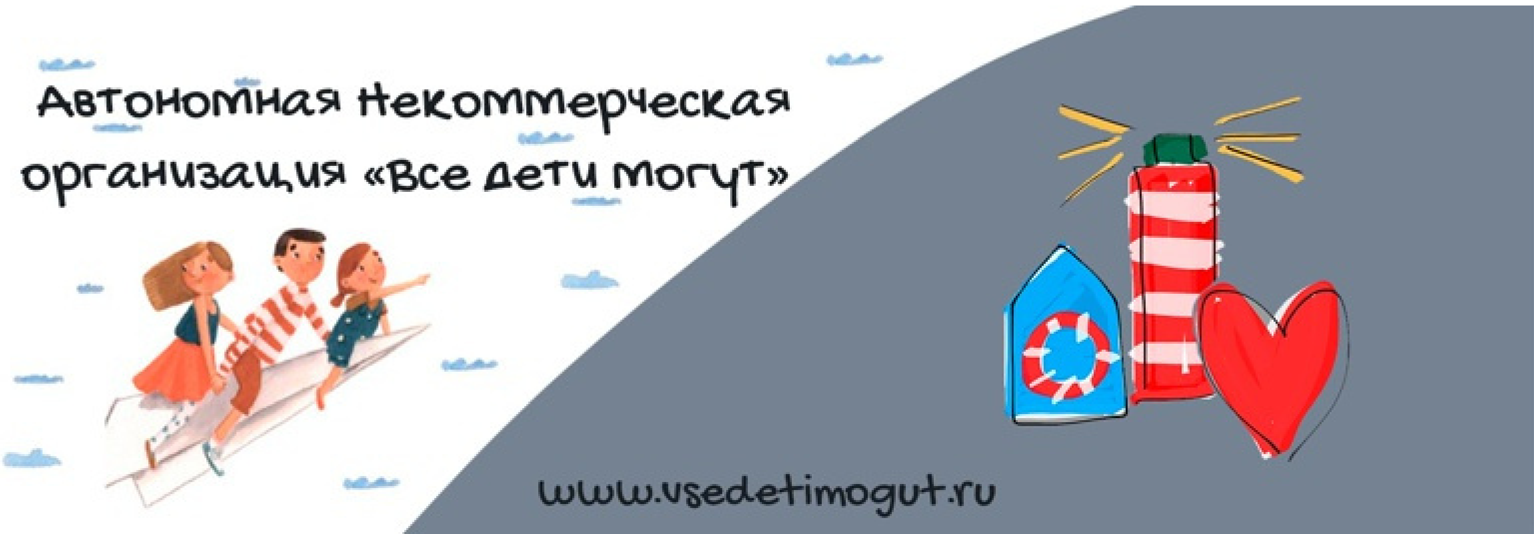
# Влияние сенсомоторных стратегий на внимание и поведение в сидячем положении у дошкольников с расстройством аутистического спектра: пилотное исследование



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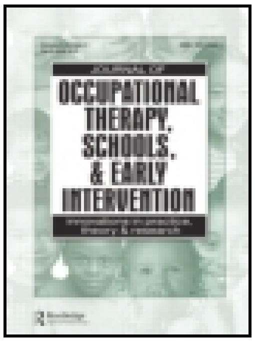

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# The Effect of Sensorimotor Strategies on Attention and In-Seat Behavior in Preschoolers with Autism Spectrum Disorder: A Pilot Study

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**ABSTRACT**

This quasi-experimental study explored the effects of sensorimotor strategies on improving attention and in-seat behavior of preschoolers with autism spectrum disorder (ASD). Using a single subject, B-A-B-A design with a sensorimotor phase (B) and non-sensorimotor phase (A), duration of attention and in-seat behavior were recorded and analyzed from a convenience sample of three participants with ASD in an integrated preschool classroom. Results indicated there were observable but inconsistent positive changes observed in attention and in-seat behavior during phases with the application of sensorimotor strategies. These findings suggest that sensorimotor strategies may be useful in increasing the average time a preschooler with ASD spends attending in the classroom, affording them the opportunity for self-modulation and participation in the educational process.

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Sensory strategies; preschool; autism

## Introduction

Among U.S. schools, teachers have been noticing decreased attention as well as increased restlessness in children in their classrooms (Budde, Voelcker-Rehage, Pietraßyk-Kendziorra, Ribeiro, & Tidow, 2008; Lundervold, Boe, & Lundervold, 2017). This behavior not only disrupts that child's ability to learn, but the ability of all students in the classroom to succeed. While this is found to be true in typically developing children, it is especially true in children with autism spectrum disorder (ASD) who face additional challenges in their occupations as students stemming from various characteristics of their diagnosis. ASD is classified as a neurodevelopmental disorder which includes a wide spectrum of social communication and social interaction disorders. Characteristics of ASD are deficits in nonverbal communication, difficulty developing relationships, difficulty with sensory modulation, and certain repetitive patterns of behavior, interests or activities, such as self-stimming behaviors or fixated interests (American Psychiatric Association, 2013). As specified in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5), in order to be diagnosed with ASD, the person must have symptoms that significantly impair occupational areas of functioning. As the screening for and diagnosis of ASD continues to increase, there is an added challenge placed on therapists in all disciplines to better

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understand how to aid those with ASD and their families in managing characteristics of the diagnosis.

## Literature Review

Not only do children with ASD face difficulty in developing and maintaining relationships and participating in social interaction and communication, but they also demonstrate difficulty in other areas. Children with ASD face unique challenges in their role as a student when compared to their typically developing peers. These challenges stem from various characteristics of their diagnosis, including the presence of stereotyped behaviors, atypical sensory processing, and limited ability to self-regulate (Ashburner, Ziviani, & Rodger, 2008; Chien, Rodger, Copley, Branjerdporn, & Taggart, 2016; Leekam, Prior, & Uljarevic, 2011; Sans-Cervera, Pastor-Cerezuela, Gonzalez-Sala, Tarraga-Minguez, & Fernandez-Sala, 2017). Often, these difficulties lead to deficits in ability to attend and are correlated with lower rates of active engagement in the classroom (Richler, Huerta, Bishop, & Lord, 2010; Sparapani, Morgan, Reinhardt, Schatschneider, & Wetherby, 2016). Inability to attend can be attributed to a number of internal factors in the child, including functional anatomy (Belmonte & Yurgelun-Todd, 2003; Courchesne et al., 1994; Sans-Cervera et al., 2017; Teder-Salejarvi, Pierce, Courchesne, & Hillyard, 2005) and sensory processing deficits, as well as external factors such as the complex sensory environment that a classroom provides (Ashburner et al., 2008; Liss, Saulnier, Fein, & Kinsbourne, 2006; Sans-Cervera et al., 2017). Ultimately, maintaining attention to the task and engaging in the required classroom activities proves to be a challenge for children with ASD as they perform their role as a student.

Common amongst much of the literature is a correlation between difficulty with attention or engagement in the classroom and problems with sensory processing, modulation, and self-regulation (Adamson, O'Hare, & Graham, 2006; Ashburner et al., 2008; Liss et al., 2006; Sans-Cervera et al., 2017). Sensory processing difficulties in the classroom may include auditory filtering deficits that impact the child's ability to attend to verbal instruction, difficulty navigating and organizing complex visual input to appropriately direct gaze and attention to visual stimuli, and an inability to self-regulate behavioral responses to shifting tactile input (Adamson et al., 2006; Ashburner et al., 2008; Sans-Cervera et al., 2017; Teder-Salejarvi et al., 2005). Other children may experience a seemingly opposite response and fixate their attention on something very specific as a way to cope with a plethora of incoming sensory information (Liss et al., 2006). Regardless of how the child copes with the sensory environment presented in the classroom, studies have found that those with ASD demonstrate lower rates of academic achievement associated with challenging behaviors and inability to attend (Ashburner et al., 2008; Sparapani et al., 2016)

With the knowledge that children with ASD have difficulties with attention and behavior in the classroom, professionals have developed and studied various forms of intervention to help increase academic achievement and classroom participation. Currently, literature exists that shows improvement in attention through various therapeutic techniques outside of the classroom, including equine-assisted therapy and attention training programs. Equine-assisted therapy for individuals with ASD has been associated with less inattention and distractibility and better sensory modulation (Bass, Duchowny, & Llabre, 2009; Llambias, Magill-Evans, Smith, & Warren, 2016). Other interventions include attention training programs which can take place in school or outside of school, but which are not integrated into the school curriculum or part of the classroom environment. These attention training programs have shown improvements, both in attention and overall academic performance (Chukoskie, Westerfield, & Townsend, 2017; Spaniol, Shalev, Kossyvaki, & Mevorach, 2018) but it is unknown whether these types of programs can allow for the transfer of skills to more functional, real-world tasks. Within the classroom, a common method of intervention to improve attention and behavior is providing alternative seating devices. For children with ASD, providing alternate seating devices had a positive effect on in-seat behavior and attention (Bagatell, Mirigliani, Patterson, Reyes, & Test, 2010; Schilling & Schwartz, 2004).

Other professionals have chosen to focus their intervention and research on the sensory modulation aspect of ASD in order to improve a child's performance in the classroom. One such intervention is the Ayres Sensory Integration (ASI) program which usually occurs in a structured clinical environment and uses play therapy to elicit an adaptive response for the child to better interact and engage with their environment (Watling & Hauer, 2015). The ASI program has been found to have positive effects on various behaviors associated with ASD (Watling & Dietz, 2007; Watling & Hauer, 2015) as well as mixed results (Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson, 2011). However, ASI programs, like other interventions described, remove the child from the natural environment, and may help to increase adaptive behaviors in the future, but are not beneficial for immediate results within the classroom. Other sensory-based intervention (SBI) methods have also been studied, such as the use of weighted vests or brushing, and have found to have positive effects on various characteristic behaviors of ASD (Watling & Hauer, 2015; Weitlauf, Sathe, McPheeters, & Warren, 2017). Although many studies in this area are limited in the strength of the evidence due to a number of factors including sample sizes, type of study, and bias.

Less structured, more activity-based sensorimotor interventions that can be utilized within the classroom to improve attention and in-seat behavior have not been studied thoroughly. Recently, strategies such as Full-Body Interaction and Sensory Activity Schedules have been gaining attention (Malinverni & Pares, 2014; Malinverni, Schaper, & Pares, 2016; Mills & Chapparo, 2018). While these strategies can be implemented in the classroom with the intent to provide sensorimotor components to the learning experience in order to improve attention, active engagement, and classroom behaviors, the evidence to support them is preliminary.

Current evidence outside of ASD-specific literature points to a link between physical activity and cognitive functioning in typically developing children with research supporting increased attention and concentration following physical activity (Budde et al., 2008; Sibley & Etnier, 2003). This evidence does not suggest that these effects carry over to children with ASD although, Menear and Neumeier (2015) suggest that physical activity for students with ASD provides numerous benefits, both biologically and behaviorally. Furthermore, physical activity has been shown through neuroimaging to increase activity in areas of the brain associated with attention, focus, and motor coordination (Menear & Neumeier, 2015). While physical activity is just one component of a sensorimotor-based intervention, engaging the child's whole body, whether it is through movement or touch, has to promise.

This study seeks to add to the body of knowledge on sensorimotor interventions used specifically within the classroom to support the learning and engagement of children with

ASD. Embedding sensory experiences and the opportunity for stimulation of multiple sensory systems associated with movement into activity may give children with ASD a chance to better modulate incoming sensory information in order to support performance in the classroom. Important to this study is keeping the child in the natural learning environment where the effects of the intervention are most needed, and where all children are able to participate in similar sensorimotor experiences. The present study intends to explore whether sensorimotor strategies embedded within activity in the classroom have an effect on attention and in-seat behaviors of preschoolers with ASD.

## Methods

This research was approved by the university's Human Subject Review Board. This quasi-experimental study utilized a single subject, B-A-B-A design across participants and included a sensorimotor phase (B) and a non-sensorimotor phase (A). While this design is non-traditional in beginning with the intervention first, when working within a clinical setting researchers work within the constraints of the environment and the B-A-B-A schedule was implemented to allow the lead clinician to ensure appropriate delivery of the sensorimotor techniques during the intervention phase. During intervention phases (B), all children present for morning circle time participated in a session including sensorimotor activities that in total comprised of at least 50% of the interaction. The occupational therapist for the preschool classroom determined the sensorimotor activities based on the task and the needs of the children. Examples of sensorimotor strategies used included the use of vibrating toys passed to the children as they answered questions, stomping feet while sitting and standing as the children identified the day of the month, clapping to the days of the week, and standing/walking/marching to act out theme-related tasks. During nonintervention, or control phases, all children present for morning circle time participated in a typically led session in which the children were expected to remain seated and engage verbally with the day's activities. The daily activities included verbally identifying the weather, the day of the week, or answering questions related to a book read to the children. The length of circle time was consistent across phases and took place in the regular routine of the children's day. The sensorimotor intervention was embedded into the circle time activities therefore the children engaged in the sensorimotor activities while concurrently engaging in the circle time activities. Both phase A and phase B took place for up to 15 min. Data were extracted from the first 10 min of each session of each phase. The independent variable was the sensorimotor strategies and the dependent variables were attention and in-seat behavior. Due to the nature of the study, all children in the classroom participating in morning circle time received the same interventions. Each child acted as its own control.

### Participants

Participants were recruited from in an integrated preschool classroom in southwestern Pennsylvania during the 2017–2018 school year. All children with a diagnosis of ASD in the integrated preschool classroom (four children with ASD, eight typically developing children) were invited to participate. A letter introducing the study was sent home to all children with ASD enrolled in the classroom. Interested parents/guardians were encouraged to contact the primary investigator for additional information regarding the specifics of the study. At the time of parent/caregiver contact, the details of the study and the consent form were reviewed. Parental consent and child assent were requested and received for all participants via signed written consent and assent forms. Ultimately, three preschoolers with ASD participated in the study (N = 3). Participants included Caucasian boys' ages: 5 years 2 months, 4 years 3 months, and 4 years 5 months, with a mean age of 4 years 6 months. All participants were verbal and placed in the integrated preschool classroom based on educational assessment data predicting readiness to learn with typically developing peers.

## Data Collection

Data collection occurred over the course of four weeks. Morning circle time was videotaped twice per week for each week of the study. Morning circle time was chosen as it occurs at the same time daily, and is a time in the children's schedules when they are regularly involved in teacher and/or staff interaction/instruction with the expectation of attention and in-seat behavior. Circle time activities typically lasted for up to 15 min. Therefore, each taped session included the first 10 min of interaction to ensure an equal length of time for each session in both phases. The 10-min timer and data extraction began after each child was seated.

Operational definitions of attention and in-seat behavior were utilized to keep observations focused. Attention was defined as: a state of awareness of the available sensory information from the environment. Target behaviors included, but were not limited to, the following: contribution to the process via verbalizations/answer/asking of questions, participation upon request (e.g. point to the symbol representing today's weather), is quiet and responsive (verbally or non-verbally to teacher directives (e.g. raises hand), the teacher utilizes no more than 2 cues (the first initial cue and one subsequent cue) to elicit engagement that matches the ongoing instruction, the child concentrates on some feature of the process to the relative exclusion of others. In-seat behavior was defined as: Maintaining physical contact with the seating option (e.g. chair or carpet square) as determined by the instructional task. Target behaviors included, but were not limited to, the following: contact with the seating device with some part of the child's body (e.g. buttocks, legs, knees, foot, etc.), breaking contact with the seating option to engage in the instructional task if appropriate (e.g. approach the teacher to interact with an aspect of the task such as a book), returning to the seating option with no more than one teacher cue (verbal or non-verbal).

Two researchers (the PI and a researcher assistant) independently reviewed the videos. The videos were watched in random order with a length of time documented for in-seat behavior and attention. After reviewing the tapes independently, the first and second authors met to discuss consistency in observations. Discrepancies 3 seconds or less were averaged. Larger differences in the timing of observations were discussed after jointly reviewing the tape and a consensus was reached.

## Data Analysis

Visual analysis was used to determine patterns both within and between phases of data collection. Specifically, within analysis included measures of level (mean) and trend (relative level change). Relative level change was determined by splitting the data in half, calculating the median of each half (Lane & Gst, 2013). Then, the smaller number was subtracted from the larger number and a determination about whether the direction of trend was improving (+) or deteriorating (-) was made (Lane & Gst, 2013). Between phase visual analysis was completed using the percent of non-overlapping data. The percent of non-overlapping data (PND) was calculated using the highest data point in the A Phases (non-sensorimotor) and then counting the number of data points in B Phases (sensorimotor) that were higher than the point in the A Phases (Lane & Gst, 2013). This value was then divided by the total number of points in the A Phases and multiplied by 100 to gain a percentage. Lobo, Moeyaert, Baraldi Cunha, and Babik (2017) report the following interpretations for this measure: PND greater than 70% indicating an effect while 50–70 would be considered questionable and less than 50 is not indicative of any effect.

Then, a statistical analysis using a celeration line and binomial test method was completed (Portney & Watkins, 2015). To determine the probability that the results of the binomial test method were not by chance, one-tailed test probabilities were evaluated with alpha set at 0.05.

## Results

### In-Seat Behavior

Visual analysis demonstrated that the mean level in intervention phases for P3 were higher than the single datapoint in phase A1 (105 s) and the control phase A2 mean. P1 and P2 also demonstrated similar level differences but only in the change from B2-A2. Trends, as measured by relative change was variable across participants and can be seen in Table 1. When looking at PND, P3 had two significant effects, P1 had one phase change with a questionable effect and both of P2 phase changes indicated no effect on in-seat behavior. Due to a limited number of data points, the celeration line and binomial analysis could not be completed for the first phase change across all participants. However, the second

**Table 1.** All participants' visual analysis duration of in-seat behavior.

| | B1 | A1 | B2 | A2 |
|---|---|---|---|---|
| P1 | | | | |
| Number of Data Points | 3 | 2 | 3 | 8 |
| Mean (seconds) | 400 | 600 | 394 | 144 |
| Relative Change | −433 | 0 | +507 | −88 |
| Percent Non-overlapping Data Using Highest Data Point in B Phase | Phase Change 1 (B1 – A1) 0% | | Phase Change 2 (B2 – A2) 66% | |
| P2 | | | | |
| Number of Data Points | 4 | 2 | 3 | 11 |
| Mean (seconds) | 299 | 600 | 397 | 106 |
| Relative Change | +66 | 0 | +299 | +39 |
| Percent Non-overlapping Data Using Highest Data Point in B Phase | Phase Change 1 (B1 – A1) 0% | | Phase Change 2 (B2 – A2) 33% | |
| P3 | | | | |
| Number of Data Points | 4 | 1 | 3 | 7 |
| Mean (seconds) | 322 | – | 399 | 182 |
| Relative Change | +131 | – | −385 | +265 |
| Percent Non-overlapping Data Using Highest Data Point in B Phase | Phase Change 1 (B1 – A1) 100% | | Phase Change 2 (B2 – A2) 100% | |

B – Sensorimotor.
A – Non-sensorimotor.

phase change was analyzed with this method and each participant was found to have a statistically significant outcome; however, P3's outcome was not in the anticipated direction of change. See Figure 1 and Table 2.

### Attention

Table 3 provides the results of the visual analysis for the duration of attention. P2 and P3 both demonstrated level differences consistent with the sensorimotor phase means having an increased duration compared to non-sensorimotor phase means. P1 only demonstrated this pattern in the second phase change. Trends, as with in-seat behavior varied by a participant in no discernable pattern. PND was questionable for P1 and P2 in the second phase change (B2-A2). P3's values suggested no effect of intervention across both phases. The results of the binomial tests varied across participants. P2's binomial findings confirmed the observations of the visual analysis demonstrating an effect for this participant across both phase changes. P1's findings also confirmed the visual analysis and lack of anticipated effect in the second phase change, but also showed an effect in a direction opposite what was anticipated in the first phase change. P3's results were contradictory of visual analysis, demonstrating a statistically significant result in the second phase change. All binomial tests and *p*-values are presented in Table 4 and the celeration lines in Figure 2.

## Discussion

In this study there were positive but inconsistent effects of the sensorimotor interventions noted for both attention and in-seat behavior for some participants. Overall P2 and P3 demonstrated anticipated changes in level across both variables, while P1 only demonstrated this for attention for the second phase changes. Effects were confirmed via statistical analysis for two out of the three participants (P1 & P2) regarding in-seat behavior for the second phase change and for attention in one participant (P2) across both phase changes. These findings suggest that sensorimotor activities embedded into circle time were effective for certain participants at certain times.

The use of sensorimotor strategies embedded into educational instruction may have supported the children's sensory needs, possibly facilitating arousal and regulation, which in turn allowed for an appropriate response to the demands of the task (Bundy & Murray, 2002; Dunn, 2007). Participation in the educational process has been found to be a predictor of academic success (McClelland, Acock, & Morrison, 2006); therefore, offering classroom strategies that support participation may lead to increased success in the classroom for children with ASD (Sparapani et al., 2016). Embedding sensory opportunities, such as standing/moving, to support participation has been reported to be beneficial (Dunn, 2007). The sensorimotor modifications made to this standard part of these children's day, circle time, were easy to incorporate and could be an achievable avenue to success for some children.

Sensory processing is complex and specific strategies need to be developed to meet the needs of the individual child (Yunnis, Liu, Bissette, & Penkala, 2015). Each participant's clinical presentation prior to the study appeared to influence the final results of this study, with the participant who historically had positive responses to movement showing the most consistently positive results overall. Examining the study data alongside each participant's clinical presentation/current level of function adds another component to be

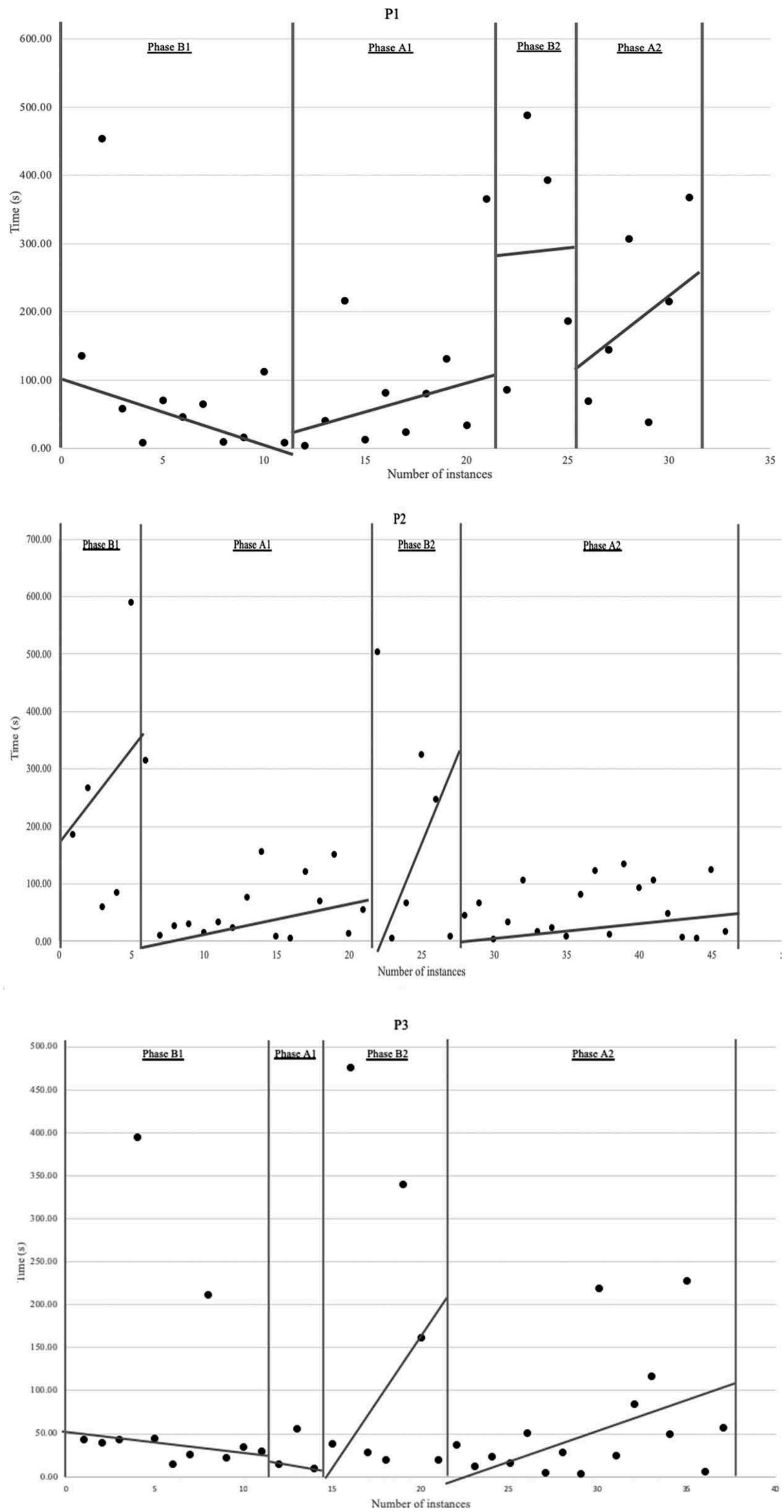


**Figure 1.** Time-series graphs with celeration lines for in-seat behavior.

**Table 2.** Binominal test for the duration of in-seat behavior.

| | | Phase Change 2 B2-A2 | |
|---|---|---|---|
| Participant | x | n | p-value |
| 1 | 0 | 8 | 0.004* |
| 2 | 0 | 11 | <0.006* |
| 3 | 0 | 4 | 0.004*† |

*Indicates statistically significant change ($p < 0.05$).
†Indicates that change was in the direction opposite of what was anticipated.

**Table 3.** All participants' visual analysis duration of attention.

| | B1 | A1 | B2 | A2 |
|---|---|---|---|---|
| P1 | | | | |
| Number of Data Points | 11 | 10 | 4 | 6 |
| Mean (seconds) | 90 | 99 | 288 | 190 |
| Relative Change | −54 | +39 | +3 | +7 |
| Percent Non-overlapping Data Using Highest Data Point in B Phase | Phase Change 1 (B1 – A1) 9 | | Phase Change 2 (B2 – A2) 50 | |
| P2 | | | | |
| Number of Data Points | 5 | 16 | 6 | 19 |
| Mean (seconds) | 236 | 68 | 191 | 55 |
| Relative Change | +110 | +34 | +15 | +14 |
| Percent Non-overlapping Data Using Highest Data Point in B Phase | Phase Change 1 (B1 – A1) 20% | | Phase Change 2 (B2 – A2) 50% | |
| P3 | | | | |
| Number of Data Points | 11 | 3 | 7 | 16 |
| Mean (seconds) | 82 | 27 | 174 | 60 |
| Relative Change | −13 | −47 | +124 | +52 |
| Percent Non-overlapping Data Using Highest Data Point in B Phase | Phase Change 1 (B1 – A1) 18% | | Phase Change 2 (B2 – A2) 29% | |

B – Sensorimotor.
A – Non-sensorimotor.

**Table 4.** Binominal test for the duration of attention.

| | | Phase Change 1 B1 – A1 | | | Phase Change 2 B2-A2 | |
|---|---|---|---|---|---|---|
| Participant | n | x | p-value | n | x | p-value |
| 1 | 10 | 0 | <0.002*† | 6 | 2 | 0.344 |
| 2 | 16 | 0 | <0.002* | 19 | 0 | <0.002* |
| 3 | – | – | – | 16 | 0 | <0.002* |

*Indicates statistically significant change ($p < 0.05$).
† Indicates that change was in the direction opposite of what was anticipated.
– Unable to calculate secondary to number of data points.

considered when examining the effects of sensorimotor strategies on attention in preschoolers with ASD. While it may not be a viable solution for all students with ASD, including sensorimotor strategies in activity was found to be an effective way to engage students who benefit from movement. The use of sensorimotor strategies embedded in activity may also be able to influence children who have inconsistent responses to their environments. Autism and the specific characteristics of each child are highly variable

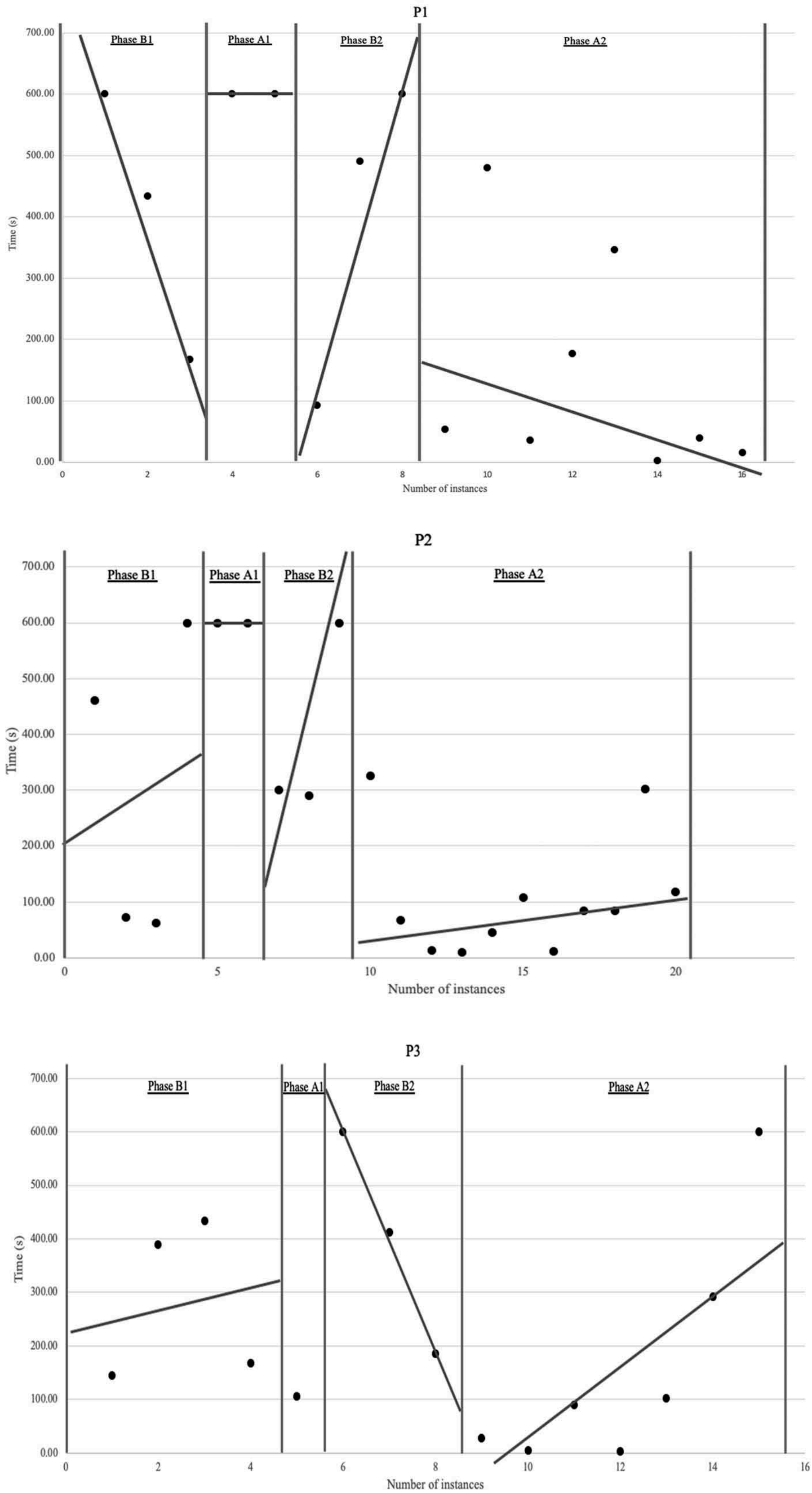


**Figure 2.** Time-series graphs celeration lines for attention.

(Hodgetts & Hodgetts, 2007); therefore, while the use of sensorimotor strategies may not consistently improve attention in children with inconsistent responses, this study provides evidence to the success in a child such as this at least part of the time. This method of utilizing sensorimotor strategies embedded in activity allows the students to stay in the natural classroom environment and participate with their peers in a way that does not exclude them. Sensorimotor strategies also provide a convenient, simple, and cost-effective option for modifying typical activities for all students, not just those with ASD.

## Limitations

The primary limitation of this study was the small convenience sample, as this sample is not generalizable to the preschool population with ASD. Additionally, all participants in the study were male, leaving female preschoolers with ASD unrepresented. Another limitation was the short duration of the study. This study took place over the course of 4 weeks, twice per week, for ten-minute sessions, more frequent data collection across an entire week may have offered a more robust dataset; however, in collaboration with the pre-school occupational therapists, this was a data collection schedule that was manageable in the classroom. Other limitations include the unpredictable nature of the preschool classroom and clinical research in general. Interruptions to morning circle time, whether it be a visitor in the room or another unexpected event may have had an impact on study results. Future studies should seek to include a larger sample size and diversity in the sample, and increase the frequency of data collection probes. Furthermore, additional research should be done to explore whether a certain type of sensorimotor strategy is more effective than another as this study looked at all sensorimotor strategies as a whole.

## Conclusion

The findings of this study suggest that sensorimotor strategies could be useful in increasing the average time a preschooler with ASD attends in the classroom. Sensorimotor strategies have a less consistent impact on in-seat behaviors. Providing sensorimotor strategies embedded in the classroom activity affords the opportunity for both self-modulation and classroom participation, while also promoting attention for some students with ASD. Implications include consultation with classroom staff to identify strategies to increase student engagement. The use of sensorimotor strategies is a noninvasive, low-cost strategy that may promote educational participation.

## Implications for Occupational Therapy Practice/Key Findings

This research has the following implications for occupational therapy practice:

- Guiding educational teams to understand the causes of a child's problematic behaviors are important for framing individualized interventions to address challenges in daily routines.
- Consultation with the educational team to identify sensorimotor strategies to manage challenges in school routines showed promise for increased attention, and for some

children improved in-seat behaviors during classroom activities of young children with autism.

- Use of sensorimotor strategies to influence classroom participation is a noninvasive, low cost, and simple intervention that may promote the educational participation of young children with autism.

This study supports the use of sensorimotor strategies embedded in school activities to support the attention and in-seat behavior and therefore educational participation of young children with ASD.

## Disclosure statement

The authors confirm there are no conflicts of interest.

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