

# The Effects of Added Physical Activity on Performance during a Listening Comprehension Task for Students with and without Attention Problems

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**Abstract:** *We conducted this study to investigate the effect of adding physical activities (sitting on therapy ball versus doodling) on listening comprehension of children with and without attention problems. We used an alternating treatment design to investigate the effects added motor activities, therapy balls versus doodling. Results show that all of the participants answered more comprehension questions compared to the baseline conditions. However, both the therapy ball condition and doodling conditions were equally effective with children. Implication for research and practice are discussed.*

Paying attention and listening during lectures or meetings or conversations can be challenging at times for all of us. When placed in such listening situations for extended time periods, most of us tend to keep ourselves occupied by doodling, moving around in our seats, tapping our finger/hands or legs, sometimes talk out of turn, making shopping or to-do lists in our note pads, or twirling strings in our clothing, etc. Listening can also be challenging for all children, who during school hours are required to listen to verbally presented educational materials such as lectures, or lesson and stories, and have to answer comprehension questions based on the content. This can be especially challenging for students who

already have attention problems, and are expected to listen without moving or fidgeting. It is estimated that up to 1 in 20 children in the U.S. , and approximately 5.9% of school age children worldwide have a diagnosis of attention problems, making it one of the most commonly diagnosed disorders of childhood (Faraone, Sergeant, Gillberg, & Biederman, 2003; Polanczyk, De Lima, Horta, Biederman, & Rohde, L.A. 2007). These students have difficulty sustaining attention to their tasks and have been reported to display between three and eight times as many off-task behaviors as comparison students (Carroll et al., 2006).

Research has suggested that instead of reprimanding students' movements and added activity, it might be beneficial to include physical activities before or during academic task. Studies have documented positive effects of physical activity for school aged children through school wide exercise programs (Hollar et al., 2010), incorporating physical activity across curriculum (Donnelly et al., 2009), reviewing school data on physical fitness tests and comparing them to academic test scores (Chomitz et al., 2009), including classroom wide exercise programs (Mahar et al., 2006), and integrating outside school activities (Coe, Pivarnik, Womack, Reeves, & Malina, 2006). In general, researchers in these studies demonstrated

improvements in standardized test scores, on task behavior, and academic time on task in average functioning school age children.

Physical activity has also been beneficial for school children who have problems in attention and learning, such as those with attention problems or diagnosed disorders. Adding physical activities to their routine academic tasks has been recommended by intervention studies that have been based on the Optimal Stimulation theory (see Kercood, Grskovic, Lee, & Emmert, 2007; Zentall, 2006 for reviews). The Optimal Stimulation Theory hypothesizes that that organisms will initiate stimulation-seeking activity to achieve a stimulatory state that might be described as homeostasis (Hebb, 1955), as in individuals with attention deficit hyperactivity disorders (ADHD) engage in excessive physical movement in an attempt to generate stimulation and reach homeostasis (Zentall, 2006; Zentall & Zentall, 1983). Therefore, by adding stimulating activities such as color, novelty or physical activities into routine tasks, one can provide the optimal level of stimulation that they require, which therefore, allows them to have improved task performance and reduced disruptive behaviors (see Zentall, 2006 for review).

The use of physical activities with persons with and without ADHD have included yoga (Jensen & Kenny, 2004), physical activity as a reinforcer for calmness (Azrin, Ehle, & Beaumont, 2006; Azrin, Vinas, & Ehle, 2007), fine motor activities such as the use of flexible tangle toys (Kercood & Grskovic, 2010), and use of therapy balls (Schilling, Washington, Billingsley, & Deitz, 2003). Jensen and Kenny (2004) conducted a study with 20 children with ADHD who were stabilized on medication. The participants were randomly assignment to Yoga group (n=11) and a control group (n=8). Results indicated the participants in

yoga performed better on several subscales of the Conners' Parental Rating Scale, Global Index Restless and Impulsive and ADHD Index. The authors concluded that Yoga may have some benefits for those students who are medically stabilized and suggested further replication of results.

Azrin, Ehle, and Beaumont (2006) investigated whether scheduled physical activity could serve as a reinforcer for calmness with a four-year-old boy diagnosed with ADHD and autism. During the intervention condition, the student was provided 1-minute opportunity to play with typical gymnastic equipment. The investigators also used other conditions such as shaping, descriptive praise, and noncontingent reinforcement. Results indicated the engaging in physical activities along with descriptive praise improved the child's sitting behavior (attention and calmness). The investigators concluded that physical activities could be used as reinforcers to improve attention in children with ADHD. Azrin, Vinas, and Ehle (2007) extended the previous study results to two older children with ADHD in a special education classroom. The authors found similar results as in the previous study and concluded that exercises could be used as behavioral contingency programs to increase attention in children with ADHD.

Recently, Kercood and Grskovic (2010) conducted two studies using fine motor activity such as tactile manipulation of a flexible tangle toy during math problem solving tasks, with school age children with attention problems. In the first study, the students were asked to listen to the math problem presented auditorily (via a taped recording) and give a verbal answer. Participants were presented with the math problems in two counterbalanced conditions, with and without the fine motor activity. Results indicated that fine motor activity was associated with more problems correct

during math tasks. In the second study, the authors presented the math problems visually (on a computer screen), with and without auditory distraction. Students were required to read the math problems and verbally provide the solution. Results showed that auditory distraction impeded the performance in the participants, but adding the fine motor activity lessened the effects of the distraction and improved the performance two of the three students. In reviewing the results of both the studies, the authors commented on the effectiveness of the fine motor activity on the listening versus the reading requirements of the experimental tasks, and suggested that adding a fine motor activity may be more beneficial for tasks that require listening but are less useful for tasks that require reading, because reading may provide adequate stimulation for some students with attention problems.

In this present study we proposed to expand on prior research and evaluate the effects of adding physical activity during a listening comprehension classroom activity. Listening comprehension is a frequently occurring classroom activity that involves attention to the auditory stimulus, ignoring distracting activities, waiting through a delayed time period, and answering questions either verbally or in writing. In a study conducted by Shroyer and Zentall (1986), it was demonstrated that students with ADHD have challenges with listening comprehension, and performed better in listening comprehension activities that were stimulating and less repetitive. Waiting through a delayed time period, a skill required for listening comprehension, is also difficult for individuals with ADHD. Antrop, Buysse, Roeyers, and Van Oost (2005) examined the activity level of 14 children with ADHD and 14 control children between the ages of 6 and 11 years. The students were observed during two non-waiting class situations

(i.e., waiting while a story read by the experimenter and waiting with clock and metronome) and three waiting situations without any stimulation. Results indicated that during the waiting condition, all participants in both groups were restless, noisier, interactive, and sought higher levels of stimulation, and were more disruptive.

Therefore, we proposed that, adding physical activities during a listening comprehension task would likely increase the task performance allowing the students to be actively attending to the task and reducing the distracting effects of delayed and waiting time.

To create interventions for children with ADHD that could be applied in an inclusive classroom, we propose to compare a large motor activity such as sitting on exercise balls versus a fine motor activity such as actively doodling during the listening task. Both these physical activities have been previously used to demonstrate improved academic performance. For example, Schilling, Washington, Billingsley, and Deitz (2003) conducted a study with children with ADHD in 4th grade language arts class, comparing therapy balls as seating versus chairs, on in-seat behavior and legible word productivity. Sitting on therapy balls resulted in students' increase in in-seat behavior and legible word productivity, and both the teachers and students preferred therapy balls to chairs. Similarly, doodling was investigated by Andrade (2010) who conducted a study by investigating the effects of doodling with adults between 18-55 years. Forty participants were divided into two groups: doodling ( $n = 20$ ) and non-doodling condition ( $n = 20$ ). Participants in the doodling group shaded printed shapes while listening to a telephone call while the control group listened to phone call and wrote the target information on a lined piece of paper. All of the participants were asked to recall the

information. Participants in the doodling group recalled more on the memory test compared to the control group participants. The author concluded that doodling may aid concentration. However, this study was conducted with adults without disabilities.

In general, children in classrooms, especially those with attention problems, doodle anyway, move around on their seats, stay off task, and have poorer performance. We decided to evaluate the effect doodling versus sitting on exercise balls (which naturally allows for gross motor movement), by adding it to their routine academic task. We believe that adding minor physical activities within a classroom setting and within regular curricular activities is likely to generalize in inclusive settings, and can be beneficial for all children with and without attention problems.

## **Method**

### **Participants and Setting**

This project was approved by the Institutional Review Board and parent permissions were obtained prior to the beginning of the study.

Four English-speaking students, two boys and two girls, attending two general education classrooms in a suburban elementary school in the U.S. were invited to participate in this study.

Nash, aged 10 years had completed 4th grade was a typical student, who was reported to have attention problems by teachers, but did not have an existing diagnosis or learning disability. Zach aged 10 years, had completed 4th grade and had a diagnosis of learning disability. Roxie aged 12 years, had completed 6th grade, and had an existing diagnosis of attention disorders. Emery aged 12 years had completed 6th grade was a typical student with no diagnosis of attention or learning problems. None of the students were on stimulant medication.

All students were given the Conner's

Teacher Rating- Revised: Short Scales (CTRS-R:S) (Conners, 1997) to assess for their inattention and hyperactivity status. All students were with a T-scores of 65 or higher (1.5 or more standard deviation above the mean) on either the (a) Cognitive/Inattention Index (b) Hyperkinesis Index or (c) the ADHD Index, on the CTRS-R:S were considered as having attention problems. According to the interpretive guidelines in the Conners Rating Scales (CRS) Technical manual (Conners, 2004, p.44), T scores of 66-70 are considered moderately atypical, and T scores of 70+ are considered markedly atypical, both of which indicate significant problems. Based on our CTRS-R: S results, two of the students, Roxie and Zach met the criterion for having significant attention problems. The guidelines also refer to T-scores of 45-55 as being the average/typical score, and t-scores of 56-60 as being slightly atypical or borderline. The student, Emery, whose t-scores ranged from 57-59 in all the subscales was in the borderline category, and Nash, whose scores ranged from 45-52 was within the average/typical student range. See Table 1 for CTRS-R: S scores.

To assess listening comprehension, paper pencil tests of 12 multiple choice questions developed for each of the respective short stories were utilized. These test included Who, What, When, Where, Why, and How factual comprehension questions, and the students had to individually answer in writing (i.e. by circling the correct answer)

### **Procedures**

In the first session, each of the students was individually administered the four WJ-III subtests. In the following sessions, all four students were evaluated together, and were seated in the quiet room, each with a small desk, asked to face the audio recorder, and listen to the story. The audio player was operated by

the researcher who stayed in front of the room, to simulate the location of the classroom teacher during a daily lecture/teaching session. While listening to the stories, the students were not given any paper or pencils. After the listening

activity, the students were given the paper pencil multiple choice test that corresponded to the story that they had just heard, and individually completed the written task.

**Table 1.**  
*Demographic Information*

Participants	Age (in years)	Woodcock Johnson Subtests (Grade equivalents)				Conners Teachers Rating Scores (CTRS)			
		SR*	UD*	RF*	PC*	O*	I*	H*	AI*
Nash (Male)	10	5.3	8.2	6.7	4.1	45	48	49	52
Zach (Male)**	10	10.3	4.9	2.7	3.1	79	59	<b>89</b>	<b>82</b>
Roxie (Female)***	12	5.9	9.0	11.4	4.5	45	<b>67</b>	59	61
Emery (Female)	12	9.0	9.0	7.6	5.1	59	57	57	58

*Note:* \*SR = Story Recall, \*UD = Understanding Directions, \*RF = Reading Fluency, \*PC = Passage Comprehension, O\* = Oppositional, I\* = Inattention, H\* = Hyperactivity, AI\* = ADHD Index. \*\* Existing diagnosis of Learning Disabilities. \*\*\*Existing diagnosis of Attention Disorders

During baseline, students listened to the short stories, and after the story was completed, they were given the multiple-choice question sheets on a clipboard, a pencil with an eraser, and asked to complete answering the questions based on the story that they had just heard. In the intervention conditions, students listened to short stories while either (a) sitting on a chair and doodling on a paper-clip boarded paper and pencil was placed on their desk or, (b) sitting on exercise ball instead of the chair. After listening to the story, the students were given the multiple choice question sheets (attached to a clipboard) and a pencil (with an attached eraser), and asked to answer the question by circling the correct answer. After each session (during both the baseline and intervention phases), students were told that they were doing a good job, and no specific information regarding their performance accuracy was provided. At the end of the entire data collection session (one time only), all

students were asked whether sitting on the ball or doodling was the most helpful to them in concentrating and answering the questions.

**Design and Dependent Measures**

This study employed a single subject alternating treatments design and included a baseline and a reversal phase. After baseline, two intervention conditions, doodling and sitting on an exercise ball were alternated, followed by a reversal phase (i.e. return to baseline). Though an initial baseline phase is not necessary in an alternating treatments design, researchers have recommended its inclusion to strengthen the conclusions from the results of the study (Cooper, Heron, & Heward, 2007; Zhan & Ottenbacher, 2001).

The dependent measures were (a) the percentage of questions answered correctly (b) time taken to complete task. The percentage of questions answered was operationally defined as the number

of multiple choice questions answered correctly divided by the total number of multiple choice questions times a 100. This percentage was calculated from the students’ permanent product worksheet. The time taken to complete task was operationally defined as the number of seconds each student took to complete the multiple choice test, and was recorded by the examiner using a timer, as soon as the student turned in the completed task.

Students were also asked their feedback on the use of exercise ball versus the doodling strategies, and which one better helped their concentration and question answering. However, this qualitative question was asked only once, towards the completion of the entire data collection.

Inter-rater reliability was assessed by having a second person grade approximately 30% of the worksheets completed by the participants for performance accuracy, using the answer key that was developed prior to the assessment. Then the number of intervals of agreements were divided by the number of intervals of agreement plus disagreement and multiplied by 100. Inter-rater reliability was 100%

**Results**

Table 2 shows the summary of results to complete tasks and accuracy for all four participants.

**Table 2.**  
*Average Percent correct and Time taken to complete task*

	Nash		Zach		Roxie		Emery	
	Percent Correct	Time*	Percent Correct	Time*	Percent Correct	Time*	Percent Correct	Time*
Baseline	45.0	155.0	45.0	192.8	56.6	155.6	63.3	202.0
Exercise Ball	63.3	115.8	51.6	145.8	70.0	107.4	78.3	144.0
Doodling	63.8	114.0	50	131.8	63.8	100.3	73.6	151.5
Reversal (Baseline)	52.7	107.7	36.1	125.3	52.7	98.0	94.4	143.3

*Note.* Time\* = Time to complete task (in seconds)

Figure 1 shows the results for Nash. Nash was a typical student, but was reported by teachers and parents as having attention problems. However, he did not have an existing diagnosis of attention disorders, and did not score high on the CTRS ratings scale for inattention or hyperactivity. During baseline, Nash took an average of 155 seconds (s) to complete the task, and during intervention, Nash took less time to complete both the tasks (116 s during exercise ball phase and 114 s during doodling). Percent correct during baseline for Nash was 45 and increased to

63 and 64 during the exercise ball and doodling conditions respectively. During the reversal phase (i.e., when the baseline procedures were re-implemented), Nash’s worked much faster in completing the task than both the previous experimental conditions (Time = 107.7 s) but the performance accuracy was lower than the intervention phase (i.e., Percent correct = 52.7). After all the sessions were completed, when asked regarding his preference for doodling versus exercise ball, Nash reported that he preferred doodling.

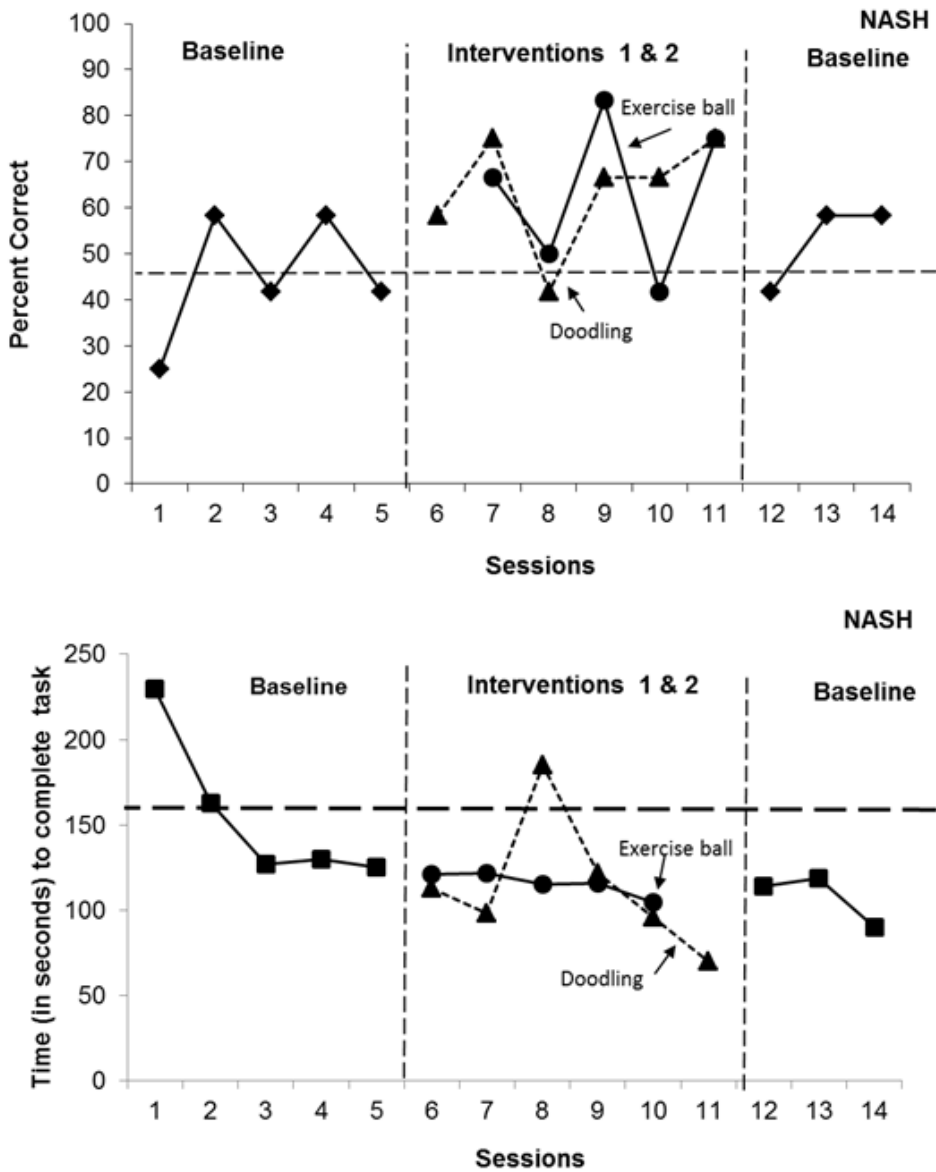


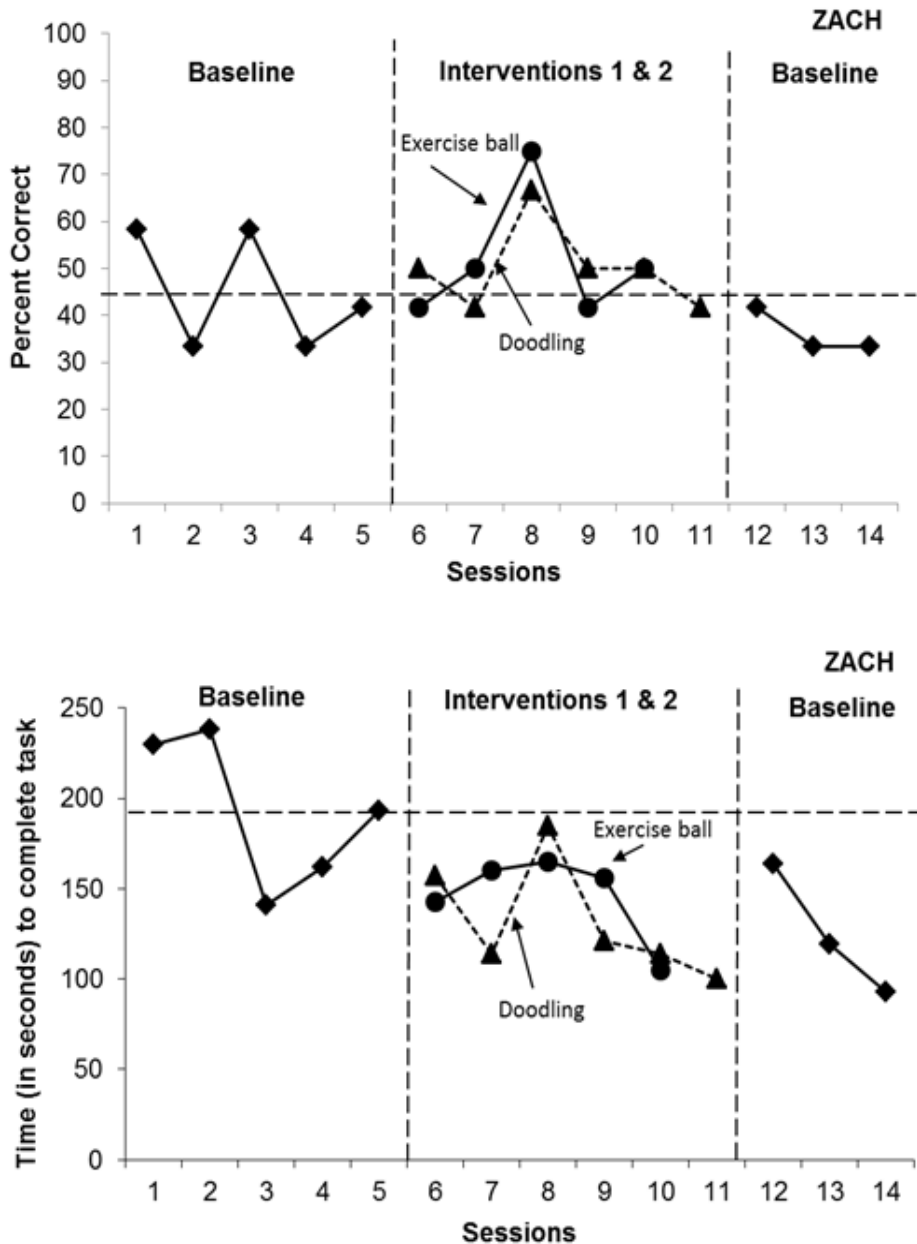
Figure 1 - Percent Correct and Time Taken to Complete Task by Nash

Figure 2 shows Zach's results. Zach had a preexisting diagnosis of a learning disability, and scored greater than 1.5 standard deviations above the mean on CTRS Hyperactivity and ADHD Index (See Table 1). Zach took an average of 193 s to complete tasks during baseline.

During intervention, Zach took less time to complete the tasks; 146 s during exercise ball and 131 s during doodling conditions. Also, Zach's percent correct increased from 45 during baseline to 52 during exercise ball condition and 50 during doodling condition. When the

baseline procedures were re-implemented Zach continued to work much faster in completing both experimental task (Time = 125.33 s), but the performance accuracy was much lower than the previous

baseline and intervention phases (Percent correct = 36.11). When asked regarding his preference for doodling versus exercise ball, Zach reported that he preferred doodling.



*Figure 2 - Percent Correct and Time Taken to Complete Task by Zach*



Figure 3 shows Roxie’s results. Roxie had an existing diagnosis of attention disorders and also scored greater than 1.5 standard deviations above the mean on the Inattention scale of CTRS. Roxie took 156 s to complete tasks during baseline. Roxie took less time during the intervention condition; 107 s during the exercise ball condition and 100 s during the doodling condition. Roxie’s percent correct also increased from 57 during baseline to 70 during the exercise ball

condition and 64 during the doodling condition. When the baseline phase was re-implemented, Roxie continued to work at a faster while completing the task (Time = 98 s), but the performance accuracy was lower than the previous baseline and intervention phases (Percent correct = 52.7). When asked regarding her preference for doodling versus exercise ball, Roxie also reported that she preferred doodling.

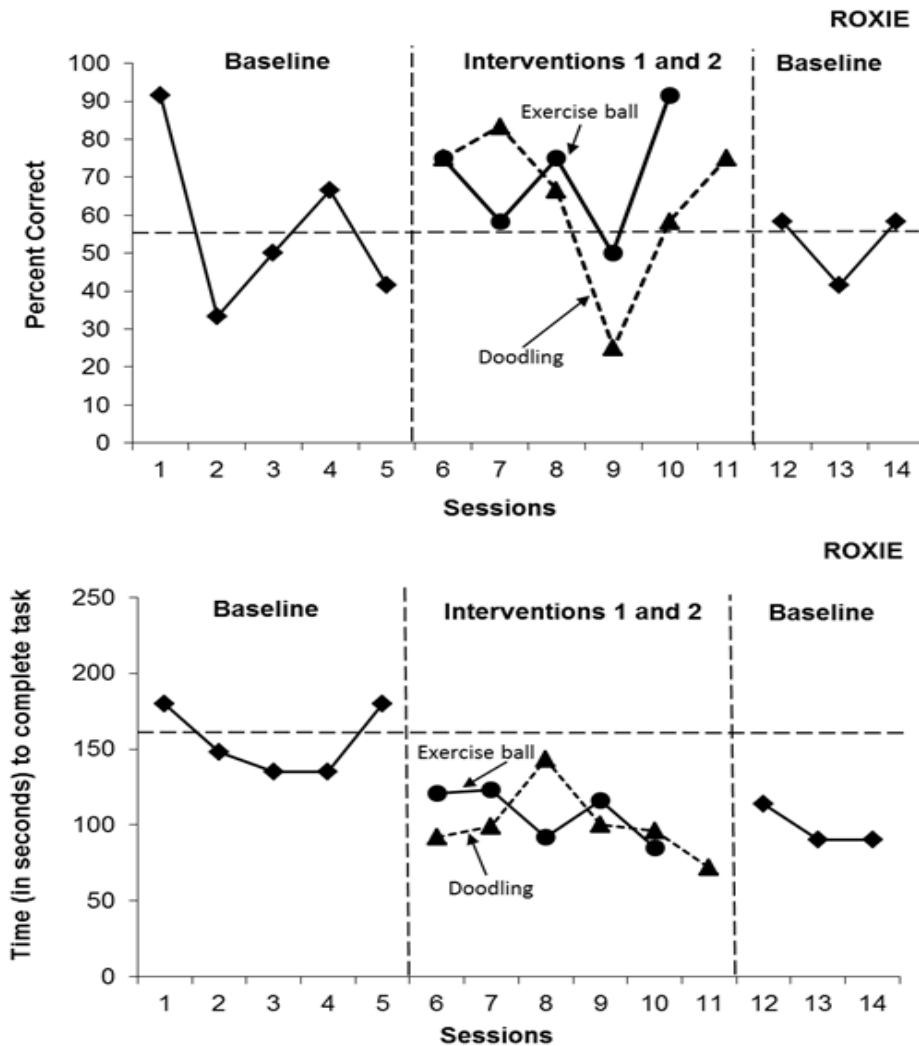


Figure 3 - Percent Correct and Time Taken to Complete Task by Roxie

Figure 4 shows Emery’s results. Emery is a typical student with no preexisting diagnosis of attention or learning disorders, and did not have high ratings on the CTRS scales. Emery took 202 s to complete the tasks during baseline. During intervention, Emery took 144 s during exercise ball condition and 152 during the doodling condition. Also, percent correct increased from 63 during baseline to 78 during the exercise ball

condition and to 74 during the doodling condition. When the baseline phase was re-implemented, Emery worked at a pace similar to the exercise ball intervention (Time = 143.3 s), and the performance accuracy was much higher than both the previous baseline and intervention phases (Percent correct = 94.4). When asked regarding her preference for doodling versus exercise ball, Emery reported that she preferred the exercise ball.

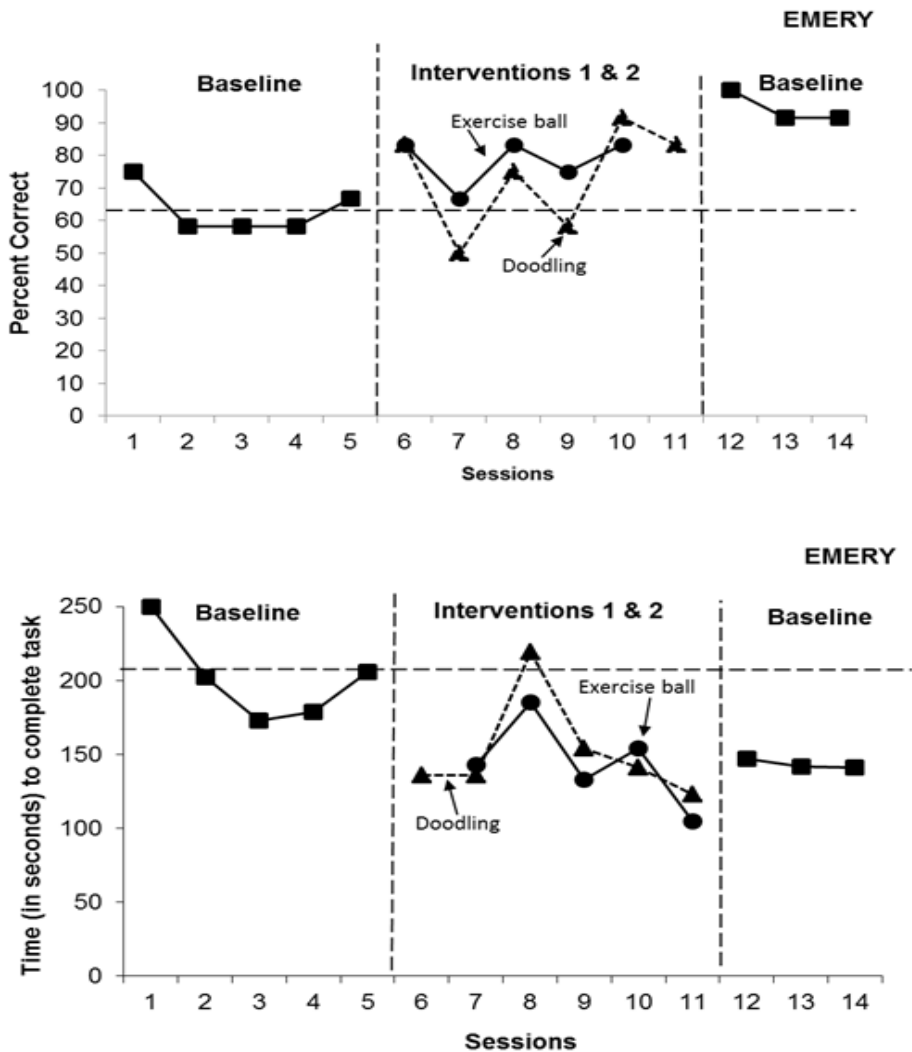


Figure 4 - Percent Correct and Time Taken to Complete Task by Emery

### **Additional Student reports**

Though three of the four students reported that they preferred doodling during the task, all of them also stated that sitting on the exercise ball forced them to stay awake and pay attention.

### **Discussion**

The purpose of this study was to assess and compare the effects of adding physical activities, gross motor (sitting on exercise ball) versus fine motor (doodling), during listening comprehension task on school age students with and without attention problems. The results indicated that all four participants took less time to complete the tasks and had improved performance accuracy during both the intervention activities (i.e., exercise ball and doodling), compared to the baseline condition. When the baseline phase (i.e. no intervention) was re-implemented (reversal), all students continued to work at a faster pace, but the performance accuracy for three of the four participants was lower than the intervention phase. All these three students were considered to have attention problems either based on CTRS-R: S rating scale or based on teacher reports. The only participant who continued to have improved performance even when intervention was no longer applied was Emery, the average functioning student without attention or learning problems.

This study provides a simple antecedent intervention that could be applied within an inclusive classroom, and would be helpful for children with or without attention or learning problems. Prior research showed that using an exercise ball and doodling was effective in improving performance in simple tasks such as handwriting or listening to phone call and recalling information (Andrade, 2010; Schilling et.al, 2003). The results of this present study extends this prior

literature by utilizing these interventions with a more complex task such as listening comprehension, a task that is frequently required within and outside school environment, and assessed on participants who have challenges with maintaining attention, such as those with attention and learning problems.

This study does differentially support the optimal stimulation theory (OST) for only participants with attention problems because, their exhibited improved performance only in the presence of intervention. Although the interventions provided an optimal level of stimulation for all participants that helped them to pay attention to the task and improve their performance, there was a decline in the performance of participants especially those with attention problems when the baseline condition (i.e. no intervention) was re-implemented.

Results further indicate that participants preferred both doodling and exercise conditions. Either sitting on an exercise ball or doodling or both conditions may be reinforcing for the participants and influenced their preferences. Previous research indicates that exercises could be used as behavioral contingency programs to increase attention in children with ADHD and may serve as reinforcers (Azrin et al. 2006; 2007). However, in the present study, we did not use physical activities as reinforcers contingent on activity completion. Also, we did not use other behavioral strategies such as shaping, noncontingent reinforcement, or praise with the participants. Thus, the role of reinforcement in our study is questionable. Future researchers should investigate whether doodling and/or sitting on a therapy ball combined with and without behavioral strategies such as praise or noncontingent reinforcement increase time on-task and enhance listening comprehension.

The results of this study should be

considered along with several other limitations, which do lead to suggestions for future research. The first limitation was, that the task of listening was less than 10 minutes long, comprehension was assessed by asking participants to complete multiple-choice questions in writing, and students were not required to give any verbal responses, even though they spoke fluently. Future research could include longer listening tasks, and the comprehension assessment involving more descriptive responses, also via a verbal modality (i.e., asking students to respond verbally).

A second limitation is that even though all four students participated in the activity together in an empty room with desks, to simulate an actual classroom, it was not analogous. Most classrooms do not have just 4 students, and have additional interruptions such as loud speaker announcements, other teachers/visitors stopping by the classroom, class change bells ring, fire drills, etc. Future studies could include an assessment with added distractions or in a typical classroom during a routine school day.

A third limitation is that students were asked regarding their preference for the exercise ball versus doodling after all the sessions were completed. A comparison of their choice of physical activity prior to the intervention session, and its subsequent effects on their academic task performance could be an area assessed in future research.

A fourth limitation is that doodling is a lesser expensive (only uses pencil and paper), and occupies no additional space in comparison to an exercise ball, which requires additional costs for investment, rearranging routine classroom furniture, and its usage with school children of various grade levels. Finally, future research could also include feedback from educators or school professionals in terms of the feasibility of either of these two

interventions in their general, inclusive or remedial classrooms in all grade levels.

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