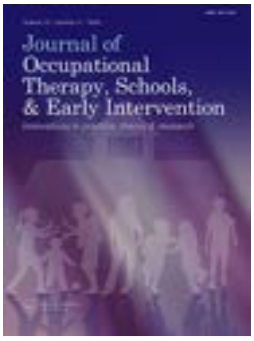

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Improving Selective Attention for All Students with Coordinative Bal A Vis X Movement Breaks: A Pilot Study

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BSTR CT

Brief coordinative movement breaks increase student attention and should be implemented by school-based occupational therapists to support the occupational potential of all students. Inattention is one of the most common reasons for student referrals to special education. Decreased physical activity is a contributing factor, yet movement opportunities are declining in schools. Despite these trends and the call from AOTA to support health promotion and prevention for all, 1:1 occupational therapy focusing on students identi ed with handwriting de cits continue to be prevalent in school-based practice. To remain a relevant service and keep pace with changing trends in special education and best practice, occupational therapists must broaden their scope to address inattention. This study explored Bal-A-Vis-X as an inclusive coordinative exercise intervention and found that 10-minutes of Bal-A-Vis-X twice per week for eight weeks improved attention in sixth grade students from d2 Test of Attention pretest to posttests. Immediate posttest improvements were statistically signi cant for processing speed (TN, $t(27) = 7.27$, $<.001$), focused attention (TN-E, $t(27) = 9.85$, $<.001$), concentration performance (CP, $t(27) = 7.90$, $<.001$), and accuracy (E , $t(27) = 1.72$, $= .048$). Delayed posttesting was completed 90-minutes after the intervention with statistically signi cant improvements in processing speed (TN, $t(21) = 10.37$, $<.001$), focused attention (TN-E, $t(21) = 12.59$, $<.001$), concentration performance (CP, $t(21) = 11.28$, $<.001$), and accuracy (E , $t(21) = 2.62$, $= .008$).

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Attention; Bal-A-Vis-X; children and adolescents; coordinative movement breaks; health promotion

Introduction

Inattention is on the rise and is one of the most common reasons for grade 1–6 student referrals to special education in the United States and Canada (Dunn, Cole, & Estrada, 2009). While nearly 70% of students receiving special education services age 6–21 in the United States have a disability associated with initiating, focusing, or sustaining attention (Dunn et al., 2009), di culty with attention may hinder student role performance even when it does not rise to the level required for a school-based disability determination. Decreased opportunities for movement and active play at school and increased sedentary and electronic play as the norm outside of school have been cited as contributing factors to inattention and other behaviors that disrupt learning, yet time allotted for movement

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Results of this study were presented at the AOTA Children & Youth Specialty Conference in Orlando, Florida in July 2019 and the Ohio Occupational Therapy Association (OOTA) annual conference in Cuyahoga Falls, Ohio in October 2019.

continues to decline in schools in order to increase academic instructional time toward the goal of improving academic test scores (Ma, Le Mare, & Gurd, 2014; McWilliams, Sayal, & Glazebrook, 2013; Rasberry et al., 2011; Spitzer & Hollmann, 2013; Suchert, Hanewinkel, & Isensee, 2015). However, this may be counterproductive, constraining rather than enhancing occupational potential and academic performance, because attention and inhibitory control decrease over time when students have to stay seated for long periods while participating in cognitive challenges (Buchele Harris, Schnabel Cortina, Templin, Colabianchi, & Chen, 2018; Drollette, Shishido, Pontifex, & Hillman, 2012; Gallotta et al., 2015). Despite evidence to the contrary, many educators and administrators fear that allotting increased time for physical activity during the school day will hinder their primary goal, academic achievement (Ma et al., 2014; Ma, Le Mare, & Gurd, 2015; Mahar, 2011). Not only does increased physical activity participation not diminish academic performance despite decreased time spent in direct academic instruction, it may actually enhance it (Ahamed et al., 2007; Buchele Harris et al., 2018; Drollette et al., 2012; Howie, Schatz, & Pate, 2015; Ma et al., 2014, 2015; McMullen, Kulinna, & Cothran, 2014; Rasberry et al., 2011; Spitzer & Hollmann, 2013). Given the prevalence of attention difficulties in children and youth and the reported relationship of such difficulties to sedentary behavior, this pilot study explored the following research question: will participation in brief coordinative Bal-A-Vis-X intervention sessions improve selective attention in sixth-grade students in a general education setting?

Attention and Academic Achievement

Colomer, Berenguer, Rosello, Baixauli, and Miranda (2017) reported a negative relationship between inattention and academic achievement, even when other variables such as intelligence and socioeconomic status are controlled. Further, the ability to demonstrate selective attention (choosing to ignore certain stimuli while attending to others) is necessary for learning and demonstrates high long-term validity for predicting academic achievement (Schmidt, Benzig, & Kamer, 2016; Schmidt, Egger, & Conzelmann, 2015). Academic achievement results from a combination of academic skills and learning behaviors called academic enablers. While some academic enablers are resistant to intervention, attention, or lack thereof, is modifiable and can be improved with targeted interventions (Colomer et al., 2017). Because attention supports academic learning and because academic achievement is the primary objective in education, attention should be promoted via direct interventions at school (Budde, Voelcker-Rehage, PietraByk-Kendziorra, Ribeiro, & Tidow, 2008; Janssen et al., 2014; Ma et al., 2015; Schmidt et al., 2015).

Coordinative Physical Activity

According to research, movement activities support increased attention and inhibitory control in children (Buchele Harris et al., 2018; Budde et al., 2008; Carlson et al., 2015; Drollette et al., 2012; Howie, Beets, & Pate, 2014; Janssen et al., 2014; Schmidt et al., 2015). However, specific types of movement have been shown to be more effective than others at facilitating attention behaviors that support learning. Studies have reported significantly greater improvement in attention and concentration in experimental groups that participated in coordinative exercise compared to control groups that participated in non-coordinative exercise (Buchele Harris et al., 2018; Budde et al., 2008; Janssen et al., 2014). Coordinative exercise involves skillful use of both sides of the body in action sequences that often include a rhythm component (Bobbio, Gabbard, & Cacola, 2009; Lin & Wu, 2014; Silva Pacheco, Gabbard, Ries, & Bobbio, 2016). These movement patterns are often cognitively engaging and may involve anticipation of time and space (Lin & Wu, 2014; Schmidt et al., 2016). Cognitive engagement during physical activity is thought to lead to better attention by pre-activating the same areas of the brain that are involved in cognitive processes (Budde et al., 2008; Schmidt et al., 2016). Improved attention and time on task have been demonstrated in pre-adolescent and adolescent students immediately following short bouts of coordinative exercise (Buchele Harris et al., 2018; Budde et al., 2008; Janssen et al., 2014) as well as 90 minutes after participation in coordinative exercise (Schmidt et al., 2015). In addition to improving attention, participation in coordinative physical activity has been positively associated with: improved reading, writing, and math test scores; overall classroom behavior (less fidgety, less listless, more focused, more on task); increased social competence; higher overall grade point average; improved short and long term memory; increased student effort and motivation; improved self-esteem; and decreased incidence of aggressive and disruptive behaviors (Carlson et al., 2015; Folino, Ducharme, & Greenwald, 2014; Rasberry et al., 2011; Spitzer & Hollmann, 2013).

Bal-A-Vis-X, a series of over 300 Balance/Auditory/Vision eXercises, meets necessary criteria to be classified as coordinative physical activity. Bal-A-Vis-X exercises vary in complexity, are deeply rooted in rhythm, and require full body coordination and focused attention (Hubert, 2016). Most exercises are done with sand-filled bags and/or racquetballs and require repeated midline crossing in a variety of three-dimensional patterns. Exercises can be graded to provide a just-right challenge for each participant and balance boards can be incorporated into many exercises to increase the di culty level. Additionally, exercises can be completed individually, with a partner, in small groups, or in large groups to alter complexity and the level of cooperation required.

Health Promotion and Prevention: A Call to School based Occupational Therapists

Over 20 percent of the occupational therapy professionals in the United States work in a school setting (American Occupational Therapy Association [AOTA], 2010). In schools, occupational therapists often provide impairment-based treatment to individuals and small groups of students with educational disabilities outside of the general education classroom (Ball, 2018; Weintraub & Kovshi, 2004). However, best practice suggests integration of occupational therapy services within natural general education settings when possible, allowing for opportunities to support health promotion and prevention for all students (Ball, 2018; Bazyk, Demirjian, Horvath, & Doxsey, 2018). Further, the American Occupational Therapy Association s (AOTA) Vision 2025 states that occupational therapy should “maximize health, well-being, and quality of life for all people, populations, and communities” (AOTA, 2017) while the overarching statement from the Occupational Therapy Practice Framework, 3rd Edition (OTPF-3) emphasizes achieving health and well-being for all people through participation in occupations (AOTA, 2014).

Schools should consider providing increased opportunities for physical activity to facilitate improved academic achievement, appropriate social and classroom behaviors, and improved self-concept for all students (Carlson et al., 2015; Donnelly & Lambourne, 2011; Folino et al., 2014; Howie et al., 2015). Occupational therapists, supported by Vision 2025 (AOTA, 2017), the OTPF-3 (AOTA, 2014), the Centers for Disease Control and Prevention (CDC) (2018), the No Child Left Behind Act of 2001 (AOTA, 2015), and the Individuals with Disabilities Education Act (AOTA, 2015), have the opportunity to provide a unique service in schools by focusing on health promotion and prevention (Ball, 2018) through provision of inclusive coordinative movement programs.

Purpose

While prior studies have examined the effectiveness of coordinative exercise interventions for improving student attention, there are no published studies which have explored the effectiveness of Bal-A-Vis-X as a coordinative exercise intervention in a middle school inclusion population where students with educational disabilities learn alongside their non-disabled peers in general education classrooms. Additionally, aside from a case series approach exploring the effectiveness of Bal-A-Vis-X as a non-pharmacological treatment for ADHD (Chibanda, 2015), there is no published research examining the effectiveness of Bal-A-Vis-X as an intervention toward any hypothesized outcome. Despite lack of a peer-reviewed evidence base and being supported primarily by anecdotal evidence, more than 15,000 occupational therapists, teachers, other professionals, and parents have attended Bal-A-Vis-X trainings since 2000 across the United States, Europe, and Asia (Hubert, 2016, n.d.) and are using this program to address attention, coordination, visual tracking, and a variety of other di culties. The purpose of this study was to explore the effectiveness of Bal-A-Vis-X as a brief coordinative exercise intervention for improving selective attention in sixth-grade students in a general education setting.

Methods

esign

This pilot study used a mixed-methods quasi-experimental design to explore use of Bal-A-Vis-X as an inclusive coordinative exercise intervention in a general education setting with the aim of increasing student attention. The intervention was inclusive in that coordinative Bal-A-Vis-X exercises were graded to match the abilities of each individual student and both students with and without identified educational disabilities were invited to participate. The study was designed as part of the first author s doctoral capstone and approved by the University Institutional Review Board. All recruited student participants signed assent prior to participation. Similar to the consent process described by Janssen et al. (2014), parents were given the option to exclude their child from data collection via passive consent, meaning that parents only had to sign and return the form if they did not want data collected on their child. Passive consent was also chosen based on findings by Shaw, Cross, Thomas, and Zubrick (2015) that students with certain characteristics (e.g., from single parent homes, academic di culties, etc.) were underrepresented in a student survey requiring active consent compared to a student survey requiring passive consent, thus leading to biased samples. Parental consent (active) and student assent were also obtained for all student volunteer instructors before the study began.

Student Participants

Participants were recruited from one sixth-grade general education classroom selected by the school director at a public, inner-city charter school in central Ohio serving primarily economically disadvantaged students. This charter school has very high academic expectations for all students, utilizing an extended school day to provide extra academic instruction while minimizing time spent in non-academic activities. While instruction in playing a musical instrument was offered periodically to a limited number of students, regular specials (music, art, physical education) were not a routine part of the curriculum. Behavioral expectations at this charter school were also very pervasive, dictating not only dress code and academic responsibilities, but also behaviors such as acceptable posture, eye contact, and line behavior. A web-based system was used to track behavioral data for all students daily. All teachers at the school were expected to rate students on both positive behaviors (e.g., excellent participation, outstanding line behavior, etc.) and negative behaviors (e.g., not paying attention/off task, talking out of turn, distracting behavior/noises, etc.) throughout each school day. Rather than students changing classes, they remained in the same classroom all day while teachers rotated from classroom to classroom to provide academic instruction in their assigned content areas. This model was used as a means to increase academic instructional time by minimizing transitions while reducing the potential for disruptions and opportunities for negative interactions with peers. The only routine exception to remaining seated within the same classroom throughout the entire extended school day for the majority of students was a brief lunch and recess period (20 minutes each including transitions) daily. However, lunch, like the rest of the school day, was very regulated and sedentary. Students entered the cafeteria in lines with teacher supervision and were expected to quietly retrieve their lunch from the serving window and proceed immediately to tables assigned by classroom. Once at the table, students were expected to remain seated and eat quickly and quietly. While allowed to get up to use the restroom if given permission, students were not otherwise allowed to stand or move about the cafeteria. Further, it was not unusual for permission to speak with friends to be revoked if staff deemed the noise level in the cafeteria to exceed expectations and students often had to sit for extended periods in silence before being allowed to transition back to their classrooms if behavior was not at expected levels. Lunch, therefore, was not a break from sedentary activity at this charter school. Additionally, recess was not a guaranteed break from sedentary activity. Students who accumulated deductions on the web-based reporting system for behaviors ranging from missing homework to school uniform violations to inattentive or disruptive behavior were required to remain in an assigned classroom during the brief recess period. Additionally, during inclement weather, which is common in Ohio during the winter months when the study took place, recess was held indoors in the same classrooms where academic instruction took place. While students were allowed to talk quietly with friends during indoor recess, they were expected to sit or stand with no opportunity for movement beyond things such as walking to another area of the classroom to retrieve an item from one s backpack or a book from the bookshelf. No games or materials were routinely provided by the school to facilitate opportunities for creativity or play during indoor recess.

Convenience sampling was used as the school director selected the classroom for the study based upon timing of the project, school scheduling availability, and teacher preferences. Like all classrooms at this school, the selected classroom was an inclusion classroom in that students with educational disabilities participated in academic instruction alongside their non-disabled peers. Specific information about the educational disability status of individual student participants was not provided to the primary author as access to such information was beyond the scope and purposes of this study. However, the following general information was available: most student participants were general education students while approximately 15% of student participants had either an Individualized Educational Program (IEP) or Section 504 Plan to address their unique learning needs. Additionally, while it was not disclosed to the primary author whether any student participants had an educational identification or medical/psychological diagnosis associated with attention di culty, review of classroom data revealed 127 documented incidents of behaviors related to inattention (not paying attention/off task, not following directions, distracting behavior) in the two months prior to the start of the intervention. While motor skills were not formally assessed for this study, none of the student participants were receiving occupational therapy services, adaptive physical education services, or physical therapy services at school to address motor skills at the time of this pilot study nor did they demonstrate any obvious motor concerns in unstructured observations completed during the study that would have hindered their participation in the intervention, pretesting, or posttesting.

The primary author is an Ohio licensed occupational therapist who provides services at the charter school site where the study took place. Students receiving occupational therapy services from the primary author at this school frequently complained about lack of opportunities for movement during the school day, stating things such as, "we don t even get to move to change classes." However, none of the potential student participants were known to the primary author from prior service provision nor were they currently receiving occupational therapy services at school from the primary author or any other provider at the time of the study intervention. All student participants spoke at least conversational English. Each of the 33 students enrolled in the selected classroom at the time of recruitment were eligible to participate. Of the 33 students enrolled in the selected classroom, 31 students volunteered and provided assent. Passive parental consent forms were distributed on two separate occasions, but no parent or guardian denied data collection for their student who was participating in the project. One student was transferred out of the project classroom due to school enrollment policies unrelated to the project prior to pretesting and implementation, leaving a total of 30 participants. Another student was withdrawn from the project classroom during week seven due to moving to another school, leaving a total of 29 participants. Finally, one student completed both posttests with the protocol upside-down despite explicit instructions, so this student s data was omitted from analysis. A total of 28 racially and ethnically diverse sixth-grade students (10 males, 18 females) with a mean age of 11.82 years (minimum age 11 years, maximum age 14 years) accurately completed pretesting, intervention, and the immediate d2 posttest (immediate = 10 minutes after Bal-A-Vis-X during the seventh week of intervention). A total of 22 participants (8 males, 14 females) also accurately completed the delayed d2 posttest (delayed = 90 minutes after the last Bal-A-Vis-X session during the eighth and final week of intervention).

Student Volunteer Instructors

Student volunteer instructors were middle school students who were enrolled in and recruited from the same public, inner-city charter middle school where the study took place. Bill Hubert, the creator of Bal-A-Vis-X, used student instructors in his Bal-A-Vis-X lab at Hadley Middle School in Wichita, Kansas until he retired (Hubert, 2016). Mr. Hubert highly recommends this practice as he believes that students becoming teachers is the natural progression of Bal-A-Vis-X and benefits both new students as they get peer assistance with learning techniques and student instructors as they develop an "I can" attitude, sense of mastery, and improved self-esteem from taking on this role (Hubert, 2016). Mr. Hubert s student instructors are children of various ages with experience in Bal-A-Vis-X who help others with little or no experience to learn the exercises.

Eligibility to participate in the study as a student volunteer instructor required enrollment as a current student at the study site and prior direct experience with Bal-A-Vis-X related to student IEP goals during occupational therapy sessions with the primary author. Further, to be eligible, students were required to be able to perform at least basic Bal-A-Vis-X sand bag and/or ball exercises with proper technique, such as a two-bag oval or a two-ball puppet arm bounce with pause, in rhythm with a partner. Student volunteer instructors were also required be able to speak at least conversational English. While no formal data collection was completed with student volunteer instructors, their responses to student participant questions and other information they provided spontaneously while demonstrating or instructing exercises for the study were recorded by the primary author for inclusion in qualitative analysis. One sixth-grade male and one seventh-grade female volunteered and provided assent to participate as volunteer instructors for the project. Each of their parents provided signed consent for participation.

Instruments

d Test of Attention

The d2 Test of Attention is a standardized test of selective attention for use with individuals age 9 to 60 years (Brickenkamp & Zillmer, 1998). Variations of this letter cancellation test (d2 and d2-R) have been used by multiple authors as a direct measure of student attention before and after exercise interventions (Buchele Harris et al., 2018; Budde et al., 2008; Ma et al., 2015; Schmidt et al., 2016, 2015; Spitzer & Hollmann, 2013). The d2 version was used for the current study as it is the only version normed for use in the United States. The d2 consists of 14 lines of randomly mixed d s and p s. Examinees are allowed 20 seconds per line with the test administrator verbally cueing them every 20 seconds to stop and move to the next line. They are required to mark the letter d only when 2 dashes accompany it while ignoring the distractor symbols (d s with more or less than 2 dashes and p s with any number of dashes). Following presentation of instructions, the entire test of 14 lines takes 4 minutes, 40 seconds and can be administered individually or in a group (Brickenkamp & Zillmer, 1998; Budde et al., 2008; Ma et al., 2015). Internal test-retest reliability of the d2 test is reportedly very high (Buchele

Harris et al., 2018; Budde et al., 2008). Additionally, criterion, construct, and predictive validity have been documented and test values have been shown to be stable over an extended period of time (Budde et al., 2008).

The d2 Test of Attention provides examiners with information related to five main outcomes: the total number of items processed (TN; processing speed), the total number of items processed minus the total number of errors (TN-E; focused/selective attention), error percentage (E%; accuracy, determined by adding all commission and omission errors and dividing this number by the total number of items processed), concentration performance (CP; selective attention, determined by subtracting commission errors from the total number of correct items processed), and fluctuation rate (FR; sustained attention, determined by subtracting the line with the lowest number of symbols processed from the line with the highest number of symbols processed). Higher scores for TN, TN-E, and CP indicate better performance. Lower scores for E% and FR indicate better performance. The d2 Test of Attention was used as the pre-post test in this study.

Student Perceptions Survey

A student satisfaction survey was created by the primary author to explore levels of enjoyment and perceived benefits related to participation in the coordinative Bal-A-Vis-X exercise intervention. The survey consisted of eight multiple choice questions, ten Likert scale questions presented in a table format, and eight open-ended questions. Survey questions were pilot tested with two sixth grade students at the project implementation site who were not participants in the intervention. Minor revisions were made to survey questions to support ease of readability and understanding based upon student feedback. Sections of the survey were administered with students who participated in the Bal-A-Vis-X intervention periodically throughout the intervention implementation period.

Intervention

After administration of the d2 Test of Attention pretest, the 28 student participants completed 10-minutes of coordinative Bal-A-Vis-X exercises led by the primary author with assistance from student volunteer instructors, a COTA/L, and the general education classroom teacher twice per week for eight weeks. Participation ranged from 11–15 sessions, with average participation being 13.93 sessions (Figure 1). Participants completed sandbag exercises for the first three weeks and transitioned to ball exercises for the remaining five weeks of the coordinative Bal-A-Vis-X exercise intervention.

Procedures

pretesting

Pretesting using the d2 Test of Attention was completed in the classroom during the scheduled intervention time (1:10 PM – 1:30 PM) with 23 students in late November 2018. Seven students who were absent on the pretesting date took the d2 pretest the following week prior to participation in the first coordinative Bal-A-Vis-X intervention.

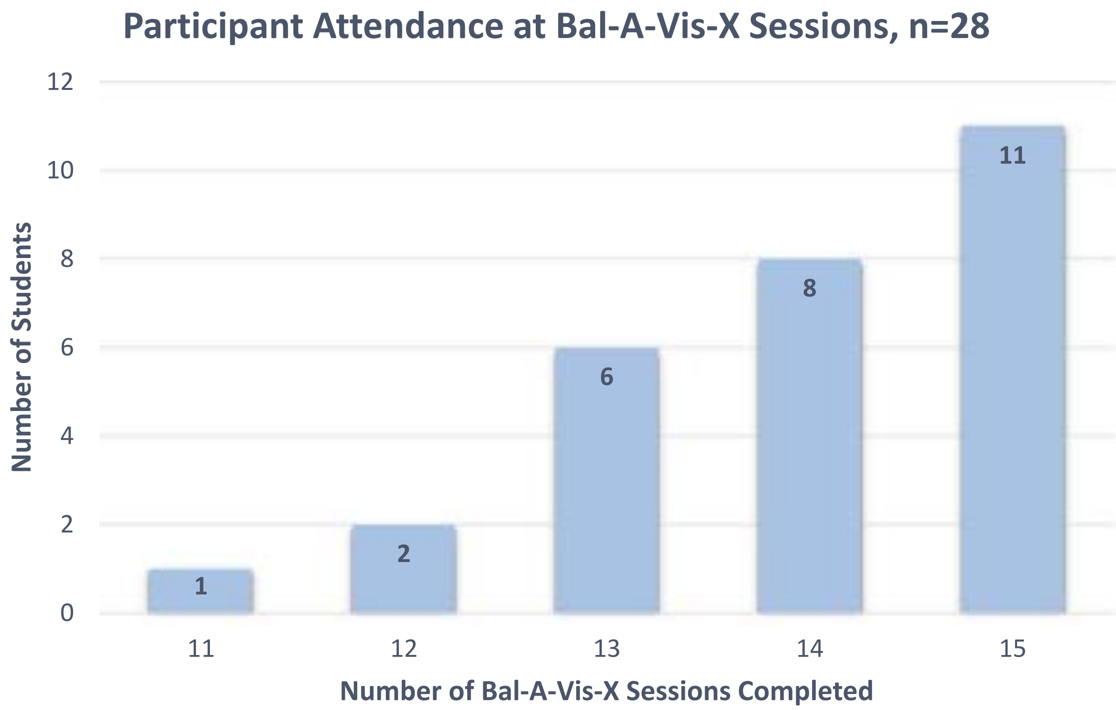

Figure 1 Student participant attendance at Bal-A-Vis-X sessions.

Intervention

The intervention was scheduled for Tuesdays and Thursdays and took place in the cafeteria immediately following the sedentary lunch period. The intervention time was 1:10 PM – 1:30 PM for most sessions. However, due to inclement weather and other scheduling issues, it was necessary to reschedule four intervention sessions for another day and/or time. The first five minutes of each session consisted of providing directions while waiting for the cafeteria to be cleared followed by ten minutes of coordinative exercise. The last five minutes was used for returning Bal-A-Vis-X materials and transitioning back to the classroom. Students participated in progressively more di cult sandbag exercises two times per week for the first three weeks of the intervention period. During week four, students were introduced to the basic Bal-A-Vis-X principles of the ball and participated in a total of nine Bal-A-Vis-X ball exercise sessions over five weeks.

Student Perceptions Survey

Sections of the author-created survey were administered with students who participated in the Bal-A-Vis-X intervention periodically throughout the intervention implementation period.

posttesting

Immediate posttesting using the d2 Test of Attention was planned during the sixth week of the implementation period, but had to be postponed until week seven due to inclement weather that caused school cancellations. Therefore, immediately after the first Bal-A-Vis-X intervention during week seven, students transitioned from the cafeteria to their classroom for administration of the immediate d2 posttest. The delayed d2 posttest was administered to 22 students approximately 90-minutes after the final intervention session of the study during week eight. Six students who participated in d2 pretesting, intervention, and immediate d2 posttesting were unavailable for participation in the delayed d2 posttest due to absences or scheduling conflicts.

Data Analysis

Quantitative

The d2 Test of Attention pretests (n = 28), immediate posttests (n = 28), and delayed posttests (n = 22) were scored for each student participant according to the instructions provided in the d2 user manual (Brickenkamp & Zillmer, 1998). Raw scores from individual participant d2 protocols were then entered into Microsoft Excel for data analysis. Descriptive statistics were calculated for the d2 Test of Attention pretest, immediate posttest, and delayed posttest. Data were analyzed for the whole group as well as by gender and age groups. To determine statistical significance, t tests for dependent means were calculated to compare pretest results to immediate posttest results and pretest results to delayed posttest results. An alpha level of .05 was used for all t tests.

Raw data for multiple choice and Likert table survey questions were also entered into Microsoft Excel for data analysis. Descriptive statistics were completed to determine mean responses for the whole group as well as with data sorted by age, gender, and number of Bal-A-Vis-X sessions completed.

Qualitative

Participant responses to open-ended survey questions were transcribed into an Excel worksheet for manual sorting by question. Question topics included: what students liked about the intervention, what students did not like about the intervention, student suggestions, and student perceptions of improvement in behaviors that support learning.

Results

Quantitative

All immediate raw posttest scores were obtained 10 minutes after the first intervention session in week seven. All delayed raw posttest scores were obtained 90 minutes after the last intervention session in week eight. No further attention testing was completed for this pilot study. Individual student d2 Test of Attention scores were calculated by gender and graphed to show changes in the two scores that measure selective attention, or one s ability to attend to relevant stimuli while disregarding irrelevant stimuli, TN-E (total number of items processed minus total number of errors) and CP (total number of relevant items processed minus commission errors) (Figures 2–5). Immediate raw posttest TN-E scores and delayed raw posttest TN-E scores increased for each student compared to raw pretest TN-E scores. While TN-E is a normally distributed and highly reliable measure, in the unusual case that an individual s TN (total number of items processed) and E% (error

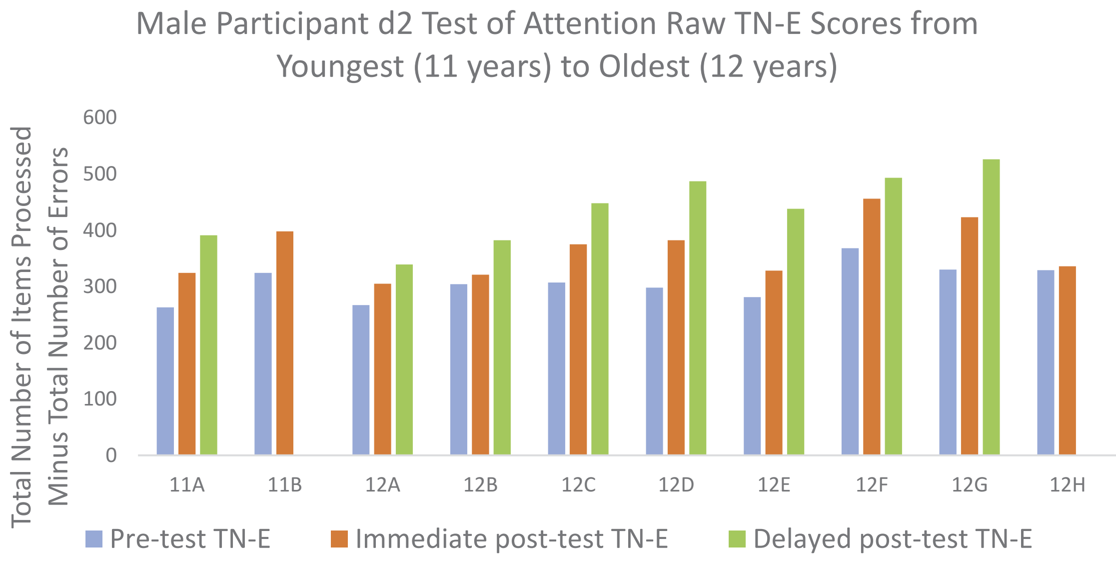

Figure 2 Changes in TN-E performance for male student participants.

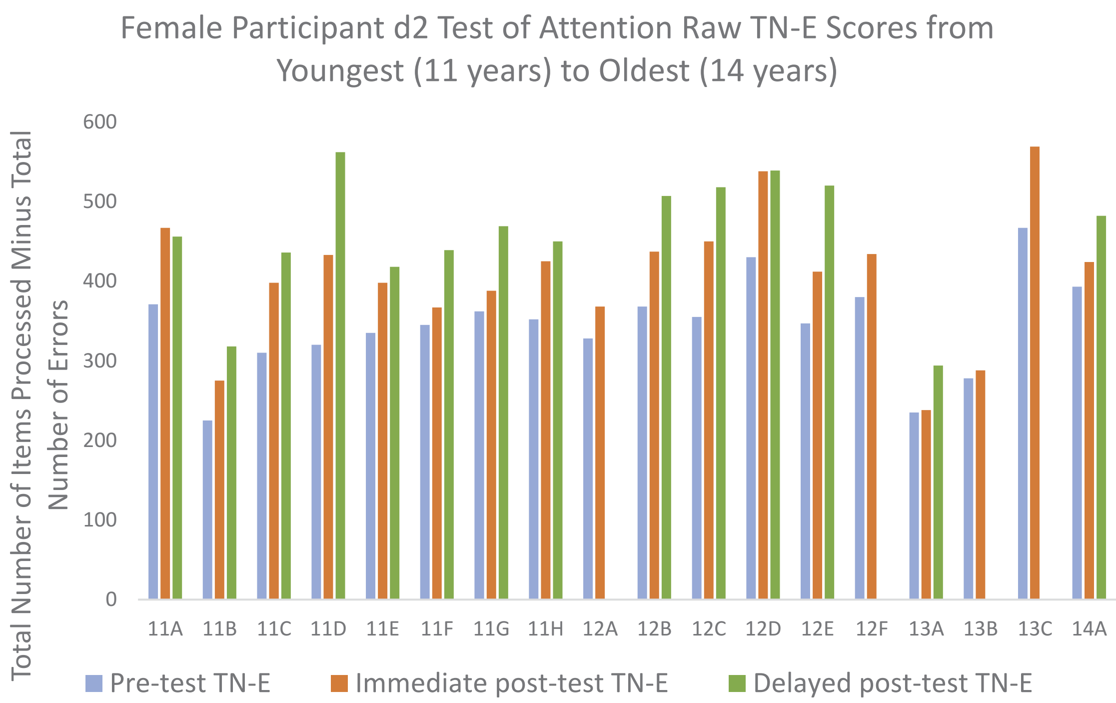

Figure 3 Changes in TN-E performance for female student participants.

percentage) scores are extremely high, TN-E tends to be an overestimation of performance (Brickenkamp & Zillmer, 1998). Unusually high TN and E% scores may occur together if a participant skips over entire sections of a line or lines on the d2 or crosses out all letters without discriminating. Calculation of CP, also a normally distributed and highly reliable score, eliminates inflated estimation of selective attention performance as this score cannot be distorted by skipping sections or crossing out letters indiscriminately (Brickenkamp & Zillmer, 1998). Immediate raw posttest CP scores increased for nine out of ten male participants compared to raw pretest CP scores. Delayed raw posttest CP scores improved

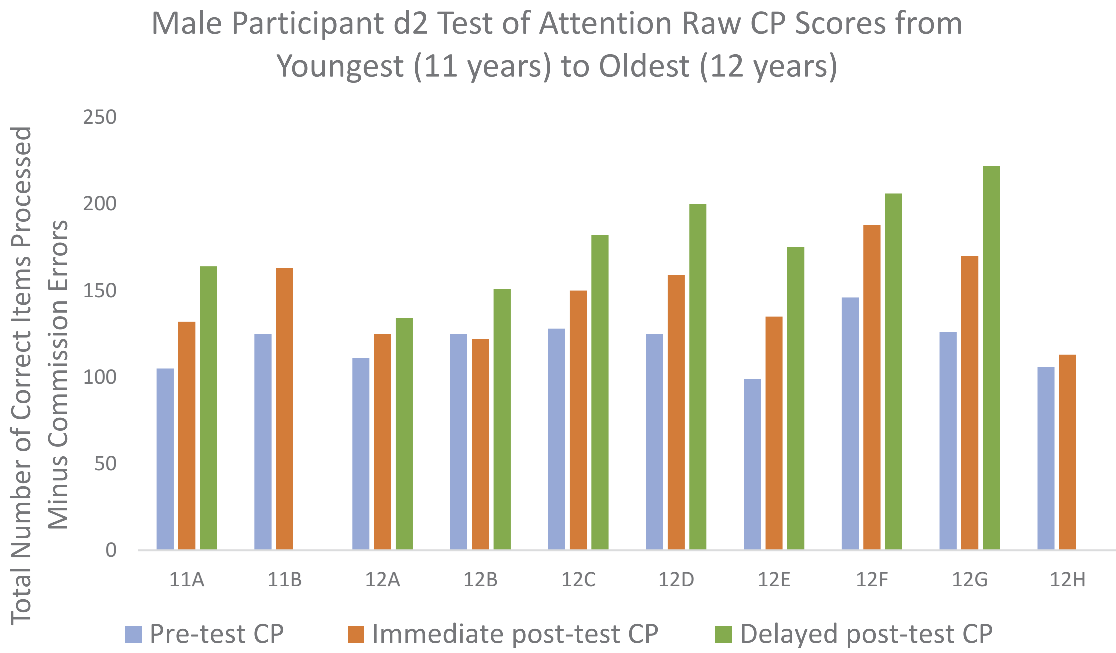

Figure 4 Changes in concentration performance (CP) for male student participants.

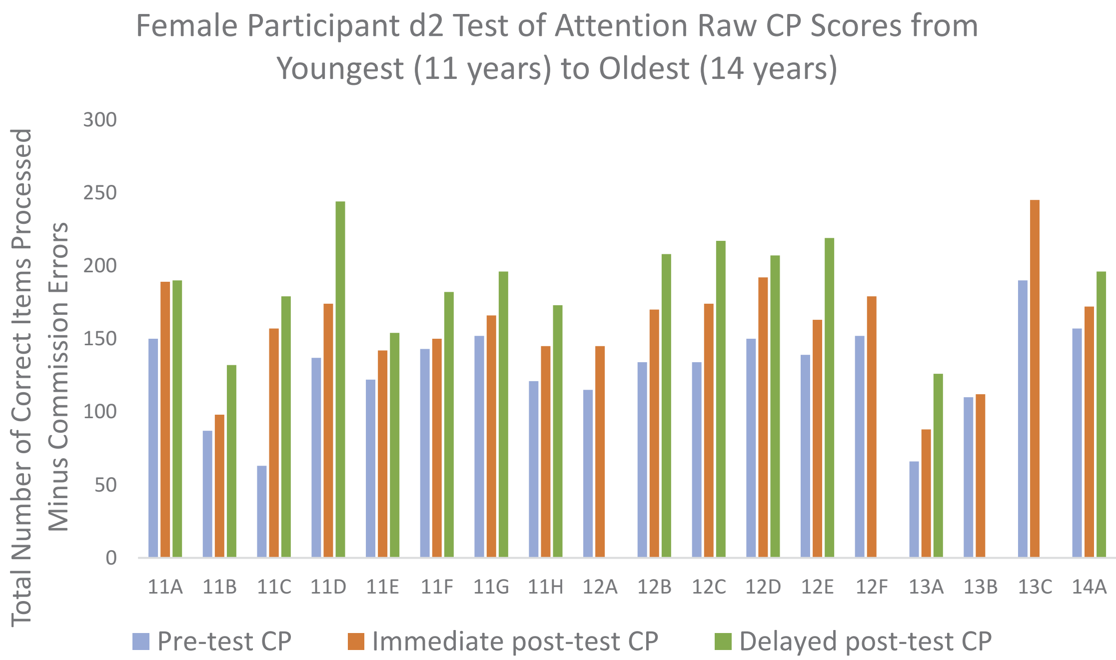

Figure 5 Changes in concentration performance (CP) for female student participants.

for all male participants compared to raw pretest CP scores. For all female participants, immediate and delayed raw posttest CP scores increased compared to raw pretest CP scores.

Group d2 Test of Attention mean scores were also calculated for TN (processing speed), TN-E, CP, E% (accuracy), and FR (sustained attention). Comparison of group mean scores indicates improved performance in all areas from pretest to immediate

Table 1 Descriptive Statistics for d2 Pretest, Immediate Posttest, and Delayed Posttest.

	d2 Pretest M ± SD (n = 28)	Immediate d2 Posttest M ± SD (n = 28)	d2 Pretest M ± SD (n = 22)	Delayed d2 Posttest M ± SD (n = 22)
Processing Speed (TN)	353.93 ± 57.21	410.29 ± 80.25	348.14 ± 56.39	463.72 ± 74.74
Focused Attention (TN-E)	331.14 ± 54.03	391.32 ± 74.30	325.72 ± 50.92	450.55 ± 71.49
Concentration Performance (CP)	125.64 ± 27.20	154.21 ± 32.60	123.64 ± 26.10	184.41 ± 31.41
Accuracy (E)	6.28 ± 5.69	4.53 ± 4.13	6.18 ± 6.10	2.77 ± 2.86
Sustained Attention (FR)	17.64 ± 7.59	16.57 ± 6.20	17.50 ± 8.15	17.64 ± 6.94

posttest (Table 1). Pretest means for the delayed posttest comparison were calculated using only the pretest data for the 22 students who also took the delayed d2 posttest. Improvements were shown in mean scores for TN, TN-E, CP, and E% from pretest to delayed posttest (Table 1). The mean score for FR from pretest to delayed posttest increased slightly, indicating a decline in FR performance at delayed posttest compared to pretest.

From d2 pretest to immediate posttest, t test results indicate statistically significant improvements in processing speed (TN, t(27) = 7.27, $p < .001$), focused attention (TN-E, t(27) = 9.85, $p < .001$), concentration performance (CP, t(27) = 7.90, $p < .001$), and accuracy (E%, t(27) = 1.72, $p = .048$) (Table 2). The improvement in sustained attention (FR, t(27) = 0.61, $p = .273$) was not statistically significant.

From d2 pretest to delayed posttest, t test results indicate statistically significant improvements in processing speed (TN, t(21) = 10.37, $p < .001$), focused attention (TN-E, t(21) = 12.59, $p < .001$), concentration performance (CP, t(21) = 11.28, $p < .001$), and accuracy (E%, t(21) = 2.62, $p = .008$) (Table 3). There was a slight decline in sustained attention performance (FR, t(21) = 0.07, $p = .273$), but the decline was not statistically significant.

Table 2 Results of t Tests for Dependent Means for Student Participants (n = 28; df = 27; t Critical One-Tail = 1.70) at d2 Pretest and Immediate d2 Posttest.

	d2 Pretest Mean	d2 Pretest SD	d2 Posttest Mean	d2 Posttest SD	value	P (one-tail)
Processing Speed (TN)	353.93	57.21	410.29	80.25	7.27	<.001
Focused Attention (TN-E)	331.14	54.03	391.32	74.30	9.85	<.001
Concentration Performance (CP)	125.64	27.20	154.21	32.60	7.90	<.001
Accuracy (E)	6.28	5.69	4.53	4.13	1.72	0.048
Sustained Attention (FR)	17.64	7.59	16.57	6.20	0.61	0.273

Table 3 Results of t Test for Dependent Means for Student Participants (n = 22; df = 21; t Critical One-Tail = 1.72) at d2 Pretest and Delayed d2 Posttest.

	d2 Pretest Mean	d2 Pretest SD	d2 Posttest Mean	d2 Posttest SD	value	P (one-tail)
Processing Speed (TN)	348.14	56.39	463.72	74.74	10.37	<.001
Focused Attention (TN-E)	325.72	50.92	450.55	71.49	12.59	<.001
Concentration Performance (CP)	123.64	26.10	184.41	31.41	11.28	<.001
Accuracy (E)	6.18	6.10	2.77	2.86	2.62	0.008
Sustained Attention (FR)	17.50	8.15	17.64	6.94	0.07	0.474

Mean responses to the student perceptions survey questions indicated overall positive perceptions of the Bal-A-Vis-X intervention (Table 4). For example, mean student responses for the whole group fell within the agree (4) to strongly agree (5) range for the following questions: I like to do Bal-A-Vis-X breaks (M = 4.61), I wish we could do Bal-A-Vis-X breaks every day (M = 4.46), I like the activities we do during Bal-A-Vis-X breaks (M = 4.43), and I feel good about myself when I master a new skill during Bal-A-Vis-X (M = 4.29). However, with the exception of responses to "Following Bal-A-Vis-X Breaks it is easier to stay on task when taking notes in class" (M = 4.04), mean student

Table 4 Mean Response to Quantitative Survey Questions for the Whole Group and Sorted by Gender, Age, and Number of Bal-A-Vis-X Sessions Completed.

	Whole Group Mean	Mean for Boys	Mean for Girls	Age 11 Mean	Age 12 Mean	Mean for 11 12 Sessions	Mean for 13 Sessions	Mean for 14 Sessions	Mean for 15 Sessions
Q1: I like doing Bal-A-Vis-X breaks at school	4.61	4.40	4.71	4.55	4.67	4.50	4.60	4.67	4.60
Q2: I feel bored during Bal-A-Vis-X	4.64	4.20	4.88	4.64	4.75	4.50	5.00	4.50	4.50
Q3: I wish we could do Bal-A-Vis-X at school daily	4.46	4.30	4.59	4.55	4.33	4.75	4.60	4.33	4.30
Q4: I think Bal-A-Vis-X breaks are too easy	3.11	3.20	3.12	3.27	3.08	3.75	3.20	3.33	2.80
Q5: I think Bal-A-Vis-X breaks are too hard	4.54	4.40	4.59	4.73	4.58	4.00	5.00	4.00	4.80
Q6: I like the Bal-A-Vis-X activities we do during movement breaks	4.43	4.10	4.65	4.54	4.33	4.25	4.60	4.33	4.40
Q7: I feel good about myself when I master a new skill during Bal-A-Vis-X	4.29	4.60	4.24	4.54	4.25	4.50	4.20	4.67	4.10
Q8: I feel frustrated during Bal-A-Vis-X breaks	4.50	4.10	4.82	4.91	4.17	4.25	4.20	4.33	4.90
Q9: It is easier to pay attention in class after Bal-A-Vis-X breaks	3.76	3.63	3.81	3.50	4.40	3.25	4.60	4.00	3.40
Q10: It is easier to follow class rules after Bal-A-Vis-X	3.73	3.56	3.81	3.70	4.09	3.75	4.60	3.40	3.40
Q11: It is easier to stay on task during independent writing after Bal-A-Vis-X	3.65	3.78	3.56	3.20	4.18	3.00	4.60	3.40	3.50
Q12: It is easier to track the teacher after Bal-A-Vis-X	3.85	3.78	3.94	3.50	4.18	3.50	4.60	3.80	3.80
Q13: It is easier to refrain from speaking out of turn after Bal-A-Vis-X	3.81	3.44	4.06	4.10	4.00	3.00	4.60	3.60	3.90
Q14: It is easier to stay focused when the teacher is talking after Bal-A-Vis-X	3.85	3.89	3.81	3.60	4.45	3.25	4.60	3.80	3.70
Q15: It is easier to stay on task during independent reading after Bal-A-Vis-X	3.88	3.89	3.94	3.80	4.27	3.00	4.80	4.20	3.70
Q16: It is easier to stay on task when taking notes in class after Bal-A-Vis-X breaks	4.04	3.67	4.31	4.00	4.09	4.50	4.40	3.80	3.90
Q17: It is easier to sit still in class after Bal-A-Vis-X breaks	3.48	2.88	3.89	3.44	3.70	3.00	4.40	3.75	3.11
Q18: It is easier to refrain from behavior that is distracting to others after Bal-A-Vis-X	3.35	3.33	3.31	3.20	4.00	2.25	4.60	3.60	2.90

For all questions, higher mean scores represent more positive perceptions. For Q2, Q4, Q5, and Q8, the scale is as follows 1 = strongly agree, 2 = agree, 3 = neither agree nor disagree, 4 = disagree, 5 = strongly disagree. For all remaining questions, the scale is in the opposite direction (strongly disagree = 1, disagree = 2, neither agree nor disagree = 3, agree = 4, and strongly agree = 5).

responses for the whole group related to their perceived ability to pay attention fell within the neutral (3) to agree range (4). Survey data were also sorted by gender, age, and number of Bal-A-Vis-X sessions completed and means were calculated for each of these categories by survey question (Table 4).

Qualitative

What Students Liked about the Intervention

Several participants reported that they liked the Bal-A-Vis-X intervention just because it was fun. One participant stated, "I like all of them, they are so fun to do and amazing " Other participants reported more practical reasons for liking the intervention, such as having a shorter math class on intervention days and just having a break from class in general. One student reported, I like that "it makes math class shorter" while another shared, "I like to get a little break from class." Many students expressed appreciation for the opportunity to move, stating, for example, "I like how we are not sitting down, taking notes, or just listening to the teacher" and "I like that we can move around and not have to sit. When we sit all day, we get tired. It s hard to learn when you re tired." Some students specifically mentioned how much they enjoyed the rhythm that is a part of all Bal-A-Vis-X exercises. One participant said, "I love the rhythm and I love the steady beat." Finally, some students enjoyed the opportunity to earn small rewards, such as gummy bears and Skittles, throughout the nine-week implementation period. This was expressed in statements such as, "I like when we get treats."

What Students Did Not like about the Intervention

Several participants stated that there was nothing they did not like about the intervention. For example, one student said, "I like it, I dislike nothing about it." A common complaint, however, was that the intervention was not long enough and not frequent enough. One student stated, I don t like "that we only get to do like ten minutes" while another said I don t like "that it s only Tuesday and Thursday and not every day." A few students noted specific rules they did not like, for example, "we can t bounce the balls without permission" to begin while a couple others shared that they did not like the timing, stating "I don t like that it s right after lunch." Finally, a few students indicated a dislike for certain exercises, such as, "what I don t like is doing the arm thing with two balls because it s hard."

Student Suggestions

When asked what they would do differently in relation to the Bal-A-Vis-X interventions, several participants suggested that they wanted the sessions to be longer and/or more frequent, as illustrated by the following quote: "I would have breaks every day and longer breaks." Several students also shared that they would change things to allow for moving to advanced exercises more quickly, for example, "start off harder, it s too easy with the bean bags" and "I would make them longer so people can get to the harder ones faster." Some students suggested that all students should be allowed to participate in Bal-A-Vis-X breaks, stating, "they should let them teach people in all grades" and "maybe we could show the whole school." Other suggestions included having more Bal-A-Vis-X instructors and doing the exercises outside.

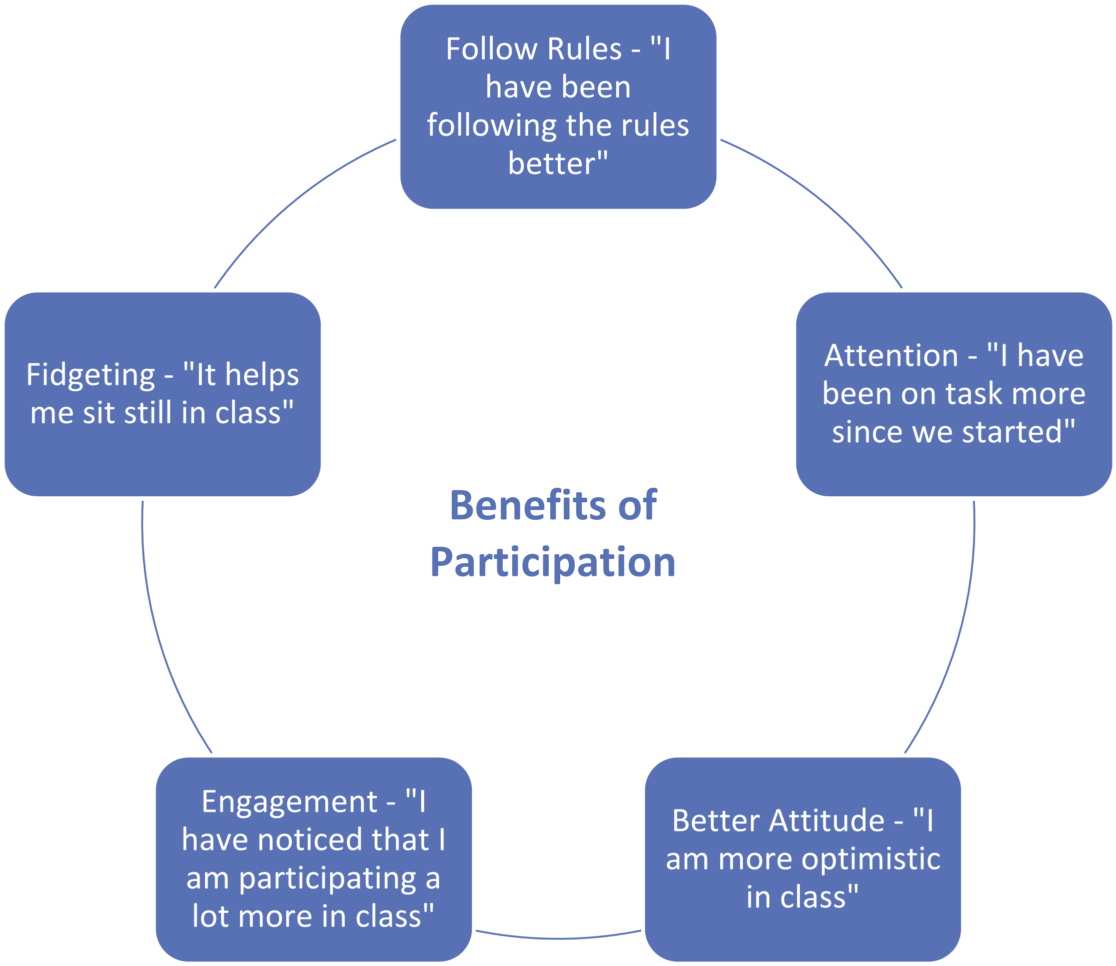

Figure 6 Student perceptions of improvement in behaviors that support learning as reported on open-ended student participant survey questions.

Student Perceptions of Improvement in Behaviors that Support Learning

While some participants indicated that they noticed no difference in their ability to follow school rules or pay attention in class, other participants stated that they felt one or more benefits in these areas related to Bal-A-Vis-X participation. Figure 6 illustrates these perceived benefits.

Discussion

This study examined whether participation in brief coordinative Bal-A-Vis-X intervention sessions implemented twice per week for eight weeks in a general education setting would improve attention in an inclusion class of sixth-grade students. Results revealed improvement in mean scores from d2 Test of Attention pretest to immediate d2 posttest in processing speed (TN), focused attention (TN-E), concentration performance (CP), accuracy (E%), and sustained attention (FR). Additionally, t tests for dependent means revealed that these improvements were statistically significant for processing speed, focused attention, concentration performance, and accuracy. Improvement was also observed in the mean score for sustained attention, but this improvement was not statistically significant. These results provide preliminary evidence that use of brief Bal-A-Vis-X breaks integrated into the school day could serve to improve attention in middle school students. These results are similar to results reported in the research literature. Budde et al. (2008) reported statistically significant improvements in processing speed, focused attention, and accuracy on the d2 at immediate posttest for 13–16 year old adolescents who completed a 10-minute coordinative exercise intervention compared to a control group that completed a 10-minute non-coordinative exercise session at the same intensity level. Additionally, results reported by Buchele Harris et al. (2018) correlated with results of the current study at immediate d2 posttest in that the coordinative exercise intervention group showed significant increases in processing speed, focused attention, and concentration performance compared to the control group. However, results of the current study also revealed statistically significant improvement in accuracy (E%) while Buchele Harris et al. (2018) results did not. While it may be that accuracy improved in the current data due to a learning effect, the time between pretest and posttest was greater in the current study (~11 weeks) than in the Buchele Harris et al. (2018) study (1 month). Given the increased time between pretesting and posttesting, it is reasonable to expect that any changes caused by the learning effect would be less for the current study participants than for Buchele Harris et al. (2018) participants. It is, therefore, hypothesized that improved accuracy for current student participants was not due to the learning effect. It may be that longer duration of the coordinative exercise intervention (10 minutes for this study versus 6 minutes for Buchele Harris et al. (2018)) or participation over a greater number of weeks (8 weeks for the current study versus 4 weeks for Buchele Harris et al. (2018)) accounts for the difference in accuracy results.

This study also revealed improvement in mean scores from d2 Test of Attention pretest to delayed (90-minutes post intervention) d2 posttest in processing speed (TN), focused attention (TN-E), concentration performance (CP), and accuracy (E%). Additionally, t tests for dependent means revealed that these improvements were all statistically significant. However, the mean score for sustained attention (FR) increased slightly, representing a decline in performance, but the difference was not statistically significant. These results are similar to results reported in the literature. Schmidt et al. (2015) studied the delayed effects of coordinative exercise on attention. They reported statistically significant improvement from d2 pretest to delayed d2 posttest (completed 90-minutes after the intervention) for participants who completed cognitively demanding (coordinative) exercise in the areas of processing speed and focused attention (Schmidt et al., 2015). While Schmidt et al. (2015) mean accuracy scores improved at delayed posttest compared to pretest, results were not statistically significant. Overall, previously published research and results of the current study suggest that brief coordinative exercise breaks are an effective intervention for facilitating immediate improvements in student attention and that attention benefits endure for at least 90 minutes post-intervention. Further, current study results provide preliminary evidence of the effectiveness of Bal-A-Vis-X as a brief coordinative exercise intervention for improving attention in an inclusion middle school population.

Previous studies of the relationship between movement breaks and attention have examined student perceptions of cognitive engagement and exertion during exercise interventions (Schmidt et al., 2016), teacher perceptions of student enjoyment (Carlson et al., 2015), and teacher perceptions of student behavior following exercise interventions (Spitzer

& Hollmann, 2013). This study surveyed students regarding enjoyment and perceived benefits related to participation in coordinative exercise interventions. The student survey revealed overall positive perceptions of the intervention. For example, in response to the statement "I like doing Bal-A-Vis-X breaks at school," 100% of students agreed or strongly agreed (17 of 28 students (60.7%) strongly agreed while the remaining 11 of 28 students (39.3%) agreed). Further, in response to the statement, "I wish we could do Bal-A-Vis-X breaks at school every day," 15 of 28 students (53.6%) strongly agreed, 11 of 28 students (39.3%) agreed, and 2 of 28 students (7.1%) neither agreed nor disagreed. These results are similar to teacher perceptions reported by Carlson et al. (2015) indicating that 97.6% of teachers who had implemented physical activity breaks in the past week reported that students enjoy physical activity breaks while 73.5% reported that students are upset if there are no physical activity breaks. These results indicate that student buy in for these types of activity breaks is high. Further, reviewed literature reveals that teachers feel they are meaningful to incorporate in school settings so support for implementation is likely.

Yamkovenko (2011) noted taking a broader scope in schools as an emerging area of occupational therapy practice. Despite the increased incidence of special education referrals with inattention as a primary concern and the call from AOTA to support health promotion and prevention for all, 1:1 occupational therapy services outside the general education setting that focus on isolated skill impairments, such as handwriting, continue to be prevalent in schools (Ball, 2018). To remain a relevant service and keep pace with changing trends in special education and best practice, occupational therapists should broaden their scope and integrate services into general education settings to address inattention and benefit all students (Ball, 2018). The No Child Left Behind Act of 2001 (NCLB) "created broader opportunities for occupational therapy to be used by schools to benefit students with and without disabilities" (AOTA, 2015). Individuals with Disabilities Education Act (IDEA) revisions further support broadening the scope of school-based occupational therapy practice by requiring Early Intervening Services (EIS) in the least-restrictive environment for all students struggling with learning or behavior (AOTA, 2015; Ball, 2018). Toward these ends, occupational therapists must have knowledge of evidence-based, inclusive interventions that can be used to directly promote attention and support the occupational potential of all students. Results of this study suggest that occupational therapists could easily incorporate Bal-A-Vis-X into Tier 1 interventions with anticipated attention benefits for students with and without disabilities in natural general education settings, thus promoting the health and well-being of all students.

Contexts and environments can either support or hinder participation in occupations (AOTA, 2014). Creating environments that support occupational performance without requiring special adaptations is economically advantageous and aligns with sustainable development (Swedish Association of Occupational Therapists, 2012). Opportunities for recess and physical education have decreased in many countries to increase academic instructional time toward the goal of improving test scores (Ma et al., 2015; Rasberry et al., 2011). However, this may actually be creating a barrier to student performance as research shows decreased attention and inhibitory control over time with extended periods of sedentary cognitive activity (Buchele Harris et al., 2018; Drollette et al., 2012; Gallotta et al., 2015). Implementing evidence-based coordinative movement breaks alters the social environment (school expectations to remain seated without movement breaks) and the temporal context (duration of extended seated activities) to support the occupational potential of all students in the general education setting. Further, the learning barrier that occurs when students have to sit for extended periods while participating in cognitive challenges is removed, thus promoting sustainable health and well-being for all students (Buchele Harris et al., 2018; Drollette et al., 2012; Gallotta et al., 2015). Results of this study align with previously published evidence suggesting that brief coordinative exercise breaks are a targeted intervention that can be used to improve student attention in school settings (Buchele Harris et al., 2018; Budde et al., 2008; Janssen et al., 2014; Schmidt et al., 2016). Because research suggests that attention is necessary for academic learning and because academic achievement is the primary objective in education, results of this pilot study, as well as evidence presented in the previously published literature, suggest that direct strategies can and should be used in schools to increase student focus and attention (Budde et al., 2008; Colomer et al., 2017; Janssen et al., 2014; Ma et al., 2015; Schmidt et al., 2015). Supported by federal law and AOTA practice guidelines, school-based occupational therapists have the opportunity to collaborate with classroom teachers in supporting the health, well-being, and occupational potential of all students in least-restrictive, general education settings via coordinative exercise strategies to facilitate improved attention and apply their unique skill set by analyzing and grading coordinative movement activities and environments to support general education staff in providing the just-right challenge for each individual.

Limitations and Recommendations for Future Research

This study adds to the body of evidence indicating that participation in brief coordinative exercise breaks improves student attention. However, lack of a control group is a recognized limitation of this pilot study. Future studies examining the effectiveness of Bal-A-Vis-X for improving student attention should include one or more control groups. For example, control groups may include students who do not receive a break, students who receive a sedentary break, students who participate in a non-coordinative exercise break, and/or students who participate in an alternate coordinative exercise break (not Bal-A-Vis-X) for comparison with the Bal-A-Vis-X study group participants. Use of one or more control groups would increase confidence in study conclusions suggesting that brief coordinative Bal-A-Vis-X breaks are the cause of improved attention scores at posttesting by taking extraneous variables, such as normal growth and development, into consideration in the study design. The use of convenience sampling to recruit sixth-grade participants from one classroom at one urban public charter middle school serving racially and ethnically diverse students from primarily socioeconomically disadvantaged families also limits confidence in generalizing results to students in other grades and/or from other educational and socioeconomic backgrounds. It is recommended that future studies include a larger sample size with participants recruited from multiple schools and randomly assigned to intervention versus control groups. Additionally, while the d2 Test of Attention has been used as a pre- posttest measure in multiple studies of the effectiveness of coordinative exercise for improving attention and research suggests that the d2 Test of Attention has high internal test-retest reliability as well as documented criterion, construct, and predictive validity (Buchele Harris et al., 2018; Budde et al., 2008; Ma et al., 2015; Schmidt et al., 2016, 2015; Spitzer & Hollmann, 2013), neither the current study nor any of the reviewed studies completed multiple d2 pretests to rule out the learning effect as an alternative explanation for improved attention scores at posttest. In order to rule out this alternate explanation and minimize the impact of the initial learning effect at posttest, completing two d2 pretests prior to initiating intervention is a recommended addition to future studies to further support conclusions that coordinative exercise interventions cause posttest improvements. Future studies should also consider follow up assessments a week or more after the end of the intervention period to check for maintenance of improved attention scores. It is also unknown how or if improved scores on the d2 Test of Attention translate to improvements in classroom performance. Future studies of Bal-A-Vis-X and other coordinative exercise interventions should include one or more outcome measures examining not only attention as an isolated client factor, but any accompanying changes in occupational performance within the student role.

Regarding student perceptions of participation in coordinative Bal-A-Vis-X interventions for the current study, lack of extensive pilot testing, revision, and analysis to ensure the reliability and validity of the author created student perceptions survey is considered a limitation. Measurement of student perceptions related to enjoyment and benefits of coordinative exercise was lacking in the reviewed literature and should be considered in future research to support client-centeredness. Availability of validated tools to measure student perceptions should be explored and, if unavailable, such measures should be developed.

Finally, Bal-A-Vis-X is currently being used by teachers, parents, occupational therapists, and other professionals as a treatment technique to address attention, coordination, visual tracking, and a variety of other di culties as indicated by the more than 15,000 individuals who have attended Bal-A-Vis-X trainings since 2000 across the United States, Europe, and Asia (Hubert, 2016, n.d.). Aside from a case series approach to exploring Bal-A-Vis-X as a non-pharmacological treatment for ADHD (Chibanda, 2015), Bal-A-Vis-X has been supported only by anecdotal evidence. This study was the first to explore the effectiveness of Bal-A-Vis-X as an inclusive coordinative exercise intervention for improving attention in a whole group general education setting. Because occupational therapists and other professionals are spending limited continuing education dollars on Bal-A-Vis-X training, it is suggested that future research continue to explore the effectiveness of Bal-A-Vis-X for increasing attention as well as for improving performance in other areas reported by the program, such as visual and motor skills.

Conclusions

This pilot study provides preliminary evidence that 10-minute coordinative Bal-A-Vis-X breaks twice per week for eight weeks is an effective intervention for improving d2 Test of Attention performance in sixth-grade students from pretest to immediate posttest (10 minutes after participation) and from pretest to delayed posttest (90 minutes after participation). Because attention supports academic achievement and because academic achievement is the primary objective in education, attention can and should be directly promoted via interventions at school (Budde et al., 2008; Janssen et al., 2014; Ma et al., 2015; Schmidt et al., 2015). Further, occupational therapy professionals should broaden their scope of practice knowledge to remain a relevant school-based service, keep pace with changing trends in special education, and support the occupational potential of all students via collaboration with teachers and other general education staff to implement coordinative exercise interventions in natural general education settings.

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