

Washington University in St. Louis School of Medicine

The Effects of Makoto Intervention on Motor Skills and Executive Function in Children with and without Autism Spectrum Disorders

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Background & Purpose
 Although not in current diagnostic criteria, motor and executive function deficits have been consistently documented in studies and clinical observation of individuals with autism spectrum disorders (ASD). One study in 1998 found that children with ASD often score lower in motor assessment than those who are unaffected, while another study in 2009 explained children with ASD as having specific patterns of executive impairment. To provide the best treatment for these individuals, it is important to identify interventions that can improve motor and executive function. The Makoto training device was developed for use in performance sports, schools, and medical rehabilitation to increase reaction time, improve attention, and improve physical fitness of the individuals who participate. Minimal research has been conducted on the effectiveness of the Makoto training device as an intervention for use with children with and without ASD and those with motor or executive function deficits. This pilot study investigated the effectiveness of Makoto training intervention on motor and executive function of school age children with and without ASD.

Method
Intervenor: The Bransford-Owen Test of Motor Proficiency-Second Edition (BOT-2), a motor function assessment, and the Behavior Rating Inventory of Executive Function (BRIEF), an executive function assessment, were used for pre/post evaluation. Motor areas measured by the BOT-2 included fine manual control, manual coordination, body coordination, and strength and agility. Executive function areas measured by the BRIEF include inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor. Average reaction speed was recorded for each Makoto session.
Intervention: The Makoto training device is described as a "light and sound interactive game that engages reflexes, brain power, a competitive play spirit and fun". Makoto participants must strike a random sequence of target lights on certain positions of the three levers in a limited amount of time. All participants in this study completed 30 two-minute therapeutic sessions in the Makoto arena (approx. 1,800 repetitions). Each participant began intervention at level 1 (10.00 seconds) and increased to the next level when mastery was achieved (Makoto has levels 1-11). With each increase in level, the amount of time allowed to react and strike the target light decreased - thus encouraging improvements in reaction time by the participant.

Results & Conclusions
 All participants increased reaction speed between intervention sessions 1 and 30 with an effect size of 1.1. Children with ASD increased reaction speed with an effect size of 1.8. Means of pre and post scores for the BOT-2 and BRIEF were compared. Patterns of improvement in certain areas of motor and executive function were observed. Data analysis of pre and post BOT-2 scores showed significant improvement (p<.05) in age corrected scale scores for motor areas of manual dexterity and bilateral coordination for all participants. ASD-unaffected children significantly improved (p<.05) in scale scores for fine motor integration and bilateral coordination. Children with ASD significantly improved (p<.05) in scale scores of strength and agility.

Research Questions
 1. Can use of the Makoto training device as a therapeutic intervention improve motor performance of children with and without ASD?
 2. Can use of the Makoto training device as a therapeutic intervention improve executive function of children with and without ASD?
Participants: Two groups of children between 4 and 18 years old participated in this study: one group with ASD diagnoses (N=7), and one unaffected group (N=6).

Acknowledgments
 Cheryl Kwikie, MS, OTR/L, Shannon Garber, OT/PT, Amanda Arman, MSOT/PT, Lisa Colton, MSOT/PT, Sarah DeBito, MSOT/PT, Bailey Johnson, MSOT/PT, Phillip, MSOT/PT, Pete Trapani, Children's Child Center, and all participants and their families.

Figure 1: Average Scale Scores of BOT-2 Subtests and Motor Areas with Significant Improvement

Subtest/Area	All Participants (N=13)	Children who are unaffected (N=6)	Children with ASD (N=7)
Manual Dexterity	42.2	42.2	42.2
Manual Coordination	42.2	42.2	42.2
Body Coordination	42.2	42.2	42.2
Strength and Agility	42.2	42.2	42.2

Figure 2: Average Scores of BRIEF Categories with Significant Improvement

Category	All Participants (N=13)	Children with ASD (N=7)
Working Memory	42.2	42.2
Organization of Materials	42.2	42.2

Improvement was observed in 7/8 areas of executive function when analyzing BRIEF scores for all participants. Significant improvement (p<.05) was shown in the executive function area of working memory for all children who participated in this study. Children with ASD significantly improved (p<.05) in working memory and organization of materials.

Findings from this pilot study suggest that participation in a Makoto protocol has potential to serve as a valuable addition to standard intervention for children with motor and executive function impairments. A larger scale examination in a random control trial study is suggested. Identification of effective, meaningful, and motivating interventions is important to provide the optimal impact through therapy for children with ASD.

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Starting Brief/Summary: This Pilot Study for the Makoto Arena is being done by Washington University in St Louis and 360 Fitness, LLC with equipment provided by Makoto USA, Inc. Hard copies of the poster data and supporting study material will be provided over the next two weeks.

Data at this poster presentation at Washington University on April 23rd 2012 showed strong results, especially for participants of the Autism Spectrum Disorder (ASD) group. Participants in the control group showed reaction time improvement and their effect size was strong, but the improvements seen for children of the ASD group were greater with a stronger effect size. Effect size is a statistical concept that measures the strength of the relationship between two variables or research on a numeric scale. Pre testing was done for each student prior to using Makoto and post testing was done afterwards to compare data points.

Early data showed improvements in the following areas:

- Manual Dexterity,
- Bilateral Coordination,
- Fine Motor Integration,
- Strength and
- Agility

Data showed that the children in the Control Group and the ASD group both had improved Short Term Working Memory and Organization of Material. Improvements in these areas would also be seen as improved learning in the classroom, reading, math, etc. The Short Term Memory improvement was quite significant and very strong. The Short Term Working Memory data is what Pete Trapani refers to as the holy grail of all the data. Wash U is now analyzing the rest of the data and trying to correlate improved reaction time to other cognitive functions including Sensory Integration which also showed great gains.

The results of this pilot study are very exciting because it indicates the use of equipment (Makoto) as an effective intervention for ASD as opposed to medication. Wash U said early results from the data are strong enough that they recommend a larger study be done. More data will be coming out over the next 30 days.

Background & Purpose

Although not in current diagnostic criteria, motor and executive function deficits have been consistently documented in studies and clinical observation of individuals with autism spectrum disorders (ASD). One study in 1998 found that children with ASD often score lower on motor assessment than those who are unaffected⁴, while another study in 2009 explained children with ASD as having specific patterns of executive impairment⁶. To provide the best treatment for these individuals, it is important to identify interventions that can improve motor and executive function. The Makoto training device was developed for use in performance sports, schools, and medical rehabilitation to increase reaction time, improve attention, and improve physical fitness of the individuals who participate⁵. Minimal research has been conducted on the effectiveness of the Makoto training intervention on motor and executive function of school age children with and without ASD.

Method

Research Questions:

1. Can use of the Makoto training device as a therapeutic intervention improve motor performance of children with and without ASD?
2. Can use of the Makoto training device as a therapeutic intervention improve executive function of children with and without ASD?

Participants:

Two groups of children between 4 and 16 years old participated in this study: one group with ASD diagnosis (N=7) and one unaffected group (N=8).

Measures:

The Bruininks-Oseretsky Test of Motor Proficiency – Second Edition (BOT-2), a motor function assessment, and the Behavior Rating Inventory of Executive Function (BRIEF), an executive function assessment, were used for pre/post evaluation. Motor areas measured by the BOT-2 included fine manual control, manual coordination, body coordination, and strength and agility¹. Executive function areas measured by the BRIEF include inhibit, shift, emotional control, initiate, working memory, plan/organize, organization of materials, and monitor³. Average reaction speed was recorded for each Makoto session.

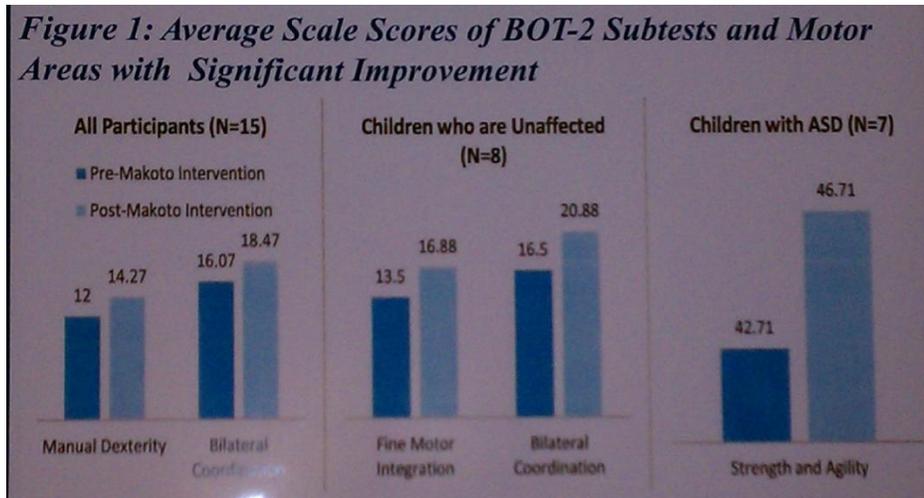
Intervention:

The Makoto training device is described as a “light and sound interactive game that engages reflexes, brain power, a competitive play spirit and fun”². Makoto participants must strike a random sequence of target lights on certain positions of the three towers in a limited amount of time. All participants in this study completed 30 two-minute therapeutic sessions in the Makoto arena (approx. 1,800 repetitions). Each participant began intervention at level 1 (10.00 seconds) and increased to the next level when mastery was achieved (Makoto has levels 1-11). With each increase in level, the amount of time allowed to react and strike the target light decreased – thus encouraging improvements in reaction time by the participant.

Results & Conclusions

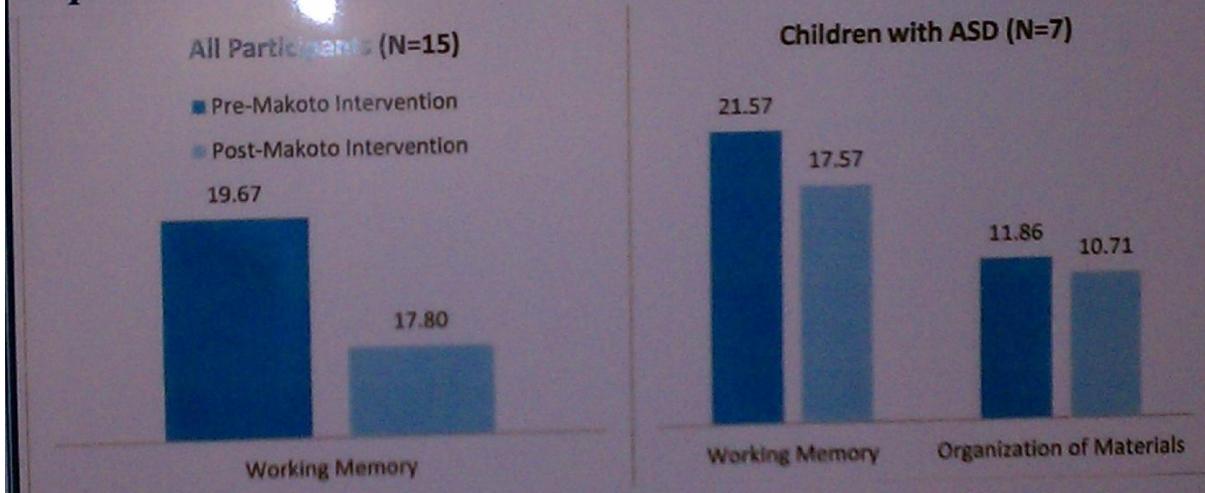
All participants increased reaction speed between intervention sessions 1 and 30 with an effect size of 1.1. Children with ASD increased reaction speed with an effect size of 1.8.

Means of pre and post scores for the BOT-2 and BRIEF were compared. Patterns of improvement in certain areas of motor and executive function were observed. Data analysis of pre and post BOT-2 scores showed significant improvement ($p < .05$) in age corrected scale scores for motor areas of manual dexterity and bilateral coordination for all participants. ASD-unaffected children significantly improved ($p < .05$) in scale scores for fine motor integration and bilateral coordination. Children with ASD significantly improved ($p < .05$) in scale scores of strength and agility.



Improvement was observed in 7/8 areas of executive function when analyzing BRIEF scores for all participants. Significant improvement ($p < .05$) was shown in the executive function area of working memory for all children who participated in this study. Children with ASD significantly improved ($p < .05$) in working memory and organization of materials.

Figure 2: Average Scores of BRIEF Categories with Significant Improvement



Findings from this pilot study suggest that participation in a Makoto protocol has potential to serve as a valuable addition to standard intervention for children with motor and executive function impairments. A larger scale examination in a random control trial study is suggested. Identification of effective, interesting, and motivating interventions is important to provide the optimal impact through therapy for children with ASD.

¹ Bruininks & Bruininks, (2005), Bruininks-Oseretsky test of motor proficiency (2nd Ed.) Minneapolis, MN: Pearson Assessment

²Exergame Fitness, USA, (nd), Makoto II. Retrieved June 28, 2011 from <http://www.exergamefitness.com/makoto.htm>

³ Gioia, G., Isquith, P., Guy, S., & Kenworthy, L., (2000), BRIEF: Behavior Rating Inventory of Executive Function, Odessa, FL: Psychological Assessment Resources.

⁴ Ghaziuddin, M., & Butler, E. (1998). Clumsiness in autism and asperger syndrome: A further report. *Journal of Intellectual Disability Research*, 42(1), 43-48.

⁵ Makoto USA (nd), Makoto: A sport for the mind and body. Retrieved June 28, 2011 from <http://www.makoto-usa.com>