Effects of Modified Melodic Intonation Therapy on Nonfluent Aphasia: A Pilot Study http://jslhr.pubs.asha.org/article.aspx?articleid=1782681
Publication	Type of publication: <i>Scholarly Reviewed Article Journal</i> Publisher: Sage Journals
Date and Citation History	Date of publication: 2010 Cited By: 51
Stated Purpose or Research Question	To measure the effects of RAS on quantitative walking parameters in ambulatory patients with MS. (p. 1)
Author's Conclusion	These results in a convenience sample of MS patients demonstrate the feasibility and safety of RAS when used at home and suggest a potential benefit on gait parameters (p. 1)
Overall Relevance to PICO	Overall Relevance to PICO: <i>Moderate</i> Rationale: The intervention was not interactive metronome, but it was a treatment that involved rhythm and sound that affected the functional ability of patients.
Overall Quality of Article	Overall Quality of Article: <i>Good</i> Rationale: Described methods, objective, and conclusion clearly, and described how treatment worked.

Type of article	Primary Research Study, Experimental
APA Reference	Kim, S.J., Kwak, E.E., Park, E.S., Cho, S.R. (2012). Differential effects of rhythmic auditory stimulation and neurodevelopmental treatment on gait patterns in adults with cerebral palsy: a randomized controlled trial. <i>Sage Publications</i> . 26(10), 904-14. Doi: 10.1177/0269215511434648.
Abstract	<p>Objectives: To investigate the effects of rhythmic auditory stimulation (RAS) on gait patterns in comparison with changes after neurodevelopmental treatment (NDT/Bobath) in adults with cerebral palsy.</p> <p>Design: A repeated-measures analysis between the pretreatment and posttreatment tests and a comparison study between groups.</p> <p>Setting: Human gait analysis laboratory.</p> <p>Subjects: Twenty-eight cerebral palsy patients with bilateral spasticity participated in this study. The subjects were randomly allocated to either neurodevelopmental treatment ($n = 13$) or rhythmic auditory stimulation ($n = 15$).</p> <p>Interventions: Gait training with rhythmic auditory stimulation or neurodevelopmental treatment was performed three sessions per week for three weeks. Temporal and kinematic data were analysed before and after the intervention. Rhythmic auditory stimulation was provided using a combination of a metronome beat set to the individual's cadence and rhythmic cueing from a live keyboard, while neurodevelopmental treatment was implemented following the traditional method.</p> <p>Main measures: Temporal data, kinematic parameters and gait deviation index as a measure of overall gait pathology were assessed.</p> <p>Results: Temporal gait measures revealed that rhythmic auditory stimulation significantly increased cadence, walking velocity, stride length, and step length ($P < 0.05$). Kinematic data demonstrated that anterior tilt of the pelvis and hip flexion during a gait cycle was significantly ameliorated after rhythmic auditory stimulation ($P < 0.05$). Gait deviation index also showed modest improvement in cerebral palsy patients treated with rhythmic auditory stimulation ($P < 0.05$). However, neurodevelopmental treatment showed that internal and external rotations of hip joints were significantly improved, whereas rhythmic auditory stimulation showed aggravated maximal internal rotation in the transverse plane ($P < 0.05$).</p> <p>Conclusions: Gait training with rhythmic auditory stimulation or neurodevelopmental treatment elicited differential effects on gait patterns in adults with cerebral palsy.</p>
Author	<p>Credentials: Department of Music Therapy, Ewha Music and Rehabilitation Center, Ewha Womans University, Korea</p> <p>Publication History in Peer-Reviewed Journals: Changes in gait patterns with rhythmic auditory stimulation in adults with cerebral palsy</p> <p>http://content.iospress.com/articles/neurorehabilitation/nre00698</p>
Publication	<p>Type of publication: Scholarly Peer Reviewed Journal</p> <p>Publisher: Elsevier</p>
Date and Citation History	<p>Date of publication: 2012</p> <p>Cited By: 39</p>
Stated Purpose or Research Question	To investigate the effects of rhythmic auditory stimulation (RAS) on gait patterns in comparison with changes after neurodevelopmental treatment (NDT/Bobath) in adults with cerebral palsy (p. 1).
Author's Conclusion	Gait training with rhythmic auditory stimulation or neurodevelopmental treatment elicited differential effects on gait patterns in adults with cerebral palsy (p. 1).
Overall Relevance to PICO	<p>Overall Relevance to PICO: <i>Moderate</i></p> <p>Rationale: This treatment is very similar to interactive metronome.</p>
Overall Quality of Article	<p>Overall Quality of Article: <i>Good</i></p> <p>Rationale: Explains methods, objective and conclusions thoroughly.</p>

Type of article	Primary Research Study, Experimental
APA Reference	Nelson, L.A., Macdonald, M., Stall, C., Pazdan, R., (2013). Effects of interactive metronome therapy on cognitive functioning after blast-related brain injury: a randomized controlled pilot trial. <i>Neuropsychology Epub.</i> (6)675-79. doi: 10.1037/a0034117.
Abstract	<p>OBJECTIVE: We report preliminary findings on the efficacy of interactive metronome (IM) therapy for the remediation of cognitive difficulties in soldiers with persisting cognitive complaints following blast-related mild-to-moderate traumatic brain injury (TBI).</p> <p>METHOD: Forty-six of a planned sample of 50 active duty soldiers with persistent cognitive complaints following a documented history of blast-related TBI of mild-to-moderate severity were randomly assigned to receive either standard rehabilitation care (SRC) or SRC plus a 15-session standardized course of IM therapy. Primary outcome measures were Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) Index Scores. Secondary outcome measures included selected subtests from the Delis-Kaplan Executive Functioning System (Trail Making Test and Color-Word Interference) and the Wechsler Adult Intelligence Scale-Fourth Edition (Symbol Search, Digit-Symbol Coding, Digit Span, and Letter-Number Sequencing) as well as the Integrated Visual and Auditory Continuous Performance Test. RESULTS: Significant group differences (SRC vs. IM) were observed for RBANS Attention ($p = .044$), Immediate Memory ($p = .019$), and Delayed Memory ($p = .031$) indices in unadjusted analyses, with the IM group showing significantly greater improvement at Time 2 than the SRC group, with effect sizes in the medium-to-large range in the adjusted analyses for each outcome (Cohen's $d = 0.511, 0.768, \text{ and } 0.527$, respectively). Though not all were statistically significant, effects in 21 of 26 cognitive outcome measures were consistently in favor of the IM treatment group (binomial probability = .00098).</p> <p>CONCLUSION: The addition of IM therapy to SRC 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.”</p>
Author	<p>Publication History in Peer-Reviewed Journals: None</p> <p>Credentials: Doctor/Ph.D, certified in clinical neuropsychology. psychologist</p> <p>Position: Professor, Principal Investigator of Research Projects</p>
Publication	<p>Type of publication: Scholarly Journal Article</p> <p>Publisher: Neuropsychology Publication</p>
Date and Citation History	<p>Date of publication: 2013</p> <p>Cited By: 8</p>
Stated Purpose or Research Question	We report preliminary findings on the efficacy of interactive metronome (IM) therapy for the remediation of cognitive difficulties in soldiers with persisting cognitive complaints following blast-related mild-to-moderate traumatic brain injury (TBI). (p. 1)
Author's Conclusion	The addition of IM therapy to SRC 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.(p. 1)
Overall Relevance to PICO	<p>Overall Relevance to PICO: <i>Strong</i></p> <p>Rationale: Interactive Metronome Treatment used on soldiers with TBI.</p>
Overall Quality of Article	<p>Overall Quality of Article: <i>Good</i></p> <p>Rationale: Explains the objective, methods, and conclusions clearly.</p>

Type of article	Primary Research Study, Experimental
APA Reference	Cosper, S. M., Lee, G. P., Peters, S. B., & Bishop, E. (2009). Interactive Metronome training in children with attention deficit and developmental coordination disorders. <i>International Journal of Rehabilitation Research</i> , 32(4), 331-336.
Abstract	The objective of this study was to examine the efficacy of Interactive Metronome (Interactive Metronome, Sunrise, Florida, USA) training in a group of children with mixed attentional and motor coordination disorders to further explore which subcomponents of attentional control and motor functioning the training influences. Twelve children who had been diagnosed with attention deficit hyperactivity disorder, in conjunction with either developmental coordination disorder (n = 10) or pervasive developmental disorder (n = 2), underwent 15 1-h sessions of Interactive Metronome training over a 15-week period. Each child was assessed before and after the treatment using measures of attention, coordination, and motor control to determine the efficacy of training on these cognitive and behavioral realms. As a group, the children made significant improvements in complex visual choice reaction time and visuomotor control after the training. There were, however, no significant changes in sustained attention or inhibitory control over inappropriate motor responses after treatment. These results suggest Interactive Metronome training may address deficits in visuomotor control and speed, but appears to have little effect on sustained attention or motor inhibition.
Author	<i>Credentials:</i> MHS <i>Position and Institution:</i> Department of Occupational Therapy, School of Allied Health Sciences, Medical College of Georgia <i>Publication History in Peer-Reviewed Journals:</i> Limited
Publication	<i>Type of Publication:</i> Scholarly, Peer-Reviewed Journal <i>Publisher:</i> Wolters Kluwer <i>Other:</i> Reputable journal
Date and Citation History	2008 <i>Cited By:</i> 25
Stated Purpose/Research Question	“The specific hypotheses for this study were as follows: children with neurodevelopmental disorders who complete treatment with the Interactive Metronome will display pretreatment to posttreatment improvement in motor coordination (as assessed by the Bruininks–Oseretsky Test of Motor Proficiency-Short Form) and sustained attention [as assessed by the Gordon Diagnostic System’s (GDS) continuous performance test].” (p. 333)
Author’s Conclusion	“Interactive Metronome’s potential to increase motor control and reaction speed seems to be evident, whereas its usefulness for increasing other skills (e.g. sustained attention and increased inhibitory control over inappropriate motor responses) has not been demonstrated. The apparent uncritical acceptance of the Interactive Metronome within the allied health professions to treat symptoms of ADHD seems to be unjustifiable at this time.” (p. 335)
Overall Relevance to PICO	<i>Relevance:</i> Moderate Relevance <i>PICO:</i> Study was directly related to the I, and O, but targeted a different population.
Overall Quality of Article	<i>Quality:</i> Moderate Recently published article, but low cited by number, author has limited other research.

Type of Article	Primary Research Studies; Case Study
APA Reference	Bartscherer, M. L., & Dole, R. L. (2005). Interactive metronome training for a 9-year-old boy with attention and motor coordination difficulties. <i>Physiotherapy Theory and Practice</i> , 21(4), 257-269.
Abstract	The purpose of this case report is to describe a new intervention, the Interactive Metronome,11 for improving timing and coordination. A nine-year-old boy, with difficulties in attention and developmental delay of unspecified origin underwent a seven-week training program with the Interactive Metronome.1 Before, during, and after training timing, accuracy was assessed with testing procedures consistent with the Interactive Metronome1 training protocol. Before and after training, his gross and fine motor skills were examined with the Bruininiks-Oseretsky Test of Motor Proficiency (BOTMP). The child exhibited marked change in scores on both timing accuracy and several BOTMP subtests. Additionally his mother relayed anecdotal reports of changes in behavior at home. This child’s participation in a new intervention for improving timing and coordination was associated with changes in timing accuracy, gross and fine motor abilities, and parent reported behaviors. These findings warrant further study.
Author	Credentials: PT, MS Position and Institution: President, Dynamic Therapy Associates Publication History in Peer-Reviewed Journals: Limited
Publication	Type of Publication: Peer-Reviewed Journal Publisher: Informa Other: N/A
Date and Citation History	2004 Cited By: 40
Stated Purpose/Research Question	“The purpose of this case report was to describe the application of the IM Intervention on timing for one child and present the ways in which this child changed over the course of seven weeks.” (pp. 257-258)
Author’s Conclusion	“This case report provides clinical evidence that this intervention can be applied safely, and was well tolerated by the child. It also appeared to be associated with positive changes in behaviors as reported by parents and as evidenced in clinical measures.” (p. 268)
Overall Relevance to PICO	<i>Relevance:</i> Moderate Relevance <i>PICO:</i> Study was directly related to the I, and O, but targeted a different population.
Overall Quality of Article	Quality: Poor Small sample size, limited other research by author, low “cited by” number.

Type of Article	Primary Research Study, Experimental Pretest-Posttest Measurement Design
APA Reference	Shaffer, R. J., Jacokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Jr, S. P. (2001). Effect of interactive METRONOME training on children with ADHD...including commentary by koomar J, burpee JD, DeJean V, frick S, kawar MJ, fischer DM. <i>American Journal of Occupational Therapy</i> , 55(2), 155-166.
Abstract	<p><i>Objective.</i> The purpose of this study was to determine the effects of a specific intervention, the Interactive Metronome®, on selected aspects of motor and cognitive skills in a group of children with attention deficit hyperactivity disorder (ADHD).</p> <p><i>Method.</i> The study included 56 boys who were 6 years to 12 years of age and diagnosed before they entered the study as having ADHD. The participants were pretested and randomly assigned to one of three matched groups. A group of 19 participants receiving 15 hr of Interactive Metronome training exercises were compared with a group receiving no intervention and a group receiving training on selected computer video games. <i>Results.</i> A significant pattern of improvement across 53 of 58 variables favoring the Interactive Metronome treatment was found. Additionally, several significant differences were found among the treatment groups and between pretreatment and posttreatment factors on performance in areas of attention, motor control, language processing, reading, and parental reports of improvements in regulation of aggressive behavior. <i>Conclusion.</i> The Interactive Metronome training appears to facilitate a number of capacities, including attention, motor control, and selected academic skills, in boys with ADHD.</p>
Author	<p><i>Credentials:</i> PhD</p> <p><i>Position and Institution:</i> Adjunct Assistant Professor of Pediatrics and Human Development, College of Human Medicine, Michigan State University, Ann Arbor, Michigan.</p> <p><i>Publication History in Peer-Reviewed Journals:</i> Limited</p>
Publication	<p><i>Type of Publication:</i> Scholarly, peer-reviewed journal</p> <p><i>Publisher:</i> American Occupational Therapy Association</p> <p><i>Other:</i> Official Journal of the AOTA</p>
Date and Citation History	<p>2001</p> <p><i>Cited by:</i> 121</p>
Stated Purpose/Research Question	“The purpose of this study was to determine the effects of the Interactive Metronome on selected aspects of motor and cognitive skills in a group of children with ADHD.” (p. 156)
Author’s Conclusion	“The present study suggests that Interactive Metronome training can improve aspects of attention, motor, and perceptual-motor functioning; cognitive and academic performance; and the control of aggression in children with major attentional problems.” (p. 161)
Overall Relevance to PICO	<p><i>Relevance:</i> Moderate Relevance</p> <p><i>PICO:</i> Study was directly related to the I, and O, but targeted a different population.</p>
Overall Quality of Article	<p><i>Quality:</i> Moderate Quality</p> <p>Reputable Journal. Published in the last 15 years. Author with limited other research.</p>

Type of Article	Primary Research Study, Case Study
APA Reference	Johansson, A. M., Domellof, E., & Ronnqvist, L. (2012). Short- and long-term effects of synchronized metronome training in children with hemiplegic cerebral palsy: A two case study. <i>Developmental Neurorehabilitation</i> , 15(2), 160-169. doi:10.3109/17518423.2011.635608 [doi]
Abstract	<i>Background:</i> Children with cerebral palsy (CP) require individualized long-term management to maintain and improve motor functions. The objective of this study was to explore potential effects of synchronized metronome training (SMT) on movement kinematics in two children diagnosed with spastic hemiplegic CP (HCP). <i>Method:</i> Both children underwent 4-weeks/12 sessions of SMT by means of the Interactive Metronome (IM). Optoelectronic registrations of goal-directed uni- and bimanual upper-limb movements were made at three occasions; pre-training, post completed training and at 6-months post completed training. <i>Results:</i> Significant changes in kinematic outcomes following IM training were found for both cases. Findings included smoother and shorter movement trajectories in the bimanual condition, especially for the affected side. In the unimanual condition, Case I also showed increased smoothness of the non-affected side. <i>Conclusions:</i> The observed short- and long-term effects on the spatio-temporal organization of upper-limb movements need to be corroborated and extended by further case-control studies.
Author	<i>Credentials:</i> None <i>Position and Institution:</i> Position unknown, Department of Psychology, Umea University <i>Publication History in Peer-Reviewed Journals:</i> Moderate
Publication	<i>Type of Publication:</i> Scholarly Peer Reviewed Journal <i>Publisher:</i> Taylor & Francis Group
Date and Citation History	2012 <i>Cited By:</i> 11
Stated Purpose/Research Question	“explore if 4 weeks of IM training may affect the quality of goal- directed upper-limb movements as expressed in movement kinematics during conditions unrelated to the IM training. An additional aim was to investigate potential long-term effects after the training period concluded in terms of effect stability and/or consolidation effects.” (p. 161)
Author’s Conclusion	“Although the effects of IM training on kinematics varied among the two children, some improvements in spatiotemporal organization were observed.” (p. 168)
Overall Relevance to PICO	<i>Relevance:</i> Moderate Relevance <i>PICO:</i> Study was directly related to the I, and O, but targeted a different population.
Overall Quality of Article	<i>Quality:</i> Moderate Moderately published author, small sample size, published in the past five years, low “cited by” number.

Initial Appraisal: Conceptual or Theoretical Articles.

Type of Article	Conceptual or Theoretical Article
APA Reference	Koomar, J., Burpee, J. D., DeJean, V., Frick, S., Kavar, M. J., & Fischer, D. M. (2001). Theoretical and clinical perspectives on the interactive metronome: A view from occupational therapy practice. <i>The American Journal of Occupational Therapy : Official Publication of the American Occupational Therapy Association</i> , 55(2), 163-166.
Abstract	N/A
Author	Credentials: PhD, OTR/L, FAOTA Position and Institution: Executive Director, Occupational Therapy Associates–Watertown Publication History in Peer-Reviewed Journals: extensive
Publication	Type of Publication: Scholarly Peer-Reviewed Article Publisher: American Occupational Therapy Association Other: Official Journal of the AOTA
Date and Citation History	2000 Cited by: 32
Stated Purpose/Research Question	“The underlying theory of the Interactive Metronome is that motor planning processes of organizing and sequencing are based on an internal sense of rhythmicity.” (p.164)
Author’s Conclusion	“Interactive Metronome training provides a promising new tool that may be helpful in improving timing and rhythmicity related to praxis; improved timing and rhythmicity may serve as a foundation for improvements in complex problem-solving behavior in school, at home, and in social relationships.” (pp.165-166)
Overall Relevance to PICO	<i>Relevance:</i> Strong Relevance <i>PICO:</i> Article was directly related to the population and the intervention. The article included comparison to typical treatment, and had some information on outcomes of IM training.
Overall Quality of Article	Quality: Good Article was published fairly recently by a reputable journal, and the author has other extensive research

Initial Appraisal: Reviews of Research Studies

Type of article	Reviews of Research Studies Systematic Review
APA Reference	Padilla, R., Anna, D.; Effectiveness of Sensory Stimulation to Improve Arousal and Alertness of People in a Coma or Persistent Vegetative State After Traumatic Brain Injury: A Systematic Review. (2016) <i>Am J Occup Ther</i> 2016;70(3):7003180030p1-7003180030p8. doi: 10.5014/ajot.2016.021022.
Abstract	OBJECTIVE. This systematic review evaluates the effectiveness of sensory stimulation to improve arousal and alertness of people in a coma or persistent vegetative state after traumatic brain injury (TBI). METHOD. Databases searched included Medline, PSYCInfo, CINAHL, OTseeker, and the Cochrane Database of Systematic Reviews. The search was limited to outcomes studies published in English in peer-reviewed journals between 2008 and 2013. RESULTS. Included studies provide strong evidence that multimodal sensory stimulation improves arousal and enhances clinical outcomes for people in a coma or persistent vegetative state after TBI. Moderate evidence was also provided for auditory stimulation, limited evidence was provided for complex stimuli, and insufficient evidence was provided for median nerve stimulation. CONCLUSION. Interventions should be tailored to client tolerance and premorbid preferences. Bimodal or multimodal stimulation should begin early, be frequent, and be sustained until more complex activity is possible.
Author	Publication History in Peer-Reviewed Journals: None Credentials: PhD, OT/L, FAOTA, LMHP
Publication	Type of publication: Scholarly Journal Article Publisher: American Occupational Therapy Association
Date and Citation History	Date of publication:2016 Cited By: 1
Stated Purpose or Research Question	This systematic review evaluates the effectiveness of sensory stimulation to improve arousal and alertness of people in a coma or persistent vegetative state after traumatic brain injury (TBI). (p. 1)
Author's Conclusion	Interventions should be tailored to client tolerance and premorbid preferences. Bimodal or multimodal stimulation should begin early, be frequent, and be sustained until more complex activity is possible.(p. 1)
Overall Relevance to PICO	Overall Relevance to PICO: <i>Limited</i> Rationale: Not focused on interactive metronome, but shows that stimulation can increase alertness.
Overall Quality of Article	Overall Quality of Article: <i>Good</i> Rationale: Clear about objective, methods, and conclusion.

Type of article	Reviews of Research Studies Systematic Review
APA Reference	Letts, L., Minezes, J., Edwards, M., Berenyi, J., Moros, K., O'Neill, C., & O'Toole, C. (2011). Effectiveness of interventions designed to modify and maintain perceptual abilities in people with alzheimer's disease and related dementias. <i>The American Journal of Occupational Therapy</i> , 65(5), 505-13. Retrieved from http://pearl.stkate.edu/login?url=http://search.proquest.com/docview/893425449?accountid=26879
Abstract	An evidence-based review was undertaken to answer the question, "What is the evidence for the effect of interventions designed to modify and maintain perceptual abilities on the occupational performance of people with Alzheimer's disease and related dementias?" A systematic search of electronic databases and application of inclusion and exclusion criteria guided the selection of 31 articles. Each article was critically appraised, and the evidence was synthesized. Some interventions use remaining perceptual abilities to enable people to find their way in a facility and decrease attempts at exiting. Preliminary evidence has supported use of visual stimulation and barriers. We found some evidence for the use of auditory stimuli and group therapy that aim to change perceptual abilities. Research with high-level evidence is required to validate these findings. Evidence on the benefits of Snoezelen is not conclusive for occupational performance outcomes; further research to justify its use as an occupational therapy intervention may be warranted.
Author	Publication History in Peer-Reviewed Journals: None
Publication	Credentials: PhD, OT Reg, Associate Professor and Assistant Dean: Occupational Therapy Program, School of Rehabilitation Science, McMaster University Type of publication: Scholarly Article Reviewed Journal Publisher: American Occupational Therapy Association
Date and Citation History	Date of publication:2011 Cited By: 17
Stated Purpose or Research Question	What is the evidence for the effect of interventions designed to modify and maintain perceptual abilities on the occupational performance of people with Alzheimer's disease and related dementias? (p. 1)
Author's Conclusion	Evidence on the benefits of Snoezelen is not conclusive for occupational performance outcomes; further research to justify its use as an occupational therapy intervention may be warranted. (p. 1)
Overall Relevance to PICO	Overall Relevance to PICO: <i>Limited</i> Rationale: Auditory stimuli was used to increase perception, but this intervention does not relate to interactive metronome.
Overall Quality of Article	Overall Quality of Article: <i>Poor</i> Rationale: <i>Not Clear with methods and results of study.</i>

Critical Appraisals.

Kim, H. H., Bo, G. H., & Yoo, B.K. (2012). The effects of a sensory integration programme with applied interactive metronome training for children with developmental disabilities: a pilot study. *Hong Kong Journal of Occupational Therapy*, 22(1), 25-30.

Cosper, S., Lee, G., Peters, S., Bishop, E. (2009). Interactive Metronome training in children with attention deficit and developmental coordination disorders. *International Journal of Rehabilitation Research*, 32, 331-336. DOI: 10.1097/MRR.0b013e328325a8cf

Shaffer, R. J., Jacokes, L. E., Cassily, J. F., Greenspan, S. I., Tuchman, R. F., & Jr, S. P. (2001). Effect of interactive metronome training on children with ADHD...including commentary by Koomar J, Burpee JD, DeJean V, Frick S, Kawar MJ, Fscher DM. *American Journal of Occupational Therapy*, 55(2), 155-166. doi:10.5014/ajot.55.2.155

Brain Gym

Executive Summary

Final EBP question and PICO.

Are the comprehensive treatment models (CTM) Makoto Therapy, Brain Gym, and Interactive Metronome effective interventions for improving occupational performance including improving executive function, academic performance, and physical coordination in children and adolescents with Autism Spectrum Disorder (ASD)?

	Keywords	More Broad And Narrow Keywords	Keyword Synonyms, abbreviations, and spelling variants
P Patient / Population / Problem	Autism Cognition Coordination Children/adolescents with Autism Spectrum Disorder (ASD)	Developmental Disorders Children with disabilities Autism Spectrum Disorder (ASD) Neurodevelopmental Disorders	Autistic Balancing Processing ASD Youth, kids Students
I Intervention	Occupational Therapy, Brain Gym, Interactive Metronome, Makoto Arena Therapy	Rehabilitation Movement Education Therapeutic Exergame Fitness arena Active video games	OT Movement Therapy Participate
C Comparison	Current Protocol for treatment Control group		
O Outcome	Reaction Time Participation Occupational Performance Performance in School Motor coordination Focus/attention Hand/eye coordination Cross body movement	Function Coordination Education/ learning Balance Executive Function Movement Exercise Activity	Distractibility Leisure Play

Themes.***Description of the Intervention***

Brain Gym® is a commercial program consisting of a “set of movements, processes, programs and materials” (Brain Gym® International, 2016, n.p.) that claims to provide physical stimulation that is needed for effective learning. The developers asserted that learning problems are caused when the brain and body do not coordinate and these learning difficulties can be overcome through simple movements that are proposed to integrate brain areas with body movements. Brain Gym® literature states that these movements improve coordination and cause dramatic improvements in “concentration, focus, memory, reading, writing, math, test taking, physical coordination, relationships, self-responsibility, organization skills and attitude” (Brain Gym® International, 2016, n.p.). Brain Gym® is described to be most effective in classrooms with children including typically developing children and children with special needs (Brain Gym® International, 2016). However, Brain Gym® has also be used in athletics, health professions, and corporations, or as an individual intervention (Brain Gym International, 2016).

Brain Gym® offers a variety of courses designed to educate practitioners about the program. The first step before facilitating Brain Gym® in practice is taking a basic introductory course called Brain Gym® 101, this course is a total of 24 hours, taught over the course of about three or four days (Brain Gym® International, 2016). Brain Gym® 101 teaches the 26 movements as well as Brain Gym® techniques and costs about \$400. Brain Gym® suggests that this intervention can be used in private sessions, usually lasting 1-2 hours (Brain Gym® International, 2016). Outside of private sessions no other recommendations for frequency or duration of use were stated.

Developers.

Brain Gym® was developed in the 1970s by Paul and Gail Dennison (Brain Gym® International, 2016, n.p.). Brain Gym® International (2016) provided the background on the Dennisons. Paul received a Ph.D. in education and Gail is an artist and movement educator. Paul incorporated his “knowledge of the relationship of movement to perception and the impact of these on fine-motor and academic skills” (Brain Gym® International, 2016, n.p.). Gail contributed movements she had learned from dance and acupuncture. Brain Gym is a registered trademark of the Educational Kinesiology Foundation, which was founded in 1987 (Brain Gym® International, 2016). In 2000, the organization began doing business under the name of Brain Gym® International. The mission of the organization is “to support self-awareness and the ease of living and learning through safe, simple, and effective movement” (Brain Gym® International, 2016, n.p.). The most visible authors of Brain Gym® are Keith Hyatt and Jennifer Stephenson, both having published at least two articles on the subject.

Description of Evidence.

A comprehensive search was conducted using OTSearch, Google Scholar, CINAHL Plus from EBSCOHost, AOTA, AOTF, WFOT, PSYCInfo, ProQuest, and OTSeeker. These search engines produced 44 articles on Brain Gym®. This initial search was narrowed down to 15 pertinent articles. These articles consisted of eight primary research studies, five reviews of research studies and two conceptual/theoretical articles. These articles were of moderate quality, having small sample sizes and not well established authors. Three of the articles were non-peer reviewed doctoral dissertations (Nussbaum, 2010; Taylor, 2009; Wachob, 2013). The dissertations were of poor quality, generally they did not contain control groups, were not widely cited by other works, and were not peer-reviewed. Overall, the articles were of moderate relevance to our research question. All 15 articles directly examined Brain Gym® but only one

involved the target population of autism (Watson & Kelso, 2014). Most of the articles pertained to Brain Gym® as an academic intervention used in a classroom setting.

Summary of Evidence.

Brain Gym® claims to cause an increase in executive function, better academic performance, and physical coordination. We found three articles that best assessed this claim (Hyatt, 2007; Nussbaum, 2010; Watson & Kelso, 2014). Hyatt (2007) conducted a comprehensive review of the literature available on Brain Gym®. The review found three articles that were peer reviewed and not published by the Brain Gym website. Hyatt described many methodological flaws present in the articles and, as a result, deemed their results inclusive. In addition, this review found that research findings have refuted the theoretical basis of Brain Gym®.

Nussbaum determined if Brain Gym® intervention improved on student's academic performance and overall behavior in primary grade students. The study took place in a rural school district in East Texas including random 297 students grades second through sixth over the course of 8 months. A variety of instruments were used to determine progress including TAKS reading, TAKS math and BASC-II. The children who received Brain Gym® intervention improved improvement in academic performance and behavior. However, because of the chosen research design, no conclusions can be made that the treatment study caused the differences in the outcomes (Nussbaum, 2010).

Watson and Kelso (2014) researched the intervention of Brain Gym® on a small sample size of three children with autism and showed no major change in academic engagement. Results were compared to the child before the intervention was observed, and when the intervention was compared to simple physical activity, such as walking in the

hallway. The two children showed no improvement in academic engagement after receiving Brain Gym® as an intervention (Watson & Kelso, 2014).

Brain Gym® was not reviewed by expert review groups (Table 1). Many of the articles on Brain Gym® were methodically flawed and yielded inconclusive results (Hyatt, 2007). In future research, studies should be quantitative, have larger sample sizes, and objective researchers. There is a need for peer-reviewed articles examining Brain Gym®. The emerging research is in the form of doctoral dissertations. In addition, many of the studies available on Brain Gym® were published by Brain Gym® International. Spaulding, Mostert, and Beam (2010) reported that according to the Official Brain Gym® website, “64% of the studies were published in the Brain Gym® Journal or the Brain Gym® Magazine. Only 5 of these articles (13%) used an experimental research design” (Spaulding, Mostert, and Beam, 2010, p.11). There is extremely limited research on Brain Gym® as an intervention for children with autism. In the single study found, Watson & Kelso (2014) suggested that Brain Gym® was not an effective intervention. This study had a small sample size of 3 children, the researcher was a Brain Gym® certified provider, and the control group was the same 3 children.

EBP summary.

Brain Gym® is a movement based comprehensive treatment model primarily used in classrooms for typically developing children to improve academic performance. However, there is a lack of empirical evidence to support that Brain Gym® is an effective intervention for any population. Most of the research available on Brain Gym® comes from the Brain Gym® website, sponsored by Brain Gym® International. The majority of these articles were not peer reviewed and were anecdotal or qualitative studies. There is a significant lack of research done on Brain Gym® as an intervention for autism. After reviewing the Wisconsin determination

levels, we have concluded that based on our research, Brain Gym® would be categorized at level five. Level five states that “there are no published studies supporting the proposed treatment package” (Wisconsin Treatment Intervention Advisory Committee, 2016). In our research, only one article studied Brain Gym® and an intervention model for autism. In this study, Brain Gym® intervention did not show an improvement of academic engagement (Watson & Kelso, 2014). Given the quality and quantity of research on Brain Gym®, it is not considered as an evidence-based practice. This can inform occupational therapists in identifying evidence-based interventions for use in practice.

Level 5 – Untested (Experimental Treatment) &/or Potentially Harmful

- Other authoritative bodies that have conducted extensive literature reviews of related treatments (e.g., National Standards Project, NPDC) have not recognized the treatment package as having an emerging evidence base; authorities are in agreement about the level of evidence.

X There are no published studies supporting the proposed treatment package.

- There exists evidence that the treatment package is potentially harmful.
 - Authoritative bodies have expressed concern regarding safety/outcomes.
 - Professional bodies (i.e., organizations or certifying bodies) have created statements regarding safety/outcomes.

References

Nussbaum, S. (2010). *The effects of “brain gym” as a general education intervention:*

Improving academic performance and behaviors. (Doctoral dissertation). Retrieved from EBSCOhost (ED517276).

Watson, A., & Kelso, G.L. (2014). The effect of Brain Gym® on academic engagement for children with developmental disabilities. *International Journal of Special Education, 29*(2), 75-83.

Wisconsin Department of Health Services Autism and Other Developmental Disabilities Treatment Intervention Advisory Committee (2016).

<https://tiac.wisconsin.gov/summary-determinations-regarding-level-evidence.htm>

Expert review table.

Table 3.

Summary of Evidence and Recommendations by Expert Review Groups for Brain Gym

Review Organization	Summary and Recommendations	Citation and Source
Wisconsin Treatment Intervention Advisory Committee	Not Reviewed	Wisconsin Department of Health Services Autism and Other Developmental Disabilities Treatment Intervention Advisory Committee (2016). https://tiac.wisconsin.gov/summary-determinations-regarding-level-evidence.htm
Evidence-Based Practices for Children, Youth, and Young Adults with Autism Spectrum Disorder	Not Reviewed	Wong, C., Odom, S. L., Hume, K. Cox, A. W., Fettig, A., Kucharczyk, S., ... Schultz, T. R. (2013). <i>Evidence-based practices for children, youth, and young adults with Autism Spectrum Disorder</i> . Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, Autism Evidence-Based Practice Review Group. http://autismpdc.fpg.unc.edu/sites/autismpdc.fpg.unc.edu/files/2014-EBP-Report.pdf
Association for Science in Autism Treatment (ASAT)	Not Reviewed	Association for Science in Autism Treatment (n.d.) Treatments in alphabetical order. (http://www.asatonline.org/for-parents/learn-more-about-specific-treatments/treatments-in-alphabetical-order/)
Cochrane Collaboration	Not Reviewed	Cochrane Collaboration (2016). http://www.cochrane.org/
U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services.	Not Reviewed	U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services. (2010). Autism spectrum disorders (ASDs) services final report on environmental scan. Retrieved from http://www.impaqint.com/sites/default/files/files/Autism_Spectrum_Disorders.pdf
National Autism Center	Not Reviewed	National Autism Center (2015). National Standards Project, Phase 2. Retrieved from http://www.nationalautismcenter.org/national-standards-project/phase-2/

American
Academy of
Pediatrics

Studies of
Complementary and
Alternative
Medicines (CAM)
interventions are
limited or
flawed. Not
recommended as an
evidence-based
intervention.

Myers, S. M., & Johnson, C. P. (2007). Management
of children with autism spectrum disorders.
Pediatrics, 120(5), 1162-1182.

<http://pediatrics.aappublications.org/content/pediatrics/120/5/1162.full.pdf>

Background Learning and Evidence Searches

Table of Resources.

Table 4.

Table of Resources

Title/Name	Brief Description	Source
Is Brain Gym® an Effective Educational Intervention?	Faculty publication from Liberty University Several articles on Brain Gym from Google search Free full text available in pdf	Faculty publications and presentations DigitalCommons@libertyuniversity
Movement Matters! An Introduction to Brain Gym® (2011)	Presentation made by Katy Held, a Movement and Learning Specialist and Licensed Brain Gym® and Bal-A-VisX® Instructor/Consultant Understandable, clearly outline information Orientated toward early childhood providers	Michigan District-The Lutheran Church- Synod http://www.michigan-district.org
Brain Gym® (educational kinesiology)	Information sourced from BrainGym.org Webpage written by Robert Todd Carrol, PhD Provides critical reviews of a variety of topics Readable, accessible through Google Search of BrainGym	The Skeptic's Dictionary http://www.skepticon.com/braingym.html
Brain Gym® Teacher Certification Training	Readable Website page Provides Information for educators Private, non-profit organization	Enza Lyons Dynamic Learning & Health Workshops: Brain Gym Teacher www.dlhc.com.au
Lifespan. Brain Gym®. Walking the mind through the Body.	Periodical orientated to massage therapy Free full text pdf online Bi-monthly journal includes research historical perspectives, massage techniques, business information and professional trends	Massage & Bodywork

Background learning paper one.

This EBP project will focus on the Brain Gym® intervention that was designed to promote learning through movement. Background learning on this topic explored characteristics of Brain Gym®, the developer of the intervention, the suggested outcomes, and the current users. Having background information on Brain Gym® will provide a foundation of knowledge before we critically analyze the research and effectiveness of this intervention.

Brain Gym® is an intervention that incorporates movement and is suggested to optimize learning. Brain Gym® incorporates 26 movements that are “divided into four categories: Midline Movements, Energy Exercises, Deepening Attitudes and Lengthening Activities” (Brain Gym® International, 2016, n.p.) A few examples of the 26 movements include: drinking water, energy yawn, thinking cap, brain buttons and calf pump. These movements were designed based off of the movements that are “naturally done during the first years of life when learning to coordinate the eyes, ears, hands, and whole body” (Brain Gym® International, 2016, n.p.)

Brain Gym® was created by a husband and wife team, Paul E. Dennison and Gail E. Dennison. Paul received a Ph.D. in education, Gail is an artist and movement educator. In the early 1980s they compiled their favorite activities to establish the 26 movements for Brain Gym®. Paul incorporated his “knowledge of the relationship of movement to perception and the impact of these on fine-motor and academic skills” (Brain Gym® International, 2016, n.p.) Gail contributed movements she had learned from dance and acupuncture. The mission of the organization that they have created is “to support self-awareness and the ease of living and learning through safe, simple, and effective movement” (Brain Gym® International, 2016, n.p.)

Clients suggest that Brain Gym® movements are effective for improved educational performance, but research is limited on how the movements are effective (Brain Gym®

International, 2016). The Brain Gym® International (2016) website claims that Brain Gym® provides dramatic improvements in the following areas: “concentration and focus, memory, academics (reading, writing, math, test taking), physical coordination, relationships, self-responsibility, organizational skills and attitude” (Brain Gym® International, 2016, n.p.).

Although Brain Gym® was originally created for use in a classroom setting, Brain Gym® has been utilized by people of all ages and abilities. Brain Gym® can be modified by changing some of the movements and activities to benefit children with special needs (Brain Gym® International, 2016). Teachers claim to have noticed a significant increase in “concentration, attention, confidence, and creativity” in their students (Brain Gym® International, 2016).

Brain Gym® is currently used by teachers, occupational therapists, and caregivers who have attended Brain Gym® training courses. The Brain Gym® International (2016) website explains how to obtain competency to provide Brain Gym® as an intervention. The first step before facilitating Brain Gym® in practice is taking a basic introductory course called Brain Gym® 101, this course is a total of 24 hours, taught over the course of about three or four days. Brain Gym® 101 teaches the 26 movements as well as Brain Gym® techniques and costs about \$400. Once teachers have completed Brain Gym® 101, they can guide an individual child or groups of children through the movements. Once students have gained experience doing the movements, they can initiate them independently based on their needs (Brain Gym® International, 2016). Brain Gym® has been recommended for students who have: performance anxiety, poor memory, lack of energy, fear of failure, poor balance, and/or lack of organizational skills, as well as many others problems (Held, 2011).

This background summary on Brain Gym® is used to determine if Brain Gym® as an intervention is beneficial to clients of occupational therapy. An understanding of what Brain

Gym® is, who developed it, what the proposed benefits are, and who is implementing the intervention provides an important context for this project. Further background knowledge on children with Autism Spectrum Disorder may need to be researched as our final project will synthesize Brain Gym® research to determine if this intervention is beneficial and appropriate to use for children with Autism Spectrum Disorder.

References

Brain Gym® International (2016). Frequently asked questions. Retrieved from

<http://braingym.org/faq>

Brain Gym® International (2016). Founders- Paul and Gail Dennison. Retrieved from

<http://www.braingym.org/history>

Brain Gym® International (2016). What is Brain Gym®? Retrieved from

<http://braingym.org/about>

Held, K. (2011). Movement matters! An introduction to Brain Gym. Retrieved from

http://www.michigandistrict.org/sites/default/files/pdf/events/2011/ecc/ecc_handouts/BG_2.5_hr_Intro_Packet_Aug_2011.pdf

Background learning paper two.

This EBP project will focus on Brain Gym® as a learning intervention. Brain Gym® has been said to increase brain function between the left and right hemispheres which prepares the brain to learn (Held, 2011). Background learning on this topic explored the definition of Brain Gym®, how Brain Gym® facilitates learning, key concepts and the variety of people that can utilize Brain Gym®.

Brain Gym® is a system comprised of 26 simple movements, exercises or activities that relieve stress naturally and enhance brain function (Brain Gym® International, 2016). Brain Gym® was founded by Paul and Gail Dennison in the 1970's (Brain Gym® International, 2016). Having struggled in school himself, Paul wanted to find a way to help others with their learning problems and “understand even more deeply the process of learning and the factors that inhibit it” (Spaulding, Mostert, & Beam, 2010, p.g. 5). Paul first developed a sensory program for students which included simple movements to enhance equilibrium and perceptual skills (Brain Gym® International, 2016) This program's relation to brain development would form the basis of Brain Gym® (Brain Gym® International, 2016). Brain Gym® was first taught in the United States, but has expanded all across the nation to 87 countries including Canada, China, Hungary, Greece, Germany, India, and Slovenia (Spaulding, Mostert, & Beam, 2010). Not only is Brain Gym® being taught nationwide, but has been translated into over 40 different languages as well (Brain Gym® International, 2016). Brain Gym® was created to enhance “learning through movement particularly during the first years of life” (Brain Gym® International, 2016, n.p.) Brain Gym® exercises has shown “drastic improvements in concentration and focus, memory, physical coordination, self-responsibility, organization skills, relationships and attitude were noted” (Brain Gym® International, 2016, n.p.).

Brain Gym® facilitates learning by enhancing the communication between the left and right hemispheres of the brain. “It draws out innate gifts and talents and bring about, “whole-brain” learning” (Held, 2011, pg. 3). Brain Gym® incorporates many different components of learning such as auditory, visual, fine motor, and postural skills (Held, 2011). The variety of learning types increase the number of individuals that may benefit from Brain Gym® movements or activities. The Brain Gym® system is said to “increase long and short term memory, improve and accelerate learning, condense the learning cycle, increase reading and math skills, create positive changes in attention and ability to focus, increase in self-confidence, and support behavioral management by reducing stress quickly” (Held, 2011, pg. 3) amongst more.

There are four main concepts that comprise Brain Gym® as explained by Held (2011). First, physical brain movement stimulates function within the brain including communication, comprehension, and organization. Second, stress inhibits learning and prepares the body for a fight or flight reaction. Third, learning blocks can be released by Brain Gym® meaning our brains “switch off” for certain tasks and Brain Gym® movements consciously activate the whole body/brain system. Lastly, noticing is a personal feedback mechanism (pg. 4). Individuals need to find out what works and what doesn’t work to become aware of various learning blocks and utilize effective tools such as Brain Gym® to enhance learning (Held, 2011).

Brain Gym® is utilized by teachers, students, caregivers and occupational therapists. Brain Gym® is most commonly utilized by teachers, but in order for them to implement Brain Gym® in their curriculum they need to take a Brain Gym® 101 course. The Brain Gym® 101 course is an introductory course that “teaches the 26 movements and how to apply them using specific Brain Gym® processes and techniques. This course introduces concepts and supporting language for the entire Brain Gym® program” (Brain Gym® International, 2016, n.p.). Brain

Gym® courses are being offered all over the world, but Brain Gym® 101 is a prerequisite course that must be taken before any higher-level course (Brain Gym® International, 2016). Brain Gym® is known to be most effective in classrooms with children including typically developing children and children with special needs (Brain Gym® International, 2016). However, Brain Gym® can also be used in athletics, health professions, and corporations (Brain Gym® International, 2016). Furthermore, modifications can be made to some of the Brain Gym® exercises to benefit individuals with special needs or learning challenges (Brain Gym® International, 2016).

Brain Gym® promotes learning through movement and emphasizes whole brain learning (Brain Gym® International, 2016). Brain Gym® is one of the many learning inventions that is being utilized today. This background study has explained the definition of Brain Gym® and history, facilitation of learning Brain Gym® movements, the key concepts of Brain Gym®, and the variety of people that use Brain Gym®.

References

Brain Gym® International. (2016). How to experience the Brain Gym® program through courses/consultation. Retrieved from <http://www.braingym.org/experience>

Brain Gym® International. (2016). What is Brain Gym®? Retrieved from <http://www.braingym.org/about>

Held, Katy. (2011). "Movement matters! An introduction to Brain Gym®". Retrieved from http://www.michigandistrict.org/sites/default/files/pdf/events/2011/ecc/ecc-handouts/BG_2.5_hr_Intro_Packet_Aug_2011.pdf

Spaulding, L. S., Mostert, M. P., & Beam, A. P. (2010). Is Brain Gym® an effective educational intervention? Retrieved from

http://digitalcommons.liberty.edu/cgi/viewcontent.cgi?article=1167&context=educ_fac_u
[bs](#)

Background learning paper three.

This project will focus on the characteristics of Brain Gym® as a comprehensive treatment model. Background learning on this topic defines and describes the components of Brain Gym®, its theoretical basis, and the contexts in which it is being implemented.

Brain Gym® is a commercial program that consists of a series of simple movements. Specifically, Brain Gym® is a “set of movements, processes, programs and materials” (Brain Gym International, 2016, n.p.) that claims to provide physical stimulation that is needed for effective learning. Brain Gym® was developed in the 1970s by Paul and Gail Dennison who published a manual (as cited in Hyatt, 2007) delineating their theory of learning. Dennison & Dennison asserted that learning problems are caused when the brain and body do not coordinate and these learning difficulties can be overcome through simple movements that are proposed to integrate brain areas with body movements. Brain Gym® has gained the attention of therapists and educators in the United States and worldwide (Brain Gym International, 2016). According to Brain Gym literature, it is being used in 87 countries and has been translated into more than 40 languages.

The Brain Gym® program is a movement-based intervention. It relies on a specific set of 26 movements such as crawling, drawing and tracing symbols in the air (Brain Gym International, 2016). These movements, created by Dennison and Dennison, are intended to integrate specific brain functions with body movements (Brain Gym International, 2016). Brain Gym International states that some of the 26 movements were developed based upon the Dennisons’ ideas about the effect of movement on perception, fine-motor skills, and academic skills. Other movements were formed from Paul Dennison’s experiences being a marathon runner and his study of visual training and acupressure.

These 26 movements are based on a relatively simple theory of brain functioning. Literature published by Dennison & Dennison (as cited in Hyatt, 2007) stated that the program is based upon improving three dimensions of brain function: laterality, focusing and centering. Hyatt (2007) expands on these three dimensions and explains their purposed functions. Laterality describes the ability to coordinate between hemispheres, which is said to be important for tasks such as reading, writing, listening, speaking and the ability to move and think at the same time. Focusing describes the coordination between the front and back portion of the brain and is said to be important for comprehension and related to attention-deficit disorder. Finally, centering describes the ability to coordinate between the top and bottom halves of the brain and is said to be important to the balance of rational thoughts and emotion. Brain Gym® literature states that these movements improving coordination across these three dimensions, which causes dramatic improvements in “concentration, focus, memory, reading, writing, math, test taking, physical coordination, relationships, self-responsibility, organization skills and attitude” (Brain Gym International, 2016, n.p.).

The Brain Gym® program has been used with people of varying ages, abilities and needs. This program is adaptable to those with special needs and learning difficulties, and has been used as an intervention strategy for those with autism, cerebral palsy, ADD, ADHD, PDD-NOS, Angelman’s Syndrome, speech impairment, blindness and deafness (Rentschler & Freeman, 2013). Brain Gym® can also be integrated into the classroom curriculum. Brain Gym facilitators recommend that teachers integrate the 26 movements in to the classroom, either using the movements with large groups of students or on an individual basis (Brain Gym® International, 2016). However, Brain Gym® literature states that this program is not limited to the educational

field and special needs. It is claimed to be successful when used by corporations, athletics, health professions, families, and individuals.

Brain Gym® offers a variety of courses designed to educate practitioners about the program. Brain Gym® literature delineates a specific five level curriculum and describes the qualifications needed to be a licensed instructor (Brain Gym® International, 2016). Those who wish to be trained in this program follow a specific curriculum taught by Brain Gym® instructors through private sessions, courses, and presentations. A practitioner can facilitate Brain Gym® in practice after taking the introductory source, called Brain Gym® 101. However, in order to be a licensed Brain Gym® instructor one must complete 96 elective credits and renew their license every four years. Only licensed Brain Gym® instructors can teach or collect fees for the program. The prices for these courses vary by instructor and location, but average around \$400 per course in the United States.

This summary introduces and describes Brain Gym® as a comprehensive treatment model. The popularity of Brain Gym® has increased the need for a critical analysis and understanding of its theoretical framework and efficacy. A review of the research around this intervention is necessary if Brain Gym® to be sanctioned as an evidence-based practice program.

References

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- Hyatt, K. J. (2007). Brain Gym: Building stronger brains or wishful thinking? *Remedial and Special Education, 28*(2), 117-124. doi:10.1177/07419325070280020201
- Rentschler, M & Freeman, C.K. (2013). Education kinesiology, Brain Gym and autism and other challenges. Retrieved from <https://epidemicanswers.org/education-kinesiology-brain-gym-and-autism-other-challenges/>

Evidence searches.**Library Database: CINAHL Plus from EBSCOhost***Preparing for Search Process*

- There are no Mesh terms for Brain Gym.
- There were three broader terms for occupational therapy and two more specific terms. Occupational therapy and therapeutic seem to be the most appropriate.
 - Indexing terms of the database:
 - Health Occupations> Allied Health Professions> Rehabilitation> Occupational Therapy> hand therapy or pediatric occupational therapy
- Final Term List for the database: “Brain Gym”, “Autism”, “Children”, “Therapeutic”,
- Database filters to be tried: I will try no filters.
- Boolean Logic Terms to be tried: Since I need children as the population I will use AND between “Brain Gym” and “Children.” I will also use “Brain Gym’ and “Autism,” “Brain Gym” and “Therapeutic,” “Brain Gym” and “Occupational Therapy.”

Summarizing a Strategic Search Process

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	("Brain Gym" AND "children")	3/3 Osborn, 2005 Hyatt, 2007 Inder & Sullivan, 2004	November 14, 2016
None Years: Unlimited	("Brain Gym")	7/3 Osborn, 2005 Hyatt, 2007 Inder & Sullivan, 2004	November 14, 2016
None Years: Unlimited	("Brain Gym" AND "Autism")	0/0	November 14, 2016
None Years: Unlimited	("Brain Gym" AND "Therapeutic" [Mesh])	1/1 Inder & Sullivan 2004	November 14, 2016
None Years: Unlimited	("Brain Gym" AND "Occupational Therapy" [Mesh])	0/0	November 14, 2016

I then decided to search on all databases on EBSCOhost to yield more results.

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	("Brain Gym")	181/- Try to narrow focus	November 14, 2016
None Years: Unlimited	("Brain Gym" AND "Autism")	1/1 Watson & Kelso, 2014	November 14, 2016
None Years: Unlimited	"Brain Gym" AND "Occupational therapy")	1/0	November 14, 2016
None Years: Unlimited	("Brain Gym" AND "Children")	23/10 Watson & Kelso, 2014 Kroze, Hyatt, & Lambert, 2015 Hyatt, 2007 Spaulding, 2010 Taylor, 2009 Maskell, Shapiro, & Ridley, 2004 Osborn, 2005 Nussbaum, 2010	November 14, 2016

		Inder & Sullivan, 2004 Clark, 2009	
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Summary of 5 Best Research Articles – Abstracts

Hyatt, K. (2007). Brain Gym: building stronger brains or wishful thinking? *Remedial & Special Education, 28*(2), 117-124.

“As part of the accountability movement, schools are increasingly called upon to provide interventions that are based on sound scientific research and that provide measurable outcomes for children. Brain Gym® is a popular commercial program claiming that adherence to its regimen will result in more efficient learning in an almost miraculous manner. However, a review of the theoretical foundations of Brain Gym® and the associated peer-reviewed research studies failed to support the contentions of the promoters of Brain Gym®. Educators are encouraged to become informed consumers of research and to avoid implementing programming for which there is neither a credible theoretical nor a sound research basis” (Hyatt, 2007).

Inder, J., & Sullivan, S. (2004). Does an educational kinesiology intervention alter postural control in children with a developmental coordination disorder? *Clinical Kinesiology: Journal of the American Kinesiotherapy Association, 58*(4), 9-26.

“The purpose of this study was to examine the effect of selected Educational Kinesiology (Edu-K) techniques on the postural responses of four children with a Developmental Coordination Disorder (DCD). METHODS: Four children with DCD, aged 9-12 years, participated in a single subject, multiple baseline research study with baseline, intervention and follow-up phases. The Edu-K intervention consisted of an individualized Laterality Repatterning process, and a series of four Brain Gym® activities known as PACE, in a daily home program. Selected questionnaires and pre-tests were administered to provide a descriptive profile of the children's background and motor performance, followed by a series of computerized Sensory Organization Tests (SOT) during each phase. RESULTS: Two of the four children demonstrated improved performance ($p < .05$) at follow-up, with evidence of improved performance in the other two children in the SOT composite equilibrium scores. A decrease in the number of falls ($p < .05$) was seen in all four children. Results also indicate some improvement in sensory system (somatosensory, visual and vestibular) scores, and sensory integration/organization during the series of six SOT sensory conditions. CONCLUSIONS: The Edu-K techniques may have been effective in improving postural responses in these four children with DCD, although the possibility of 'learning' with repetition of SOT testing cannot be discounted. Further research in

different populations and settings using single subject and group designs are needed to examine the efficacy of these intervention techniques” (Inder & Sullivan, 2004).

Watson, A., & Kelso, G.L. (2014). The effect of Brain Gym on academic engagement for children with developmental disabilities. *International Journal of Special Education*, 29(2), 75-83.

“Following recent legislative initiatives in education requiring evidence-based practices, schools have implemented various instructional programs characterized as "evidence-based." However, it is important to question whether these methods are truly effective. One example of a methodology currently promoted and used in schools is an educational kinesiology program called Brain Gym®. Brain Gym® is reported to improve various education related skills. The purpose of this study is to investigate the effect of Brain Gym® on academic engagement for children with developmental disabilities. In this study, Brain Gym® was compared to an alternate intervention, simple physical activity, which did not conform to Brain Gym® guidelines. Neither intervention produced consistently positive effects for academic engagement. Based on these findings, it is questionable whether Brain Gym® can successfully be used with children with developmental disabilities to improve engagement. These results can inform the decision-making process of selecting evidence-based practices in education” (Watson & Kelso, 2014).

Kroeze, K., Hyatt, K., Lambert, C. (2015). Brain Gym: Let the user beware. *Journal of Interactive Learning Research*, 26(4), 395-401.

“As part of the No Child Left behind Act of 2001 and the Individuals with Disabilities Education Improvement Act of 2004, schools are called upon to provide students with academic instruction using scientific, research-based methods whenever possible. One of these supposed research-based methods is a program by the name of Brain Gym®. Brain Gym® is a popular commercial program claiming that adherence to its regimen of carrying out certain movements will result in more efficient learning in an almost miraculous manner. Although being particularly popular, Brain Gym® itself has failed to support the contentions of the promoters. For this reason, educators are encouraged to become informed consumers and avoid implementing programs for which there is neither credible theoretical nor a sound research basis” (Kroeze, Hyatt & Lambert, 2015).

Nussbaum, S. (2010). *The effects of “Brain Gym” as a general education intervention:*

Improving academic performance and behaviors. (Doctoral dissertation). Retrieved from EBSCOhost (ED517276)

"Individuals with Disabilities Education Act" ("IDEA") and "No Child Left Behind" ("NCLB") now mandate that all at-risk students receive empirical, scientific research-based interventions.

"Brain Gym" is a movement-based program designed to address a diverse range of students' academic and behavior needs by promoting whole-brain learning. However, the scientific research base supporting "Brain Gym" is limited and findings are inconclusive. The goal of this study was to evaluate the effects of Dennison's 26 "Brain Gym" movements as a tier-one Response to Intervention (RtI) and a class-wide general education intervention on primary grade-level students' (the at-risk population as well as the overall population) academic performance and behaviors as measured by the "TAKS Reading," "TAKS Math," and "BASC-II" instruments. To accomplish this goal, an eight-month quantitative posttest experimental study with random assignment of 364 second through sixth grade students to classrooms and random assignment of participating classrooms to control and experimental groups was implemented in a school district located in East Texas. Based on two-tailed independent sample t tests at a 95% confidence level ($\alpha = 0.05$), at-risk students demonstrated statistically significant gains in reading, $t(66) = -2.13$, $p = 0.04$, and math, $t(71) = -2.42$, $p = 0.02$, after receiving "Brain Gym" as a tier-one RtI academic intervention. Similarly, students who received "BrainGym" as a general education classroom management strategy demonstrated statistically significant improvements in maladaptive behaviors (e.g., aggression, hyperactivity, inattention, depression, anxiety, somatization, and atypicality), $t(46) = -2.71$, $p = 0.01$, and adaptive behaviors (e.g., social skills, functional communication, and adaptability), $t(46) = -2.95$, $p = 0.01$. Therefore, educators may confidently use "Brain Gym" as a tier-one RtI reading and math intervention and a general education classroom management strategy for primary grade-level students. Further research is needed to explore the efficacy of "Brain Gym" with secondary and special population students" (Nussbaum, 2010).

Evidence Resource(s): OT organizations (AOTA/AOTF/WFOT)***Preparing for Search Process***

As the search tools for the AOTA, AOTF, and WFOT provided basic searches for materials on their respective websites I decided to just search “Brain Gym.” I initially searched “Brain Gym” on AOTA, AOTF, and WFOT and yielded zero relevant results. I then remembered that AJOT was part of the AOTA website so I decided to search on there.

AOTA

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	(“Brain Gym”)	6/0	November 14, 2016

WFOT

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	(“Brain Gym”)	0/0	November 14, 2016

AOTF

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	(“Brain Gym”)	0/0	November 14, 2016

AJOT

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
None Years: Unlimited	(“Brain Gym”)	1/1 Garg & Koenig, 2015	November 14, 2016

Summary of 5 Best Research Articles- Abstracts

- There was only one article found and the abstract doesn't mention Brain Gym®, but the article does talk about how OTs are using it in practice.

Garg, S., & Koenig, K. (2015). The effectiveness of the get ready to learn program in improving executive functions in children with disabilities. *American Journal of Occupational Therapy, 69*. doi:10.5014/ajot.2015.69S1-PO2081

“There is a huge gap in the literature when it comes to studies done to evaluate the effects of yoga-based interventions on executive functions. In the current study, we bridge this gap and enhance understanding of yoga-based interventions to explore their use as a therapeutic intervention” (Garg & Koenig, 2015).

Library Database: OT Search*Preparing for Search Process*

- Brain Gym is not a MeSH heading on OT Search. I tried brain based learning and found brain activity. Autism was a MeSH heading which matched our population for our EBP PICO.
- Movement was a MeSH heading. Movement therapy seemed to be the closest to our EBP PICO.
- There were a few terms for child. Both adolescent and child seemed to be appropriate.
- Movement seemed to be a common intervention utilized with this age group. It could be used as a comparison group.
 - c. Subject Headings or Indexing Terms of the Database:
 - Brain Gym>Brain based learning>Brain activity
 - Movement>Movement Therapy
 - Adolescent>Children
 - Autism>ASD
 - d. Final concept or Term List for the Database
“Brain Activity” {Mesh}, “Movement” {Mesh}, “Child” {Mesh}, “Adolescent” {Mesh}, “Autism” {Mesh}
 - e. Database filters to be tried: I will try no filters and journal articles.
 - f. Boolean Logic Terms to be tried: Since I need all three terms, I will start with “AND”

Summarizing a Strategic Search Process

Filters/Years	Keywords	Total Yield	Date
None: Years Unlimited	("Brain Activity" {Mesh} AND "Movement" {Mesh} AND "Child" {Mesh})	1/0 Broaden Search	November 13, 2016
None: Years Unlimited	("School based occupational therapy" {Mesh} AND "Learning therapy" {Mesh} AND "child" {Mesh})	20/2 DeLuca et al. (2015) Ashburner et al. (2013).	November 13, 2016
None: Years Unlimited	("Movement" {Mesh} AND "Learning" {Mesh} AND "Child" {Mesh})	21/0	November 14, 2016
None: Years Unlimited	("Movement" {Mesh} AND "Adolescents" {Mesh})	44/1 DeLuca et al. (2015) (Duplicate)	November 14, 2016
None: Years Unlimited	("Brain Based Learning" {Mesh} AND "movement" {Mesh})	3/0	November 15, 2016

Summary of 5 best research articles (Only able to find 2 semi-relevant)

Ashburner, J., Rodger, S., Ziviani, J., Jones, J. (2013). Occupational therapy services for people with autism spectrum disorders: Current state of play, use of evidence and future learning priorities. *Australian Occupational Therapy Journal*, 61(2), 110-120. doi: 10.1111/1440-1630.12083

Abstract: A dramatic increase in the prevalence of autism spectrum disorders and increased funding to support children with autism spectrum disorders have added to the demand for occupational therapy services. This study explored current practices and future learning priorities of Queensland occupational therapists who work in this field.

A survey in relation to occupational therapy services for people with autism spectrum disorders was distributed to all registered Queensland occupational therapists ($N = 2547$). The development of the survey was informed by a series of focus groups comprising occupational therapy clinicians, supervisors and academics. The survey covered demographics, caseload composition, collaboration, context/setting, service-delivery models, information gathering, goal setting, interventions, perceived challenges and confidence, use of evidence, and experience of professional development and support, and future learning priorities.

Of 818 surveys returned, 235 respondents provided services to clients with autism spectrum disorders, with young children being more likely to receive a service than adolescents or adults. A pervasive focus on sensory processing was apparent in relation to assessment, intervention, and key areas of knowledge. Around half the respondents indicated that they lacked confidence at least some of the time. Autism spectrum disorders-specific experience was a significant predictor of confidence. Many therapists reported challenges in finding useful information in the literature and reliance on conferences or workshops as their main source of evidence. Commonly identified learning priorities included new developments in the field, early intervention, school support, sensory processing and clinical reasoning.

This research highlights the need for comprehensive autism spectrum disorders-specific, face-to-face training focusing on evidence-based and occupation-centered practices.

DeLuca, S. C., Landesman, S. R., Trucks, M. R., Wallace, D. A. (2015) Multiple treatments of pediatric constraint-induced movement therapy: a clinical cohort study. *American Journal of Occupational Therapy*, 69(6). doi: 10.5014/ajot.2015.019323

Pediatric constraint-induced movement therapy (pCIMT) is one of the most efficacious treatments for children with cerebral palsy (CP). Distinctive components of pCIMT include constraint of the less impaired upper extremity (UE), high-intensity therapy for the more impaired UE (3 hr/day, many days per week, for multiple weeks), use of shaping techniques combined with repetitive task practice, and bimanual transfer. A critical issue is whether multiple treatments of pCIMT produce additional benefit. In a clinical cohort (mean age 5 31 mo) of 28 children with asymmetrical CP whose parents sought multiple pCIMT treatments, the children gained a mean of 13.2 (standard deviation [SD] 5 4.2) new functional skills after Treatment 1; Treatment 2 produced a mean of 7.3 (SD 5 4.7) new skills; and Treatment 3, 6.5 (SD 5 4.2). These findings support the conclusion that multiple pCIMT treatments can produce clinically important functional gains for children with hemiparetic CP.

Library Database: Google Scholar***Preparing for Search Process:***

- Google Scholar did not have MeSH headings.
- Google Scholar tends to yield a lot of results therefore I tried to narrow my search by inputting specific criteria. For example, I tried looking up Brain Gym, then Brain Gym International to narrow the results.
 - c. Subject Headings or Indexing Terms for Google Scholar
 - Brain Gym>Brain Gym International
 - Brain based learning
 - Adolescent>Children>Child
 - Autism>ASD
 - Movement
 - Learning
 - Implementation
 - d. Final concept or Term List for the Database
 - “Brain Gym/Brain Gym International”, “Brain Based Learning”, “Movement”, “Adolescent/Children/Child”, “Autism”, “Learning”, “Implementation”
 - e. Database filters to be tried: I will try filtering by year and journal article.
 - f. Boolean Logic Terms to be tried: Since google scholar yields a lot of articles I will start with Brain Gym and input AND if I need more relevant or narrow articles.

Summarizing a Strategic Search Process

Filters/Years	Keywords	Total Yield	Date
None: 2005-Present	("Brain Gym" AND "Child" AND "Autism")	3,270/5 Walsh, Morrow, & Rubenstein, (2008) Stephenson (2009) Peters & Forlin, (2011) Watson & Kelso, 2014) Hyatt (2007)	November 16, 2016
None: 2016	("Brain Gym International" AND "Children" AND "Autism")	317/- Narrow focus	November 15, 2016
None: Years: 2010-2016	("Brain Gym International" AND "Children" AND "Learning" AND "Movement")	15,300/11 Spaulding, Mostert, & Beam (2010). Dow (2010) Gehris & Gooze (2015) Call (2010) Pennington (2010) Watson & Kelso (2014) Grosse (2013) Kariuki & Kent (2014) Hoag (2015) Singh (2012)	November 14, 2016
None: Years: 2011-2016	("Movement" AND "Implementation" AND "Brain based" AND "Learning")	16,600/2 Wachob (2013) Krauss & Boss (2013)	November 16, 2016
None: Years: 2016	("Brain based learning" AND "Autism" AND "adolescent" AND "movement")	3,960/- Broaden search, too many variables	November 15, 2016

Summary of 5 best research articles

Hyatt, K. J. (2007). Brain gym®: Building stronger brains or wishful thinking? *Remedial and Special Education, 28*(2), 117-124. doi:10.1023/A:1016052026435

Abstract: As part of the accountability movement, schools are increasingly called upon to provide interventions that are based on sound scientific research and that provide measurable outcomes for children. Brain Gym® is a popular commercial program claiming that adherence to its regimen will result in more efficient learning in an almost miraculous manner. However, a review of the theoretical foundations of Brain Gym® and the associated peer-reviewed research studies failed to support the contentions of the promoters of Brain Gym®. Educators are encouraged to become informed consumers of research and to avoid implementing programming for which there is neither a credible theoretical nor a sound research basis.

Kariuki, P. N., & Kent, H. D. (2014) *The effects of Brain Gym® activities and traditional teaching strategies on students' performance in comprehension in a 4th grade classroom.*

Institute of Education Services. Retrieved from <http://eric.ed.gov/?id=ED550515>

Abstract: The purpose of this study was to examine the difference between students' scores in comprehension (English Language Arts) tests when they are led in Brain Gym® activities before class instruction and when they are taught using traditional teaching strategies. The sample for this study consisted of 11 males and 9 females. Data were collected by using Pearson Reading Comprehension tests. The students were tested after five days of receiving traditional teaching strategies and again after five days of participating in Brain Gym® activities before class instruction began. Data were analyzed using a paired t-test. The results indicated a significant difference in students' comprehension test scores when taught using Brain Gym® activities over the students' comprehension test scores who were taught using only traditional teaching strategies $t(19) = -5.461, P = 0.001$. However, there was no significant difference between genders on performance. The results suggest that implementing Brain Gym® activities before instruction significantly influences comprehension scores; therefore, teachers are encouraged to use Brain Gym® activities to help improve their students' comprehension scores.

Spaulding, L. S., Mostert, M. P., & Beam, A. P. (2010). Is Brain Gym® an effective educational intervention? *Exceptionality, 18*(1), 18.

Abstract: Brain Gym® (BG; BGI, 2008) is a popular commercial program sold by Brain Gym® International (BGI). Making extravagant claims for improved intellectual and physical development, it is used in more than 80 countries. While BGI's claims are persuasive, to date there is little empirical evidence validating the approach. We examine some theoretical assumptions from which BGI was developed, review the efficacy literature, and provide

suggestions for making informed decisions about the judiciousness of investing time and resources in this program.

Wachob, D. A. (2013) Public school teachers' knowledge, perception, and implementation of brain based learning practices. Indiana University Pennsylvania. Retrieved from <http://dspace.iup.edu/handle/2069/1908>

Abstract: The purpose of this study was to determine K-12 teachers' knowledge, beliefs, and practices of brain-based learning strategies in western Pennsylvania schools. The following five research questions were explored: (a) What is the extent of knowledge K-12 public school teachers have about the indicators of brain-based learning and Brain Gym?; (b) To what extent do K-12 public school teachers rate the value of brain-based learning and Brain Gym?; (c) To what extent do K-12 public school teachers report implementing brain-based learning indicators in their classrooms?; (d) What is the relationship between K-12 public school teachers' level of knowledge of brain-based learning and indicators of Brain Gym and their beliefs about brain-based learning?; (e) What is the relationship between gender, years of teaching experience, grade level being taught, and teachers' knowledge, perceptions, and implementation related to brain-based learning? The participants (N=256) included in this study consisted of K -12 public school teachers within three selected school districts in western Pennsylvania. The data was collected by using the Brain-Based Learning Survey Questionnaire (BBSLQ), developed by Shelley Klinek (2009), and was administered electronically using an online survey software program called Qualtrics. The survey was designed to measure participants' knowledge, beliefs, and practices of brain-based learning strategies. The results of the study indicate that teacher's knowledge of learning strategies are related to their beliefs about those strategies, as well as their instructional practices. It was further determined that teachers had positive attitudes towards learning new strategies; they feel it is important to demonstrate and show educators new ways of teaching; and they feel the need to be more adequately trained in the area of how the brain learns best. This study indicates that teachers are interested in how students learn best, and are willing to change their teaching practices to improve the learning process.

Walsh, C. A., Morrow, E. M., & Rubenstein, J. L. (2008) Autism and brain development. *Cell Press*, 135(3), 396-400. <http://dx.doi.org/10.1016/j.cell.2008.10.015>

Abstract: Genetic studies are refining our understanding of neurodevelopmental mechanisms in autism. Some autism-related mutations appear to disrupt genes regulated by neuronal activity, which are especially important in development of the postnatal nervous system. Gene replacement studies in mice indicate that the developmental window to ameliorate symptoms may be wider than previously anticipated.

Library Database: PsychInfo

Preparing for Search Process

- I looked at the MeSH headings provided by the ProQuest database and found them too be too medical for this project. Instead, I used the thesaurus provided by the PsychInfo database to find keywords. I also used the automatically generated search terms provided by the database.
- Brain Gym was a automatically generated word provided when typing into the search engine. To search for a phrase, PsychInfo requires you to place the words in quotations. I Searched for Brain gym and then “Brain gym” to narrow down the results.
 - Indexing Terms of the database:
 - Treatment>Rehabilitation> Occupational Therapy
 - Disorders>Mental Disorders> Autism Spectrum Disorders
 - Treatment>Movement Therapy
 - Final Term List for the database
 - “Brain Gym”, “Occupational Therapy”, “Autism,” “Rehabilitation”
 - Database filters: I will use the Advanced Search feature.
 - Boolean Terms: Since I need all the terms, I will use “AND”
 - PsychInfo has a filter for peer-reviewed articles. I began searching for all articles but then narrowed it down by applying the “Peer Reviewed” filter.
 - I further narrowed down the search by placing Brain Gym in quotations, allowing me to only see articles that contain that phrase.
 - When searching for a combination of terms, where I suspected there to be a small yield, I broadened my search by using not placing quotations around brain gym.
 - PsychInfo is one of 18 databases provided by ProQuest. After searching PsychInfo, I utilized ProQuest’s 18 databases in order to expand my findings.
 - Again, I further narrowed down the search by placing Brain Gym in quotations.
 - I then searched for “Brain Gym” and Autism, thinking this search may I get some hits in this larger database.

Summarizing the Search Process

Filters/Years	Keywords	Total Yield/ Relevant Hits	Date
Advanced Search No Filter Years:Unlimited	Brain Gym	123/9 Sift & Khalsa, 1991 Wolfsont, 2002 Moore & Hibbert, 2005 Hyatt, 2007 Miller & Robertson, 2010 Spaulding, Mostert & Beam, 2010 Cancela, Vila, Suárez, Vasconcelos,Lima, & Ayán, 2015 Taylor, 2009 Nussbaum, 2010	Nov,13,2016
Advanced Search Peer Reviewed Years:Unlimited	Brain Gym	83/7 Sift & Khalsa, 1991 Wolfsont, 2002 Moore & Hibbert, 2005 Hyatt, 2007 Miller & Robertson, 2010 Spaulding, Mostert & Beam, 2010 Cancela, Vila, Suárez, Vasconcelos,Lima, & Ayán, 2015	Nov, 13, 2016
Advanced Search Peer Reviewed Years: Unlimited	“Brain Gym”	12/7 Found same 7 articles as in the basic search (see above)	Nov,13,2016
Advanced Search Peer Reviewed Years: Unlimited	Brain gym AND autism	2/0	Nov,13,2016
Advanced Search Peer Reviewed Years: Unlimited	Brain gym AND Occupational therapy	0	Nov,13,2016
Advanced Search Peer Reviewed Years:Unlimited	Brain gym AND Rehabilitation	10/0	Nov,13,2016

PROQUEST: 18 databases including PsychInfo			
Advanced Search Peer Reviewed Years:Unlimited	Brain Gym	886/- Too broad, narrow	Nov,13,2016
Advanced Search Peer Reviewed Years: Unlimited	“Brain Gym”	72/11 Sift & Khalsa, 1991 Wolfsont, 2002 Moore & Hibbert, 2005 Hyatt, 2007 Hyatt, Stephenson & Carter, 2009 Stephenson, 2009 Miller & Robertson, 2010 Spaulding, Mostert & Beam, 2010 McCall, 2012 Kroeze, Hyatt & Lambert 2015 Cancela, Vila, Suárez, Vasconcelos,Lima, & Ayán, 2015	Nov,13,2016
Advanced Search Peer Reviewed Years:Unlimited	“Brain Gym” AND Autism	13/3 Stephenson, 2009 Hyatt, Stephenson & Carter, 2009 McCall, 2012	Nov,13,2016

Hyatt, K. J. (2007). Brain Gym®: Building stronger brains or wishful thinking? *Remedial and Special Education*, 28(2), 117-124. doi: 10.1177/074193250702800202016t

As part of the accountability movement, schools are increasingly called upon to provide interventions that are based on sound scientific research and that provide measurable outcomes for children. Brain Gym is a popular commercial program claiming that adherence to its regimen will result in more efficient learning in an almost miraculous manner. However, a review of the theoretical foundations of Brain Gym and the associated peer-reviewed research studies failed to support the contentions of the promoters of Brain Gym. Educators are encouraged to become informed consumers of research and to avoid implementing programming for which there is neither a credible theoretical nor a sound research basis.

Nussbaum, S. (2010). *The effects of “brain gym” as a general education intervention:*

Improving academic performance and behaviors. (Doctoral dissertation). Retrieved from PsychInfo (ED517276).

Individuals with Disabilities Education Act (IDEA) and No Child Left Behind (NCLB) now mandate that all at-risk students receive empirical, scientific research-based interventions. 'Brain Gym' is a movement-based program designed to address a diverse range of students' academic and behavior needs by promoting whole-brain learning. However, the scientific research base supporting 'Brain Gym' is limited and findings are inconclusive. The goal of this study was to evaluate the effects of Dennison's 26 'Brain Gym' movements as a tier-one Response to Intervention (RtI) and a class-wide general education intervention on primary grade-level students' (the at-risk population as well as the overall population) academic performance and behaviors as measured by the TAKS Reading, TAKS Math, and BASC-II instruments. To accomplish this goal, an eight-month quantitative posttest experimental study with random assignment of 364 second through sixth grade students to classrooms and random assignment of participating classrooms to control and experimental groups was implemented in a school district located in East Texas. Based on two-tailed independent sample t tests at a 95% confidence level ($\alpha = .05$), at-risk students demonstrated statistically significant gains in reading, $t(66) = -2.13$, $p = .04$, and math, $t(71) = -2.42$, $p = .02$, after receiving 'Brain Gym' as a tier-one RtI academic intervention. Similarly, students who received 'Brain Gym' as a general education classroom management strategy demonstrated statistically significant improvements in maladaptive behaviors (e.g., aggression, hyperactivity, inattention, depression, anxiety, somatization, and atypicality), $t(46) = -2.71$, $p = .01$, and adaptive behaviors (e.g., social skills, functional communication, and adaptability), $t(46) = -2.95$, $p = .01$. Therefore, educators may confidently use 'Brain Gym' as a tier-one RtI reading and math intervention and a general education classroom management strategy for primary grade-level students. Further research is needed to explore the efficacy of 'Brain Gym' with secondary and special population students.

Spaulding, L. S., Mostert, M. P., & Beam, A. P. (2010). Is Brain Gym® an effective educational intervention? *Exceptionality*, 18(1), 18. doi: 10.1080/09362830903462508

Brain Gym (BG; BGI, 2008) is a popular commercial program sold by Brain Gym International (BGI). Making extravagant claims for improved intellectual and physical development, it is used in more than 80 countries. While BGI's claims are persuasive, to date there is little empirical evidence validating the approach. We examine some theoretical assumptions from which BGI was developed, review the efficacy literature, and provide suggestions for making informed decisions about the judiciousness of investing time and resources in this program

Stephenson, J. (2009). Best practice? Advice provided to teachers about the use of Brain Gym® in Australian schools. *Australian Journal of Education*, 53(2), 109-124. Retrieved

from http://go.galegroup.com/ps/i.do?p=EAIM&sw=w&u=clic_stkate&v=2.1&it=r&id=

G

Perceptual motor programs continue to be used in Australian schools despite evidence showing they do not influence academic learning. Brain Gym is one perceptual motor program that is used in schools in Australia and overseas. There is little evidence to support the claims made about the benefits of Brain Gym; its theoretical underpinning has been subject to criticism by neuroscientists. A search was made of Internet sites, including state department of education sites to locate information provided to teachers about Brain Gym. Although education departments and others responsible for providing advice and professional development to teachers espouse research-based practice, they continue to endorse and support the use of Brain Gym.

Taylor, A. E. (2010). *A study of the effects of Brain Gym exercises on the achievement scores of fifth-grade students*. (Doctoral dissertation). Retrieved from PsycINFO. (787010721; 2010-99170-425).

This study explored whether an intervention involving Brain Gym exercises designed to increase academic achievement in the areas of math and reading/language arts would be successful. Three groups were used in the study: an initial treatment group, a delayed treatment group, and a control group. Each of the three groups was comprised of 20 fifth-grade students. Students' ThinkLink global proficiency scores in math and reading/language arts were used as the measure of academic achievement. It was hypothesized that students in the initial and delayed treatment groups would demonstrate higher math and reading/language arts academic achievement as compared to students in the control group. These hypotheses were not supported. There were no significant differences in math or reading/language arts academic achievement among the three groups. This study further explored whether students in the initial treatment group would continue to engage in Brain Gym exercises once the researcher was no longer directly monitoring their participation. It was hypothesized that students in this group would self-initiate Brain Gym exercises at least 75% of the time. This hypothesis was supported. However, there was a significant difference between the percentage of students' self-initiation of Brain Gym exercises in their morning and afternoon classes. Potential reasons underlying these differential rates of self-initiation are explored. One conclusion that can be drawn from this study is that Brain Gym exercises are ineffective in increasing the math or reading/language arts academic achievement of fifth-grade students. However, the results of this study are in contrast with available research involving Brain Gym exercises and academic achievement. Further research is needed to determine whether Brain Gym exercises are more effective with students who have some form of learning challenge or disability and less effective with students who are

academically average or above average in ability. Additional issues that may have impacted the results of this study are explored and recommendations for further research are presented.

References

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- Taylor, A. E. (2010). *A study of the effects of brain gym exercises on the achievement scores of fifth-grade students.* (Doctoral dissertation). Retrieved from PsycINFO. (787010721; 2010-99170-425).

Evidence Source: OTseeker

- OTseeker is a resource containing controlled trials and systematic reviews relevant to occupational therapy. OTseeker utilizes a simple search engine with the option to conduct a basic or advanced search.
 - With the basic search, OTseeker combines the words entered in the search box by using AND. In the advanced search, you can select and, or or not.
 - Boolean Terms: Since I need all the terms, I will use “AND”
 - Database filters: I used the basic search and I only needed to use the boolean term “and”
- To search for a particular phrase, OTseeker instructs you to enclose the phrase in double quotation marks.
- I used the same keywords identified in my library database search.
 - Indexing Terms Used:
 - Treatment>Rehabilitation> Occupational Therapy
 - Disorders>Mental Disorders> Autism Spectrum Disorders
 - Treatment>Movement Therapy
 - Final Term List for the database
 - “Brain Gym”, “Occupational Therapy”, “Autism” “Rehabilitation”
- Brain Gym did not produce any hits, so I instead tried educational kinesiology and movement therapy

Filters/Years	Keywords	Total Yield/Relevant Hits	Date
Basic Search	Brain Gym	0	Nov, 15 2016
Basic Search	“Brain Gym”	0	Nov, 15, 2016
Basic Search	Educational Kinesiology	0	Nov, 15, 2016
Basic Search	Movement Therapy	259/- Too broad,	Nov, 15, 2016
Basic Search	Movement Therapy Rehabilitation	107/0	Nov, 15, 2016
Basic Search	Movement Therapy Occupational Therapy	51/0	Nov, 15, 2016
Basic Search	Movement Therapy Autism	0	Nov, 15, 2016
Basic Search	Occupational Therapy Autism	2/1 Case-Smith & Arbesman, 2008	Nov, 15, 2016

Case-Smith, J., Arbesman, M., (2008). Evidence-Based review of interventions for autism used in or of Relevance to Occupational Therapy. *American Journal of Occupational Therapy*, 62(4):416-429. doi: 10.5014/ajot.62.4.416.

Occupational therapy practitioners are among the professionals who provide services to children and adults with autism spectrum disorder (ASD), embracing both leadership and supportive roles in service delivery. The study's primary aims were as follows: (1) to identify, evaluate, and synthesize the research literature on interventions for ASD of relevance to occupational therapy and (2) to interpret and apply the research literature to occupational therapy. A total of 49 articles met the authors' criteria and were included in the review. Six categories of research topics were identified, the first 3 of which are most closely related to occupational therapy: (1) sensory integration and sensory-based interventions; (2) relationship-based, interactive interventions; (3) developmental skill-based programs; (4) social cognitive skill training; (5) parent-directed or parent-mediated approaches; and (6) intensive behavioral intervention. Under each category, themes supported by research evidence and applicable to occupational therapy were defined. The findings have implications for intervention methods, communication regarding efficacious practices to professionals and consumers, and future occupational therapy research.

Appraisal of Evidence

Initial Appraisal: Primary Research Studies

Type of article	Overall Type: Primary Research Study Specific Type: Survey Research
APA Reference	Wachob, D. A. (2013) <i>Public school teachers' knowledge, perception, and implementation of brain based learning practices</i> (Doctoral dissertation). Indiana University Pennsylvania. Retrieved from http://dspace.iup.edu/handle/2069/1908
Abstract	<p>The purpose of this study was to determine K-12 teachers' knowledge, beliefs, and practices of brain-based learning strategies in western Pennsylvania schools. The following five research questions were explored: (a) What is the extent of knowledge K-12 public school teachers have about the indicators of brain-based learning and Brain Gym?; (b) To what extent do K-12 public school teachers rate the value of brain-based learning and Brain Gym?; (c) To what extent do K-12 public school teachers report implementing brain-based learning indicators in their classrooms?; (d) What is the relationship between K-12 public school teachers' level of knowledge of brain-based learning and indicators of Brain Gym and their beliefs about brain-based learning?; (e) What is the relationship between gender, years of teaching experience, grade level being taught, and teachers' knowledge, perceptions, and implementation related to brain-based learning? The participants (N=256) included in this study consisted of K -12 public school teachers within three selected school districts in western Pennsylvania. The data was collected by using the Brain-Based Learning Survey Questionnaire (BBLSQ), developed by Shelley Klinek (2009), and was administered electronically using an online survey software program called Qualtrics. The survey was designed to measure participants' knowledge, beliefs, and practices of brain-based learning strategies. The results of the study indicate that teacher's knowledge of learning strategies are related to their beliefs about those strategies, as well as their instructional practices. It was further determined that teachers had positive attitudes towards learning new strategies; they feel it is important to demonstrate and show educators new ways of teaching; and they feel the need to be more adequately trained in the area of how the brain learns best. This study indicates that teachers are interested in how students learn best, and are willing to change their teaching practices to improve the learning process.</p>
Author	<p>Credentials: PhD in Education Position and Institution: Assistant professor and program coordinator for the undergraduate teacher education program in the department of kinesiology, health, and sport science. Publication History in Peer-Reviewed Journals: Limited</p>

Publication	Type of publication: Grey Literature Publisher: Indiana University of Pennsylvania
Date and Citation History	Date of publication: 2013 Cited By: 3
Stated Purpose or Research Question	“The purpose of this study was to determine K-12 teachers' knowledge, beliefs, and practices of brain-based learning strategies in western Pennsylvania schools.” (p. 2)
Author’s Conclusion	“This study indicates that teachers are interested in how students learn best, and are willing to change their teaching practices to improve the learning process.” (p. 12)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: The article directly relates to the I in our PICO project. It discusses the knowledge teachers have about Brain gym, the beliefs and implementation of Brain Gym in a specific school district. This article did not address our P, we did not have a C, but it did touch on our O in discussing participation from students depending on the teaching practices implemented by teachers.
Overall Quality of Article	Overall Quality of Article: Poor Rationale: This author is not reputable and has not published many works nor has he been cited frequently by other authors. The information appears valid and was published within the last 5 years.

Type of article	Overall Type: Primary Research Study Specific Type: Single Subject Quantitative study
APA Reference	Watson, A., & Kelso, G.L. (2014). The effect of Brain Gym on academic engagement for children with developmental disabilities. <i>International Journal of Special Education</i> , 29(2), 75-83.
Abstract	Following recent legislative initiatives in education requiring evidence-based practices, schools have implemented various instructional programs characterized as "evidence-based." However, it is important to question whether these methods are truly effective. One example of a methodology currently promoted and used in schools is an educational kinesiology program called Brain Gym®. Brain Gym® is reported to improve various education related skills. The purpose of this study is to investigate the effect of Brain Gym® on academic engagement for children with developmental disabilities. In this study, Brain Gym® was compared to an alternate intervention, simple physical activity, which did not conform to Brain Gym® guidelines. Neither intervention produced consistently positive effects for academic engagement. Based on these findings, it is questionable whether Brain Gym® can successfully be used with children with developmental disabilities to improve engagement. These results can inform the decision-making process of selecting evidence-based practices in education.
Author	Credentials: PhD Position and Institution: Stephen F. Austin State University Publication History in Peer-Reviewed Journals: limited
Publication	Type of publication: scholarly peer-reviewed journal Publisher: International Journal of Special Education
Date and Citation History	Date of publication: 2014 Google Scholar Cited By: 1
Stated Purpose or Research Question	“This study seeks to provide information that can be used by educators in order to decide whether Brain Gym® is an appropriate intervention for children with developmental disabilities.” (p. 3)
Author’s Conclusion	“The results of this study show that Brain Gym® does not produce clear and substantial differences in academic engagement when compared to a control (physical activity) intervention or baseline (unstructured fine motor activity) for children with developmental disabilities.” (p. 8)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Relevance

	Rationale: Directly related to the P (children with developmental disabilities), directly related to I (Brain Gym), directly related to the C (control group), and directly related to O (academic engagement).
Overall Quality of Article	Overall Quality of Article: Good Rationale: Author is not well established. Reputable journal and publisher. Publication within the last 10 years.

Type of article	Overall Type: Primary Research Study Specific Type: Quantitative
APA Reference	Kariuki, P, N., & Kent, H. D. (2014) <i>The effects of Brain Gym® activities and traditional teaching strategies on students' performance in comprehension in a 4th grade classroom</i> . Institute of Education Services. Retrieved from http://eric.ed.gov/?id=ED550515
Abstract	The purpose of this study was to examine the difference between students' scores in comprehension (English Language Arts) tests when they are led in Brain Gym® activities before class instruction and when they are taught using traditional teaching strategies. The sample for this study consisted of 11 males and 9 females. Data were collected by using Pearson Reading Comprehension tests. The students were tested after five days of receiving traditional teaching strategies and again after five days of participating in Brain Gym® activities before class instruction began. Data were analyzed using a paired t-test. The results indicated a significant difference in students' comprehension test scores when taught using Brain Gym® activities over the students' comprehension test scores who were taught using only traditional teaching strategies $t(19) = -5.461, P=0.001$. However, there was no significant difference between genders on performance. The results suggest that implementing Brain Gym® activities before instruction significantly influences comprehension scores; therefore, teachers are encouraged to use Brain Gym® activities to help improve their students' comprehension scores.
Author	Credentials: Kariuki-PhD in Education, Kent-PhD in Education Position and Institution: Kariuki- Teacher at Elementary school, Kent-Professor at Kent University Publication History in Peer-Reviewed Journals: Limited
Publication	Type of publication: Grey Literature Sponsoring Organization: Mid-South Educational Research Association
Date and Citation History	Date of publication: 2014 Cited By: 0
Stated Purpose or Research Question	“The purpose of this study was to examine the difference between students' scores in comprehension (English Language Arts) tests when they are led in Brain Gym® activities before class instruction and when they are taught using traditional teaching strategies.” (p.1)
Author's Conclusion	“The results suggest that implementing Brain Gym® activities before instruction significantly influences comprehension scores; therefore, teachers are encouraged to use Brain Gym® activities to help improve their students' comprehension scores.” (p. 10).

Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: This article does not relate to our P in our EBP PICO project, but it does directly relate to the intervention strategy of Brain Gym. We did not have a C and it somewhat relates to our O in that it broadly addressed occupational performance.
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: This article specifically discusses our intervention, but the authors are not very reputable. The article was published recently, within the last 10 years and the information provided appears reliable.

Type of article	Overall Type: Primary Research Study Specific Type: Clinical Cohort Study
APA Reference	DeLuca, S. C., Landesman, S. R., Trucks, M. R., Wallace, D. A. (2015) Multiple treatments of pediatric constraint-induced movement therapy: a clinical cohort study. <i>American Journal of Occupational Therapy</i> , 69(6). doi: 10.5014/ajot.2015.019323
Abstract	Pediatric constraint-induced movement therapy (pCIMT) is one of the most efficacious treatments for children with cerebral palsy (CP). Distinctive components of pCIMT include constraint of the less impaired upper extremity (UE), high-intensity therapy for the more impaired UE (3 hr/day, many days per week, for multiple weeks), use of shaping techniques combined with repetitive task practice, and bimanual transfer. A critical issue is whether multiple treatments of pCIMT produce additional benefit. In a clinical cohort (mean age 5 31 mo) of 28 children with asymmetrical CP whose parents sought multiple pCIMT treatments, the children gained a mean of 13.2 (standard deviation [SD] 5 4.2) new functional skills after Treatment 1; Treatment 2 produced a mean of 7.3 (SD 5 4.7) new skills; and Treatment 3, 6.5 (SD 5 4.2). These findings support the conclusion that multiple pCIMT treatments can produce clinically important functional gains for children with hemiparetic CP.
Author	Credentials: Deluca-PhD Position and Institution: Director of Neuromotor Research Clinic, Virginia Tech Research Institute, and Assistant professor in the Department of pediatrics. Publication History in Peer-Reviewed Journals: 0
Publication	Type of publication: Scholarly Peer Reviewed Journal Publisher: American Occupational Therapy Association Other: Official Journal of AOTA
Date and Citation History	Date of publication: 2015 Cited By: 1
Stated Purpose or Research Question	“Distinctive components of pCIMT include constraint of the less impaired upper extremity (UE), high-intensity therapy for the more impaired UE (3 hr/day, many days per week, for multiple weeks), use of shaping techniques combined with repetitive task practice, and bimanual transfer. A critical issue is whether multiple treatments of pCIMT produce additional benefit.” (p. 1)
Author’s Conclusion	“These findings support the conclusion that multiple pCIMT treatments can produce clinically important functional gains for children with hemiparetic CP.” (p. 6)

Overall Relevance to PICO	Overall Relevance to PICO: Limited Rationale: This article only relates to the I in our PICO project slightly since it mentions the intervention of movement therapy. This article does not address our population, we do not have a C and it does not address any of our outcomes.
Overall Quality of Article	Overall Quality of Article: Poor Rationale: These authors are not reputable, have not been cited by any other authors, and lack publications.

Type of article	Overall Type: Primary Research Study Specific Type: Survey Research
APA Reference	Ashburner, J., Rodger, S., Ziviani, J., Jones, J. (2013). Occupational therapy services for people with autism spectrum disorders: Current state of play, use of evidence and future learning priorities. <i>Australian Occupational Therapy Journal</i> , 61(2), 110-120. doi: 10.1111/1440-1630.12083
Abstract	A dramatic increase in the prevalence of autism spectrum disorders and increased funding to support children with autism spectrum disorders have added to the demand for occupational therapy services. This study explored current practices and future learning priorities of Queensland occupational therapists who work in this field. A survey in relation to occupational therapy services for people with autism spectrum disorders was distributed to all registered Queensland occupational therapists ($N = 2547$). The development of the survey was informed by a series of focus groups comprising occupational therapy clinicians, supervisors and academics. The survey covered demographics, caseload composition, collaboration, context/setting, service-delivery models, information gathering, goal setting, interventions, perceived challenges and confidence, use of evidence, and experience of professional development and support, and future learning priorities. Of 818 surveys returned, 235 respondents provided services to clients with autism spectrum disorders, with young children being more likely to receive a service than adolescents or adults. A pervasive focus on sensory processing was apparent in relation to assessment, intervention, and key areas of knowledge. Around half the respondents indicated that they lacked confidence at least some of the time. Autism spectrum disorders-specific experience was a significant predictor of confidence. Many therapists reported challenges in finding useful information in the literature and reliance on conferences or workshops as their main source of evidence. Commonly identified learning priorities included new developments in the field, early intervention, school support, sensory processing and clinical reasoning. This research highlights the need for comprehensive autism spectrum disorders-specific, face-to-face training focusing on evidence-based and occupation-centered practices.
Author	Credentials: Ashburner-PhD, BOccThy, Position and Institution: Occupational Therapists at University of Queensland in the School of Health and Rehab Sciences department. Publication History in Peer-Reviewed Journals: Substantial
Publication	Type of publication: Scholarly Peer Reviewed Journal Publisher: Occupational Therapy Australia Other: Australian Occupational Therapy Journal
Date and Citation History	Date of publication: 2013 Cited By: 153

Stated Purpose or Research Question	“A dramatic increase in the prevalence of autism spectrum disorders and increased funding to support children with autism spectrum disorders have added to the demand for occupational therapy services. This study explored current practices and future learning priorities of Queensland occupational therapists who work in this field” (p.110).
Author’s Conclusion	“The Research highlights the need for comprehensive autism spectrum disorders-specific, face-to-face training focusing on evidence-based and occupation-centered practices” (p. 120).
Overall Relevance to PICO	Overall Relevance to PICO: Limited Rationale: This article related to the population (P) in our PICO project by discussing children with Autism spectrum disorder, but did not have information about our intervention (I-Brain Gym) There was no C, and none of our Outcomes were mentioned throughout this article.
Overall Quality of Article	Overall Quality of Article: Strong Rationale: Publication within the last 5 years, authors are well known-reputable and established, author has been cited by many other authors, and are established in the healthcare field.

Type of article	Overall Type: Primary Research Study Specific Type: Quantitative research study; Randomized control trial
APA Reference	Taylor, A. E. (2009). <i>A study of the effects of Brain Gym exercises on the achievement scores of fifth-grade students</i> . (Doctoral dissertation). Retrieved from PsycINFO. (787010721; 2010-99170-425).
Abstract	<p>This study explored whether an intervention involving Brain Gym exercises designed to increase academic achievement in the areas of math and reading/language arts would be successful. Three groups were used in the study: an initial treatment group, a delayed treatment group, and a control group. Each of the three groups was comprised of 20 fifth-grade students. Students' ThinkLink global proficiency scores in math and reading/language arts were used as the measure of academic achievement. It was hypothesized that students in the initial and delayed treatment groups would demonstrate higher math and reading/language arts academic achievement as compared to students in the control group. These hypotheses were not supported. There were no significant differences in math or reading/language arts academic achievement among the three groups. This study further explored whether students in the initial treatment group would continue to engage in Brain Gym exercises once the researcher was no longer directly monitoring their participation. It was hypothesized that students in this group would self-initiate Brain Gym exercises at least 75% of the time. This hypothesis was supported. However, there was a significant difference between the percentage of students' self-initiation of Brain Gym exercises in their morning and afternoon classes. Potential reasons underlying these differential rates of self-initiation are explored. One conclusion that can be drawn from this study is that Brain Gym exercises are ineffective in increasing the math or reading/language arts academic achievement of fifth-grade students. However, the results of this study are in contrast with available research involving Brain Gym exercises and academic achievement. Further research is needed to determine whether Brain Gym exercises are more effective with students who have some form of learning challenge or disability and less effective with students who are academically average or above average in ability. Additional issues that may have impacted the results of this study are explored and recommendations for further research are presented.</p>
Author	Credentials: Ed. D. Position and Institution: The University of Memphis Publication History in Peer-Reviewed Journals: 0
Publication	Type of publication: Grey Literature Publisher: UMI Dissertation Publishing Other: Accepted Dissertation, available on ProQuest

Date and Citation History	2009 Google Scholar cited By:0
Stated Purpose or Research Question	“This study explored whether an intervention involving Brain Gym exercises designed to increase academic achievement in the areas of math and reading/language arts would be successful” (p. iv)
Author’s Conclusion	“One conclusion that can be drawn from this study is that Brain Gym exercises are ineffective in increasing the math or reading/language arts academic achievement of fifth-grade students.” (p. iv)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: Evaluates the efficacy of Brain Gym as an intervention model (O) but focuses on school achievement instead of participation or performance. This study also has a different P (regular education school, not children with autism or special needs). Directly relates to the I (Brain Gym). No C group.
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: This dissertation was reviewed and accepted for a Doctorate degree. Published within the last 10 years. However, not published in a peer reviewed journal, cited by any other articles and the author is not established.

Type of article	Overall Type: Primary Research Study Specific Type: Quantitative; single subject design
APA Reference	Inder, J., & Sullivan, S. (2004). Does an educational kinesiology intervention alter postural control in children with a developmental coordination disorder? <i>Clinical Kinesiology: Journal of the American Kinesiotherapy Association</i> , 58(4), 9-26.
Abstract	The purpose of this study was to examine the effect of selected Educational Kinesiology (Edu-K) techniques on the postural responses of four children with a Developmental Coordination Disorder (DCD). METHODS: Four children with DCD, aged 9-12 years, participated in a single subject, multiple baseline research study with baseline, intervention and follow -up phases. The Edu-K intervention consisted of an individualized Laterality Repatterning process, and a series of four Brain Gym(R) activities known as PACE, in a daily home program. Selected questionnaires and pre-tests were administered to provide a descriptive profile of the children's background and motor performance, followed by a series of computerized Sensory Organization Tests (SOT) during each phase. RESULTS: Two of the four children demonstrated improved performance ($p < .05$) at follow-up, with evidence of improved performance in the other two children in the SOT composite equilibrium scores. A decrease in the number of falls ($p < .05$) was seen in all four children. Results also indicate some improvement in sensory system (somatosensory, visual and vestibular) scores, and sensory integration/organization during the series of six SOT sensory conditions. CONCLUSIONS: The Edu-K techniques may have been effective in improving postural responses in these four children with DCD, although the possibility of 'learning' with repetition of SOT testing cannot be discounted. Further research in different populations and settings using single subject and group designs are needed to examine the efficacy of these intervention techniques.
Author	Credentials: Physiotherapist, NZRP, Dip Phty, M Phty, Registered Educational Kinesiologist/ Brain Gym® Instructor, Craniosacral Therapist Position and Institution: School of Physiotherapy, University of Otago, Dunedin, New Zealand Publication History in Peer-Reviewed Journals: limited
Publication	Type of publication: scholarly peer-reviewed journal Publisher: American Clinical Kinesiology Association
Date and Citation History	2004 Google Scholar cited By:3

Stated Purpose or Research Question	“The purpose of this study was to examine the effect of selected Educational Kinesiology (Edu-K) techniques on the postural responses of four children with a Developmental Coordination Disorder (DCD)” (p.9)
Author’s Conclusion	“The Edu-K techniques may have been effective in improving postural responses in these four children with DCD, although the possibility of 'learning' with repetition of SOT testing cannot be discounted. Further research in different populations and settings using single subject and group designs are needed to examine the efficacy of these intervention techniques” (p. 9)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Relevance Rationale: Moderately related to the P (children with developmental coordination disorder, not children with Autism) and directly related to I (Brain Gym). Limited relevance to O (postural responses) and there was no C.
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: Publication within the last 12 years. Author is not well established. Reputable journal and publisher.

Type of article	Overall Type: Primary Research Study Specific Type: Quantitative; randomize control trial
APA Reference	Nussbaum, S. (2010). <i>The effects of "brain gym" as a general education intervention: Improving academic performance and behaviors</i> . (Doctoral dissertation). Retrieved from EBSCOhost (ED517276).
Abstract	<p>Individuals with Disabilities Education Act" ("IDEA") and "No Child Left Behind" ("NCLB") now mandate that all at-risk students receive empirical, scientific research-based interventions. "Brain Gym" is a movement-based program designed to address a diverse range of students' academic and behavior needs by promoting whole-brain learning. However, the scientific research base supporting "Brain Gym" is limited and findings are inconclusive. The goal of this study was to evaluate the effects of Dennison's 26 "Brain Gym" movements as a tier-one Response to Intervention (RtI) and a class-wide general education intervention on primary grade-level students' (the at-risk population as well as the overall population) academic performance and behaviors as measured by the "TAKS Reading," "TAKS Math," and "BASC-II" instruments. To accomplish this goal, an eight-month quantitative posttest experimental study with random assignment of 364 second through sixth grade students to classrooms and random assignment of participating classrooms to control and experimental groups was implemented in a school district located in East Texas. Based on two-tailed independent sample t tests at a 95% confidence level ($\alpha = 0.05$), at-risk students demonstrated statistically significant gains in reading, $t(66) = -2.13$, $p = 0.04$, and math, $t(71) = -2.42$, $p = 0.02$, after receiving "Brain Gym" as a tier-one RtI academic intervention. Similarly, students who received "BrainGym" as a general education classroom management strategy demonstrated statistically significant improvements in maladaptive behaviors (e.g., aggression, hyperactivity, inattention, depression, anxiety, somatization, and atypicality), $t(46) = -2.71$, $p = 0.01$, and adaptive behaviors (e.g., social skills, functional communication, and adaptability), $t(46) = -2.95$, $p = 0.01$. Therefore, educators may confidently use "Brain Gym" as a tier-one RtI reading and math intervention and a general education classroom management strategy for primary grade-level students. Further research is needed to explore the efficacy of "Brain Gym" with secondary and special population students.</p>
taylAuthor	Credentials: Ed.D. Position and Institution: Northcentral University Publication History in Peer-Reviewed Journals: limited
Publication	Type of publication: Grey Literature Publisher: <i>UMI Dissertation Publishing</i> Other: Publishing company of ProQuest

Date and Citation History	Date of publication: 2010 Google Scholar Cited By: 2
Stated Purpose or Research Question	“The purpose of this quantitative experimental study was to examine the effects of Dennison's 26 'Brain Gym' movements as a tier-one Rtl and a class-wide general 8 education intervention on primary grade-level students' (the at-risk as well as the overall population) academic performance and behaviors as measured by the TAKS Reading, TAKS Math, and BASC-II instruments (Dennison, 2003).” (p. 7-8)
Author's Conclusion	“According to the results of the independent samples two-tailed t tests with equal variance assumed, there were no significant differences between control and experimental 2008 TAKS reading or the math standard scores (see Table 1). Therefore, the control and experimental groups' reading or math performance on the TAKS test did not have significant pre-existing differences before implementing 'Brain Gym' as an intervention. Any significant differences between the groups' performance on the 2009 TAKS tests are thus not likely due to pre-existing differences.” (p. 96)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Relevance Rationale: Moderately related to the P (primary grade-level students), directly related to the I (Brain Gym), directly related to the C (control group), and directly related to the O (performance in school).
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: Author is not well established as this is a Doctoral dissertation. Publication within the last 10 years.

Initial Appraisal: Review of Research Studies

Type of article	Overall Type: Review of Research Studies Specific Type: Systematic Review
APA Reference	Stephenson, J. (2009). Best practice? Advice provided to teachers about the use of Brain Gym® in Australian schools. <i>Australian Journal of Education</i> , 53(2), 109-124. Retrieved from http://go.galegroup.com/ps/i.do?p=EAIM&sw=w&u=clic_stkate&v=2.1&it=r&id=GALE%7CA211431855&sid=summon&asid=bb0be8848f4cef8701bf6a5f0a59cdcc
Abstract	Perceptual motor programs continue to be used in Australian schools despite evidence showing they do not influence academic learning. Brain Gym is one perceptual motor program that is used in schools in Australia and overseas. There is little evidence to support the claims made about the benefits of Brain Gym; its theoretical underpinning has been subject to criticism by neuroscientists. A search was made of Internet sites, including state department of education sites to locate information provided to teachers about Brain Gym. Although education departments and others responsible for providing advice and professional development to teachers espouse research-based practice, they continue to endorse and support the use of Brain Gym.
Author	Credentials: PhD Position and Institution: Associate Professor, Macquarie University Special Education Center Publication History in Peer-Reviewed Journals: extensive
Publication	Type of publication: Scholarly peer-reviewed journal Publisher: Sage
Date and Citation History	2009 Google Scholar cited By: 20
Stated Purpose or Research Question	“Searches were carried out to locate materials relevant to Brain Gym® on Australian sites on the Internet that teachers might encounter in their search for professional development or might consult to find information about the effectiveness of educational practices.” (p.112)
Author’s Conclusion	“The kindest thing that could be suggested about Brain Gym® is that doing the Brain Gym® exercises provides a break that may increase alertness.” (p. 119) “All state and territory education departments [In Australia] provided some level of explicit support for the use of Brain Gym® in schools, and that no source

	provided information about independent, empirical research on Brain Gym.” (p. 118)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: Directly related to the O (efficacy of brain gym) but focuses on academic performance. Directly examines our I (Brain Gym). Not directly related to the P, as it focuses on its use in Australia and focuses on its use in a regular educational setting, not those with autism or special needs. There is no C group.
Overall Quality of Article	Overall Quality of Article: Good Rationale: Cited by many sources, established author, credible publisher, publication within last 10 years

Type of article	Overall Type: Review of Research Studies Specific Type: Systematic Review
APA Reference	Case-Smith, J., Arbesman, M., (2008). Evidence-Based review of interventions for autism used in or of relevance to Occupational Therapy. <i>American Journal of Occupational Therapy</i> , 62(4):416-429. doi: 10.5014/ajot.62.4.416.
Abstract	Occupational therapy practitioners are among the professionals who provide services to children and adults with autism spectrum disorder (ASD), embracing both leadership and supportive roles in service delivery. The study's primary aims were as follows: (1) to identify, evaluate, and synthesize the research literature on interventions for ASD of relevance to occupational therapy and (2) to interpret and apply the research literature to occupational therapy. A total of 49 articles met the authors' criteria and were included in the review. Six categories of research topics were identified, the first 3 of which are most closely related to occupational therapy: (1) sensory integration and sensory-based interventions; (2) relationship-based, interactive interventions; (3) developmental skill-based programs; (4) social cognitive skill training; (5) parent-directed or parent-mediated approaches; and (6) intensive behavioral intervention. Under each category, themes supported by research evidence and applicable to occupational therapy were defined. The findings have implications for intervention methods, communication regarding efficacious practices to professionals and consumers, and future occupational therapy research.
Author	Credentials: EdD, OTR/L, FAOTA Position and Institution: Professor and Chair, Division of Occupational Therapy, School of Allied Medical Professions, The Ohio State University Publication History in Peer-Reviewed Journals: moderate
Publication	Type of publication: Scholarly peer-reviewed journal Publisher: American Occupational Therapy Association (AOTA) Other: Official journal of AOTA
Date and Citation History	2008 Google Scholar cited By: 174
Stated Purpose or Research Question	"The study's primary aims were as follows: (1) to identify, evaluate, and synthesize the research literature on interventions for ASD of relevance to occupational therapy and (2) to interpret and apply the research literature to occupational therapy. " (p. 416)
Author's Conclusion	"Sensory-based interventions, such as those that provide therapeutic touch, can decrease maladaptive behaviors, reduce hyperactivity, inhibit self-stimulation and stereotypic movements, and improve attention and focus

	<p>(Escalona, Field, Singer-Strunck, Cullen, & Hartshorn, 2001; Field et al., 1997)” (p .419)</p> <p>“Most scholars recommend use of sensory-based interventions as one component of a comprehensive intervention that uses a variety of methods to promote performance (Baranek, 2002; Greenspan & Wieder, 1997).” (p. 419)</p> <p>“Relationship-based interventions (e.g., Hwang & Hughes, 2000) that use adult imitation of the child’s actions, implement high levels of positive responsiveness, apply prompting and cueing, facilitate peer interactions, establish environments that support social interaction, and demonstrate positive effects on social engagement in children with ASD.” (p. 420)</p> <p>“Structured play activities, such as block construction or games that include cueing, prompting, and reinforcement, are effective interventions to enhance turn-taking, sharing, communication, and social interaction in children with ASD (Legoff, 2004).” (p. 420)</p> <p>“Intervention emphasizing responsive, supportive relationships, and social–emotional development in young children can facilitate the child’s social–emotional growth and promote development of pivotal behaviors essential for learning (Greenspan & Wieder, 1997; Mahoney & Perales, 2005; Wieder & Greenspan, 2005).” (p. 420)</p> <p>“Programs that emphasize a developmental, play-based approach that emphasizes positive affect, nonverbal communication play, social relationships, and classroom structure have small positive effects (Rogers, Herbison, Lewis, Pantone, & Rels, 1986).” (p. 421)</p> <p>“Cognitive-based social skills training in which simple, discrete steps of social–emotional skills are explained, modeled, and practiced appears to have modest, positive effects (Ozonoff & Miller, 1995).” (p. 422)</p>
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: This articles strongly related to our comparison group (other, evidence based interventions for ASD). This article relates to the P (children with autism) and the O (outcomes of intervention) but addresses interventions other than brain gym (the I).
Overall Quality of Article	Overall Quality of Article: Good Rationale: Article cited by many sources, well established author, credible publisher, publication within last 10 years.

Type of article	Overall Type: Review of research studies Specific Type: Systematic Review
APA Reference	Hyatt, K. J. (2007). Brain Gym®: Building stronger brains or wishful thinking? <i>Remedial and Special Education</i> , 28(2), 117-124. doi:10.1023/A:1016052026435
Abstract	As part of the accountability movement, schools are increasingly called upon to provide interventions that are based on sound scientific research and that provide measurable outcomes for children. Brain Gym is a popular commercial program claiming that adherence to its regimen will result in more efficient learning in an almost miraculous manner. However, a review of the theoretical foundations of Brain Gym and the associated peer-reviewed research studies failed to support the contentions of the promoters of Brain Gym. Educators are encouraged to become informed consumers of research and to avoid implementing programming for which there is neither a credible theoretical nor a sound research basis.
Author	Credentials: EdD Position and Institution: Assistant Professor of Special Education at Western Washington University Publication History in Peer-Reviewed Journals: moderate
Publication	Type of publication: scholarly, peer-reviewed journal Publisher: Sage Other: Journal impact factor: 2.016
Date and Citation History	2007 Google Scholar cited By: 88
Stated Purpose or Research Question	“The specific purposes of this article are (a) to review the theoretical bases and research findings on which the developers of Brain Gym® base the claim that their movement activities will enhance learning and (b) to determine whether those activities are scientific, research-based practices.” (p. 117)
Author’s Conclusion	“A review of the theoretical foundations of Brain Gym® and the associated peer-reviewed research studies failed to support the contentions of the promoters of Brain Gym®.” (p. 117)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Rationale: This study relates to the O (the efficacy of brain gym). Directly relates to the I (Brain Gym). It is a review of the literature on brain gym so it is not targeted at children with autism (the P). No C group.

Overall Quality of Article	Overall Quality of Article: Good Rationale: Article cited by many sources, moderately established author. Article is a comprehensive and logical review of brain gym literature. Credible publisher, publication within last 10 years.
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Type of article	Overall Type: Review of Research Studies Specific Type: Systematic Review
APA Reference	Spaulding, L. S., Mostert, M. P., & Beam, A. P. (2010). Is Brain Gym® an effective educational intervention? <i>Exceptionality</i> , 18(1), 18. doi: 10.1080/09362830903462508
Abstract	Brain Gym (BG; BGI, 2008) is a popular commercial program sold by Brain Gym International (BGI). Making extravagant claims for improved intellectual and physical development, it is used in more than 80 countries. While BGI's claims are persuasive, to date there is little empirical evidence validating the approach. We examine some theoretical assumptions from which BGI was developed, review the efficacy literature, and provide suggestions for making informed decisions about the judiciousness of investing time and resources in this program.
Author	Credentials: Ph.D Position and Institution: Associate Professor, School of Education, Liberty University Publication History in Peer-Reviewed Journals: extensive
Publication	Type of publication: scholarly peer-reviewed journal Publisher: Taylor and Francis Online Other: <i>Exceptionality</i> is a special education journal
Date and Citation History	2010 Google Scholar cited By: 27
Stated Purpose or Research Question	"We examine some theoretical assumptions from which BGI was developed, review the efficacy literature, and provide suggestions for making informed decisions about the judiciousness of investing time and resources in this program)" (p.2)
Author's Conclusion	"BGI [Brain Gym International] was founded on long-invalidated theoretical assumptions, and second, there are no high quality, empirical research studies validating its claims." (p. 16)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Rationale: This study provides a comprehensive review of the efficacy of brain gym, relating to our O. It focuses on school achievement instead of participation or performance. It relates to our P (children with special needs). Directly examines our I (Brain Gym). No C group.
Overall Quality of Article	Overall Quality of Article: Good Rationale: Established author, credible publisher, cited by other articles, publication within last 10 years.

Type of article	Overall Type: Review of Research Studies Specific Type: Scoping Review
APA Reference	Kroeze, K., Hyatt, K., Lambert, C. (2015). Brain Gym: Let the user beware. <i>Journal of Interactive Learning Research</i> , 26(4), 395-401.
Abstract	As part of the No Child Left behind Act of 2001 and the Individuals with Disabilities Education Improvement Act of 2004, schools are called upon to provide students with academic instruction using scientific, research-based methods whenever possible. One of these supposed research-based methods is a program by the name of Brain Gym®. Brain Gym® is a popular commercial program claiming that adherence to its regimen of carrying out certain movements will result in more efficient learning in an almost miraculous manner. Although being particularly popular, Brain Gym® itself has failed to support the contentions of the promoters. For this reason, educators are encouraged to become informed consumers and avoid implementing programs for which there is neither credible theoretical nor a sound research basis.
Author	Credentials: Bachelor degree in Special Education Position and Institution: Student at Western Washington University in Special Education Program Publication History in Peer-Reviewed Journals: limited
Publication	Type of publication: scholarly peer-reviewed journal Publisher: Association for the Advancement of Computing in Education Other: Journal of the Association for the Advancement of computing in Education
Date and Citation History	2015 Google Scholar Cited By: 0
Stated Purpose or Research Question	“While there is debate in the field regarding the level of scientific rigor needed for a particular methodology to be judged as evidence-based or research-based, there are general guidelines that can be used by individuals who may not have a high level of training in research methodology to determine the likelihood that a particular intervention may have merit” p.395-396)
Author’s Conclusion	“In conclusion, given the limited time children are able to spend in the classroom environment, educators need to implement practices that have been validated by empirical research and not waste valuable time participating in the nuisance of Brain Gym or other pseudoscientific interventions that claim to provide a magical cure for all that ails humanity” (p. 400).

Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: Directly related to the P (children with disabilities and I (Brain Gym). Does not have a C (control group), but is directly related to O (efficient learning).
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: Author is not well established. Reputable journal and publisher. Publication within last 10 years.

Initial Appraisal: Conceptual or Theoretical Articles

Type of article	Overall Type: Theoretical Article Specific Type: Theoretical framework for the pathways of executive function
APA Reference	Garg, S., & Koenig, K. (2015). The effectiveness of the get ready to learn program in improving executive functions in children with disabilities. <i>American Journal of Occupational Therapy</i> , 69. doi:10.5014/ajot.2015.69S1-PO2081
Abstract	There is a huge gap in the literature when it comes to studies done to evaluate the effects of yoga-based interventions on executive functions. In the current study, we bridge this gap and enhance understanding of yoga-based interventions to explore their use as a therapeutic intervention.
Author	Credentials: MS, OTR/L Position and Institution: Adjunct Faculty/PhD candidate, Program in Occupational Therapy, New York University Publication History in Peer-Reviewed Journals: <i>limited</i>
Publication	Type of publication: Scholarly peer-reviewed journal Publisher: American Occupational Therapy Association Other: Official Journal of the AOTA
Date and Citation History	2015 Google Scholar Cited By: 0
Stated Purpose or Research Question	“This study will clarify whether the yoga-based GRTL intervention improves executive functions (working memory, inhibition, and attention) in students with disabilities, which significantly influence a child’s ability to learn effectively and function adaptively—a major concern within the occupational therapy practice.” (n.p.)
Author’s Conclusion	“The results will not only encourage evidence-based practice in the field of occupational therapy but will also provide practicing occupational therapists with a proven therapeutic modality to address executive functions in children with disabilities.” (n.p.)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Relevance Rationale: Directly related to the P (children with disabilities), but targeted to a different I (yoga not Brain Gym). Not related to the C (control group) and directly related to the O (attention).
Overall Quality of Article	Overall Quality of Article: Moderate Rationale: Author is not well established. Reputable journal and publisher. Publication within the last 10 years.

Type of article	Overall Type: Conceptual Article Specific Type: Neurodevelopment Mechanisms of Autism.
APA Reference	Walsh, C. A., Morrow, E. M., & Rubenstein, J. L. (2008) Autism and brain development. <i>Cell Press</i> , 135(3), 396-400. http://dx.doi.org/10.1016/j.cell.2008.10.015
Abstract	Genetic studies are refining our understanding of neurodevelopmental mechanisms in autism. Some autism-related mutations appear to disrupt genes regulated by neuronal activity, which are especially important in development of the postnatal nervous system. Gene replacement studies in mice indicate that the developmental window to ameliorate symptoms may be wider than previously anticipated.
Author	Credentials: Walsh-MD Neurology Position and Institution: Professor of pediatrics and neurology at Boston's Children's Hospital Publication History in Peer-Reviewed Journals: Substantial
Publication	Type of publication: Journal Article Publisher: Elsevier Inc. Other: Published in <i>Cell Press</i>
Date and Citation History	Date of publication: 2008 Cited By: 143
Stated Purpose or Research Question	"Yet, a key question about autism is at what stage during brain development does the primary lesion occur?" (p. 396).
Author's Conclusion	"The later onset of autism-specific defects in synaptic activity is an optimistic sign that, if we can develop medications to modulate these synaptic changes, we may be able to provide better therapies for this devastating disorder." (p. 399).
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Rationale: This article specifically discusses our population of autism, but does not directly relate to our intervention of Brain Gym, rather the development of children with Autism. We do not have a C, and this article does not address any of our outcomes for our EBP PICO project.
Overall Quality of Article	Overall Quality of Article: Moderate This author appears to be very reputable and has been cited substantially by other authors. Article published within the last 10 years.

Brain Gym® was not reviewed by the Wisconsin Treatment Intervention Advisory Committee.

Critical Appraisals

Watson, A., & Kelso, G.L. (2014). The effect of Brain Gym® on academic engagement for children with developmental disabilities. *International Journal of Special Education*, 29(2), 75-83.

Nussbaum, S. (2010). The effects of “brain gym” as a general education intervention: Improving academic performance and behaviors. (Doctoral dissertation). Retrieved from EBSCOhost (ED517276). DOI number not assigned.

Hyatt, K. J. (2007). Brain Gym®: Building stronger brains or wishful thinking? *Remedial and Special Education*, 28(2), 117-124. doi:10.1023/A:1016052026435

Makoto Therapy

Executive Summary

Final EBP question and PICO.

Are the comprehensive treatment models (CTM) Makoto Therapy, Brain Gym, and Interactive Metronome effective interventions for improving occupational performance including improving executive function, academic performance, and physical coordination in children and adolescents with Autism Spectrum Disorder (ASD)?

	Keywords	More Broad And Narrow Keywords	Keyword Synonyms, abbreviations, and spelling variants
P Patient / Population / Problem	Autism Cognition Coordination Children/adolescents with Autism Spectrum Disorder (ASD)	Developmental Disorders Children with disabilities Autism Spectrum Disorder (ASD) Neurodevelopmental Disorders	Autistic Balancing Processing ASD Youth, kids Students
I Intervention	Occupational Therapy, Brain Gym, Interactive Metronome, Makoto Arena Therapy	Rehabilitation Movement Education Therapeutic Exergame Fitness arena Active video games	OT Movement Therapy Participate
C Comparison	Current Protocol for treatment Control group		
O Outcome	Reaction Time Participation Occupational Performance Performance in School Motor coordination Focus/attention Hand/eye coordination Cross body movement	Function Coordination Education/ learning Balance Executive Function Movement Exercise Activity	Distractibility Leisure Play

Themes

Makoto USA claims that Makoto Arena increases executive function and motor integration (Makoto USA, n.d.). However, our research produced very few studies that used the Makoto Arena in therapy, and only two studies that used it as an intervention for children with autism spectrum disorder. Although the studies of the Makoto Arena intervention for children with ASD reported changes in executive function and motor coordination in their participants, both studies were performed by the same author, did not contain control groups, reported small sample sizes, and results have not been replicated. Multiple studies have explored movement therapies as an intervention for children and adolescents with ASD. However, due to a level 4 determination from the *Wisconsin Treatment Advisory Committee*, excessive startup costs, and lack of peer reviewed evidence, we do not recommend the Makoto Arena as an intervention in clinical practice until further research is conducted.

Description of Intervention.

The Makoto Arena is exercise equipment that is used for performance training. The company that markets the equipment, Makoto USA, describes key characteristics of the intervention. (MakotoNow, n.d.). The arena has three steel, six or eight feet tall pillars arranged in a triangle of the same distance apart. Each pillar has an array of 16 sensors, LED lights, and speakers controlled by a computer. During a game, a light on one of the pillars flashes accompanied by tone cueing location of the light. The player must tap the correct sensor to accrue points. The arena has 11 levels adaptable to the player's skill level. The manufacturer promotes this product as a technology that enhances visual, cardiovascular, and neurological performance through improved physical condition, balance, cognitive function, range of motion, working memory and focus (MakotoNow, n.d.). This exergame has been used by athletes,

diverse populations with special needs such as autism, ADD, and ADHD, rehabilitation patients and the military. (MakotoNow, n.d.). There are no recommendations for duration or frequency of use and equipment cost is \$15,000 (MakotoNow, n.d.).

Developers/ Proponents, Researchers, and Organization/ Company.

Makoto was patented in 1993 by Paul R. Russell and Alys Hassenforder as an active light and sound game called “Real encounter game for balancing the body, mind and spirit” (U.S. Patent No. 5,271,627, 1993). Today, the company Makoto U.S.A owns the technology and promotes the product on their website, outlining uses for rehabilitation, athletic training, and people with special needs (Makoto USA, n.d.). Multiple companies throughout the country act as distributors for the Makoto Arena. Claudia List Hilton is the principal investigator for the two studies that investigate the effects of the Makoto Arena on individuals with autism spectrum disorder (Hilton et al, 2014; Hilton et al., 2015). Hilton is a Doctor in Occupational Therapy; Occupational Therapist Registered, Licensed; Master of Business Administration; and State Registered Occupational Therapist and is an assistant professor of occupational therapy at the University of Texas Medical Branch, Galveston, Texas (UTMB Health, 2016). The majority of her publications review interventions for ASD published in the American Journal of Occupational Therapy (The American Journal of Occupational Therapy, n.d.).

Description of the Quality and Quantity of Available Evidence.

Most of the information available about therapy using the Makoto Arena came from marketing information from the Makoto company (Makoto USA, n.d.; MakotoNow, 2016), and there is limited peer reviewed research on the Makoto Arena and even less linking it to interventions for ASD. Research produced three conceptual articles, two of which had moderate relevancy to our PICO question (Cai & Kornspan, 2012; Kee, 2014) and one had poor author

credentials due to research malpractice (Chia & Li, 2012). The articles were not directly related to Makoto Therapy, but involve exergaming and special needs populations, ASD included. Eleven primary research articles were found and only two had a direct connection to children and adolescents with ASD and Makoto therapy (Hilton et al., 2014; Hilton et al., 2015). The remaining articles moderately related to Makoto therapy (Xbox, exergaming, exercise, etc.) or did not contain data on children or adolescents with ASD. Out of four systematic review articles found, three articles were peer reviewed. Only one article had strong relevance to our PICO, but the article had poor quality. The remaining articles had different populations (elderly, obesity in youth) or a different intervention than addressed in our EBP question.

Expert Review Table.

Table 5.

Summary of Evidence and Recommendations by Expert Review Groups for The Makoto Arena

Review Organization	Summary and Recommendations	Citation and Source
Wisconsin Treatment Intervention Advisory Committee	Not Reviewed	Wisconsin Department of Health Services Autism and Other Developmental Disabilities Treatment Intervention Advisory Committee (2016). https://tiac.wisconsin.gov/summary-determinations-regarding-level-evidence.htm
Evidence-Based Practices for Children, Youth, and Young Adults with Autism Spectrum Disorder	Makoto was not reviewed, but the broad category of exercise was reviewed. The review reports that exercise can be used to enhance motor skills and behavior as well as increase academic performance.	Wong, C., Odom, S. L., Hume, K. Cox, A. W., Fettig, A., Kucharczyk, S., ... Schultz, T. R. (2013). <i>Evidence-based practices for children, youth, and young adults with Autism Spectrum Disorder</i> . Chapel Hill: The University of North Carolina, Frank Porter Graham Child Development Institute, Autism Evidence-Based Practice Review Group. http://autismpdc.fpg.unc.edu/sites/autismpdc.fpg.unc.edu/files/2014-EBP-Report.pdf
Association for Science in Autism Treatment (ASAT)	Makoto was not reviewed, but the broad category of recreational sports was reviewed. The review concluded that participation in exercise may provide benefits to behavior regulation, social interaction, and enjoyment for children	Association for Science in Autism Treatment (n.d.) Treatments in alphabetical order. (http://www.asatonline.org/for-parents/learn-more-about-specific-treatments/treatments-in-alphabetical-order/)
Cochrane Collaboration	Not Reviewed	Cochrane Collaboration (2016). http://www.cochrane.org/
U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services.	Makoto Therapy not specifically stated. Exercise reported as unestablished intervention. Reported benefits in reducing	U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services. (2010). Autism spectrum disorders (ASDs) services final report on environmental scan. Retrieved from

Review Organization	Summary and Recommendations	Citation and Source
	problem behaviors in school children. Only reviewed in one study.	http://www.impaqint.com/sites/default/files/files/Autism_Spectrum_Disorders.pdf
National Autism Center	Not reviewed	National Autism Center (2015). National Standards Project, Phase 2. Retrieved from http://www.nationalautismcenter.org/national-standards-project/phase-2/
American Academy of Pediatrics	Not reviewed	Myers, S. M., & Johnson, C. P. (2007). Management of children with autism spectrum disorders. <i>Pediatrics</i> , <i>120</i> (5), 1162-1182. http://pediatrics.aappublications.org/content/pediatrics/120/5/1162.full.pdf

Summary and Review of Current Evidence.

We refined our research to the three most relevant and highest quality articles to our EBP question. Hilton et al. (2014) used the Makoto Arena intervention for children/adolescents with ASD. The results report changes to executive functioning and motor ability in this population. The study was a non-randomized pre-test/post-test with a small sample size of 7. Pan et al. (2016) used a table-tennis intervention for 22 children with ASD. At the end of the 12-week intervention, participants had improved motor skills and executive function. This study included only a small sample size. Huang (2011) conducted a study comparing the use of a virtual Wii exergame with traditional sensory integration occupational therapy for children with Downs Syndrome. Results of sensorimotor tests showed that the virtual reality Wii intervention resulted in a greater improvement of sensory integration with motor response for the participants. The researchers reported limitations in the differences of intensity and frequency of home practice and the need for a long term follow up to replicate results and demonstrate the correlation between skill improvements and P.E. performance in school. Only one of the primary research studies (Hilton et al., 2014) directly related to the EBP question, although it had a small sample size. The other two studies (Pan et al., 2016; Huang, 2011) only addressed parts of the EBP question, with Pan et al. (2016) using participants with ASD but in a different exercise intervention and Huang (2011) using participants with a different population than children with ASD, but with an exergame-style intervention. Most available relevant research involves different types of movement-based therapy with a wide range of populations. Researchers have yet to replicate the findings of the Hilton et al. (2014) study designed to use the Makoto Arena as an intervention for children with ASD, which is directly relevant to this review.

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<http://patft.uspto.gov/netacgi/nphParser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=%2Fmetahtml%2FPTO%2Fsrchnum.htm&r=1&f=G&l=50&s1=5271627.PN.+A000000.PN.&OS=PN/5271627+OR+PN/A000000&RS=PN/5271627+OR+PN/A000000>

Background Learning and Evidence Searches

Table 6.

Electronic Sources Addressing Makoto Therapy in Relation to Autism Treatment

Title/Name	Brief Description	Source
MakotoNow	Easy to navigate website-company that rents out Makoto equipment Description of how Makoto works and benefits for individuals with special needs. Contains testimonials about benefits of therapy http://www.makotonow.com/	MakotoNow Private Company
American Journal of Occupational Therapy	Peer-reviewed journal. Publishes evidence-based research pertaining to occupation studies and reviews of occupational therapy of interventions Occupational therapy practitioner-oriented. Accessed through membership to the American Occupational Therapy Association www.aota.org	American Occupational Therapy Association
United States Patent and Trademark Office Full-Text and Image Database	Public database containing all United States patents since 1790. Searchable by issue date, patent number, and current classification http://patft.uspto.gov/metahtml/PTO/index.html	United States Patent and Trademark Office Department of Commerce United States Government
Journal of Sports and Exercise Medicine	Peer reviewed journal publishing original research pertaining to sports and exercise medicine. http://clinmedjournals.org/International-Journal-of-Sports-and-Exercise-Medicine.php	ClinMed International Library

Alternative and
Complementary Therapies

Peer reviewed research journal focusing on
alternative and complementary therapies.
[http://www.liebertpub.com/overview/alternative
-and-complementary-therapies/3/](http://www.liebertpub.com/overview/alternative-and-complementary-therapies/3/)

Mary Ann
Liebert, Inc.

Background learning paper one.

This EBP project will focus on three different movement-based interventions for individuals with autism. Background learning on movement-based interventions for autism focused on Makoto therapy and its origins, its uses in different areas of training and rehabilitation, and its use as a tool in autism interventions.

Makoto began in the 1990s as an active light and sound game. Makoto was patented in 1993 by Paul R. Russell and Alys Hassenforder as “Real encounter game for balancing the body, mind and spirit” (U.S. Patent No. 5,271,627, 1993). The game consists of three obelisks arranged in an equilateral triangle. A lighted target appears on the surface of one of the obelisks accompanied by a sound. The player then needs to hit the light target with a padded stick. A correct hit is acknowledged with a musical tone (U.S. Patent No. 5,271,627, 1993).

Makoto has been used in athletic training, the military, rehabilitation, and research. Makoto has been used in training for sports because of its claims to decrease reaction times and improve accuracy and agility; professional sports teams including the Denver Nuggets, Pittsburgh Pirates, and St. Louis Cardinals utilize the technology in training and tryouts (MakotoNow, 2016). Its listed benefits for sports also include increased coordination and “systemic improvement in the performance of the brain and central nervous system” (Makoto USA, n.d., n.p.). For these same reasons, the United States military has also utilized Makoto in training at the “Air Force Academy, Special Forces Training, and the Naval Warfare Center” (Makoto USA, n.d., n.p.).

Makoto has also been used in rehabilitation. Makoto USA, the company who owns Makoto, outlines their suggestions for areas of use in rehabilitation and proposes the theoretical framework that they use to support these claims. The company asserts that Makoto can be useful

in rehabilitative therapies for “stroke, concussions, traumatic brain injuries, sensory processing disorder, depression, ADD, and ADHD” (Makoto USA., n.d., n.p.). This is based on the idea of neuroplasticity as well as research pertaining to interventions using similar methods of integration of sound, visual stimuli, and full body movement (Makoto USA, n.d., n.p.). Makoto Now, one of the distributors of the Makoto Arena, reports that Makoto has been used in rehabilitation clinics and hospitals in Alabama, Colorado, New Mexico, Oklahoma, Illinois, and Maryland (MakotoNow, 2016).

Furthermore, Makoto can be used as a research tool. The technology used in Makoto tracks and records reaction time which has led to some applications in research (Makoto USA., n.d.). Therefore, it has been used as a measurement tool in research, for example to test reaction time in a study that looked at the effects of static and dynamic stretching on that dependent variable (Magner et al., 2012).

Makoto has also been used as a tool in interventions for individuals with autism. The company’s website claims that because the Makoto Arena has simple steps for use, is adjustable to ability level, and measures achievement, it can help individuals with autism improve “working memory, fine motor integration, metacognition indexes, bilateral coordination, organization of materials, strength, manual dexterity, and agility” (Makoto USA, n.d., n.p.). One peer-reviewed study examined Makoto as an intervention for children with autism to determine the effects of Makoto on participants’ executive function and motor impairment (Hilton et al., 2014).

Practitioners and teachers have shared their experiences with Makoto. A testimony published on Makoto USA’s website from Dr. Lucy Jane Miller, an occupational therapist who works with children with autism and sensory processing disorders, recommends Makoto because it is adaptable to ages and skill levels, engaging, and uses the whole body to work on skills such as

the ones listed by Makoto USA (Makoto USA, n.d.). Other users of Makoto attest to increased attention in students (Interactive Fitness and Game Solutions, 2012).

This background study of Makoto provides insight into its origins, breadth of uses, and the reasons it is being implemented in autism interventions and therapists' input on Makoto's use in therapy.

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Background learning paper two.

This EBP project will focus on the connections found between Autism Spectrum Disorder (ASD) and the use of the Makoto Therapy. The paper will explore what Makoto Therapy is, the reported benefits, different settings using it, and research pertaining to use for individuals with ASD.

Makoto is a movement therapy that requires multiple pieces of equipment and can be modified for each individual. Makoto therapy is being used primarily in sports, advertised as a game, and can be used for all ages of individuals (Makoto, n.d.). The equipment involved are three large towers spaced in a triangle which contain 12 targets on each tower (Makoto, n.d.). The specific target lights up and makes sound to alert player which tower they should turn towards and hit (Makoto, n.d.). The official Makoto website (n.d.) explains the game as, “Listen for tone, look for light, hit the target” (n.p.). As a player is hitting the target, the towers are measuring response time and accuracy (MakotoNOW, 2016). Each session or game can be tailored to fit individual needs such as changing speed of light on tower and required actions of players (Makoto, n.d.). Sensory issues can be accommodated by adjusting tone of noise or light from tower (MakotoNOW, 2016). In addition, the game can be changed based on which sport you are working on. For example, basketball teams may use the therapy by having individuals dribble a basketball while hitting target with their hands (MakotoNOW, 2016). To rent Makoto equipment, MakotoNOW (2016) website offers 4 hour rentals with setup from \$1,000 for an indoor event to \$1,200 for an outdoor set-up.

There are many reported benefits of using Makoto therapy. Using the therapy as a game and being able to modify to fit individual creates an environment for success (Makoto, n.d.). The director of the Sensory Therapies and Research (STAR), Dr. Lucy Jane Miller, OTR, describes

the benefits of Makoto therapy when she states “We have seen amazing therapeutic gains in clients in motor planning and inter-sensory processing” (Makoto, n.d., n.p.). Additional benefits claimed are improved mental fitness and executive function (Exergaming improves, 2015).

Susie Bass, DPT, Stroke Therapy states benefits of Makoto,

In addition to visual scanning, it’s great for attention, dynamic balance and reaction time.

I’ve also used it in brain injury cases. It helps them concentrate and attend. It’s very good for amputees....Makoto can be adjusted to be as easy or challenging as you like...for endurance-type tasks- patients will stay with it because they’re having fun (Makoto, n.d., n.p.)

Benefits found were primarily from the Makoto organization website or websites that sell the equipment.

Different settings and organizations use Makoto therapy. It has been used with sports teams, older adults, and individuals with ASD (Makoto, n.d.). The official Makoto website (Makoto, n.d.) addressed how it’s used for sports teams, older adults, and gave examples of specific organizations that use their therapy. First, in sports it’s used to increase a player’s reaction time, speed, and concentration. Second, senior/older adults use therapy for cardio and increasing mental sharpness. Lastly, the following organizations report using Makoto: “Denver Nuggets (NBA), Pittsburgh Pirates (MLB), Airforce Academy, Law enforcement, and more.”

Specifically, there has been emerging research done on using Makoto therapy with individuals who have ASD. Makoto therapy claims to improve an individual’s mental sharpness, cognitive ability, and coordination (Makoto, n.d.). Multiple studies have been found to claim a positive link between this therapy and treating ASD. One study looked at 17 individuals with ASD and claimed that Makoto therapy increased their executive functioning and physical

activity (Exergaming improves, 2015). Another study by Washington University claimed the therapy helped with individual's organization and attention (MakotoNOW, 2016). Both of these studies had small research participants. The study done by Washington University was found on the MakotoNOW website. More research needs to be found on this therapy to further conclude its effectiveness on individuals with ASD.

This summary gave a broad overview of what Makoto therapy is and its pricing. The reported benefits, settings it is used in, and research give important background knowledge to further understand the uses of this therapy.

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Background learning paper three.

This Evidence Based Practice project will focus on the effectiveness of exercise therapies using the Makoto Arena for clients diagnosed with autism. Background learning on this topic explored the characteristics of the Makoto Arena, behaviors associated with autism spectrum disorder (ASD), and the proposed applications of the Makoto Arena for individuals with disabilities.

The best description of the Makoto Arena can be found on the manufacturer's website. The Makoto Arena is exercise equipment that is used in athletic training, educational settings and rehabilitation. MakotoNow (n.p.) describes the key features of the equipment and how it is used. It consists of three steel pillars that may be six or eight feet tall. The pillars are arranged in a triangle with the pillars either six or eight feet apart. Each pillar has an array of 16 sensors, LED lights and a speaker. The apparatus is controlled by a computer bolted to the outside of the frame. When the player enters the arena to play a game, a light on one of the pillars flashes accompanied by a tone. High tones signal a sensor high on the pillar and low tones signal low sensors. The player must tap the correct sensor with their hand or with a long stick with a pad on the end in the case of a disabled player. Points accrue with each correct tap. The arena has a wide variety of levels (11) and adaptations to promote usage by the widest audience including those with vision or auditory disabilities (MakotoNow, n.p.). The Makoto Arena is promoted as a technology that improves visual, cardiovascular, and neurological performance, as well as improving physical condition, balance, cognitive function, range of motion, working memory and focus (MakotoNow, n.p.). This exergame has been used by athletes, those with special needs such as autism, ADD, and ADHD, as well as students, and patients in rehabilitation settings (MakotoNow, n.p.).

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that impacts how a person interacts and communicates with others. According to the Mayo Clinic's online directory of diseases and conditions, it is characterized by restricted repetitive behaviors and hyper-focused interests and activities (2016). People with ASD have difficulty seeing the big picture because they focus so intently on one aspect of the whole. Individuals may be hyper or hypo sensitive to sensory input and motor function may not develop normally. It is most often diagnosed early in life and young children may develop normally and then lose skills due to regression. ASD is defined as a spectrum because people may present with a wide variety of symptoms and ability levels. ASD is becoming a more common diagnosis (Mayo Clinic, 2016).

A 2015 research study, examined the Makoto Arena as an intervention to address these autistic disabilities specifically in terms of executive function and gross motor skills (Hilton, 2015). Because of its flashing lights and sounds, it has been proposed as a therapeutic modality well suited to the individual with autism due to the integration of sensory stimuli in multiple modalities. The movement aspect of the Makoto Arena may improve motor function as well due to the use of the whole body while playing the game. A study by Washington University in St. Louis showed improvement in working memory and organization of materials in participants with ASD (Hilton, 2014). A 2015 study by the same author supported the previous findings of improvement in "reaction speed, executive function and motor performance" (Hilton, 2015, p.4).

The background summary of the Makoto Arena defines the characteristics and benefits of this exercise equipment in addition to its use as a possible intervention for people with special needs, specifically autism. Information concerning the diagnostic criteria for autism provide focus areas for occupational therapy intervention. Further research may clarify the effectiveness of this exergaming intervention in occupational therapy.

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Evidence Searches

Library Database: CINAHL

Preparing for Search Process

- Makoto is not in the CINAHL headings. Instead I found Exergames which is less specific but within the same realm of technology. I will still search for Makoto in addition to Exergames since it is our specific
- For “Autism” use “autistic disorder”
- Database suggestions for headings: “Autism intervention” > early childhood intervention; “Occupational therapy”> pediatric occupational therapy, occupational therapy practice, research-based, occupational therapy practice, evidence-based;
- Database filters to be tried: Full Text, Peer Reviewed, Age Groups: Child and Adolescent
- Search: Autistic disorder AND early childhood intervention OR intervention AND Exergames OR Makoto

Summarizing a Strategic Search Process

Filters/Years	Keywords	Total Yield /Relevant Hits	Date
None Years: Unlimited	(“Exergames”) AND ((MH “Autistic Disorder/Therapy/Rehabilitation” OR “Autistic Disorder”) AND (MH “Early Childhood Intervention” OR “Intervention”))	0/0	November 13, 2016
None Years: Unlimited	“Makoto” AND ((MH “Autistic Disorder/Therapy/Rehabilitation” OR “Autistic Disorder”) OR (MH “Early Childhood Intervention” OR “Intervention”) OR “Exergames”)	5/1 Hilton et al., 2014	November 13, 2016
None Years: Unlimited	“Autistic disorder” AND “Exergames”	1/1 Foran, 2014	November 13, 2016
None Years: Unlimited	((MH "Early Childhood Intervention") OR "movement intervention") AND (((MH "Autistic Disorder") OR (MH "Developmental Disabilities") OR "autism") AND ((MH "Early Childhood Intervention") OR "movement intervention"))	657/1 Refine Search More Koehne, 2014	November 14, 2016

Age Groups: Child, Preschool 2-5 years; Child, 6-12 years; Adolescent, 13-18 years Years: None	((MH "Early Childhood Intervention") OR "movement intervention") AND (((MH "Autistic Disorder") OR (MH "Developmental Disabilities") OR "autism") AND ((MH "Early Childhood Intervention") OR "movement intervention"))	494/0 Refine Search More	November 14, 2016
Age Groups: Child, Preschool 2-5 years; Child, 6-12 years; Adolescent, 13-18 years Years: None	((MH "Motion Therapy, Continuous Passive") OR (MH "Therapeutic Exercise") OR (MH "Pediatric Physical Therapy") OR (MH "Pediatric Occupational Therapy") OR "movement therapy") AND (MH "Autistic Disorder") OR (MH "Developmental Disabilities") OR "autism")	142/2 Srinivasan et al., 2014 Salem et al., 2012	November 14, 2016
None Years: Unlimited	((MH "Video Games") OR (MH "Physical Activity") OR "active video games") AND (MH "Autistic Disorder") OR (MH "Developmental Disabilities") OR "Autism" AND (MH "Motion Therapy, Continuous Passive") OR (MH "Pediatric Physical Therapy") OR (MH "Pediatric Occupational Therapy") OR "movement therapy"	4/2 Srinivasan et al., 2014 Salem et al., 2012	November 14, 2016

Summary of 5 Best Research Articles

Foran, A. C. (2014). Social interaction moderates enjoyment and perception for physical activity during exergame play in young adults with autism spectrum disorders (Doctoral dissertation, University of Southern California).

Background Technology has been used successfully to enhance social engagement for individuals with Autism Spectrum Disorders(ASD), yet the majority of screen-based media are sedentary and solitary activities. Young adults with ASD are at risk for overweight/obesity and sedentary behavior. Exergaming is an emerging physically active occupation that may benefit individuals with ASD who are often drawn to technology, and who may have limited opportunities for physical activity in the community. In pilot studies, subjects reported enjoying exergaming more than playing traditional seated videogames, and they consistently achieved moderate-to-vigorous physical activity levels while exergaming. Typically developing individuals tend to work harder and enjoy physical activities more when playing with a partner. However, individuals with ASD are known to have limitations in conventional social interaction skills. Method We measured the physiological and psychological responses of young adults with and without ASD to videogame play under varying conditions. We sought to describe the relationship of exergaming to physical activity levels in this group, and to determine if exergame playing condition (alone versus with a peer playing partner) influenced physical activity level and/or enjoyment. We used a two diagnostic group (ASD and neuro-typical) by two playing status (alone and with partner) by three game type (boxing exergame, tennis exergame, traditional seated videogame) repeated-measures crossover design with randomized conditions. Results Participants experienced high levels of enjoyment and perceived exertion while exergaming. For individuals on the Autism Spectrum, perceived exertion was mediated by enjoyment during partner play. That is, subjects on the Autism Spectrum reported significantly lower perceived exertion and greater enjoyment when playing the most physically challenging games with the greatest intensity, as measured by heart rate, energy expenditure, and activity counts. Conclusion For some young adults with ASD, exergaming with a partner contributes to greater enjoyment and higher-intensity gameplay as compared to playing alone and playing TSVGs. Exergaming represents a cost-effective, socially relevant, and accessible way to incorporate physical activity into the daily lives of young adults with Autism Spectrum, many of whom are at risk for sedentary lifestyle and overweight/obesity. Incorporating a social component into physical activities may further enhance the health-promoting effects for individuals with ASD, who have previously been characterized as uninterested or unable to interact socially.

Hilton, C. L., Cumpata, K., Klohr, C., Gaetke, S., Artner, A., Johnson, H., & Dobbs, S. (2014).

Effects of exergaming on executive function and motor skills in children with autism spectrum disorder: A pilot study. *American Journal of Occupational Therapy*, 68, 57–65.

doi: 10.5014/ajot.2014.008664

Executive function (EF) and motor deficits have consistently been documented in studies of people with autism spectrum disorders (ASD). We investigated the effects of a pilot 30-session Makoto arena training intervention, a light and sound speed-based exergame, on response speed, EF, and motor skills in school-aged children with ASD. Strong correlations were seen between certain EF and motor scores, suggesting a relationship between the two constructs. Participants increased their average reaction speed (effect size 5 1.18). Significant improvement was seen in the EF areas of working memory and metacognition and the motor area of strength and agility. Findings suggest that use of exergaming, specifically the Makoto arena, has the potential to be a valuable addition to standard intervention for children with ASD who have motor and EF impairments.

Koehne, S., Behrends, A., Fairhurst, M. T., & Dziobek, I. (2016). Fostering social cognition through an imitation- and synchronization-based dance/movement intervention in adults with autism spectrum disorder: A controlled proof-of concept study. *Psychotherapy & Psychosomatics*, 85(1), 27-35. doi: 10.1159/000441111

Background: Since social cognition is impaired in individuals with autism spectrum disorder (ASD), this study aimed at establishing the efficacy of a newly developed imitation- and synchronization-based dance/movement intervention (SI-DMI) in fostering emotion inference and empathic feelings (emotional reaction to feelings of others) in adults with high-functioning ASD.

Methods: Fifty-five adults with ASD ($IQ \geq 85$) who were blinded to the aim of the study were assigned to receive either 10 weeks of a dance/movement intervention focusing on interpersonal movement imitation and synchronization (SI-DMI, $n = 27$) or a control movement intervention (CMI, $n = 24$) focusing on individual motor coordination (2 participants from each group declined before baseline testing). The primary outcome measure was the objective Multifaceted Empathy Test targeting emotion inference and empathic feelings. Secondary outcomes were scores on the self-rated Interpersonal Reactivity Index. The well-established automatic imitation task and synchronization finger-tapping task were used to quantify effects on imitation and synchronization functions, complemented by the more naturalistic Assessment of Spontaneous Interaction in Movement.

Results: Intention-to-treat analyses revealed that from baseline to 3 months, patients treated with SI-DMI showed a significantly larger improvement in emotion inference ($d = 0.58$), but not empathic feelings, than those treated with CMI ($d = -0.04$). On the close generalization level, SI-DMI increased synchronization skills and imitation tendencies, as well as whole-body imitation/synchronization and movement reciprocity/dialogue, compared to CMI.

Conclusions: SI-DMI can be successful in promoting emotion inference in adults with ASD and warrants further investigation.

Salem, Y., Gropack, S. J., Coffin, D., & Goodwin, E. M. (2012). Effectiveness of a low cost virtual reality system for children with developmental delay: a preliminary randomized

single-blind controlled trial. *Physiotherapy*, 98(3), 189-195. doi:

10.1016/j.physio.2012.06.003

Abstract: Physical and occupational therapists have started to use the Nintendo Wii™ gaming system with adults and children as part of their regular treatment. Despite the growing use of the Wii and trend towards evidence-based practice, limited evidence is available on the effectiveness of virtual reality using the Wii for children with developmental delay. The purpose of this study was to determine the feasibility and preliminary effectiveness of a low-cost gaming system for young children with developmental delay. Study design: Single-blind, randomised controlled trial. Participants and setting: Forty children with developmental delay (age 39 to 58 months) who attended a segregated or integrated preschool participated in this study. All children's parents read and signed an informed consent form approved by the institutional review board. Children were assigned at random to an experimental (Wii) group (n =20) or a control group (n =20). Intervention: Two weekly sessions for 10 weeks using Nintendo Wii Sports™ and Nintendo Wii Fit™, including balance, strength training and aerobics games. Main outcome measures: Participants were evaluated 1 week before and 1 week after the programme by a blinded investigator. Primary outcomes were gait speed, timed up and go test, single leg stance test, five-times-sit-to-stand test, timed up and down stairs test, 2-minute walk test and grip strength. The Gross Motor Function Measure (GMFM) was used to assess gross motor skills. Results: The two groups were homogenous regarding all parameters at baseline. The Wii training was feasible and enjoyable for those in the experimental group. There were no adverse effects or injuries reported over 267 training sessions. Comparison of groups following the intervention indicated that the experimental group showed significant improvements compared with the control group in single leg stance test {mean difference 1.03 [standard deviation (SD) 1.7], 95% confidence interval (CI) 0.2 to 1.9; P =0.017}, right grip strength [mean difference 1.11 (SD 1.84), 95% CI 0.15 to 2.06; P =0.024] and left grip strength [mean difference 0.90 (SD 1.67), 95% CI 0.03 to 1.77; P =0.043]. Although changes in other outcome measures were not significant between the study groups, there were trends towards greater improvements in the experimental group compared with the control group. Conclusion: This study supports use of the Wii as a feasible, safe and potentially effective therapeutic tool to augment the rehabilitation of young children with developmental delay. The potential application of the Wii to increase the intensity of therapy or as a rehabilitation tool in children's homes and rural settings is an area worthy of investigation. The promising results of this study suggest that further studies are warranted to validate the potential benefits of a low-cost commercially available gaming system as a treatment strategy to supplement rehabilitation of children with disabilities.

Srinivasan, S. M., Pescatello, L. S., & Bhat, A. N. (2014). Current perspectives on physical activity recommendations for children with autism spectrum disorders. *Physical Therapy*, 94(6), 875-889. doi: 10.2522/ptj.20130157

Recent evidence suggests that childhood obesity is increasing in children who are developing typically as well as in children with developmental disabilities such as autism spectrum disorders (ASDs). Impairments specific to autism as well as general environmental factors could lead to an

imbalance between the intake and expenditure of energy, leading to obesity. In this article, we describe the mechanisms by which autism-specific impairments contribute to obesity. The evidence on exercise interventions to improve physical fitness, address obesity, and reduce autism-specific impairments in children and adolescents with ASDs is discussed. Limited evidence is currently available for exercise interventions in individuals with ASDs. Therefore, literature on other pediatric developmental disabilities and children who are developing typically was reviewed to provide recommendations for clinicians to assess physical activity levels, to promote physical fitness, and to reduce obesity in children and adolescents with ASDs. There is a clear need for further systematic research to develop sensitive assessment tools and holistic multisystem and multifactorial obesity interventions that accommodate the social communication, motor, and behavioral impairments of individuals with ASD.

Evidence Resources: OT Organizations (AOTA/AOTF/WFOT)*Preparing for Search Process*

I initially found the Hilton et al., 2014, article in my background research when it appeared in both my preliminary searches in the American Journal of Occupational Therapy and in the database CINHAL. This article seems to be a good foundation for research on Makoto for childhood and adolescent autism interventions but it also seems to be one of the only research studies about the topic. A related article of a different study was done by the same author a year later (Hilton et al., 2015). Because these are the two main sources of researched information on the topic, I wanted to look further into the background of these studies and if and how they have been applied.

Goal 1: What is the author's affiliations to either Makoto and/or autism interventions?

Goal 2: Has this research been cited and implemented anywhere else in the realm of occupational therapy? If so, how has it been used?

Documenting the Search Process

Goal 1: What is the author's affiliations to either Makoto and/or autism interventions? The steps I used to finding more information about Hilton on the AOTA, AOTF, WFOT websites are as follows:

Step 1: Search each website with the search term "Claudia List Hilton."

Step 2: No results were found from AOTF or WFOT, so I read any related articles from AOTA's website.

Step 3: Search AJOT on the AOTA website for "Claudia List Hilton."

I followed this process and found that Hilton, PhD, OTR/L, SROT won a 2009 AOTA and AOTF award for "Contributions to Research and Intervention in Autism." She was a co-author in

a few relevant studies including a study about children with high functioning autism's participation in activities outside of school (Hilton, Crouch, & Israel, 2008), and reviews of AJOT articles pertaining to children and interventions from 2011, 2012 based on the ICF (Hilton & Smith, 2012; Whitney & Hilton, 2013; Hilton, Goloff, Altaras, & Josman, 2013). She is an assistant professor of occupational therapy at Washington University School of Medicine in St. Louis, Missouri.

Goal 2: Has this research been cited and implemented anywhere else in the realm of occupational therapy? If so, how has it been used?

Step 1: Search "Claudia List Hilton," author of "Effects of exergaming on executive function and motor skills in children with autism spectrum disorder: A pilot study" (Hilton et al., 2014) on AJOT, AOTF, and WFOT

Step 2: Search "Hilton C.L." on AOTA, AJOT, AOTF, and WFOT

No results for the author were found on AOTF or WFOT, indicating that the paper she co-authored has not been cited on either website. The same results as Goal 1 for the search of the author appeared on AOTA and AJOT's website, but did not display any research that her 2014 paper was cited in but rather the papers that she was a contributor to. There may be research that cites Hilton et al., 2014 elsewhere, but not on the AJOT, AOTA, AOTF, or WFOT websites.

Summary of Best Research Articles

Hilton, C. L., Crouch, M. C., & Israel, H. (2008). Out-of-school participation patterns in children with high-functioning autism spectrum disorders. *American Journal of Occupational Therapy*, 62(5), 554–563. doi: 10.5014/ajot.62.5.554

PURPOSE. This study examined differences in out-of-school activity participation between typically developing children and those with high-functioning autism spectrum disorders (HFASD).

METHOD. Children with HFASD, ages 6 to 12 (N = 52), and a control group (N = 53) were assessed using the Children's Assessment of Participation and Enjoyment and the Social Responsiveness Scale.

RESULTS. Significant differences were seen in participation between typical and HFASD groups in number of activities in which children participate, the numbers of individuals with whom they participate, and the variety of environments in which they participate.

CONCLUSIONS. These findings indicate that out-of-school participation is significantly different for children with HFASD than for typically developing peers. Findings suggest that social impairment is related to some aspects of participation and that addressing social skills in intervention could contribute to increased participation in out-of school activities by children with HFASD, which would contribute to their long-term mental and physical health.

Hilton, C. L., Cumpata, K., Klohr, C., Gaetke, S., Artner, A., Johnson, H., & Dobbs, S. (2014). Effects of exergaming on executive function and motor skills in children with autism spectrum disorder: A pilot study. *American Journal of Occupational Therapy*, 68, 57–65. doi: 10.5014/ajot.2014.008664

Executive function (EF) and motor deficits have consistently been documented in studies of people with autism spectrum disorders (ASD). We investigated the effects of a pilot 30-session Makoto arena training intervention, a light and sound speed-based exergame, on response speed, EF, and motor skills in school-aged children with ASD. Strong correlations were seen between certain EF and motor scores, suggesting a relationship between the two constructs. Participants increased their average reaction speed (effect size 5 1.18). Significant improvement was seen in the EF areas of working memory and metacognition and the motor area of strength and agility. Findings suggest that use of exergaming, specifically the Makoto arena, has the potential to be a valuable addition to standard intervention for children with ASD who have motor and EF impairments.

Hilton, C. L., Goloff, S. E., Altaras, O., & Josman, N. (2013). Centennial Vision- Review of instrument development and testing studies for children and youth. *American Journal of Occupational therapy*, 67(3), e30-e54. doi: 10.5014/ajot.2013.007831

We reviewed 12 articles from 2012 that addressed development and testing of instruments for children and youths and *American Journal of Occupational Therapy* articles from 2009–2013 that addressed 11 activity and participation instruments to determine how well this group of instruments facilitates the generation of evidence sufficient to support practice in accordance with the Centennial Vision. We observed an increase in the number of instrument development and testing studies and in higher level studies and larger cohorts; funding was provided for almost half of the studies, and attention was given to use of blind testing and transition to adult-age assessments. Further development of performance-based activity and participation instruments; instruments that examine biomedical molecular–cellular, biomedical, and environmental mechanisms; and intervention fidelity measures and increased use of blind testing are necessary for occupational therapy to meet the Centennial Vision.

Hilton, C. L., & Smith, D. L. (2012). Centennial Vision—Research focused on children and youth. *American Journal of Occupational Therapy*, 66(3), e39–e51. doi:

10.5014/ajot.2012.004325

We reviewed 22 articles on children and youth published in 2011 in the *American Journal of Occupational Therapy* and organized the articles by level of research and research type according to a framework adapted from the International Classification of Functioning, Disability and Health (ICF; World Health Organization, 2007). The largest percentage of articles described intervention effectiveness studies classified as Level III or IV. The bulk focused on the Body Function/Body Structure construct of the ICF, but as a whole the studies addressed all the constructs except Biomedical Molecular/Cellular. Rigor remains a concern, although laudable efforts have been made to increase strength of the evidence. Longitudinal, efficacy, and qualitative studies, as well as studies examining adolescents and the transition to adulthood, were absent from articles in this review and are important areas for future investigation. Several studies explicitly addressed intervention fidelity, an imperative in evidence-based research needed to move the profession toward the Centennial Vision.

Whitney, R., & Hilton, C. L. (2013). Centennial Vision—Intervention effectiveness for children and youth. *American Journal of Occupational Therapy*, 67(6), e154–e165.

doi:10.5014/ajot.2013.008557

We reviewed 11 articles, including efficacy and effectiveness studies, addressing intervention effectiveness for children and youth published in 2012 in the *American Journal of Occupational Therapy* and organized them by level and type of research according to a framework adapted from the International Classification of Functioning, Disability and Health. Compared with articles published in previous years, these studies showed improvement in their ability to guide practitioners to make evidence-based decisions by increasing understanding of the intervention's pragmatic relevance and the extent to which it promotes participation in childhood and adolescent occupations. Studies' evidence levels have increased along with efforts to increase scientific rigor. Intervention fidelity was included in several of the studies, but not consistently. Siblings and other family members were not examined, and none of the articles reviewed described longitudinal studies. Measures of client acceptability and cost–benefit analysis need more attention in future studies.

Evidence Sources

Library Database: Medline/Pubmed

Preparing for Search Process

- Side bar filters available to narrow search by date, article types
Contains biomedical literature from Medline, online books, and journals
- Able to expand search by clicking “similar” –“article”-“see all”
- Subject Headings or Indexing Terms of the Database:
Makoto Therapy>exergaming>active video games>fitness arena>occupational therapy>autism spectrum disorder>ASD>youth>adults>benefits
- Final Concept or Term List for the Database:
“Makoto Therapy”, “autism spectrum disorder”, “exergaming”, “occupational therapy”, “fitness arena”, “ASD”
- Database filters to be tried: I will try no filter and journal articles.
- Boolean Logic Terms to be tried: I will start with ‘AND.’

Summarizing a Strategic Search Process

Filters/Years	Keywords	Total Yield/Relevant Hits	Date
None Years: Unlimited	(“Makoto Therapy” AND “ASD” AND “Occupational Therapy”)	1/1 Hilton et al., 2014	November, 2016
None Years: Unlimited	(“exergaming” AND “autism spectrum disorder” AND “Occupational Therapy”)	1/1 Same results as before: Hilton et al., 2014	November, 2016
None Years: Unlimited	(“exergaming” AND “autism spectrum disorder”)	1/1 Same results as before: Hilton et al., 2014	November, 2016
None Years: Unlimited	(“fitness arena” AND “ASD”)	No results found	November, 2016
None Years: Unlimited	(“exergaming” AND “occupational therapy”)	6/1 results found Choi et al., 2016 (not directly related to ASD)	November, 2016
None Years: Unlimited	(“exergaming”)	1/159 results found Shih et al., 2016 (not directly related to ASD) Zeng, N., and Gao, Z. (2016). (related to obesity and exergaming)	November, 2016

Summary of 5 BEST Research Articles

Hilton, C.L., Cumpata, K., Klohr, C., Gaetke, S., Artner, A., Johnson, H., & Dobbs, S. (2014).

Effects of exergaming on executive function and motor skills in children with autism spectrum disorder: a pilot study. *American Journal of Occupational Therapy*, 68(1):57-65. doi: 10.5014/ajot.2014.008664

Executive function (EF) and motor deficits have consistently been documented in studies of people with autism spectrum disorders (ASD). We investigated the effects of a pilot 30-session Makoto arena training intervention, a light and sound speed-based exergame, on response speed, EF, and motor skills in school-aged children with ASD. Strong correlations were seen between certain EF and motor scores, suggesting a relationship between the two constructs. Participants increased their average reaction speed (effect size = 1.18). Significant improvement was seen in the EF areas of working memory and metacognition and the motor area of strength and agility. Findings suggest that use of exergaming, specifically the Makoto arena, has the potential to be a valuable addition to standard intervention for children with ASD who have motor and EF impairments.

Choi, S. D., Guo, L., Kang, D., & Xiong, S. (2016). Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review. *Applied Ergonomics*. doi: 10.1016/j.apergo.2016.10.013

Training balance and promoting physical activities in the elderly can contribute to fall-prevention. Due to the low adherence of conventional physical therapy, fall interventions through exergame technologies are emerging. The purpose of this review study is to synthesize the available research reported on exergame technology and interactive interventions for fall prevention in the older population. Twenty-five relevant papers retrieved from five major databases were critically reviewed and analyzed. Results showed that the most common exergaming device for fall intervention was Nintendo Wii, followed by Xbox Kinect. Even though the exergame intervention protocols and outcome measures for assessing intervention effectiveness varied, the accumulated evidences revealed that exergame interventions improved physical or cognitive functions in the elderly. However, it remains inconclusive whether or not the exergame-based intervention for the elderly fall prevention is superior to conventional physical therapy and the effect mechanism of the exergaming on elderly's balance ability is still unclear.

Shih, M., Wang, R., Cheng, S., & Yang, Y. (2016). Effects of a balance-based exergaming intervention using the Kinect sensor on posture stability in individuals with Parkinson's disease: a single-blinded randomized controlled trial. *Journal of NeuroEngineering and Rehabilitation*, 13(78), n. p. doi: 10.1186/s12984-016-0185-y

Background

The present study examined the effects of a balance-based exergaming intervention using the Kinect sensor on postural stability and balance in people with Parkinson's disease (PD).

Methods

We conducted a subject-blinded, randomized controlled study. Twenty people with PD (Hoehn and Yahr stages I through III) were recruited and randomly assigned to either a balance-based exergaming group (N = 10) or a balance training group (N = 10) for an 8-week balance training period. Postural stability was assessed using the limits of stability (LOS) and one-leg stance (OLS) tests. Balance was assessed using the Berg Balance Scale (BBS) and the timed up and go (TUG) test. Participants were assessed pre- and post-training.

Results

After training, participants in the balance-based exergaming group showed significant improvements in LOS performance, and in the eyes-closed condition of the OLS test. Both training programs led to improvements in BBS and TUG performance. Furthermore, balance-based exergaming training resulted in significantly better performance in directional control in the LOS test ($78.9 \pm 7.65\%$) compared with conventional balance training ($70.6 \pm 9.37\%$).

Conclusions

Balance-based exergaming training resulted in a greater improvement in postural stability compared with conventional balance training. Our results support the therapeutic use of exergaming aided by the Kinect sensor in people with PD.

Zeng, N., and Gao, Z. (2016). Exergaming and obesity in youth: current perspectives.

International Journal of General Medicine, 2016(9), 275-284. doi:

10.2147/IJGM.S99025

Although exergaming has been used as a physical activity modality among various populations, the evidence regarding its effectiveness on health-related outcomes in overweight/obese individuals remains unclear. The current study systematically reviewed literature and summarized findings of exergame-based interventions in overweight/obese populations with the goal of clarifying the current perspectives on exergaming and obesity. The initial search yielded 202 articles from six databases; 12 studies were included after evaluating for inclusion criteria and removing duplicates. Among these studies, seven were randomized controlled trials, two were control trials, and three were comparison studies. Overall, exergaming has the potential to attenuate weight gain and shows promise when used for physical activity and physical fitness promotion. Further, exergame play is positively associated with psychological well-being, but its effects on physiological outcomes are inconclusive. Finally, effects of exergaming on energy intake are not clear. Existing evidence supports that exergaming may elicit some health benefits in people who are overweight or/and obese. The limited number of available randomized controlled trials, however, restrict the ability to draw a conclusion that exergaming can trigger a change in all health-related outcomes. More research is warranted to make definitive conclusions regarding the effects of exergaming on health-related outcomes in such populations.

Library Database: OT Seeker**Preparing for Search Process**

I have never used OT seeker, so before I started searching I learned more about this database. I learned that OT seeker contains articles, systematic reviews, studies, and other information related to occupational therapy. Uses wide range of sources.

Goal 1: Does this article have any relation to the Makoto USA corporation?

Found in preliminary searches that majority of articles were stating benefits of Makoto Therapy, but found that these articles came from the Makoto Organization. Would like to search for more articles that are not related to the Makoto Organization because they will present more unbiased information. Want to make sure our group finds all the information that is out there and any articles that go against using this therapy.

Analyzed the two articles I found for any connection back to MakotoUSA. Both articles were from credible journals: *Journal of NeuroEngineering and Rehabilitation*. *Medicine & Science in Sports & Exercise*. Looked at authors of articles and none of the authors were seen on the Makoto website.

Goal 2: What other populations are showing up in searches to benefit from Makoto Therapy (or exergaming)

I am finding it difficult to find specific articles related to Makoto Therapy and effects on Autism Spectrum Disorder. Think it will be beneficial to help broaden search to see what other populations are benefiting from this therapy. Can apply these findings to potential benefits to the ASD population. For example, effects on motor ability, exercise, executive functioning, etc. All results that came up were in relation to exergaming and other disorders such as: older adult cognition, Parkinson's Disease, therapy for patients with chronic stroke, individuals with history

of lower limb injury. The only article that was accessible was the article relating to Parkinson's Disease. The other journals were unavailable because the trials used had not been rated or confirmed yet. Need for more valid research on this therapy.

Article regarding exergaming on Parkinson's disease touched on benefits of exergaming on motor ability and studies involving these therapies. Article could be helpful in information on effects on balance but doesn't specifically mention "Makoto Therapy" or have relationship to ASD population.

After searching fitness and youth, found article relating to the effect of fitness in schools on youth. Way off topic, but thought could look closer at benefits of fitness.

Documenting the Search Process

Goal 1: Does this article have any relation to the Makoto USA corporation?

Searched "Makoto Therapy" AND "Autism Spectrum Disorder." This search came up with 0 results

Searched "Exergaming" AND "ASD". No results.

Searched "Exergaming" AND "occupational therapy." No results.

Searched "Exergaming" AND "youth." 4 results. Barry, G. and Rochester, L

Searched "fitness arena" AND "ASD" 0 results

Searched "fitness arena" AND "Youth" 0 results

Searched "fitness arena" 0 results

Searched "fitness" AND "youth" 1 of 385: Aburto, N.J, et. Al (2011)

Goal 2: What other populations are showing up in searches to benefit from Makoto Therapy (or exergaming)

Searched “Makoto Therapy” AND “Autism Spectrum Disorder.” This search came up with 0 results

Searched “Exergaming” AND “ASD”. No results.

Searched “Exergaming” AND “occupational therapy.” No results.

Searched “Exergaming” AND “youth.” 4 results. Barry, G. and Rochester, L

Searched “fitness arena” AND “ASD” 0 results

Searched “fitness arena” AND “Youth” 0 results

Searched “fitness arena” 0 results

Searched “fitness” AND “youth” 1 of 385: Aburto, N.J, et. Al (2011)

Found article by Barry, G. and Rochester, L summarizing exergaming and relation to individuals with Parkinson’s disease.

Article by Aburto, N.J. et. al, looked at the benefits of physical activity in youth’s day at school

Summary of 5 BEST Research Articles

Barry, G., Galna, B., & Rochester, L. (2014). The role of exergaming in Parkinson’s disease rehabilitation: a systematic review of the evidence. *Journal of NeuroEngineering and Rehabilitation*, doi: 10.1186/1743-0003-11-33

Evidence for exercise based computer games (exergaming) as a rehabilitation tool for people with Parkinson’s disease (PD) is only now emerging and is yet to be synthesized. To this end, we conducted a systematic review of the exergaming literature to establish what is known about the safety, feasibility and effectiveness of exergaming for rehabilitation of motor symptoms experienced by people with PD. Seven electronic databases were searched for key terms surrounding exergaming and PD. Data were extracted by two reviewers independently. From an initial yield of 1217 articles, seven were included in the review. Six studies used commercial games with the Nintendo Wii fit platform. The scientific quality of reporting was generally good,, however the overall methodological design of studies was weak, with only one randomized controlled trial being reported. Safety: Participant safety was not measured in any of the studies. Feasibility: People with PD were able to play exergames, improve their performance of gameplay and enjoyed playing. However, one study observed that people with PD had difficulty with fast and complex games. Effectiveness: Six studies showed that exergaming elicited improvements in a range of clinical balance measures or reduction in the severity of

motor symptoms. Results from the only randomized controlled trial showed that exergaming was as effective as traditional balance training for people with PD to improve the UPDRS II, standing balance and cognition, with improvements in both groups retained 60 days after the training ended. In conclusion, exergaming is an emerging tool to help rehabilitate motor skills in people with PD. Although we were able to establish that exergaming is feasible in people with PD, more research is needed to establish its safety and clinical effectiveness, particularly in the home. The use of commercial games may be too difficult for some people with PD and exergames tailored specifically to the rehabilitation needs and capabilities of people with PD are required for optimal efficacy, adherence and safety.

Aburto, N.J, Fulton, J.E., Safdie, M., Duque, T., Bonvecchio, A., & Rivera, J.A. (2011). Effect of a School-Based Intervention on Physical Activity: Cluster-Randomized Trial.

Medicine & Science in Sports & Exercise, 43(10) pp 1898-1906 doi:

10.1249/MSS.0b013e318217ebec

Physical activity in childhood has many health benefits; however, the majority of children in many countries, including Mexico, are insufficiently active. The objective of this investigation was to test the effect of a school-based environmental intervention on the physical activity and physical fitness of students attending public primary schools in Mexico City. Methods: Twenty-seven schools were randomly assigned to basic or plus intervention or control. The basic and plus groups were exposed to school environment and policy changes to enhance physical activity. Physical activity was evaluated in 699 randomly selected fourth- and fifth-grade students by measuring school-day and all-day (24 h) steps using pedometers worn for 5 d before and after the 6-month intervention. Physical fitness was assessed by measuring the 9-min run, flexibility, and sit-ups. We calculated the average change in school-day and all-day steps and fitness measures from baseline to follow-up. Using linear regression, we tested the effect of intervention on change controlling for baseline measures and covariates and accounting for the design effect of school. Using logistic regression, we tested the effect of intervention on reaching step cutoffs at baseline and follow-up.

Results: The plus group significantly ($P < 0.05$) increased school-day steps relative to control (change = 687 vs -639). Significantly ($P < 0.05$) more participants in the basic (25.8%) and plus (36.4%) groups reached step cutoffs during school relative to control (12.0%). The basic group significantly ($P < 0.05$) increased all-day steps relative to control (change = 581 vs -419). The plus group significantly ($P = 0.05$) increased sit-ups relative to control (change = 0.3 vs -1.7).

Conclusions: A school-based environmental intervention improved student physical activity during school in public schools in Mexico City.

Evidence Sources

Library Database: ERIC

Preparing for Search Process

- Thesaurus doesn't have Makoto or Makoto arena
- Thesaurus offered: movement education, perceptual motor coordination, dance, and dance education
- Tried exergame and autism, no results
- Changed exergame to video game and got good results. Decided to plug in specific game systems like WII, xbox and playstation
- Virtual reality brought many results but scope is too far away from exergaming and makoto arena
- Computer game is computer simulation in thesaurus.
- ERIC is a database dedicated to Educational research. I was surprised to find many articles on Occupational Therapy. Unfortunately, there were none that applied to both autism and exergaming.

Summarizing a Strategic Search Process

Filters/Years	Keywords	Total Yield/Relevant Hits	Date
None Years: Unlimited	Makoto arena and exergame and autism	0	
None Years: Unlimited	Exergame and autism	0	
None Years: Unlimited	Video games and autism	1/22	Cai, 2012
None Years: Unlimited	"wii therapy" and autism	1/6	Wuang, 2011
None Years: Unlimited	computer simulation and autism	2/36	Chia, 2012 Kee, 2014

Summary of 5 Best Research Articles

Cai, S. X., & Kornspan, A. S. (2012). The use of exergaming with developmentally disabled students. *Strategies*, 25(3), 15-18. doi: 10.1080/08924562.2012.10592146

The physical activity patterns of students with disabilities have been studied in order to understand how much moderate and vigorous daily physical exercise is obtained. For example, Pan (2008) found that children with autism spectrum disorders were not as physically active during recess sessions. Similarly, literature suggests that students with disabilities are less physically active as compared to children without disabilities. As a result of being less physically active, these students' fitness levels appear to be much lower than the general population (Pitetti & Campbell, 1991; Pitetti, Rimmer, & Fernhall, 1993). Consequently, these students have a higher body fat percentage (Rimmer, Braddock, & Fujiura, 1993; Rubin, Rimmer, Chicoine, Braddock, & McGuire, 1998). Therefore, one strategy that may be effective to increase these students' physical activity is through the use of exergaming and interactive video games.

Chia, N., & Li, J. Y. (2012). Design of a generic questionnaire for reflective evaluation of a virtual reality-based intervention using virtual dolphins for children with autism.

International Journal of Special Education 27(3), 45-53.

There is an alarming increase in more Singaporean children diagnosed with special needs and it could be attributed to higher awareness and better screening procedure. However, research and development on various intervention strategies for children with special needs is still very lacking. With the introduction of information and communication technology, a wide range of useful intervention tools are now available to both special education professionals and parents with disabled children. In particular, interest in virtual reality (VR) within the domain of special education community is on the rise as reflected in a growing number of special issues of journals on this subject. VR offers a new channel to reach out to individuals with special needs such as cerebral palsy and autism. However, its effectiveness in intervention for such individuals has not been fully explored. In this paper, the authors have collaborated with a research team of the Pink Dolphin Simulation project at the Institute for Media Innovation, Singapore, to design a generic questionnaire for VR researchers and special education professionals to use in evaluating reflectively the possible benefits a VR-based intervention can offer. In this case, the VR-based intervention using the specially designed virtual dolphins was used for reflective evaluation.

Chia, N.K.H, & Kee, N. K. N. (2014). Application of Universal Design for Learning (Udl1) and Living (Udl2) in Virtual Dolphin-Assisted Intervention (Vdai) for Children with Autism.

The Journal of the International Association of Special Education, 15(1), 75-82.

In Singapore, the Special Education for Autism (SEA) calls for a more focused, systematically structured framework to cater to the needs of children with autism in schools. As autism is a

syndrome with co-morbid subtypes and different degrees of severity, a universal design for both learning and living becomes necessary to meet all the various needs and demands of the children. Adapted from the Response to Intervention (RTI) initiative first introduced under the IDEA 2004, the SEA framework is divided into three intervention levels: Level 1 covers all core autism intervention practices; Level 2 includes supplemental autism interventions; and Level 3 concerns individually customized autism interventions. This paper focuses on one virtual reality (VR) based autism intervention using artificial agents (3D virtual dolphins) in a 3D virtual dolphinarium developed and conducted at the Institute for Media Innovation, Singapore. The authors explored the possible application of universal design in this VR-based intervention within the framework of contextual teaching and learning (CTL) for children with autism.

Wuang, Y. P., Chiang, C. S., Su, C. Y., & Wang, C. C. (2011). Effectiveness of virtual reality using Wii gaming technology in children with Down syndrome. *Research in developmental disabilities, 32*(1), 312-321.

This quasi-experimental study compared the effect of standard occupational therapy (SOT) and virtual reality using Wii gaming technology (VRWii) on children with Down Syndrome (DS). Children ($n = 105$) were randomly assigned to intervention with either SOT or VRWii, while another 50 served as controls. All children were assessed with measures of sensorimotor functions. At post-intervention, the treatment groups significantly outperformed the control group on all measures. Participants in the VRWii group had a greater pre-post change on motor proficiency, visual-integrative abilities, and sensory integrative functioning. Virtual reality using Wii gaming technology demonstrated benefit in improving sensorimotor functions among children with DS. It could be used as adjuvant therapy to other proven successful rehabilitative interventions in treating children with DS.

Other Evidence Resources

Evidence Resource: Google Scholar

Preparing for Search Process:

- When I searched for Makoto Arena or Makoto Therapy, I found only the articles by Hilton which have already been documented in this research project.
- After speaking with Dr. Bass, I decided to focus my search on exergaming and autism.
- I made a list of the keywords for game systems: xbox, playstation, wii,
- I made one search into a particular exergame called “Dance, Dance Revolution” that I had seen in previous research. Then I decided that dance therapy was not within the scope of Exergaming.
- To narrow results I filtered by date, 2012-present.
- I found several books that may apply. I have put these in the references.

Summarizing a Strategic Search Process:

Filters/Years	Keywords	Total Yield/Relevant Hits	Date
2012-present	Makoto, arena, exergame, autism	5/10	Duckworth, 2014 Horowitz, 2015 Pan, 2016 Anderson Haney, 2011 Yee, 2007
2012-present	Exergame, wii, autism, therapy, intervention. Narrow: cognitive and repetitive behaviors, narrow with 2012-present	3/19	Golden, 2015 Chung, Tentori, 2016
2012-present	Exergame, dance, dance revolution, autism, therapy, intervention	0/23 Sources documented use of this game in dance therapy	
2012-present	X box, therapy, intervention, autism	0/19 No new sources	
2012-present	Xbox, autism, therapy, interventions, cognitive, repetitive behavior	0/21 No new sources	

Summary of 5 Best Research Articles

Google Scholar

Anderson-Hanley, C., Tureck, K., & Schneiderman, R. L. (2011). Autism and exergaming: effects on repetitive behaviors and cognition. *Psychology Research and Behavior Management, 4*, 129-137. doi: 10.2147/PRBM.S24016

Abstract: Autism is a neurodevelopmental disorder that leads to impairment in social skills and delay in language development, and results in repetitive behaviors and restricted interests that impede academic and social involvement. Physical exercise has been shown to decrease repetitive behaviors in autistic children and improve cognitive function across the life-span. Exergaming combines physical and mental exercise simultaneously by linking physical activity movements to video game control and may yield better compliance with exercise. In this investigation, two pilot studies explored the potential behavioral and cognitive benefits of exergaming. In Pilot I, twelve children with autism spectrum disorders completed a control task and an acute bout of Dance Dance Revolution (DDR); in Pilot II, ten additional youths completed an acute bout of cyber cycling. Repetitive behaviors and executive function were measured before and after each activity. Repetitive behaviors significantly decreased, while performance on Digits Backwards improved following the exergaming conditions compared with the control condition. Additional research is needed to replicate these findings, and to explore the application of exergaming for the management of behavioral disturbance and to increase cognitive control in children on the autism spectrum. **Keywords:** autism, repetitive behaviors, exergaming, exercise, executive function.

Chung, P. J., Vanderbilt, D. L., & Soares, N. S. (2015). Social Behaviors and Active Videogame Play in Children with Autism Spectrum Disorder. *Games for Health Journal, 4*(3), 225-234. doi: 10.1089/g4h.2014.0125

Abstract: Children with autism spectrum disorder (ASD) often display problematic and excessive videogame play. Using active videogames (AVGs) may have physical benefits, but its effects on socialization are unknown. **Materials and Methods:** We conducted an A-B-A' experiment comparing sedentary videogames and AVGs for three dyads of a child with ASD and his sibling. An augmented reality (AR) game was used to introduce AVGs. Sessions were coded for communication, positive affect, and aggression. **Results:** One dyad had increases in positive affect with AVGs. Otherwise, social behaviors were unchanged or worse. The AR game demonstrated consistent elevations in social behaviors. **Conclusions:** Use of AVGs has inconsistent effects on social behavior for children with ASD. Further research is needed to understand mediators of response to AVGs. AR games should be evaluated for potential benefits on socialization and positive affect.

Golden,D. (2015). The short-term effect of xbox kinect active videogame on physical activity level and executive function in children with and without autism spectrum disorder (Doctoral Dissertation, University of Delaware). Retrieved from <http://udspace.udel.edu/handle/19716/17569>

The care and loss of quality of life that accompanies the rising number of children identified with autism spectrum disorder (ASD) poses a significant strain on society. Identification of children has increased from 1 in 88 in 2012 to 1 in 68 in 2014. This population has a higher incidence of sedentary lifestyles making them at greater risk for many obesity-related health complications. In addition, executive function (EF) deficits have far reaching impact on functional skills, such as academic, socialization, communication, home life, healthcare and overall required care. Physical Activity (PA) could be a cost effective and multidimensional intervention to decrease healthcare and educational costs, and improve functional outcomes in individuals with ASD. Due to the high interest and already established virtual reality interventions in this population, the commercially available Xbox Kinect active videogame (AVG) has the potential of improving routine participation. The new infrared 3D technology provides additional feedback to the user that promotes use of the full body compared to the previous single point sensors. This study investigated the levels of PA and impact on executive function using 2 fast paced fully body games played on the system compared to walking and sedentary video-game (SVG). Methods: A group of 8-11 years old boys with ASD were age matched to a typically developing (TD) group and completed 3 PA conditions (AVG, SVG, walking). From an initial sample of 11 ASD and 11 TD boys, 9 ASD and 8 TD boys, completed all conditions. Activity count (AC) and percent time in moderate to vigorous physical activity (MVPA) were measured using an Actical Resperonics Minimeter Accelerometer during 20 minute activity bouts. The Inquisit Children Modified Flanker captured the response time and accuracy in six ASD and five TD boys. A repeated measure ANOVA followed by post hoc analysis was used AC and % MVPA. Results: The groups did not differ in either AC ($p = .273$) or % MVPA ($p = .107$). In Conditions, post hoc analysis revealed both % MVPA and AC in the SVG condition was significantly lower than the AVG condition ($p < .001$), which in turn was significantly lower than walking ($p < .001$). The lack of group differences between the AVG and walking suggests children with ASD do not require adaptations to participate in these activities. In terms of conditions, while % MVPA was highest in walking, over 77.65% time of the interval was achieved with the AVG. EF: A within group Friedman's ANOVA followed by a post hoc Wilcoxon were used to analyze differences in response time and accuracy among conditions. The TD group had no significant differences in both response time and accuracy. In the ASD group, accuracy approached significance ($p = .058$) and no other differences were found. Pairwise comparison analysis revealed a significant difference in AVG posttest to the pretest ($p = .043$) and the AVG posttest to SVG posttest ($p = .043$) values. Conclusion: An acute bout of the AVG could be used as a mechanism to facilitate increased PA, and to improve EF through the use of the readily available reasonably priced Kinect unit in children with ASD.

Horowitz, S. (2015). Trends, and treatments for autism. *Alternative and Complementary Therapies. Alternative and Complimentary Theories, 21(2), 77-83.* doi:

10.1089/act.2015.21203

No Abstract Available.

Pan, C. Y., Chu, C. H., Tsai, C. L., Sung, M. C., Huang, C. Y., & Ma, W. Y. (2016). The impacts of physical activity intervention on physical and cognitive outcomes in children with autism spectrum disorder. *Autism, 1-13.* doi: 10.1177/1362361316633562

This study examined the effects of a 12-week physical activity intervention on the motor skill proficiency and executive function of 22 boys (aged 9.08 ± 1.75 years) with autism spectrum disorder. In Phase I of the 12 weeks, 11 boys with autism spectrum disorder (Group A) received the intervention, whereas the other 11 boys with autism spectrum disorder (Group B) did not (true control, no intervention). The arrangement was reversed in Phase II, which lasted an additional 12 weeks. The Bruininks–Oseretsky Test of Motor Proficiency, Second Edition, and the Wisconsin Card Sorting Test were conducted three times for each participant (Group A, primary grouping: baseline (T1), post-assessment (T2), and follow-up assessment (T3); Group B, control grouping: T1–T2; intervention condition, T2–T3). The main findings were that both groups of children with autism spectrum disorder significantly exhibited improvements in motor skill proficiency (the total motor composite and two motor-area composites) and executive function (three indices of the Wisconsin Card Sorting Test) after 12 weeks of physical activity intervention. In addition, the effectiveness appeared to have been sustained for at least 12 weeks in Group A. The findings provide supporting evidence that physical activity interventions involving table tennis training may be a viable therapeutic option for treating children with autism spectrum disorder.

Appraisal of Evidence**Initial Appraisal of Evidence: Conceptual or Theoretical Articles**

Type of article	Overall Type: Conceptual or Theoretical Specific Type: Lesson plan for intervention and author observations
APA Reference	Cai, S. X., & Kornspan, A. S. (2012). The use of exergaming with developmentally disabled students. <i>Strategies</i> , 25(3), 15-18. doi: 10.1080/08924562.2012.10592146
Abstract	The physical activity patterns of students with disabilities have been studied in order to understand how much moderate and vigorous daily physical exercise is obtained. For example, Pan (2008) found that children with autism spectrum disorders were not as physically active during recess sessions. Similarly, literature suggests that students with disabilities are less physically active as compared to children without disabilities. As a result of being less physically active, these students' fitness levels appear to be much lower than the general population (Pitetti & Campbell, 1991; Pitetti, Rimmer, & Fernhall, 1993). Consequently, these students have a higher body fat percentage (Rimmer, Braddock, & Fujiura, 1993; Rubin, Rimmer, Chicoine, Braddock, & McGuire, 1998). Therefore, one strategy that may be effective to increase these students' physical activity is through the use of exergaming and interactive video games.
Author	Credentials: Associate professor Position and Institution: The Sport Science & Wellness Education Department at the University of Akron in Akron, OH. Publication History in Peer-Reviewed Journals: Four articles noted on his University of Akron web page.
Publication	Type of publication: Scholarly, peer-reviewed practical journal Publisher: Society of Health and Physical Educators Other: published 6 times per year, aimed at sport and physical educators
Date and Citation History	2012 Google Scholar Cited By: 6
Stated Purpose or Research Question	"In response to this issue, the purpose of this article is to explain the benefits of exergaming, describe specifically how Nintendo Wii Tennis can be used for students with disabilities, and how these interactive video games could be implemented in an adapted physical education setting."(p.15)
Author's Conclusion	"Based on the authors' observations, it is believed that the use of the Nintendo Wii Tennis can be a helpful instructional tool in teaching the sport of tennis to students with disabilities. Nintendo Wii Tennis is effective for children with disabilities because it provides a teaching tool which allows interaction with

	<p>each student. This interaction seems to increase the level of attention in the student. The technology is effective because students learn the technical skills of the game of tennis, which then allows them to move through a transition phase from learning the game of Nintendo Wii Tennis, to mini-tennis, to the actual game of tennis. Nintendo Wii Tennis allows students with disabilities to learn various technical and tactical aspects of the game in a fun and enjoyable setting.” (p.18)</p>
Overall Relevance to PICO	<p>Overall Relevance to PICO: Limited PICO: This article addresses an intervention considered exergaming, which is the closest term I could find for Makoto Arena. It is aimed at the proper population, outcomes are congruent, no comparative group.</p>
Overall Quality	<p>Overall Quality of Article: Moderate</p>

Type of article	Overall Type: Conceptual or theoretical article Specific Type: Examining framework of SEA or Special Education for Autism using a VR exergaming intervention
APA Reference	Chia, N., & Li, J. Y. (2012). Design of a generic questionnaire for reflective evaluation of a virtual reality-based intervention using virtual dolphins for children with autism. <i>International Journal of Special Education</i> 27(3), 45-53.
Abstract	There is an alarming increase in more Singaporean children diagnosed with special needs and it could be attributed to higher awareness and better screening procedure. However, research and development on various intervention strategies for children with special needs is still very lacking. With the introduction of information and communication technology, a wide range of useful intervention tools are now available to both special education professionals and parents with disabled children. In particular, interest in virtual reality (VR) within the domain of special education community is on the rise as reflected in a growing number of special issues of journals on this subject. VR offers a new channel to reach out to individuals with special needs such as cerebral palsy and autism. However, its effectiveness in intervention for such individuals has not been fully explored. In this paper, the authors have collaborated with a research team of the Pink Dolphin Simulation project at the Institute for Media Innovation, Singapore, to design a generic questionnaire for VR researchers and special education professionals to use in evaluating reflectively the possible benefits a VR-based intervention can offer. In this case, the VR-based intervention using the specially designed virtual dolphins was used for reflective evaluation.
Author	Credentials: Journal withdrew 9 articles by N. Chia for suspected lack of informed consent and inability to show research data. Position and Institution: Formerly with National Institute of Education in Singapore, part of Nanyang Technological University (NTU) Publication History in Peer-Reviewed Journals: <i>Journal of the American Academy of Special Education Professionals (JAASEP)</i> retracting at least 9 articles with 9 more in question.
Publication	Type of publication: peer reviewed scholarly professional journal Publisher: The American Academy of Special Education Professionals Other: Extensive code of ethics for this organization
Date and Citation History	2012 Google Scholar Cited By: 2
Stated Purpose or	“In this paper, we have chosen to focus on the virtual reality (VR) application in autism intervention using artificial agents (3D virtual

Research Question	dolphins) in a 3D virtual dolphinarium environment (Cai, Chia, Thalman, Kee, Zheng, & Thalman, 2013.”) (p. 76)
Author’s Conclusion	“The use of VR technology in SEA is still at its infancy phase. However, there are a rising number of papers presented at international conferences and published in journals on VR-based interventions that have been designed specifically for people with autism. Perhaps, many researchers have discovered their natural interest and strength to be able to make sense and work meaningfully within digital environments. Digital environments operate within the framework of logic used in computer programs. People with autism can harness their natural systematizing strengths to discover and learn the logic within VDAI. The current paper explicates our conceived theoretical structure of UDL1 and UDL2 as applied to children with autism in the CTL framework of VDAI incorporating four core educational orientations (i.e., academic rationalism, development of cognitive skills, conative and affective processes, personal relevance, and societal adaptation/reconstruction). The thinking and the principles behind the requirements, issues and tensions are discussed with our proposal of the need to reach an effective balance that is to be derived from practical use with the spectrum of diverse needs evident in individuals with autism.” (p. 81)
Overall Relevance to PICO	Overall Relevance to PICO: moderate PICO: Article is not directly related to intervention, but population and outcomes are congruent. No comparative population.
Overall Quality	Overall Quality of Article: Poor It looked promising until I googled author and first article up was a mass retraction of every article this author wrote for this journal. Apparently he is accused of research malpractice.

Type of article	Overall Type: Conceptual Specific Type: Generic questionnaire developed to raise awareness of characteristics needed to evaluate VR interventions in special education
APA Reference	Chia, N.K.H, & Kee, N. K. N. (2014). Application of Universal Design for Learning (Udl1) and Living (Udl2) in Virtual Dolphin-Assisted Intervention (Vdai) for Children with Autism. <i>The Journal of the International Association of Special Education</i> , 15(1), 75-82.
Abstract	In Singapore, the Special Education for Autism (SEA) calls for a more focused, systematically structured framework to cater to the needs of children with autism in schools. As autism is a syndrome with co-morbid subtypes and different degrees of severity, a universal design for both learning and living becomes necessary to meet all the various needs and demands of the children. Adapted from the Response to Intervention (RTI) initiative first introduced under the IDEA 2004, the SEA framework is divided into three intervention levels: Level 1 covers all core autism intervention practices; Level 2 includes supplemental autism interventions; and Level 3 concerns individually customized autism interventions. This paper focuses on one virtual reality (VR) based autism intervention using artificial agents (3D virtual dolphins) in a 3D virtual dolphinarium developed and conducted at the Institute for Media Innovation, Singapore. The authors explored the possible application of universal design in this VR-based intervention within the framework of contextual teaching and learning (CTL) for children with autism.
Author	Credentials:, Credentials unknown Position and Institution: National Institute of Education, Nanyang Technological University Publication History in Peer-Reviewed Journals: Moderate
Publication	Type of publication: scholarly peer reviewed, professional journal Publisher: The American Academy of Special Education Professionals Other: Extensive code of ethics for this organization
Date and Citation History	2014 Google Scholar Cited By: 9
Stated Purpose or Research Question	“To evaluate the effectiveness of a VR-based intervention and in this case, the use of virtual dolphins instead of real dolphins in the virtual dolphin-assisted therapy.” (p.46)
Author’s Conclusion	“The purpose of developing this generic questionnaire is intended to raise the awareness among VR researchers and special education professionals of the essential elements (from technological, pedagogical and

	<p>psychological dimensions) that they need to reflect on and use to evaluate the effectiveness of a VR-based intervention, such as the use of virtual dolphins described here. VR has provided a new frontier in special education and it can be used in many ways to aid children with autism and other disorders. As in the case of the Pink Dolphin Simulation project, the use of virtual dolphins as intervention tool has provided the potential to enhance delphisbot-human interaction as a vehicle for learning support and behavior modification for children with autism. ” (p.81)</p>
<p>Overall Relevance to PICO</p>	<p>Overall Relevance to PICO: moderate PICO: Population is congruent. Other characteristics tangential at best. Not sure this will aid in evaluating Makoto Arena intervention. Also, this author co-authored many papers with Chia whose reputation casts doubts on Kee.</p>
<p>Overall Quality</p>	<p>Overall Quality of Article: Good. The information in the article looks good, I am just not sure how applicable it is to our intervention.</p>

Initial Appraisal: Reviews of Research Studies

Type of article	Overall Type: Review of research Specific Type: Trends in ASD treatment
APA Reference	Horowitz, S. (2015). Trends, and treatments for autism. <i>Alternative and Complementary Therapies</i> . <i>Alternative and Complimentary Theories</i> , 21(2), 77-83. doi: 10.1089/act.2015.21203
Abstract	The prevalence and awareness of autism spectrum disorder (ASD) is increasing. This article reviews trends in the prevalence of this neurodevelopmental disorder, ASD diagnostic issues, etiologic theories, complementary and alternative medicine (CAM) and other treatment approaches, and related research and controversies.
Author	Credentials: PhD Position and Institution: Sala Horowitz, Ph.D., is a Portland, Oregon writer/researcher with extensive experience in health, education and the social sciences Publication History in Peer-Reviewed Journals: numerous published articles, all in this journal, not peer reviewed.
Publication	Type of publication: practical evidence based journal, not peer reviewed Publisher: Mary Ann Liebert, Inc. Other: Audience: Holistic nurses and health practitioners, alternative medicine specialists, acupuncture/acupressure practitioners, massage therapists, and schools of Oriental medicine, among others.
Date and Citation History	2015 Google Scholar Cited By: 1
Stated Purpose or Research Question	“ This article reviews trends in the prevalence of this neurodevelopmental disorder, ASD diagnostic issues, etiologic theories, complementary and alternative medicine (CAM) and other treatment approaches, and related research and controversies.” (p. 77)
Author’s Conclusion	“ASD is a developmental disorder with a complex etiology, including genetic, neurologic, immunologic, metabolic, perinatal, and environmental risk factors. The rising prevalence of this neurodevelopmental disorder—whether because of a genuine increase in cases or other factors—makes it vital that further research be conducted into ASD’s etiology and efficacy of treatments for it. Early integrative treatment comprised of CAM therapies, such as nutritional supplementation, expressive arts, and qigong sensory massage, in combination with ABA therapy and parent-training programs, can make a significant difference in the lives of affected children and their families. “ (p. 81)

Overall Relevance to PICO	Overall Relevance to PICO: strong PICO: This article mentions Makoto Arena as a therapy for autism. As a literature review it doesn't have any evidence based original research. Strong connections to population and intervention. However, no comparative populations or outcomes of note
Overall Quality	Overall Quality of Article: Poor This article is a short overview of alternative treatments for ASD. There is no primary research here and the overview is cursory at best. I was unable to find what the author's PhD is in. She is a writer for a magazine and publishes in it regularly.

Type of article	Overall Type: Review of research study Specific Type: systematic review
APA Reference	Choi, S. D., Guo, L., Kang, D., & Xiong, S. (2016). Exergame technology and interactive interventions for elderly fall prevention: A systematic literature review. <i>Applied Ergonomics</i> . doi: 10.1016/j.apergo.2016.10.013
Abstract	Training balance and promoting physical activities in the elderly can contribute to fall-prevention. Due to the low adherence of conventional physical therapy, fall interventions through exergame technologies are emerging. The purpose of this review study is to synthesize the available research reported on exergame technology and interactive interventions for fall prevention in the older population. Twenty-five relevant papers retrieved from five major databases were critically reviewed and analyzed. Results showed that the most common exergaming device for fall intervention was Nintendo Wii, followed by Xbox Kinect. Even though the exergame intervention protocols and outcome measures for assessing intervention effectiveness varied, the accumulated evidences revealed that exergame interventions improved physical or cognitive functions in the elderly. However, it remains inconclusive whether or not the exergame-based intervention for the elderly fall prevention is superior to conventional physical therapy and the effect mechanism of the exergaming on elderly's balance ability is still unclear.
Author	Credentials: NA Position and Institution: Department of Occupational & Environmental Safety & Health, University of Wisconsin - Whitewater, Whitewater, WI, USA Publication History in Peer-Reviewed Journals: minimal
Publication	Type of publication: scholarly peer-reviewed journal Publisher: Applied Ergonomics Journal, ScienceDirect Freedom Collection Other:
Date and Citation History	2016 Google Scholar Cited By: 0
Stated Purpose or Research Question	“The aim of this study is to synthesize the available research on exergame technology and interactive interventions for fall prevention in the older population. The outcome of this study is expected to provide a systematic review on the current state-of-the-art of the exergame technologies and their applications in interactive fall interventions, along with the identification of associated problems.” (pg. 2)
Author's Conclusion	“The interactive exergaming is enjoyable and auspicious to bring some benefits related to physical (e.g., postural balance, human mobility and

	gait, and muscle strength) and cognitive functioning (e.g., self-confidence, reaction time, and enjoyment) to not only healthy older adults but also the elderly with impaired balance, different disabilities or diseases.” (pg. 10)
Overall Relevance to PICO	Overall Relevance to PICO: limited PICO: Not related to P (elderly instead of children with ASD). Related to I (exergaming), O (balance/coordination), not related to C
Overall Quality	Overall Quality of Article: Moderate. Author has not had many published works. 0 citations of article. Reputable journal. Publication within last 10 years.

Type of article	Overall Type: Review Specific Type: Literature Review
APA Reference	Srinivasan, S. M., Pescatello, L. S., & Bhat, A. N. (2014). Current perspectives on physical activity recommendations for children with autism spectrum disorders. <i>Physical Therapy</i> , 94(6), 875-889. doi: 10.2522/ptj.20130157
Abstract	Recent evidence suggests that childhood obesity is increasing in children who are developing typically as well as in children with developmental disabilities such as autism spectrum disorders (ASDs). Impairments specific to autism as well as general environmental factors could lead to an imbalance between the intake and expenditure of energy, leading to obesity. In this article, we describe the mechanisms by which autism-specific impairments contribute to obesity. The evidence on exercise interventions to improve physical fitness, address obesity, and reduce autism-specific impairments in children and adolescents with ASDs is discussed. Limited evidence is currently available for exercise interventions in individuals with ASDs. Therefore, literature on other pediatric developmental disabilities and children who are developing typically was reviewed to provide recommendations for clinicians to assess physical activity levels, to promote physical fitness, and to reduce obesity in children and adolescents with ASDs. There is a clear need for further systematic research to develop sensitive assessment tools and holistic multisystem and multifactorial obesity interventions that accommodate the social communication, motor, and behavioral impairments of individuals with ASD.
Author	Credentials: MSPT Position and Institution: Physical Therapy Program, Department of Kinesiology, Neag School of Education, and Center for Health, Intervention, and Prevention, Department of Psychology, University of Connecticut, Storrs, Connecticut. Publication History in Peer-Reviewed Journals: Moderate.
Publication	Type of publication: Scholarly peer-reviewed journal Publisher: American Physical Therapy Association Other: Official journal of the APTA
Date and Citation History	2014 Google Scholar Cited By: 32
Stated Purpose or Research Question	“In light of the growing prevalence of ASDs in recent years,¹⁴ this review highlights the important issues related to physical inactivity and obesity in individuals with ASDs and encourages clinicians to develop and implement effective exercise interventions for this population. The specific aims of this article are: (1) to provide estimates on the

	<p>prevalence of obesity in children and adolescents with ASDs; (2) to explain the mechanisms by which impairments characteristic of individuals with ASDs could contribute to obesity; (3) to discuss the evidence on exercise and physical activity (PA) interventions that address overweight and obesity, physical fitness, and autism-related impairments; and (4) to provide recommendations for assessment and intervention for individuals with ASDs.” (p. 876)</p>
Author’s Conclusion	<p>“Existing reviews on the positive effects of exercise interventions in individuals with ASDs have suggested that regular exercise has beneficial effects in alleviating social, behavioral, cognitive, and motor impairments of autism.” (p. 879)</p>
Overall Relevance to PICO	<p>Overall Relevance to PICO: Limited Relevance PICO: Directly related to P (Children with Autism). Mild relevance to I (Physical activity therapy interventions), and O (some discussion about school performance and motor performance, but more focused on obesity). No C group in this study.</p>
Overall Quality	<p>Overall Quality of Article: Good Quality Reputable journal and publisher. Publication within last 5 years</p>

Type of article	Overall Type: Review of research studies Specific Type: systematic review of exergaming on obesity
APA Reference	Zeng, N., and Gao, Z. (2016). Exergaming and obesity in youth: current perspectives. <i>International Journal of General Medicine</i>, 2016(9), 275-284. doi: 10.2147/IJGM.S99025
Abstract	Although exergaming has been used as a physical activity modality among various populations, the evidence regarding its effectiveness on health-related outcomes in overweight/obese individuals remains unclear. The current study systematically reviewed literature and summarized findings of exergame-based interventions in overweight/obese populations with the goal of clarifying the current perspectives on exergaming and obesity. The initial search yielded 202 articles from six databases; 12 studies were included after evaluating for inclusion criteria and removing duplicates. Among these studies, seven were randomized controlled trials, two were control trials, and three were comparison studies. Overall, exergaming has the potential to attenuate weight gain and shows promise when used for physical activity and physical fitness promotion. Further, exergame play is positively associated with psychological well-being, but its effects on physiological outcomes are inconclusive. Finally, effects of exergaming on energy intake are not clear. Existing evidence supports that exergaming may elicit some health benefits in people who are overweight or/and obese. The limited number of available randomized controlled trials, however, restrict the ability to draw a conclusion that exergaming can trigger a change in all health-related outcomes. More research is warranted to make definitive conclusions regarding the effects of exergaming on health-related outcomes in such populations.
Author	Credentials: None listed Position and Institution: College of Human Education and Development, School of Kinesiology, University of Minnesota, Minneapolis, MN, USA Publication History in Peer-Reviewed Journals: minimal
Publication	Type of publication: scholarly peer-reviewed journal Publisher: International Journal of General Medicine
Date and Citation History	2016 Google Scholar Cited By: 0
Stated Purpose or Research Question	“There- fore, the purpose of this study was to systematically review and synthesize the exergame-based research that targets overweight or/and obese individuals as well as to discuss the effectiveness of exergaming on health-related outcomes in this population.” (p. 276)

Author's Conclusion	“The current review supports that exergaming, as a physical activity modality, leads to a more active lifestyle by promoting physical activity, psychological well-being, motor competence, energy expenditure, and cardiorespiratory fitness and by reducing body fat and sedentary behaviors in overweight or/and obese children and youth. High-quality research is needed, to determine how different exergames may relate to the initiation and maintenance of some health benefits and understand the effects of exergaming on health-related outcomes, to resolve such discrepancies.” (283)
Overall Relevance to PICO	Overall Relevance to PICO: moderate relevance PICO: Related to P, but not our specific focus (ASD). Focuses on obesity in youth. I (exergaming). O (exercise/balance). No C.
Overall Quality	Overall Quality of Article: Moderate quality. Not an established author. Reputable journal and publisher. Publication within last 10 years.

Initial Appraisal: Primary Research Studies

Type of article	Overall Type: Primary Research Specific Type: To test the hypotheses, a within-subjects experimental design was employed, wherein participants were exposed to both the control and experimental condition in an A–B sequential design.
APA Reference	Anderson-Hanley, C., Tureck, K., & Schneiderman, R. L. (2011). Autism and exergaming: effects on repetitive behaviors and cognition. <i>Psychology Research and Behavior Management, 4</i> , 129-137. doi: 10.2147/PRBM.S24016
Abstract	Abstract: Autism is a neurodevelopmental disorder that leads to impairment in social skills and delay in language development, and results in repetitive behaviors and restricted interests that impede academic and social involvement. Physical exercise has been shown to decrease repetitive behaviors in autistic children and improve cognitive function across the life-span. Exergaming combines physical and mental exercise simultaneously by linking physical activity movements to video game control and may yield better compliance with exercise. In this investigation, two pilot studies explored the potential behavioral and cognitive benefits of exergaming. In Pilot I, twelve children with autism spectrum disorders completed a control task and an acute bout of Dance Dance Revolution (DDR); in Pilot II, ten additional youths completed an acute bout of cyber cycling. Repetitive behaviors and executive function were measured before and after each activity. Repetitive behaviors significantly decreased, while performance on Digits Backwards improved following the exergaming conditions compared with the control condition. Additional research is needed to replicate these findings, and to explore the application of exergaming for the management of behavioral disturbance and to increase cognitive control in children on the autism spectrum. Keywords: autism, repetitive behaviors, exergaming, exercise, executive function.
Author	Credentials: PhD Psychology, assistant professor Position and Institution: Department of Psychology, Union college, Schenectady, NY, USA Publication History in Peer-Reviewed Journals: extensive, 1300 citations
Publication	Type of publication: An international, peer-reviewed, open access journal focusing on the science of psychology and its application in behavior management to develop improved outcomes in the clinical, educational, sports and business arenas. Publisher: Dovepress Other: International

Date and Citation History	2011 Google Scholar Cited By: 43
Stated Purpose or Research Question	The purpose of the current research is to assess the effects of an acute bout of exergaming on the repetitive behaviors and cognitive performance of children with autism.” (p. 131)
Author’s Conclusion	“This research provides initial evidence that exergaming may be useful for the management of behavioral disturbance and for increasing cognitive control in children on the autism spectrum. Additional research should be conducted to replicate and extend these findings, to clarify exergaming components which may influence the behavioral and cognitive outcomes, and to examine the long-term and applied utility of exergaming for ASD.” (p.135)
Overall Relevance to PICO	Overall Relevance to PICO: Strong PICO: Intervention parallel/exergaming, control group, outcomes strongly congruent
Overall Quality	Overall Quality of Article: Good Extensively published author, good quality research design, OT focus

Type of article	Overall Type: Primary research Specific Type: As an initial “proof-of-concept” study, we used a single case experimental design with an A-B-A’ withdrawal format following guidelines for research in ASD put forth by Smith et al.31
APA Reference	Chung, P. J., Vanderbilt, D. L., & Soares, N. S. (2015). Social Behaviors and Active Videogame Play in Children with Autism Spectrum Disorder. <i>Games for Health Journal</i> , 4(3), 225-234. doi: 10.1089/g4h.2014.0125
Abstract	Objective: Children with autism spectrum disorder (ASD) often display problematic and excessive videogame play. Using active videogames (AVGs) may have physical benefits, but its effects on socialization are unknown. Materials and Methods: We conducted an A-B-A’ experiment comparing sedentary videogames and AVGs for three dyads of a child with ASD and his sibling. An augmented reality (AR) game was used to introduce AVGs. Sessions were coded for communication, positive affect, and aggression. Results: One dyad had increases in positive affect with AVGs. Otherwise, social behaviors were unchanged or worse. The AR game demonstrated consistent elevations in social behaviors. Conclusions: Use of AVGs has inconsistent effects on social behavior for children with ASD. Further research is needed to understand mediators of response to AVGs. AR games should be evaluated for potential benefits on socialization and positive affect.
Author	Credentials: M.D. Position and Institution: 1The Center for Autism & Neurodevelopmental Disorders, Department of Pediatrics, School of Medicine, University of California Irvine, Irvine, California. Publication History in Peer-Reviewed Journals: 9
Publication	Type of publication: bimonthly peer-reviewed journal dedicated to the development, use, and applications of game technology for improving physical and mental health and well-being. The Journal breaks new ground as the first to address this emerging, widely-recognized, and increasingly adopted area of healthcare. Publisher: Mary Ann Liebert, Inc. Other:
Date and Citation History	2015 Google Scholar Cited By: 3
Stated Purpose or Research Question	“The objective of our study was to investigate the differences in communication, positive affect, and aggression in children with ASD when playing AVGs versus traditional videogames with a sibling. Our hypothesis was that active video gaming would be associated with

	increases of prosocial behavior (joint positive affect and reciprocal communication) and decreases in aggression between the sibling dyad.” (p.226)
Author’s Conclusion	“In our sample of children with ASD who already play videogames, active video gaming did not sustainably improve the quality of social engagement with their siblings over sedentary video gaming. AR games, however, hold potential for improving peer interactions and warrant further study in this population. Social behaviors during naturalistic gaming practice can be reliably coded and may provide valuable insights into the real-world effects of videogame play.” (p. 231)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate PICO: Aim of study is to evaluate social skills which are not included in our outcomes. Population is congruent, intervention is parallel, no comparative population.
Overall Quality	Overall Quality of Article: good Established author, good research design. It just doesn’t investigate pertinent information to our study.

Type of article	Overall Type: Primary research study Specific Type: Single-group pretest-posttest and controlled clinical trial
APA Reference	Foran, A. C. (2014). Social interaction moderates enjoyment and perception for physical activity during exergame play in young adults with autism spectrum disorders (Doctoral Dissertation, University of Southern California).
Abstract	<p>Background: Technology has been used successfully to enhance social engagement for individuals with Autism Spectrum Disorders (ASD), yet the majority of screen-based media are sedentary and solitary activities. Young adults with ASD are at risk for overweight/obesity and sedentary behavior. Exergaming is an emerging physically active occupation that may benefit individuals with ASD who are often drawn to technology, and who may have limited opportunities for physical activity in the community. In pilot studies, subjects reported enjoying exergaming more than playing traditional seated videogames, and they consistently achieved moderate-to-vigorous physical activity levels while exergaming. Typically developing individuals tend to work harder and enjoy physical activities more when playing with a partner. However, individuals with ASD are known to have limitations in conventional social interaction skills. Method: We measured the physiological and psychological responses of young adults with and without ASD to videogame play under varying conditions. We sought to describe the relationship of exergaming to physical activity levels in this group, and to determine if exergame playing condition (alone versus with a peer playing partner) influenced physical activity level and/or enjoyment. We used a two diagnostic group (ASD and neuro-typical) by two playing status (alone and with partner) by three game type (boxing exergame, tennis exergame, traditional seated videogame) repeated-measures crossover design with randomized conditions. Results: Participants experienced high levels of enjoyment and perceived exertion while exergaming. For individuals on the Autism Spectrum, perceived exertion was mediated by enjoyment during partner play. That is, subjects on the Autism Spectrum reported significantly lower perceived exertion and greater enjoyment when playing the most physically challenging games with the greatest intensity, as measured by heart rate, energy expenditure, and activity counts. Conclusion: For some young adults with ASD, exergaming with a partner contributes to greater enjoyment and higher-intensity gameplay as compared to playing alone and playing TSVGs. Exergaming represents a cost-effective, socially relevant, and accessible way to incorporate physical activity into the daily lives of young adults with Autism Spectrum, many of whom are at risk for sedentary lifestyle and overweight/obesity. Incorporating a social component into physical activities may further enhance the health-promoting effects for individuals with ASD, who have previously been characterized as uninterested or unable to interact socially.</p>

Author	Credentials: PhD Position and Institution: PhD Student at University of Southern California Publication History in Peer-Reviewed Journals: None
Publication	Type of publication: Doctoral Dissertation- Research Publisher: University of Southern California
Date, Citation History	2014 Google Scholar Cited By: 0
Stated Purpose or Research Question	“To address the gaps in the literature concerning exergaming and individuals with ASD, three studies were conducted: (a) a survey to describe videogame ownership trends among families of youth with ASD, patterns of videogame play within this population, and to report relationships between active and traditional videogame play and parents' satisfaction with their child's current physical activity level; (b) a series of case studies to explore the feasibility of using an exergaming system with youth with ASD, how much exercise they get from exergaming, and how much assistance they need to play exergames; and (c) a participatory program study to determine the amount and intensity of physical activity young adults with ASD achieve while exergaming alone and with a playing partner, and their level of enjoyment while exergaming under various conditions.” (p. 8)
Author's Conclusion	“1. For young adults on the Autism Spectrum, exergaming is an accessible and enjoyable way to engage in physical activity. 2. Young adults with ASD respond similarly to NT young adults when playing (exercising) with a partner – that is, they expend more energy and report greater enjoyment than if they were playing alone. 3. The medium of exergaming, in particular, is especially well-suited as a health promoting activity for young adults with ASD, as it may contribute to enhanced physical health, mental health, and social participation.” (p. 149)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate Relevance PICO: Moderately related to P (One study with children with autism, another study with young adults with autism). Moderately related to I (Exergaming), and O (enjoyment, physical and mental health and social participation). No relation to C (no C group or neurotypical C group).
Overall Quality	Overall Quality of Article: Moderate Quality Author a PhD student from a reputable university nationally ranked for occupational therapy but no journal publications

Type of article	Overall Type: Primary Research, Repeated Measures Design Specific Type: Dissertation
APA Reference	Golden, D. (2015). The short-term effect of Xbox Kinect active videogame on physical activity level and executive function in children with and without autism spectrum disorder (Doctoral Dissertation, University of Delaware). Retrieved from http://udspace.udel.edu/handle/19716/17569
Abstract	<p>The care and loss of quality of life that accompanies the rising number of children identified with autism spectrum disorder (ASD) poses a significant strain on society. Identification of children has increased from 1 in 88 in 2012 to 1 in 68 in 2014. This population has a higher incidence of sedentary lifestyles making them at greater risk for many obesity-related health complications. In addition, executive function (EF) deficits have far reaching impact on functional skills, such as academic, socialization, communication, home life, healthcare and overall required care. Physical Activity (PA) could be a cost effective and multidimensional intervention to decrease healthcare and educational costs, and improve functional outcomes in individuals with ASD. Due to the high interest and already established virtual reality interventions in this population, the commercially available Xbox Kinect active videogame (AVG) has the potential of improving routine participation. The new infrared 3D technology provides additional feedback to the user that promotes use of the full body compared to the previous single point sensors. This study investigated the levels of PA and impact on executive function using 2 fast paced fully body games played on the system compared to walking and sedentary video-game (SVG). Methods: A group of 8-11 years old boys with ASD were age matched to a typically developing (TD) group and completed 3 PA conditions (AVG, SVG, walking). From an initial sample of 11 ASD and 11 TD boys, 9 ASD and 8 TD boys, completed all conditions. Activity count (AC) and percent time in moderate to vigorous physical activity (MVPA) were measured using an Actical Resperonics Minimeter Accelerometer during 20 minute activity bouts. The Inquisit Children Modified Flanker captured the response time and accuracy in six ASD and five TD boys. A repeated measure ANOVA followed by post hoc analysis was used AC and % MVPA. Results: The groups did not differ in either AC ($p = .273$) or % MVPA ($p = .107$). In Conditions, post hoc analysis revealed both % MVPA and AC in the SVG condition was significantly lower than the AVG condition ($p < .001$), which in turn was significantly lower than walking ($p < .001$).</p> <p>The lack of group differences between the AVG and walking suggests children with ASD do not require adaptations to participate in these activities. In terms of conditions, while % MVPA was highest in walking, over 77.65% time of the interval was achieved with the AVG. EF: A within group Freidman's ANOVA followed by a post hoc Wilcoxon were</p>

	<p>used to analyze differences in response time and accuracy among conditions. The TD group had no significant differences in both response time and accuracy. In the ASD group, accuracy approached significance ($p = .058$) and no other differences were found. Pairwise comparison analysis revealed a significant difference in AVG posttest to the pretest ($p = .043$) and the AVG posttest to SVG posttest ($p = .043$) values.</p> <p>Conclusion: An acute bout of the AVG could be used as a mechanism to facilitate increased PA, and to improve EF through the use of the readily available reasonably priced Kinect unit in children with ASD.</p>
Author	<p>Credentials: PhD. Candidate Position and Institution: University of Delaware, Philosophy Biomechanics and Movement Science Publication History in Peer-Reviewed Journals:</p>
Publication	<p>Type of publication: Dissertation Publisher: ProQuest LLC</p>
Date and Citation History	<p>2016 Google Scholar Cited By: 0</p>
Stated Purpose or Research Question	<p>“Therefore, the purpose of this study was to determine PA as measured by ACs and percentage of time in MVPA levels in 8-11 years old boys with and without ASD in three conditions (SVG, AVG, walking).” (p.33)</p>
Author’s Conclusion	<p>“Conclusion: An acute bout of the AVG could be used as a mechanism to facilitate increased PA, and to improve EF through the use of the readily available reasonably priced Kinect unit in children with ASD. “ (p.xi)</p>
Overall Relevance to PICO	<p>Overall Relevance to PICO: moderate PICO: Population and outcomes are strongly related and the intervention is parallel but not exactly alike. Comparative interventions were applied.</p>
Overall Quality	<p>Overall Quality of Article: Moderate Quality Author a PhD student. Subject is congruent with our intervention but not exactly the same.</p>

Type of article	Overall Type: Primary research study Specific Type: Single-group pretest-posttest
APA Reference	Hilton, C. L., Cumpata, K., Klohr, C., Gaetke, S., Artner, A., Johnson, H., & Dobbs, S. (2014). Effects of exergaming on executive function and motor skills in children with autism spectrum disorder: A pilot study. <i>American Journal of Occupational Therapy</i> , 68, 57–65. doi: 10.5014/ajot.2014.008664
Abstract	Executive function (EF) and motor deficits have consistently been documented in studies of people with autism spectrum disorders (ASD). We investigated the effects of a pilot 30-session Makoto arena training intervention, a light and sound speed-based exergame, on response speed, EF, and motor skills in school-aged children with ASD. Strong correlations were seen between certain EF and motor scores, suggesting a relationship between the two constructs. Participants increased their average reaction speed (effect size 5 1.18). Significant improvement was seen in the EF areas of working memory and metacognition and the motor area of strength and agility. Findings suggest that use of exergaming, specifically the Makoto arena, has the potential to be a valuable addition to standard intervention for children with ASD who have motor and EF impairments.
Author	Credentials: PhD, OTR/L, SROT Position and Institution: Assistant professor, Occupational Therapy Department, University of Texas Medical Branch, Galveston, TX Publication History in Peer-Reviewed Journals: Moderate. Well known for systematic reviews of autism interventions.
Publication	Type of publication: Scholarly peer-reviewed journal Publisher: American Occupational Therapy Association (AOTA) Other: Official journal of the AOTA
Date and Citation History	2014 Google Scholar Cited By: 19
Stated Purpose or Research Question	“In the current study, we investigated the effectiveness of a Makoto arena training intervention on response speed, EF, and motor performance in school-age children with ASD. The research questions asked were as follows: 1. Does response speed improve after participation in the Makoto arena intervention? 2. Does EF improve after participation in the Makoto arena intervention? 3. Does motor performance improve after participation in the Makoto arena intervention?” (p. 59)
Author’s Conclusion	“Given the improvements observed in reaction speed, motor performance, and EF through comparison of pre and posttest scores, the Makoto arena

	training device may serve as a valuable addition to other types of therapy for children with ASD who have EF and motor impairments. This device appeared motivating for the children and was both quick and easy to use, and improvements seen in performance of the Makoto arena intervention translated to the activities and everyday tasks involved in both assessments.” (p. 63)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Relevance PICO: Directly related to P (Children with Autism), I (Makoto Therapy), and O (executive function and motor). No C group in this study.
Overall Quality	Overall Quality of Article: Good Quality Established author with background in this subject. Reputable journal and publisher. Publication within last 10 years

Type of article	Overall Type: Primary research study Specific Type: Repeated measures study
APA Reference	Hilton, C. L., Attal, A., Best, J. R., Reistetter, T. A., & Trapani, P. (2015). Exergaming to improve physical and mental fitness in children and adolescents with autism spectrum disorders: Pilot study. <i>International Journal of Sports and Exercise Medicine</i> , 1(3), n.p.
Abstract	Although not included as core characteristics of autism spectrum disorders (ASD), children and adolescents with this diagnosis often experience executive function (EF) and motor impairments. This study investigated the use of a speed-based exergame called the Makoto arena as an intervention strategy to improve EF and motor performance in 17 school-aged children and adolescents with ASD. All areas of EF improved, with significance in the overall global executive composite and in the metacognition index of the Behavior Rating Inventory of Executive Function. All motor skills improved except fine manual coordination, with significance in strength and agility on the Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition. Participants increased response speed showing a large effect size. Findings suggest that use of exergaming may be a beneficial addition to be included in interventions for children and adolescents with ASD who experience impairments in EF and motor performance.
Author	Credentials: PhD, OTR/L, SROT Position and Institution: Assistant professor, Occupational Therapy Department, University of Texas Medical Branch, Galveston, TX Publication History in Peer-Reviewed Journals: Moderate. Well known for systematic reviews of autism interventions.
Publication	Type of publication: Open access peer-reviewed journal, publishing original research, reviews, case reports, commentaries etc., in the field of sports and exercise medication. Publisher: ClinMed International Library, Science Resource Online LLC Other: International
Date and Citation History	2015 Google Scholar Cited By: 0
Stated Purpose or Research Question	“The current study combines novel data with data collected from our previous pilot study [45] to address the following research questions: 1) Does participation in the Makoto arena as an OT intervention improve EF among school-aged, high-functioning children on the autism spectrum? 2) Does participation in the Makoto arena intervention positively affect motor skills and performance among school-aged, high-functioning children on the autism spectrum? and 3) Does participation in the Makoto

	arena result in improved response speeds among school-aged, high-functioning children on the autism spectrum? “ (p.2)
Author’s Conclusion	“Findings from this study corroborate previous studies, which found motor impairment [11, 14-18] and EF impairment [12, 13] in children with ASD. They also suggest that the relationship between motor performance and EF observed in typically developing children [36-40] and those with intellectual disability [41] may also exist in children with ASD. “ (p.4)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Relevance PICO: Directly related to P (Children with Autism), I (Makoto Therapy), and O (executive function and motor). No C group in this study.
Overall Quality	Overall Quality of Article: Good Quality Established author with background in this subject. Reputable journal and publisher. Publication within last 10 years

Type of article	Overall Type: Primary research study Specific Type: Randomized control trial
APA Reference	Koehne, S., Behrends, A., Fairhurst, M. T., & Dziobek, I. (2016). Fostering social cognition through an imitation- and synchronization-based dance/movement intervention in adults with autism spectrum disorder: A controlled proof-of-concept study. <i>Psychotherapy & Psychosomatics</i> , 85(1), 27-35. doi: 10.1159/000441111
Abstract	Background: Since social cognition is impaired in individuals with autism spectrum disorder (ASD), this study aimed at establishing the efficacy of a newly developed imitation- and synchronization-based dance/movement intervention (SI-DMI) in fostering emotion inference and empathic feelings (emotional reaction to feelings of others) in adults with high-functioning ASD. Methods: Fifty-five adults with ASD (IQ \geq 85) who were blinded to the aim of the study were assigned to receive either 10 weeks of a dance/movement intervention focusing on interpersonal movement imitation and synchronization (SI-DMI, n = 27) or a control movement intervention (CMI, n = 24) focusing on individual motor coordination (2 participants from each group declined before baseline testing). The primary outcome measure was the objective Multifaceted Empathy Test targeting emotion inference and empathic feelings. Secondary outcomes were scores on the self-rated Interpersonal Reactivity Index. The well-established automatic imitation task and synchronization finger-tapping task were used to quantify effects on imitation and synchronization functions, complemented by the more naturalistic Assessment of Spontaneous Interaction in Movement. Results: Intention-to-treat analyses revealed that from baseline to 3 months, patients treated with SI-DMI showed a significantly larger improvement in emotion inference (d = 0.58), but not empathic feelings, than those treated with CMI (d = -0.04). On the close generalization level, SI-DMI increased synchronization skills and imitation tendencies, as well as whole-body imitation/synchronization and movement reciprocity/dialogue, compared to CMI. Conclusions: SI-DMI can be successful in promoting emotion inference in adults with ASD and warrants further investigation.
Author	Credentials: Diplom (German degree) Position and Institution: Department of Psychology staff, Berlin School of Mind and Brain Publication History in Peer-Reviewed Journals: Small
Publication	Type of publication: Peer-reviewed journal Publisher: Karger Medical and Scientific Publishers
Date and Citation History	2016 Google Scholar Cited By: 2

Stated Purpose or Research Question	“Taken together, fostering interpersonal movement imitation and synchronization might serve as an effective leverage to enhance social cognition in adults with ASD, but experimental evidence of its efficacy is lacking. In the context of this study we developed an imitation-and-synchronization-based dance/movement intervention (SI-DMI) for adults with ASD aiming at fostering social cognition. We aim at showing that SI-DMI enhances sociocognitive (emotion inference and perspective taking) and socioaffective process (empathetic feelings) in adults with ASD compared to a control movement intervention (CMI)” (p. 28)
Author’s Conclusion	“A dance/movement intervention based on interpersonal movement imitation and synchronization (SI/DMI) was effective in fostering emotion inference in adults with high-functioning ASD compared to a CMI focusing on individual movement tasks.” (p. 33)
Overall Relevance to PICO	Overall Relevance to PICO: Mild relevance PICO: Partially related to P (Individuals with ASD but not children), I (Movement therapy). There was strong relevance to C (control movement intervention). There was no relevance to O (sociocognitive and socioaffective skills).
Overall Quality	Overall Quality of Article: Moderate Quality Publication within last year

Type of article	Overall Type: Primary research Specific Type: pre/posttest design incorporating an intervention
APA Reference	Pan, C. Y., Chu, C. H., Tsai, C. L., Sung, M. C., Huang, C. Y., & Ma, W. Y. (2016). The impacts of physical activity intervention on physical and cognitive outcomes in children with autism spectrum disorder. <i>Autism</i> , 1-13. doi: 10.1177/1362361316633562
Abstract	This study examined the effects of a 12-week physical activity intervention on the motor skill proficiency and executive function of 22 boys (aged 9.08 ± 1.75 years) with autism spectrum disorder. In Phase I of the 12 weeks, 11 boys with autism spectrum disorder (Group A) received the intervention, whereas the other 11 boys with autism spectrum disorder (Group B) did not (true control, no intervention). The arrangement was reversed in Phase II, which lasted an additional 12 weeks. The Bruininks–Oseretsky Test of Motor Proficiency, Second Edition, and the Wisconsin Card Sorting Test were conducted three times for each participant (Group A, primary grouping: baseline (T1), post-assessment (T2), and follow-up assessment (T3); Group B, control grouping: T1–T2; intervention condition, T2–T3). The main findings were that both groups of children with autism spectrum disorder significantly exhibited improvements in motor skill proficiency (the total motor composite and two motor-area composites) and executive function (three indices of the Wisconsin Card Sorting Test) after 12 weeks of physical activity intervention. In addition, the effectiveness appeared to have been sustained for at least 12 weeks in Group A. The findings provide supporting evidence that physical activity interventions involving table tennis training may be a viable therapeutic option for treating children with autism spectrum disorder.
Author	Credentials: 23 publications, fields of study: Physiology, Psychiatry & Psychology, and Neuroscience. Position and Institution: Department of Physical Education, National Kaohsiung Normal University Publication History in Peer-Reviewed Journals: prolific,
Publication	Type of publication: <i>Autism</i> is a major, peer-reviewed, international journal, published 8 times a year, providing research of direct and practical relevance to help improve the quality of life for individuals with autism or autism-related disorders. It is interdisciplinary in nature, focusing on evaluative research in all areas, Publisher: sagepub.co.uk Other:
Date and Citation History	2016 Google Scholar Cited By: 1

Stated Purpose or Research Question	<p>“Does motor skill proficiency assessed using the BOT-2 (Bruininks and Bruininks, 2005) improve after participation in the physical activity intervention through table tennis exercise in two groups of children with ASD?</p> <p>2. Does executive function measured using the computer version of the Wisconsin Card Sorting Test (WCST; Heaton and PAR Staff, 2003) improve after participation in the physical activity intervention through table tennis exercise in two groups of children with ASD? 3. Does the intervention effect sustained for at least 12 weeks in primary-grouping children with ASD (i.e. Group A)?” (p.3)</p>
Author’s Conclusion	<p>“Our study provides initial evidence that 12 weeks of physical activity intervention through table tennis exercise exerted a positive effect in enhancing motor skill proficiency and executive function in children with ASD. These motor skill and executive function enhancements further elucidate the potential application of table tennis training as a complementary intervention for rehabilitating motor skill disturbances and for increasing executive function in children with ASD or other motor skill and executive function problems.” (p.12)</p>
Overall Relevance to PICO	<p>Overall Relevance to PICO: Moderate</p> <p>PICO: Population congruent, intervention questionable as to parallel with Makoto Arena, comparable population and outcomes mention executive function.</p>
Overall Quality	<p>Overall Quality of Article: Good</p> <p>The author publishes often and in a variety of reputable journals. Except for not finding his credentials, this author seems trustworthy and expert in his field.</p>

Type of article	Overall Type: Primary research study Specific Type: Single-blind randomized controlled trial
APA Reference	Salem, Y., Gropack, S. J., Coffin, D., & Goodwin, E. M. (2012). Effectiveness of a low-cost virtual reality system for children with developmental delay: a preliminary randomized single-blind controlled trial. <i>Physiotherapy</i> , 98(3), 189-195. doi: 10.1016/j.physio.2012.06.003
Abstract	<p>Abstract: Objectives: Physical and occupational therapists have started to use the Nintendo Wii™ gaming system with adults and children as part of their regular treatment. Despite the growing use of the Wii and trend towards evidence-based practice, limited evidence is available on the effectiveness of virtual reality using the Wii for children with developmental delay. The purpose of this study was to determine the feasibility and preliminary effectiveness of a low-cost gaming system for young children with developmental delay. Study design: Single-blind, randomized controlled trial. Participants and setting: Forty children with developmental delay (age 39 to 58months) who attended a segregated or integrated preschool participated in this study. All children's parents read and signed an informed consent form approved by the institutional review board. Children were assigned at random to an experimental (Wii) group (n =20) or a control group (n =20). Intervention: Two weekly sessions for 10weeks using Nintendo Wii Sports™ and Nintendo Wii Fit™, including balance, strength training and aerobics games. Main outcome measures: Participants were evaluated 1week before and 1week after the programmer by a blinded investigator. Primary outcomes were gait speed, timed up and go test, single leg stance test, five-times-sit-to-stand test, timed up and down stairs test, 2-minute walk test and grip strength. The Gross Motor Function Measure (GMFM) was used to assess gross motor skills. Results: The two groups were homogenous regarding all parameters at baseline. The Wii training was feasible and enjoyable for those in the experimental group. There were no adverse effects or injuries reported over 267 training sessions. Comparison of groups following the intervention indicated that the experimental group showed significant improvements compared with the control group in single leg stance test {mean difference 1.03 [standard deviation (SD) 1.7], 95% confidence interval (CI) 0.2 to 1.9; P =0.017}, right grip strength [mean difference 1.11 (SD 1.84), 95% CI 0.15 to 2.06; P =0.024] and left grip strength [mean difference 0.90 (SD 1.67), 95% CI 0.03 to 1.77; P =0.043]. Although changes in other outcome measures were not significant between the study groups, there were trends towards greater improvements in the experimental group compared with the control group. Conclusion: This study supports use of the Wii as a feasible, safe and potentially effective therapeutic tool to augment the rehabilitation of young children with developmental delay. The potential application of the Wii to increase the intensity of therapy or as a rehabilitation tool in children's homes and rural settings is an area worthy of investigation. The promising</p>

	results of this study suggest that further studies are warranted to validate the potential benefits of a low-cost commercially available gaming system as a treatment strategy to supplement rehabilitation of children with disabilities.
Author	Credentials: PT, PhD, NCS, PCS Position and Institution: Associate Professor of Physical Therapy at North Texas Health Science Center Publication History in Peer-Reviewed Journals: Moderate.
Publication	Type of publication: Scholarly peer-reviewed journal Publisher: Elsevier Other: The Chartered Society of Physiotherapy
Date and Citation History	2012 Google Scholar Cited By: 52
Stated Purpose or Research Question	“The purpose of this study was to demonstrate the feasibility, safety and effectiveness of using a low-cost commercially available gaming system in the rehabilitation of children with developmental delay.” (p. 190)
Author’s Conclusion	“The results indicate that training with the Wii is feasible, safe and beneficial for young children with developmental delay... The results indicate that Wii training yielded significant improvements in some of the measured outcomes, and trends towards improvements in all of the measures. These results suggest that this training strategy could benefit children with developmental delay.” (p. 193)
Overall Relevance to PICO	Overall Relevance to PICO: Strong Relevance PICO: Weak relation to P (Children with developmental delays but no autism) and I (Active video game use but with physical therapy) and C (Regular movement therapy protocol but with physical therapy). Limited relevance to O (leg stance and grip strength).
Overall Quality	Overall Quality of Article: Good Quality. Reputable journal and publisher. Publication within last 5 years

Type of article	Overall Type: Primary Research study Specific Type: quasi experimental
APA Reference	Wuang, Y. P., Chiang, C. S., Su, C. Y., & Wang, C. C. (2011). Effectiveness of virtual reality using Wii gaming technology in children with Down syndrome. <i>Research in Developmental Disabilities</i> , 32(1), 312-321. doi: 10.1016/j.ridd.2010.10.002
Abstract	This quasi-experimental study compared the effect of standard occupational therapy (SOT) and virtual reality using Wii gaming technology (VRWii) on children with Down syndrome (DS). Children ($n = 105$) were randomly assigned to intervention with either SOT or VRWii, while another 50 served as controls. All children were assessed with measures of sensorimotor functions. At post-intervention, the treatment groups significantly outperformed the control group on all measures. Participants in the VRWii group had a greater pre–post change on motor proficiency, visual-integrative abilities, and sensory integrative functioning. Virtual reality using Wii gaming technology demonstrated benefit in improving sensorimotor functions among children with DS. It could be used as adjuvant therapy to other proven successful rehabilitative interventions in treating children with DS.
Author	Credentials: Assistant Professor at KMU Position and Institution: Department of Occupational Therapy, Kaohsiung Medical University, Department of Physical Medicine and Rehabilitation, Kaohsiung Medical University Chung-Ho Memorial Hospital Publication History in Peer-Reviewed Journals: 32 hits on google scholar
Publication	Type of publication: <i>Research In Developmental Disabilities</i> is an international journal aimed at publishing original research of an interdisciplinary nature that has a direct bearing on the understanding or remediation of problems associated with developmental disabilities. Publisher: Elsevier Other: does not mention peer review but says it's primary research
Date and Citation History	2011 Google Scholar Cited By: 108
Stated Purpose or Research Question	“Thus, we hypothesized that virtual reality using Wii gaming technology (VRWii) is potentially efficacious in enhancing sensorimotor functions compared to standard sensorimotor training among children with DS. (p.313)
Author's Conclusion	“Despite these limitations, VRWii is a feasible and potentially effective intervention to enhance sensorimotor functions in children with DS. Repetitive intensive training and the observation, practice, and

	<p>representation on the screen of task specific activities can facilitate brain plasticity of children that engage the mirror neuron system or long-term effects. In conclusion, therapeutic intervention (i.e. VRWii or SOT) conducted at a regular basis was beneficial in improving sensorimotor functions in school-aged children with DS. More effort should be made to help these children generalize the training effects to the functional tasks that demand similar motor skills.” (p.320)</p>
Overall Relevance to PICO	<p>Overall Relevance to PICO: moderate PICO: population is Down’s syndrome, but intervention is exergaming. Does have control group and outcomes are similar. Very OT oriented focus</p>
Overall Quality	<p>Overall Quality of Article: Good Systematic, OT focused, well published author</p>

Type of article	Overall Type: Primary research study Specific Type: Quantitative
APA Reference	Shih, M., Wang, R., Cheng, S., & Yang, Y. (2016). Effects of a balance-based exergaming intervention using the Kinect sensor on posture stability in individuals with Parkinson's disease: a single-blinded randomized controlled trial. <i>Journal of NeuroEngineering and Rehabilitation</i> , 13(78), n. p. doi: 10.1186/s12984-016-0185-y
Abstract	<p>Background The present study examined the effects of a balance-based exergaming intervention using the Kinect sensor on postural stability and balance in people with Parkinson's disease (PD).</p> <p>Methods We conducted a subject-blinded, randomized controlled study. Twenty people with PD (Hoehn and Yahr stages I through III) were recruited and randomly assigned to either a balance-based exergaming group (N = 10) or a balance training group (N = 10) for an 8-week balance training period. Postural stability was assessed using the limits of stability (LOS) and one-leg stance (OLS) tests. Balance was assessed using the Berg Balance Scale (BBS) and the timed up and go (TUG) test. Participants were assessed pre- and post-training.</p> <p>Results After training, participants in the balance-based exergaming group showed significant improvements in LOS performance, and in the eyes-closed condition of the OLS test. Both training programs led to improvements in BBS and TUG performance. Furthermore, balance-based exergaming training resulted in significantly better performance in directional control in the LOS test ($78.9 \pm 7.65\%$) compared with conventional balance training ($70.6 \pm 9.37\%$).</p> <p>Conclusions Balance-based exergaming training resulted in a greater improvement in postural stability compared with conventional balance training. Our results support the therapeutic use of exergaming aided by the Kinect sensor in people with PD.</p>
Author	<p>Credentials: Position and Institution: Department of Physical Therapy and Assistive Technology, National Yang-Ming University, 155, Sec 2, Li Nong St., Beitou, Taipei, Taiwan. Publication History in Peer-Reviewed Journals: minimal</p>
Publication	<p>Type of publication: scholarly peer-reviewed journal Publisher: Journal of Neuroengineering and rehabilitation Other:</p>

Date and Citation History	2016 Google Scholar Cited By: Not been cited
Stated Purpose or Research Question	“The present study sought to test a therapeutic application of exergaming using the Kinect sensor. We examined the effects of an 8- week balance-based exergaming program developed in our lab, compared with an 8-week period of conventional balance training (16 training sessions), on postural stability and balance in people with PD. We hypothesized that participants who underwent an 8-week balance-based exergaming intervention would demonstrate superior performance on measures of postural stability and balance, compared with those who received balance training.” (pg. 78)
Author’s Conclusion	“The current study revealed that an 8-week period of balance-based exergaming training using the Kinect sensor resulted in a greater improvement of postural stability than conventional balance training. Both exergaming and conventional balance training had positive effects on functional balance.” (pg. 78)
Overall Relevance to PICO	Overall Relevance to PICO: Moderate. PICO: Not directly related to P (effects of exergaming on individuals with Parkinson's). O (posture, balance, stability). No C.
Overall Quality	Overall Quality of Article: Moderate. Author has not had many publications and article not cited. Reputable journal and publisher. Publication within 10 years.

Critical Appraisals

- Pan, C. Y., Chu, C. H., Tsai, C. L., Sung, M. C., Huang, C. Y., & Ma, W. Y. (2016). The impacts of physical activity intervention on physical and cognitive outcomes in children with autism spectrum disorder. *Autism*, 1-13. doi: 10.1177/1362361316633562
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- Wuang, Y. P., Chiang, C. S., Su, C. Y., & Wang, C. C. (2011). Effectiveness of virtual reality using wii gaming technology in children with down syndrome. *Research in developmental disabilities*, 32(1), 312-321. doi:10.1016/j.ridd.2010.10.002

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