

## PHYSICAL ACTIVITY

# Effect of Sensory Stimulation in Physical Activity on Memory, Reading, and Classroom Behavior in Elementary Students

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### Abstract

*During a six-week period, students in Grades 1-5 participated in 15 sensory activities that focused on processing and integration motor skills. The intervention group participated in 20 minutes of the Minds in Motion maze (10 minutes in the morning and afternoon) while the control group continued with normal school activities. Pre and post difference scores of the dependent variables (Auditory Memory Test, Developmental Reading Assessment, and Office Referrals) were calculated. Manova results showed that the intervention group scored higher than the control on the auditory memory test. Groups did not differ on reading level or classroom behavior. However, post interviews with participating teachers indicated that the maze was a positive addition to the school day, especially with classroom management.*

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## Introduction

Remarkably, over the past 50 years, opportunities for children to play freely have declined continuously and dramatically in the United States and other developed nations; that decline continues, with serious negative consequences for children's physical, mental, and social development (Gray, 2011). Typically, children provided abundant vestibular stimulation—jumping, swinging, turning somersaults, walking on the garden wall, riding skateboards—mastering all movement through space. Today, many schools have removed swings and other playground equipment. So, because of fear that a child might be injured, children are affected by a lack of needed movement opportunities (Almon, 2018). The overarching question is how this shift in “play” has impacted children's sensory systems and how they perform physically, academically, and socially.

The sensory system is responsible for detecting stimuli from the external environment. Once detected, the body responds through the interpretation of such stimuli. This occurs when information about sensations is passed back and forth between the central nervous system (CNS), nerves in the brain and spinal cord, and the peripheral nervous system with the nerves outside the CNS. Research suggests that stimulation of the sensory system can positively affect a child's cognitive, emotional, and social well-being. Furthermore, by specifically challenging the senses of touch, hearing, vision, and balance, not only is there evidence of enhanced learning but also improvement in children's behavior (Kranowitz, 2004).

The vestibular system is the sensory system specifically involved in developing the middle and inner ear and is recognized mostly for its critical role in balance, equilibrium, and motor development. When the head is moved, the fluid in the ears moves and shifts, constantly providing information about the position of the head and body in space, known as spatial awareness. The vestibular system holds another important responsibility as it combines with the eyes to filter through environmental stimuli and provide responses. Movements such as jumping, swinging, rolling, crawling, and climbing are responsible for developing the vestibular system, thus aiding in the more appropriate sensory information analysis and response (Braley, 2014).

Rolling, climbing, jumping, crawling, and spinning are basic motor skills that stimulate the sensory system, encourage development in both sides of the brain, and serve as the foundation for growth and learning. Without this sensory stimulation, children will have difficulty fully developing their auditory or visual systems when they use both sides of the brain. With good integration and timing, smooth and coordinated movements occur. However, when both sides of the brain do not integrate on a regular basis, non-fluid movements occur due to poor brain processing. This non-fluid movement indicates poor brain processing that can manifest itself in learning problems, learning disabilities, poor academic performance, and many other struggles in life (Belgau & Belgau, 2000).

On the other hand, when a child has a well-developed sensory system, information from the eyes, ears, balance, and movement can be organized more efficiently and filtered in the brain quickly, allowing the brain to respond appropriately to environmental stimuli. To accomplish this, research suggests activities promoting brain integration be performed frequently until movements are fluid and coordinated and the eyes converge efficiently. Likewise, a growing body of mainstream scientific research clearly points to the critical role sensory/motor neural development through the vestibular system (balance/inner ear system) plays in learning (Meyer, 2012).

Research also suggests sensory stimulation exercises can quickly enrich visual-perceptual problems in children with vestibular dysfunction. In fact, children respond more quickly than adults because of their greater neural plasticity and thus can more quickly compensate for and adapt to vestibular deficits. With an individualized approach, exercises addressing eye-movement control, balance, and body movement functions could have an immediate and dramatic positive effect on elementary children's academic achievement and classroom behavior (Cronin, 2003).

One program based solely on physical activity is the Minds in Motion Maze (MIMM). This program proposes a link between early afferent neural stimulation and cognitive abilities (Meyer, 2012). Specifically, movement activities that stimulate the vestibular system, such as balancing, rolling, pushing, pulling, stomping, and jumping, to name a few, have an impact on children's academic, social, behavioral, and physical domains. MIMM consists of 15 different daily

activities configured into stations that provide motor development exercises for students to experience increased sensory processing and sensory integration during the study to improve children's visual and auditory processing and motor skills. Minds-in-Motion activities have been designed to develop and challenge a student's balance and learning capabilities for the use of classroom or physical education teachers, inside or outside environment, in limited space, and with affordable equipment. Internal clinical data of Meyer's program suggests that when students of any age, race, or socioeconomic level have opportunities to build strong neurological foundations by activating sensory-motor integration processes, they become positioned to learn with ease and success and may be able to reach a higher potential (Meyer, 2012).

However, there is limited evidence that the maze curriculum has been used to show its specific effect on cognitive skills and classroom behavior. Using the MIMM curriculum taken from the first six weeks of the Minds in Motion curriculum, this study aimed to investigate the MIMM and the effect of sensory stimulation within physical activity on auditory memory, reading levels, and classroom behavior. This curriculum ensured participants' consistent activity over the six-week intervention period. Three research questions were developed: 1) to what extent does the Minds-in-Motion intervention maze affect auditory memory as measured by the Auditory Digital Span, 2) to what extent does the Minds-in-Motion intervention maze affect composite reading levels of elementary students as measured by the Developmental Reading Assessment, and 3) to what extent does the Minds-in-Motion intervention maze affect the classroom behavior of elementary students as measured by number of office referrals.

## **Method**

### **Participants and Design**

Participants were 185 6- to 11-year-old students who attended grades 1-5 in the same Midwest elementary school. The largest segment of this student population consisted of Caucasians (88.1%), a similar ethnic distribution to other schools in the district. The gender breakdown of the participants was nearly equal, with male (51.9%) and female (48.1%) students.

This study received formal approval in compliance with all the institutional and federal regulations concerning the ethical use of human volunteers for research studies. The principal, teachers, students, and parents/guardians of all children in first through fifth-grade classes provided consent. To protect participant identity, each student had an assigned identification number to assist with data analysis. The study was voluntary, and a participant could withdraw for any reason and at any time. The researcher and a small research team assisted in collecting data at both pretest and posttest. Each classroom (intervention) teacher ensured that the students attended their respective maze sessions each morning and afternoon, monitoring protocols as they maneuvered through each activity.

During the typical school day, one class from each grade served as the intervention group ( $n= 91$ , 52 male; 39 female, mean age = 9.07), participating for 20 minutes in the Minds in Motion maze, which was broken down into two 10-min sessions, one in the morning and one in the afternoon for 6 wks. The other class in each grade was the control group ( $n= 94$ , 49 male; 45 female, mean age = 8.80), and they continued with their normal school day activities. For purposes of the study, the students in the control group did not have access to the Minds in Motion maze during the conducted time of the study; however, they were promised to be given access to the maze after the six-week study was concluded, as stated in their parental consent form.

### *Maze*

The maze followed the Maze Handbook approach (Meyer, 2012), which consisted of 15 daily stations designed to develop and challenge a student's balance and learning capabilities. The obstacle course takes less than five minutes to complete; thus, under the 10-minute specifications of this study, each student could finish at least two rounds during each session. The Minds in Motion maze was called the Brain Ninja Maze to accommodate a more elementary setting. Using the appropriate terminology, "Ninja" students were associated with being safe, respectful, quiet, and focused on that of a Ninja cartoon character. The 15 MIMM activities, along with a description of each activity, follows:

**Station 1: Eye to Eye:** The instructor stands in front of a student and moves a pencil with a topper in front of the student's eyes

(approximately 14 inches away) while the student follows the object with his/her eyes. The pencil is moved in the following pattern: two horizontal, two vertical, two circles clockwise, two circles counter-clockwise, two horizontal, and two convergence training (going in toward the nose).

**Station 2: Monster Mash:** Students stomp down hard on padded shapes or blocks on the floor in a pattern.

**Station 3: Puppy Dog Crawl:** Students crawl on their hands and knees on the floor in a given direction for a specified distance.

**Station 4: The Electric Slide:** Students side-step along a path, keeping their toes, hips, and shoulders parallel to a wall. In a step-slide motion, they lead with one foot until halfway through the path, then turn so that another foot is leading.

**Station 5: Eye Can Convergence:** Students hold a beaded string (three beads affixed to a four-foot string) in their hand and focus on each differently colored bead one at a time while counting to 10 at each bead.

**Station 6: Strong Arm Push:** Students stand facing the wall and push against it with the palms of their hands as hard as they can for 10 seconds. The push is initiated straight from the chest and perpendicular to the wall.

**Station 7: Balance Board Bash:** Students stand on balance boards, training their bodies to suspend in balance.

**Station 8: The Beam Team:** Students walk on balance beams in a variety of ways in order to develop balance.

**Station 9: Jelly Roll:** Students roll on a mat placed on the floor in a predetermined manner.

**Station 10: Climb Every Mountain:** Students step over hurdles or obstacles of varying height.

**Station 11: Bean Bag Boogie:** Students throw and catch a bean-bag while walking along a pre-determined path. Students are encouraged to follow the bag with their eyes at all times. Students will progress through several skill levels of throwing and catching during the six sequential weeks.

**Station 12: Jumping Jack Flash:** Students perform a standing “broad jump” between two designated lines taped on the floor.

**Station 13: Cross Walk:** Students slowly walk while touching alternating knees with opposite hands. **Benefit:** Integrates the brain

with bilateral coordination movements while crossing the body's midline. **Application:** Aids students in bringing their hand to the left margin of their paper for writing assignments and speeds up brain processing.

**Station 14: Skip to My Lou:** Students skip down a designated line while swinging their arms cross-laterally in an exaggerated fashion.

**Station 15: Step Back:** Students walk backward up a set of stairs, holding onto a rail for support.

### *Modifications to the MAZE*

Progressions made to Week One of the maze activities allowed for differentiation of movement and eclectic stimulation throughout the study. Various changes included holding arms in different positions while walking along the beam or throwing the beanbag and catching it in different ways.

## **Procedure**

### *Intervention Preparation*

Before the study, the teachers received Maze training involving several teaching strategies. A first-grade teacher who attended a MIM Training Workshop taped a previous first-grade class as they performed all 15 Maze activities. This video gave the teachers and students visual demonstrations of proper Maze protocol. In addition, to verify that the maze setup was correct, and the children were taught the correct procedures, Minds in Motion founder Candace Meyer received the instructional video for critical review. Aside from a few minor revisions, the maze was deemed appropriate for the study.

Teacher training consisted of background information about the program, a daily morning/afternoon participation schedule for each class, and an outline of weekly changes to the maze. The teachers also received weekly email reminders full of helpful tips and reminders. The Maze, set up appropriately at the beginning of the intervention period, remained set up throughout the duration of the study. The researcher made the necessary changes for the weekly activities on Monday morning of each week. Each teacher was accompanied by an equipment list and maze diagram.

### *Intervention Group*

Under the supervision of the classroom teacher, the students in the intervention group participated in structured physical activity time for six weeks once a day that consisted of two 10-minute bouts (once in the morning and once in the afternoon) of activity using the 15-movement activities provided in the Maze. Each child started the maze at a pre-assigned station to ensure that all children would be participating with effectiveness and time efficiency. This helped ensure maximum participation without the students waiting in line for their turn or using equipment. For timing purposes, the classroom teacher monitored the class by timing the students for 40 seconds at each station. The activities occurred in a hallway connecting the main school building with the gymnasium.

All teachers received a six-week plan based on the Maze Handbook before the intervention sessions. Every Sunday, an email with changes and additional challenges was sent to all teachers via email. They were instructed to notify the children of such changes on Monday before beginning the maze and to keep such added activities for the remainder of that particular week. Monday's sessions needed verbal instructions, demonstrations, cues, and feedback due to the changes and new challenges in the program. During the remainder of the week, cues, feedback, and additional demonstrations were not delivered unless necessary. The goal was to let the children explore, adapt, and experience the tasks according to their motor development needs.

### *Control Group*

While the intervention group received structured movement in the maze for 20 minutes per day (two 10-minute increments), the control group participated in their regular school-day activities. These activities included academic classroom activities, unstructured recess, art, music, and other activities typical of students attending an elementary school.

## **Dependent Measures**

### *Auditory Digit Span Assessment*

Auditory memory involves taking in information that is presented orally, processing that information, storing it in one's mind, and

then recalling what one has heard. It involves attending, listening, processing, storing, and recalling. Because students with auditory memory weaknesses pick up only bits and pieces of verbalized during a classroom lecture, they make sense of only small amounts of what the teacher says. Afterward, they can recall only a small amount or none of what was said. Being unable to take in verbal instructions, process, and respond to a teacher's voice, whether through giving directions, laying out behavioral expectations, or instructing, would be troublesome to both academic achievement and classroom behavior. Students with auditory memory deficiencies will often have trouble understanding words and remembering terms and information presented orally (Cusimano, 2010).

For the study, students repeated a series of numbers dispensed by a computerized auditory program. The assessment began at two numbers and proceeded up to seven. Six columns of 10 words made up the assessment. Collected data included the difference in the number of lines a student repeated correctly until obtaining three errors.

### *The Developmental Reading Assessment (DRA)*

The DRA Assessment is part of the Missouri Assessment Program (MO DOE Website). It is given four times a year to all elementary students in the school district, and it measures a student's reading proficiency through observation, recording, and evaluation of performance. The test involves observing a student's reading engagement, analyzing and recording oral reading fluency, and evaluating the student's comprehension level. The researcher chose the DRA because it is a criterion-referenced assessment supported by sound validity and reliability analyses. This study used a composite score of the student's accuracy, oral reading fluency, and comprehension levels. Each DRA assessment occurred during one-on-one reading sessions between the teacher and student. A series of texts were used, each increasing in difficulty. Each classroom teacher gave their students the reading assessment. It was presented in one sitting because only a few students can be tested daily. Thus, the test was administered in all grade levels during the week before the intervention period beginning and immediately after the intervention period concluding. The principal collected the DRA results and provided them to the researcher.

### *Think Sheets and Office Referral*

A two-step protocol was used to assess classroom behavior. The first is Think Sheets, used at elementary schools to document inappropriate classroom behavior. Following the Behavioral Flow Chart provided by the administration to each of the teachers at the beginning of the school year, teachers decide when a behavior requires the Think Seat. The Think Seat is located in the principal's office, removing the student from the undesired situation and allowing ample time to reduce their stress level and reflect upon the occurrence. It also enables the administration and teachers to assess whether the student can return to the classroom setting.

After a brief cooling-off period, the student must complete a *Think Sheet*. This self-reflection and processing activity forces the student to think about *what* incident occurred, *why* it took place, *how* it could be handled in the future (if the same incident occurred), and whether or not the student believes he/she is ready to return to the classroom. The number of *Think Sheets* six weeks before the date of the Maze initiation was collected. This total was compared to the number of *Think Sheets* given to students, both in the control and intervention groups, during the intervention period. These office referrals are usually for grievances deemed more serious and typically result in consequences for the student, such as in-school suspension, removal from the lunchroom, removal from recess, conference with a counselor, conference with parents, etc. The number of office referrals from the beginning of the semester to the date of the Maze initiation was collected, and the number of office referrals given during the intervention period was calculated to calculate the difference score.

### **Treatment of the Data**

The Statistical Package for Social Sciences (SPSS) version 23 was used to analyze the data for this study. MANOVA was conducted to identify differences between the intervention and control groups on the three dependent variables: memory, reading levels, and classroom behavior. The score for each dependent variable was determined by taking the difference between the post-test and the pre-test score. For all analyses, the alpha was set at .05.

## Results

Before the final analysis, the sample population was analyzed to determine their viability for use during analysis. Participants who did not meet the 8 out of 11 sessions (80%) attendance had their data removed from the final analysis. Participants were also removed from the analysis due to pretest and/or posttest absences. After a review of the attendance records, 174 students (94% of the total students involved) met the attendance requirements. Means and standard deviations for all dependent variables can be found in Table 1.

**Table 1**

*Means and standard deviations for each assessment*

<u>Assessments</u>	<u>Control</u>			<u>Intervention</u>		
	<i>n</i>	<i>M</i>	<i>SD</i>	<i>n</i>	<i>M</i>	<i>SD</i>
Auditory Memory*	91	1.87	4.45	83	3.51	5.57
DRA Levels	91	4.95	4.634	83	4.67	7.10
Office Referrals	91	.0330	0.567	83	.229	0.786

Note: \* $p < .05$

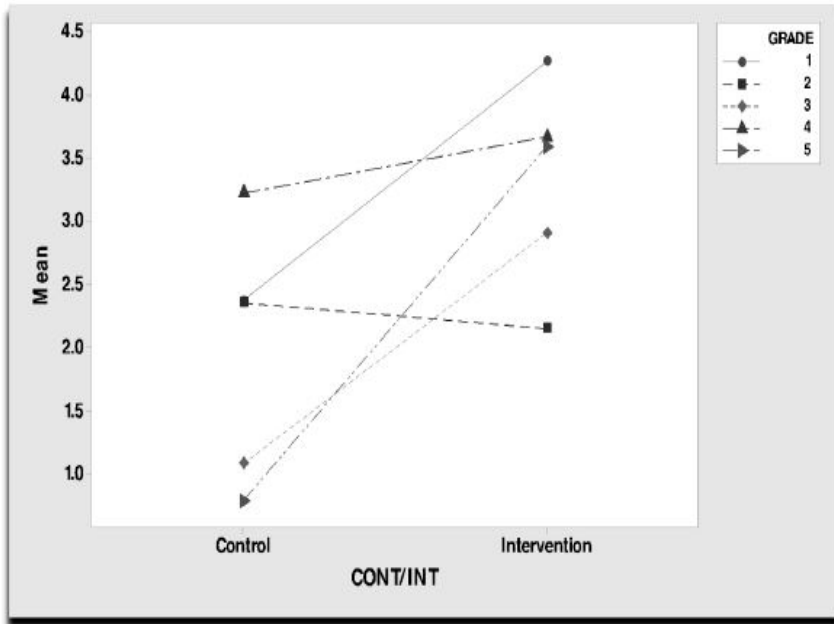
## MANOVA Results

A one-way multivariate analysis of variance was conducted to determine the effect of the Maze (compared to those in the control group) on the three dependent variables: auditory digit span assessment, DRA, and behavior.

Results of the MANOVA revealed a significant multivariate F: Wilks's  $\Lambda = .95$ ,  $F = (3,170) = 2.95$ ,  $p = .034$ . The univariate tests for each dependent variable found significance in only one variable (auditory memory),  $p = .029$ . Specifically, the results show that the intervention resulted in an improvement of about two points higher than that of the control group. Differences in improvement for neither of the other two variables reached significance.

An interactive plot showed a positive change for four of the grade levels to show the intervention's effect on auditory assessment more

**Figure 1**  
*Grade-level Scores for Auditory Memory*



clearly (see Figure 1). Grades 1, 3, 4, and 5 experienced an increase from the intervention, while Grade 2 showed a slight decrease.

### **Follow-up Qualitative Data**

This section details the meeting notes from the follow-up teacher’s meeting. The participating teachers volunteered to attend a short informative meeting one week after the conclusion of the six-week study to express impressions and observations of the Minds in Motion Maze and to discuss possible improvements for future research studies. The first and third-grade teachers associated with the intervention group stated that they saw an improvement in classroom behavior after participating in the maze. The teachers in the second, fourth, and fifth grades did not seem to notice a difference in behavior. All intervention group teachers believed in the connection between sensory stimulation and academic improvement, seeing growth in their classrooms.

All teachers believed that having a longer intervention phase would make the Maze very effective. For example, having the stu-

dents participate in the Maze over an entire semester rather than just six weeks would provide more opportunities to participate in and solidify the maze movements. Likewise, purchasing more equipment would make the Maze more challenging for students, especially those in the fourth and fifth grades. Lastly, teachers felt that some stations needed to be adjusted to fit the narrow hall space provided for the maze set up, which would make it more efficient for the students to complete more rounds in the time allotment.

Another issue was effort. Effort was an intangible element that was hard to measure as some students might not have put forth the energy required to see significant improvement. Teachers mentioned that some incentive programs, such as naming a “Ninja of the Day,” would help improve behavior. When they randomly videotaped their students, students were more motivated to work hard during the stations. The final recommendation was that one person be responsible for the maze, a person who knew all the students well, could motivate them to give their best and give extra support to those students who needed it most.

## **Discussion**

This quantitative study investigated the effect of a sensory stimulation maze on auditory memory, reading levels, and classroom behavior in first through fifth-grade students.

One assessment, the Auditory Digit Span Assessment, was employed from the Minds in Motion program. At the same time, the Developmental Reading Assessment (DRA) was used due to its convenience as the main reading assessment for the school district employed in the study. The office referrals were a consistent measurement of student behavior that the principal could track every day.

Implementing the Maze in an elementary school setting is challenging due to the age of the children and the vast number of stimuli they are subjected to in their educational environment. In essence, the real world contributes to a loss of control that could have been eliminated had the study been conducted in a lab under controlled settings. These challenges pose an interesting scenario in attempting to discover what contributes to or hinders the improvement rate of children in this setting. However, the researcher set up the Maze in the same location, and the classes were scheduled for predetermined

times during the day for consistency and limited interruptions due to weather or overlapping responsibilities.

From an extensive literature review, Madan and Singhal (2012) concluded that memory is retrieved better when learned through movement. The results found for the present study's auditory memory test would seem to support that assertion. Intervention students outperformed control students at every grade level except for second grade, which experienced very similar means. A poor auditory short-term memory is often the cause of a child's inability to learn to read using the phonics method (Ringoen, 2001). Phonics is an auditory learning system, and it is imperative to have sufficient auditory short-term memory to learn, use, and understand reading using the phonics method (Ringoen, 2001). According to Ringoen, a child must have an auditory digit span of close to six to begin to use phonics beyond memorizing a few individual sounds.

The Auditory Digit Span Assessment could help determine reading levels, especially regarding reading comprehension. Some students may have trouble processing and recalling information that they have read to themselves. When we read, we must listen and process the information we say to ourselves, even when we read silently. If we do not attend and listen to our silent input of words, we cannot process the information or recall what we have read. Therefore, even silent reading involves a form of listening (Cusimano, 2010). Given the auditory memory results of this study, one would expect that differences in reading ability would be found between the intervention and the control groups. However, this was not the case.

The results showed that the Maze's effect on reading levels was insignificant. It is possible that the insignificant results do not consider that there could have been improvement in reading levels that were not evident through the assessment used. The way in which the DRA measures improvement is not consistent among all grade levels; thus, students could have improved in reading but had not progressed to the next level. Also, it might have been beneficial to use the assessment components, reading fluency, and reading comprehension scores, as the measurement for reading improvement instead of reading levels. Another limitation is that the DRA does not provide a percentile score to be used for comparative means. In future studies, using a more sensitive assessment may show differ-

ent effects of the Maze on reading ability and a positive correlation between auditory memory and reading ability.

Furthermore, it is also possible that no differences might have resulted due to the reading activity of students in the control group. Although all students read in their regular classroom activities, at least some students in the control group could have spent more time reading while the intervention group was performing the Maze. Future studies will need to control this possibility. Lastly, the intervention was only six weeks, and it is possible that this was not long enough to notice differences between the intervention and the control groups.

The non-significant results of classroom behavior were somewhat unexpected. However, no formal evaluation was done on improved focus and completed work, which may have favored the intervention group. Also, a floor effect likely contributed to the nonsignificant results because the number of office referrals was minimal. Some behavioral improvement was, however, noted by the teachers in this study, especially for those in the higher grade levels during the teacher feedback session.

Another factor may have been the assessment instrument used. Using office referrals only amplified a small portion of behavior issues—the more extreme cases. Had the researcher used a broader approach to obtain more data, such as classroom observations, results may have been different.

Furthermore, using another standard behavior management system is recommended. By having the teachers set the same criteria for managing classroom behavior and consequences, a more accurate measurement of behavior could be collected and measured on a more objective scale. Perhaps a behavior rubric could have been used to ask each teacher to rate the severity of the behavior of the children in their class per incident.

The comments made by some of the teachers during the post-study meeting attest to the fact that some teachers saw improvement in behavior and felt as though the intervention did not have any negative effects on the students. They further expressed their desire to continue doing the maze for a longer period, especially in preparation for future school testing. As noted above, a longer study duration with the Maze should be considered in future research.

As a final note, a national recommendation for schools is to have a comprehensive approach for addressing physical education and physical activity in schools known as the *Comprehensive School Physical Activity Program* (CDC, ND). It includes Physical Education and family and community engagement. The Minds in Motion curriculum enabled the elementary students in the intervention group to increase their exercise time by 20 minutes each day, which enabled them to meet a portion of their daily requirement of 60 minutes of moderate physical activity. Considering that the students were participating in the maze activities for the first time, more experience in the Maze could improve cardiovascular stamina as the maze curriculum develops more challenging skill progressions. The Minds in Motion Maze could have a place in the other aspects of the program: staff involvement, physical activity during school, and physical activity before and after school as key components to the program. However, more research must be conducted to fully determine its effect on children's cognitive development and behavior.

## References

- Almon, J. (2018). *Improving children's health through play: Exploring issues and recommendations*. Alliance for Childhood and US Play Coalition.
- Belgau, F., & Beverly, B. (2000). *A perceptual motor and visual perception: Handbook of developmental activities for schools, clinics, parents, and preschool programs*. Balametrics.
- Braley, P. (2014). *Sensory processing: The auditory system*. The Inspired Treehouse. <http://www.theinspiredtreehouse.org>
- Centers For Disease Control. (n.d.). *Physical education and physical activity*. <https://www.cdc.gov/healthyschools/physicalactivity/index.htm>
- Cronin, A. (2003). *Asynchronous development and sensory integration in the gifted and talented*. <https://www.sengifted.org/post/asynchronous-development-and-sensory-integration-intervention-in-the-gifted-and-talented-population>
- Cusimano, A. (2010). *Learning disabilities: There is a cure*. Achieve Publications.
- Gray, P. (2011). The decline of play and the rise of pathology in children and adolescents. *American Journal of Play*, 3(4).
- Kranowitz, C. S. (2004) *Answers to Questions Teachers Ask about Sensory Integration*. Sensory Resources.

- Madan C. R., & Singhal, A. (2012). Using actions to enhance memory: Effects of enactment, gestures, and exercise on human memory. *Frontiers in Psychology*, 3(507).
- Meyer, C. S. (2012). *Minds in motion: The maze handbook*. Minds-in-Motion Inc. Press. Missouri Department of Elementary and Secondary Education. <https://dese.mo.gov/quality-schools/assessment/grade-level>.
- Ringoen, C. (2001). *Auditory memory: The overlooked learning skill deficiency*. <https://www.thereadingclinic.co.za/e/auditory-memory-2.htm>