The effect of the wearing of weighted vests on the sensory behaviour of learners diagnosed with attention deficit hyperactivity disorder within a school context

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ABSTRACT

Purpose: *Children diagnosed with attention deficit hyperactivity disorder (ADHD) often have sensory processing difficulties. Therefore, they find it difficult to function optimally in the classroom environment. This study investigated the effect that wearing a weighted vest had on their in-seat behaviour, task completion speed and attention-to-task.*
Method: *A longitudinal experimental research design was employed with 30 foundation Phase learners from the School of Achievement; cross-over of treatment was implemented. Data on in-seat behaviour was measured by recording the period of time participants were able to stay seated. Task completion speed was assessed by timing how long participants were able to stay seated during literacy periods. The Conners' Continues Performance Test II was used to measure participants' attention to the task.*
Results: *The Phase group effect for in-seat behaviour and attention-to-task indicated a statistically significant difference when learners wore weighted vests. This was not true for task completion speed.*
Conclusion: *The weighted vests improved the in-seat behaviour and attention to task of learners diagnosed with ADHD in a classroom context.*

Key words: attention deficit hyperactivity disorder (ADHD), weighted vests, sensory modulation, school-based occupational therapy

Introduction

The South African Department of Education issued the White Paper Six[1] on Special Needs Education, in 2001 which aimed to uncover and minimise barriers to learning[1] and acknowledged that some learners may require intensive and specialised forms of support. It was reported that in order to reduce barriers to learning within education and training it was essential to strengthen education support services (ESS) such as those offered by the Occupational Therapist (OT). The goal of the OT within the education setting is thus to enable learners to participate in school activities to the maximum[2] by focussing on learners' academic skills as well as functional skills. Schools for learners with special educational needs (LSEN schools) have occupational therapists who deal, among other things, with learners diagnosed with attention deficit hyperactivity disorder (ADHD).

There is a strong indication of a relationship between ADHD and sensory processing deficits also referred to as sensory modulation dysfunction in the literature[3, 4, 5, 6, 7]. A study indicated statistically significant differences (i.e., $p<0.5$) between the sensory processing skills of children without disabilities and children with ADHD on 118 of 125 items of the sensory profile[3].

Ayers[8] suggested as early as 1979 that children with sensory integration dysfunction often struggle to function optimally in the classroom environment, and needed special education interventions. Learners with poor sensory processing display either exceedingly high thresholds (habituation and hyposensitivity) or exceedingly low thresholds to sensory input[9]. Dunn suggested that when sensory thresholds are too high, learners react less readily to stimuli, take longer to respond and appear lethargic[9]. She also documented that when thresholds are too low, learners act too quickly and frequently to stimuli and appear to be overly excitable or hyperactive[9].

Difficulties in sensory processing can be seen in certain performances such as over or under-responsiveness to sensory stimuli or behaviours specific to ADHD[3,4,8,10] for instance hyperactivity, impulsiveness and distractibility. Consequently the children with these problems attempt to modulate their behaviour by seeking proprioceptive input by not sitting still on the chair during desktop activities, bashing their feet against the ground and leaning back on the chair thereby lifting the feet of the chair from the ground. This affects their in-seat behaviour while engaged in formal academic activities involving work speed which in turn may have a negative effect on their academic performance. Off task behaviour such as not attending to the task at hand, poor task completion and slow work speed is also affected.

Seeking proprioceptive input may be an indication of a larger sensory modulation dysfunction including proprioceptive dysfunction, problems in the tactile and or vestibular function[11,12]. In an effort to improve the sensory modulation difficulties such as poor in-seat behaviour, slow work speed and off-task behaviour, therapists may implement sensory strategies within the classroom setting to regulate learner's sensory systems[4,6,8,9,12,13]. Therefore unless appropriate sensory modulation intervention strategies are in place, poor academic performance may ensue.

The problem that led to this study was identified during a multidisciplinary team discussion at a School for Learners with Special Educational Needs (LSEN) where teachers reported on their observations and confirmed that their learners displayed poor in-seat and off task behaviour in their classrooms. These behaviours seem to cause carelessness and result in poor academic performance. The teachers complained that the learners' behavioural problems caused frustration for fellow pupils as well as teachers. Teachers expressed the opinion that the situation prevented them from proper service delivery or teaching the rest of the class.

A review of the literature was conducted to establish the treatment options appropriate to occupational therapy that could be used in the classroom, and that would assist in reducing the disruptive behaviour, and improve the child's attention in classroom.

Environmental adaptation has been shown to assist with these problems and research has found that seating these learners on therapy balls in the classroom decreased the out-of-seat behaviour[14], as the vestibular and proprioceptive stimulation allowed them to stay on task and remain seated.

A well-known person who was diagnosed with autism, Temple Grandin, developed the concept of adapting a learner's environment by using a weighted vest to provide calming, deep pressure input[12]. Olson[15] reported that weighted vests can be used as a means of applying deep pressure, which was believed to decrease purposeless hyperactivity and increase functional attention to purposeful activity. Blanche and Schaaf[12] adopted this and recommend that these vests be used with children who seek proprioceptive or deep pressure input and who are extremely active in search of this input, which makes them appear to be hyperactive.

The proprioception input provided by weighted vests has been shown to have a physically calming and organising effect when worn during everyday occupations[6,13,16,17]. Research evidence showed it to be effective for children who constantly seek deep-touch pressure, who are sensory defensive and who are easily distracted[9]. Weighted vests can be used as part of a balanced sensory diet which includes a personalised activity plan that provides sensory input that a person needs to stay focused and organised throughout the day[6,12]. However, limited research is available on the use of weighted vests with children who have attention difficulties.

There are no standardised protocols available on the use of weighted vests in terms of time used or the amount of weight that should be used. Therefore, the purpose of this study was to determine whether weighted vests would improve the in-seat behaviour, task completion speed and attention-to-task skills of learners diagnosed with ADHD presenting with sensory modulation deficits.

The Sensory Profile School Companion developed by Winnie Dunn[9] that evaluates the child's sensory processing skills and how these skills affect the child's classroom behaviour and performance was used as a screening tool in this study. Performance in the various sensory systems is classified as typical performance, probable difference and definite difference according to the scores of the profile. There are also four school factors that are classified in the same way. Definite difference scores was used in this research study as it "reflects scores that are more than 2 SDs above or below the mean. Quadrant, School Factor, and Section raw scores total within this range indicate definite sensory processing problems"[5:38]. The researcher used definite difference scores in School Factors 1 and 2 as criteria that participants had to meet to be included in the study. In School Factor 1 learners need a lot of extra sensory input to activate their high thresholds in order to be prepared for learning[5]. Learners with difficulties in School Factor 2 might be getting pulled away from learning activities because of this attention to other stimuli in the environment[5].

Methodology

Aim

To determine whether learners diagnosed with attention deficit hyperactivity disorder (ADHD), having definite difference scores in School Factor 1 or 2 of the sensory profile would be able to improve the organisation of their behaviour in terms of: in-seat behaviour, task completion speed and attention-to-task.

Research Design

The researcher employed a longitudinal quantitative research design; cross-over of treatment (see *Figure 1*). Subjects were given two treatments, one being the treatment using the weighted vests (called the "real"treatment) the other a control or reference treatment during which time the participants received no treatment. Group B is called the control group if the alternative treatment is nothing at all[18,19]. Group A received the real treatment first, Group B the control first. After sufficient time had elapsed to allow any treatment effect to wash out, the treatments were crossed over.

Group	Data Collection	Group
Pre-Test Group A	PHASE 1 • Data on In-seat behaviour collected 10 times by primary investigator • Data on Task Completion Speed collected 10 times by classroom teacher • Data on Attention-to-task collected 3 times by school counsellors	Pre-Test Group B
Intervention Group A	PHASE 2 • Data on In-seat behaviour collected 10 times by primary investigator • Data on Task Completion Speed collected 10 times by classroom teacher • Data on Attention-to-task collected 3 times by school counsellors	Assessment Group B
"Washout Period" Group A	PHASE 3 • Data on In-seat behaviour collected 10 times by primary investigator • Data on Task Completion Speed collected 10 times by classroom teacher • Data on Attention-to-task collected 3 times by school counsellors	Assessment Group B
Intervention Group B	PHASE 4 • Data on In-seat behaviour collected 10 times by primary investigator • Data on Task Completion Speed collected 10 times by classroom teacher • Data on Attention-to-task collected 3 times by school counsellors	Assessment Group A
"Washout Period" Group B	PHASE 5 • Data on In-seat behaviour collected 10 times by primary investigator • Data on Task Completion Speed collected 10 times by classroom teacher • Data on Attention-to-task collected 3 times by school counsellors	Assessment Group A
Post-Test Group B	PHASE 6 • Data on In-seat behaviour collected 10 times by primary investigator • Data on Task Completion Speed collected 10 times by classroom teacher • Data on Attention-to-task collected 3 times by school counsellors	Post-Test Group A

Figure 1: Schematic representation of research design and data collection

The study consisted of six phases (*Figure 1*) with the initial phase comprising the assessment of the two groups. Phase 2 was the intervention Phase for Group A, followed by an assessment of Group A and Group B, and a wash-out period in Phase 3. Group B received intervention during Phase 4, followed by assessment of Group A and Group B. A wash-out period followed in Phase 5. The researcher conducted a post-intervention assessment in Phase 6.

Population

The study population included all learners in the Foundation Phase (Gr 1-3) from a remedial school in Gauteng who had been diagnosed with ADHD by a neurologist. Forty learners met the inclusion criteria ie they had definite difference scores in School Factors one and two on the Sensory Profile[9] while on medication, and were invited to participate in the study. Ten participants did not participate in the study due to the following reasons:

- Five parents did not give consent for the study.
- Three participants had to drop out of the study because their medication changed, which would have had an impact on the end results of the study.
- Two participants left the school.

A final sample size of thirty learners participated in the study; these learners gave consent and did not drop out during the data collection period. Participants were randomly assigned either to Group A or Group B. According to this sampling method each element in the population has an equal chance of being selected. The researcher assigned a number to each learner in the sample. All numbers were placed in a container and drawn randomly. The researcher used the simple random sampling technique separately for each grade and gender. The sampling was conducted on the Gr 1 boys first, thereafter on the Gr 1 girls, following, Gr 2 boys, Gr 2 girls, Gr 3 boys and Gr 3 girls. There were thus six separate simple random sampling proceedures carried out.

Research tools

Weighted vests

The weighted vests from Sensory Stuff[a] were made in navy blue fabric to blend in with the participants' school uniform. The vests had two pockets in front, two at the shoulders and four at the back. Each pocket could be fitted with a maximum of four 100g strip weights. The weighted vests were a convenient sensory strategy to use within the classroom environment with learners who need additional proprioceptive input. Using them was easy in comparison to other time-consuming proprioceptive modulating sensory strategies, as implementation occurred while the learners were seated and working in the classroom.

Development of a weighted vest protocol

As there were no published protocols on the use of weighted vests[19,20], guidelines from previous research had to be used. The researcher weighed all the research participants a week prior to the study and calibrated the vests to 10% of the participants' body weight. In the study by Stephenson and Carter[21] it was recommended that the weight of the vests should not exceed 10 to 15% of a participant's body weight. Learners wore the vests during the intervention phase of the study for one school period (45 minutes) at a time each day for 15 consecutive school days, in other words during phase 2 (Group A) and phase 4 (Group B). In-seat behaviour and task completion speed were assessed during this period while participants wore the vests. The wearing time was consistent with the literature which recommends that vests be worn for less than an hour up to a period of four hours[21]. The learners put the weighted vests on ten minutes prior to observation times, as the researcher felt that learners would have adjusted to the weighted vests after ten minutes. Children with ADHD adapt more slowly to changes in their environment[22]. It is documented in the literature that weighted vests were put on five minutes prior to observations in previous research[16].

Data Collection

In-seat behaviour: The in-seat behaviour of Group A and Group B was observed ten times during each Phase of the study. Observations of both groups occurred at the same time by using video cameras during all phases of the study. Two video cameras were permanently installed in each classroom; these were fitted in front of the classroom above the chalkboard. In order to get the best camera angle, participants were moved in the classroom prior to the data collection. Observations were therefore made unobtrusively. The video cameras allowed the researcher to measure the in-seat behaviour of various research participants at the same time. The researcher viewed the video tapes at the end of each day to record the in-seat behaviour. The in-seat behaviour of participants was measured according to the length of time learners were able to stay seated in a 20-minute period. Timing was done with a standard stopwatch. The timing was recorded in minutes (if a recording exceeded 0.55 seconds it was rounded off to a minute). Timing was stopped when any part of a participant's buttocks was not in contact with the seat of the chair. Timing commenced when the participant's buttocks made contact with the seat of the chair again. The researcher used computerised software to pause the video tape and zoom in (digital zoom) if there was uncertainty about whether the participants' buttocks made contact with the chair. The baseline assessment served as a norm against which the participants' in-seat behaviour can be measured. The research participants were doing literacy worksheets

[a] Sensory Stuff is an online store that sells products to enhance the sensory development of babies, children and adults. Supplying the weighted vests was their only involvement in this study.

during this observation. The researcher used a Microsoft Excel spreadsheet to capture the data.

Task completion speed: Each learner's task completion speed was measured ten times in each Phase of the study. Task completion speed was recorded by the teacher measuring the duration of time participants took to complete their written literacy worksheets and to present their completed work to the teacher. (It is standard routine for learners to present their completed work to teachers). Time was recorded in minutes. (If a recording exceeded 0.55 seconds it was rounded off to a minute). If participants did not complete their tasks the teacher wrote the maximum time of the school period down. The mean value of the individual non-participating class members served as a norm which the participants' task completion speed was measured against. The mean average of the non-participating members of the class was used because the literacy worksheets were not all on the same level of difficulty, learners from Gr 1- 3 participated in the study. This norm helped to excluded external variables that could have had an effect on the results of the study. Teachers were trained to collect the data for task completion speed by the researcher. The teachers were instructed to start the stopwatch after they gave the instructions to the learners when all the learners were seated. They stopped the stopwatch when the last learner finished. The stopwatches had lap split times and the teacher recorded the completion of each participant`s work as a "lap". They could therefore go back and write down all the saved "laps". This assisted with the achievement of accurate results. The researcher collected the task completion sheet from the teachers at the end of the day and captured the data on a Microsoft Excel data capture sheet.

Attention-to-task: Two school counsellors assessed the participants' attention-to-task three times during each Phase by using Conners' Continuous Performance Test II (CPT II)[23,24]. The counsellors were instructed to perform the assessment during the various Phases of the study. School counsellors accompanied the participants from the classroom to the computer to conduct the assessment. Participants wore the weighted vests during the intervention Phases of the study while doing the CPT II assessment (phase 2 -Group A and phase 4 -Group B). Participants did not wear the weighted vests during the other phases of the study. The CPT II is a computer-based assessment that gives accurate information regarding attention-to-task. Attention-to-task was measured in percentages. Letters were used as stimuli during the CPT II assessment[24]. The school counsellors instructed the participants to "... press the space bar or click the mouse whenever any letter except the letter 'X' appears on the screen"[24:50].

The researcher collected the data from the school counsellors daily and captured the data on a Microsoft Excel file spreadsheet.

Data Analysis

The data were analysed with the help of a statistician, using Statistica to process the data. The programme used a two-way repeated measure of ANOVA. This was used to test for significant differences between selected time points in each group ($p<0.05$). The mean data of group A and group B were compared during each phase of the study. A combined mean of group A and B was used to compare each phase with one another. Significant levels of in-seat behaviour, task completion speed and attention-to-task were determined during the six Phases of the study. Regression analysis was used to determine the difference between Group A and Group B.

Ethical Consideration

The study was approved by the Committee for Human Research at the Faculty of Health Sciences, Stellenbosch University. Permission was also obtained from the Gauteng Education Department and the remedial school in Gauteng. After being granted permission by the above stakeholders, the researcher handed out information letters to all parents whose children met the inclusion criteria of the study. All learners whose parents signed informed consent were included in the study. Learners also gave verbal consent in terms of participating in the study. Data of the learners were kept anonymous by assigning a number to each participant. Records were kept safe on the researcher's computer by using a password to access the files. Parents and children had the right to withdraw at any time during the study. Feedback was given to teachers during in-service training and parents received feedback at the quarterly parents meetings.

Results

Demographic Data

Table 1 describes the demographic data of participants.

Table 1: Demographic data of the study sample

GENDER		AGE		MEDICATION	
Boys	70% (n=21)	*Six-year-olds*	7% (n=2)	*Concerta 18 mg*	10% (n=3)
Girls	30 % (n=9)	*Seven-year-olds*	23% (n=7)	*Strattera 25 mg*	13.3% (n=4)
		Eight-year-olds	37% (n=11)	*Ritalin 20 mg*	10% (n=3)
		Nine-year-olds	33% (n=10)	*Ritalin 5 mg*	3.3% (n=1)
				Ritalin 10 mg	30% (n=9)
				Concerta 36 mg	16.6% (n=5)
				No medication	16.6% (n=5)

In-seat Behaviour, Task Completion Speed and Attention-to-task

No significant difference existed between the groups at baseline for in-seat behaviour, task completion speed and attention-to-task (*Table 2*). This indicates that the groups were homogeneous at the start of the study.

Table 2: Baseline measurements for the three constructs

Mean value at the beginning of the study	Unit of measurement	Group A Mean	Group B Mean	p-values (≤0.05)
In-seat behaviour	Minutes	17.29	17.95	0.09
Task completion speed (difference between group and class average)	Minutes	3.74	4.45	0.2
Attention-to-task	Percentage	64.21%	61.09%	0.5

In-seat behaviour

In-seat behaviour improved in the two intervention Phases, although this was only statistically significant ($p\leq 0.00$) in Phase 4 of in-seat behaviour when Group B received intervention (*Table 3*). The mean value for Group A during phase 1 was 17.95 minutes and in phase 2 (intervention phase) the group's in-seat behaviour value was 18.52 minutes. In-seat behaviour of Group B commenced with 17.95 minutes during Phase 1 and during Phase 4 (intervention phase) they were able to stay seated for 18.76 minutes. In the wash-out and intervention Phases Group B had slightly better in-seat behaviour throughout the study.

Task completion speed

In the case of task completion speed when Group A received intervention (*Table 4*) there was a significant improvement ($p\leq 0.00$). The difference between Group A and the class average was 3.74 minutes during Phase 1 and 2,26 minutes during Phase 2 (Group A intervention). In the wash-out and intervention Phases Group A had slightly better task completion speed throughout the study (see *Table 4*).

Table 3: In-seat behaviour over six Phases for group A and B

IN-SEAT BEHAVIOUR	p-VALUES	MEAN VALUE MINUTES		STANDARD DEVIATION
		Group A	Group B	
Phase 1	0.09	17.29	17.95	1.23
Phase 2 Intervention Group A	0.15	18.52	17.95	0.85
Phase 3	0.27	17.31	17.82	1.15
Phase 4 Intervention Group B	0.00*	17.28	18.76	1.32
Phase 5	0.26	17.48	17.91	1.08
Phase 6	0.17	17.31	17.99	1.19

*Significance p≤0,05

Table 4: Task completion speed over six Phases of Group A and B

TASK-COMPLETION SPEED	p-VALUES	MEAN VALUE MINUTES (difference between group and class average)		STANDARD DEVIATION
		Group A	Group B	
Phase 1	0.20	3.74	4.45	1.45
Phase 2 Intervention Group A	0.00*	2.26	4.49	1.77
Phase 3	0.28	3.72	4.31	1.34
Phase 4 Intervention Group B	0.29	4.31	3.28	1.58
Phase 5	0.11	4.28	4.62	1.72
Phase 6	0.12	3.72	4.52	1.62

*Significance p≤0,05

Table 5: Attention-to-task of Group A and B

ATTENTION-TO-TASK	p-VALUES	MEAN VALUE PERCENTAGE		STANDARD DEVIATION
		Group A	Group B	
Phase 1	0.59	64.21	61.09	16.33
Phase 2 Intervention Group A	0.02*	48.20	62.02	16.27
Phase 3	0.97	63.12	63.11	15.0
Phase 4 Intervention Group B	0.01*	64.61	49.39	17.66
Phase 5	0.11	63.82	61.83	15.74
Phase 6	0.12	63.94	61.48	15.55

*Significance p≤0,05

Attention-to-task

A statistically significant improvement occurred in attention-to-task in the two intervention Phases (p≤ 0.00) in other words in Phase 2 and Phase 4 in terms of attention-to-task for both groups (*Table 5*). Group A had a baseline score of 64.51 % and they achieved a score of 48.2% during the intervention phase (phase 2). The baseline score for Group B was 61.09% and they obtained a score of 49.39% during their intervention phase (Phase 4). In the wash-out and intervention phases, values for both groups were very similar (see *Table 5*).

Summary

Significant improvement of in-seat behaviour (Group B), task completion speed (Group A) and attention to task (Group A and B) was observed while participants wore weighted vests. Other factors that will be discussed later may have affected the results concerning in-seat behaviour and task completion. A baseline assessment was done during Phase 1 of the study, while a post-test commenced during Phase 6 of the study. The p-values of in-seat behaviour, task completion speed and attention-to-task did not indicate statistically significant differences during Phase 6 of the study. The mean values returned to baseline as indicated in *Tables 2, 3* and *4*. This suggests that the weighted vests did not have a lasting effect. Previous research could not determine the long-term effects of weighed vests on duration of focused attention once the vests had been removed[6,16,28,29].

Qualitative feedback

Teachers reported that the participants appeared to be much calmer when they wore the weighted vests. Literature confirmed that proprioceptive input has a calming effect on the central nervous system of an individual[7,8,11,12,13,25]. Participants also appeared to be more alert while wearing the vests. An important function of proprioception is the modulation of arousal levels[11,23,25]. This may have been a contributing factor that affected the participants' improvement of attention-to-task as seen in the results. The researcher observed on the video recordings that the participants were less likely to kick their feet on the floor or chair while wearing the weighted vests and seated at a desk. Proprioceptive input provided by the weighted vests might have increased the participants body awareness[11] and assisted them to improve their postural stability. The additional feedback that they obtained about body position might have played a role in the improvement of postural stability[12] and thereby decreasing sensation seeking behaviour that was mentioned above.

Discusssion

In-seat behaviour

Although wearing the weighted vests (intervention) did not provide significant results for Group A, the mean value of the in-seat behaviour results for Group A increased, indicating that there was a slight improvement in the in-seat behaviour of Group A (*Table 3*). The reason for the intervention not yielding effective results could be because the weighted vests were a novelty to the learners which excited them to the extent that they were unable to sit still. Children with ADHD adapt more slowly to changes in their environment[22]. Previous research revealed that children diagnosed with ADHD had significant problems with adaption[22,26]. The learners of group B were able to observe the intervention phase of group A, therefore the "novelty effect" did not have an influence on Group B`s results.

The results of Group B were better throughout the study (*Table 3*), although the two groups were homogenous in terms of gender and age. The pre-test indicated that from the start of the study (*Table 2*), the in-seat behaviour of Group B was better than that of Group A. The within-group results for Group B indicated significance during the intervention Phase. Group A started at a lower level than Group B and therefore presented more room for improvement compared to group B, but their results did not improve significantly (*Table 3*). Therefore, it is possible that Group B had more potential in this specific factor than Group A.

Children with proprioceptive deficits do not receive adequate information about body position and it is often difficult for them to remain in a chair[27]. Integration of proprioceptive and vestibular information takes place at the level of the cerebellum, and this information contributes to postural control and a sense of gravity[27]. The researcher observed that participants were able to stay seated for longer periods while wearing the weighted vests. The proprioceptive information may have enabled learners to improve their postural control or overresponsivity to movement. Proprioception has a modulating role over other senses and assists with the regulation of overrresponsivity of movement[27]. Previous research proved that alternative seating (on therapy balls) for children diagnosed with ADHD also improved in-seat behaviour[27]. The vestibular and proprioceptive input, therefore, assisted learners to regulate their modulation levels and remain seated for longer periods.

Therefore, it may be concluded that the intervention improved in-seat behaviour, although not significantly for those starting at a baseline of below 17.5 minutes.

Task completion speed

Data analysis revealed a statistically significant difference in the task completion speed occurring during the intervention Phase for Group A, but not for Group B. The results for Group A were better throughout the study, and Group B never caught up with Group A (*Table 4*). *Table 2* illustrates the mean value of Group A and Group B at the beginning of the study. The mean value is the difference between the group performance and the class average.

The school holidays took place between Phase 3 and Phase 4 of the study, which may have had an influence on the task completion speed of the research participants. The learners were introduced to new work at the beginning of Phase 4. The intensity of the new work and the level of difficulty may have decreased their task completion speed. The participants in Group B worked more slowly in Phase 4, even with the presence of the weighted vests, and the slowest speeds for the entire study were recorded after their intervention Phase (*Table 4*). Therefore, although both groups had an increase in speed when the weighted vests were introduced, the influence on the learners' task completion speed during Phase 4 was probably affected by the introduction of unfamiliar work and the school holidays.

After the school holidays learners had to re-adjust to the school routine and work pace. This was a limitation of the study, i.e. that one school term was simply too short a space in which to complete the study. The researcher had to break up the data collection over two school terms. This limited the study and may have had an impact on the results.

Therefore, it may be concluded that the intervention was successful and that the participants' task completion speed improved when they wore weighted vests. The differences in significance between Group A and Group B indicate that other classroom factors played a role in task completion speed and these need to be taken into account. The inattentive subtype of ADHD may process information more slowly and, therefore, this subtype may not complete tasks[5,10]. Learners who have been diagnosed with the hyperactive subtype are impulsive, while combined subtypes of ADHD may rush through their work[5,10]. Another limitation of the study is that there was no differentiation between the two subtypes in the inclusion criteria of the study. The two unspecified subtypes affected the results of task completion speed. As quality of class performance was not taken into account, participants may have compensated by improving the task completion speed, but not necessarily the quality of their classroom performance.

Attention- To-Task

The research participants in Group A and Group B improved their attention-to-task significantly during the intervention Phases of the study as measured by the CPT II (*Table 5*). The CPT II was standardised in the United States of America using 2 500 participants and has satisfactory test-retest reliability and validity[23,24]. Therefore, the instrument that recorded attention-to-task may have been more accurate than the measurements used to assess in-seat behaviour and task completion speed. Unfortunately there are currently no standardisation data available for a South-African population.

Sustained attention-to-task requires the maintenance of sensory modulation[26]. Inadequate sensory modulation causes distraction, which means the individual attends to all input in the environment[8,26]. The literature suggests that proprioception has a regulatory influence over other sensory systems, including arousal levels in general[12]. The weighted vests may provide sensory input that alleviates over or under sensitivity to sensory input that is associated with inattentiveness[4,6,7,11]. "The modulating influence of proprioception over the other senses appears to occur at the level of the cerebellum, thalamus and somatosensory context"[25:113]. A survey completed by school-based occupational therapists in the United States reported that weighted vests assisted them with their goals of improving attention while completing desktop academic tasks[15,28]. Previous research proved that the on-task behaviour of children with attention difficulties improved while they were wearing weighted vests[6,29].

Protocol for using the weighted vest

A weighted vest is a useful tool to use in the classroom. However, it should be used in collaboration with a trained sensory integration therapist. There are no standardised protocols available for the use of weighted vests therefore the researcher recommends that the protocol for this research be used. Learners wore the weighted vests for one school period at a time (approximately 45 minutes). There are no guidelines in the literature as to how long it can be worn, however habituation might occur and the wearing time should be monitored by a therapist. Therapists should calibrate the weight of the vest to 10% of the child`s body weight. The learner should also be asked if the weighted vest is comfortable. If the learner is not comfortable the weight can be decreased or increased by 1 % depending on the learners' preference.

Conclusion

Evidence of this study suggests that learners diagnosed with ADHD have improved their in-seat behaviour and attention-to-task while wearing weighted vests in a school context (*Table 3-5*). Under or over responsivity to sensory information was improved by the proprioceptive and deep pressure input provided by the weighted vest, allowing participants to better attend to tasks.

A weighted vest is a convenient tool to use in the classroom environment as it does not disrupt the normal class routine. In order to achieve optimal results the vest should be used as part of a balanced sensory diet[13,15]. The therapist will also be able to monitor the child's progress and adapt the sensory diet or weighted vest accordingly.

Future research may be directed to developing a standardised protocol for the use of weighted vests in terms of duration of use, amount of weight used and type of activities for which they are suitable. It is recommended that prospective research investigate whether children's handwriting and posture improve while wearing weighted vests. Future research should also include qualitative feedback from learners, teachers, parents and the therapists treating children through the wearing of weighted vests.

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