

## How does visual praxis based occupational therapy program effect motor skills in children with hyperactivity and attention disorder? Single blind randomized study design

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### Abstract

Attention Deficit and Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized with problems such as; atypical attention skills increased impulsive behaviors at least two of the child's areas of daily living. In studies investigating developmental aspect of the said problems of children with ADHD, it was stated that the children usually do not demonstrate normal development regarding the motor proficiency and may fall behind their peers in exhibiting normal motor performance. These problems in motor skills are said to cause a hindered development in complex skills which may result in; distorted body image, increased anxiety and poor social communication skills. This study's aim was to investigate effects of a Visual-Praxis-based Occupational Therapy program (VPOT) on motor proficiency of children with ADHD. The 58 children who were included to the study were assigned numbers from 1 to 58 and randomized into two groups (the intervention group and the control group). Both groups were subjected to the Bruninks-Oserestry Test of Motor Proficiency 2–Brief Form (BOT2-BF). After the initial assessment, the participants in the intervention group were admitted into the VPOT program for a duration of 8 weeks with twice-weekly sessions of 45 minutes. End of the program, BOT2-BF was applied once more. The participants mean age was  $8.44 \pm 1.39$  years. There were no differences between the intervention and the control group in terms of age. When the BOT2-BF results for the intervention group were analyzed, it was found that there were significant differences between pre- and post-intervention scores of all sub-scores and the total score. Due to approaching the motor development aspect of ADHD within the context of motor proficiency and visual perception, this study can be considered to be one of the innovative and pioneer studies in the field and is positively unique regarding the usage of the intervention approach that was used.

**Keywords:** Attention Deficit and Hyperactivity Disorder, occupational therapy, Motor Skills, visual perceptions

### 1. Introduction

Attention Deficit and Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by problems such as; atypical attention skills, increased impulsive behaviors, or physical activity affecting at least two of the areas of daily living over a period of one year, usually before the age of seven (1). It was detected that these symptoms start during early childhood and their effects continue throughout adolescence or adulthood. In addition to that, research in this area shows that these symptoms may create performance problems that may influence the social, academic, and other activities of daily living directly (2). In studies investigating the developmental aspect of the said problems of children with ADHD, it was stated that the children usually do not demonstrate normal development regarding motor proficiency and may fall behind their peers in exhibiting

normal motor performance (3–6). These problems in motor skills are said to cause a hindered development in complex skills, which may result in; distorted body image, increased anxiety, and poor social communication skills (4, 7, 8). Due to the problematic areas being complex and having a high variety, a need for the treatment plans having dynamic properties within a high variety has arisen (9, 10).

It is possible to classify the approaches that offer solutions to the problems of children with ADHD into two categories; medical and rehabilitative methods. In medical treatment methods, medication is the primary treatment modality. It was emphasized that medical treatment cannot solve all problems on its own, and especially in problems regarding normal skill development and its effects on

behaviors, supporting the process with rehabilitation-based approaches is needed (11, 12).

In studies focusing on rehabilitation-based approaches for children with ADHD, it was seen that the rehabilitation applications focused on a wide variety of developmental areas and included different health professionals. However, it was realized that most of the rehabilitation programs in the field focused on the behavioral aspect and more specific and individual problems, such as bursts of rage and infringement of interpersonal boundaries, rather than motor, sensory or cognitive skills (6, 13, 14). A very limited number of studies focused on motor and sensory skills. In studies focused on providing solutions for the sensory problems experienced by children with ADHD, the behavioral outcomes after sensory-based approaches or brain stimulations were investigated (16). On the other hand, the studies on motor skill problems usually focused on single motor skill or investigated motor outcomes as secondary outcomes of other rehabilitation approaches. It was stated in previous research that the inability to demonstrate normal motor development was on the basis of other problems experienced by children with ADHD, and the importance of conducting comprehensive intervention studies within this area of focus was emphasized (17).

In the light of this information, this aim was to investigate the effects of a Visual-Praxis-based Occupational Therapy program (VPOT) on the motor proficiency of children with ADHD.

## 2. Materials and methods

### 2.1. Ethical statement

This study was designed as a single-blind, randomized, controlled trial of the Visual-Praxis-based Occupational Therapy program (VPOT) on motor skills in children with SLD. The protocol used in this study was approved by the Clinical Ethics Boards and Commissions (ID: 2022-060), and written informed consent was obtained from every child and his/her legal guardian.

### 2.2. Participants

Fifty-eight children who applied to a Research and Training Outpatient Pediatric and Adolescent Mental Health Clinic were admitted to the study. The inclusion criteria were; (1) Having an ADHD diagnosis given by a pediatric psychiatrist, according to the DSM-V criteria, (2) Continuing to primary school education, and (3) Being between 7 and 10 years of age. The exclusion criteria were; (1) Having another diagnosis for a neurodevelopmental disease other than ADHD, (2) Continuing to occupational therapy, physiotherapy, or any other rehabilitation program, and (3) Being a professional athlete or sportsperson.

### 2.3. Procedure

The 58 children who were included to the study were assigned numbers from 1 to 58 and randomized into two

groups (the intervention group and the control group) using a computer-based random number selector between 1 and 58. After the randomization, both groups were subjected to the Bruininks-Oserestry Test of Motor Proficiency 2 – Short Form (BOT2-BF) by the third author. After the initial assessment, the participants in the intervention group were admitted into the VPOT program, which was carried out by the first author for a duration of 8 weeks with twice-weekly sessions of 45 minutes. After the training program finished, the BOT2-BF was applied once more by the second author (Fig. 1).

### 2.4. Measurements

**Sociodemographic Information Form:** This form was prepared by the authors and included questions about the participants' age, gender, dominant side, and current education status.

**Bruininks-Oserestry Test of Motor Proficiency 2 – Short Form (BOT2-BF):** The BOT2-BF is a tool to assess the motor proficiencies of children between 4.5 and 14.5 years of age. The BOT2-BF has 8 subtests and a total of 46 items and enables assessing gross and fine motor skills alongside motor proficiency. While Dr. Robert H. Bruininks was developing the BOT2-BF, he started his work from the basis of the Oseretsky Motor Proficiency Test. While both tests are similar, the Bruininks-Oseretsky Test of Motor Proficiency had significant positive differences in its contents construction, and technical quality. Therefore, the Bruininks-Oseretsky Test of Motor Proficiency became a significantly important tool for therapists and researchers to assess children's motor skills, prepare intervention programs, and detect current or possible motor development problems. The Bruininks-Oseretsky Test of Motor Proficiency was updated in 2005, and the Bruininks-Oseretsky Test of Motor Proficiency 2 (BOT2) was developed. The BOT2 is applicable for children between 4 and 21 years of age and takes between 45 and 60 minutes to complete, and the maximum possible score is 243. BOT2 also has a short form, namely the Bruininks-Oseretsky Test of Motor Proficiency 2 – Short Form (BOT2-SF), which was updated in 2010 to include 12 items rather than 14. The BOT2-BF takes between 15 and 20 minutes to complete, and the maximum possible score is 72. The validity and reliability of the Turkish version of BOT2-BF were previously shown to be satisfactory in children with SLD by Köse et al. in 2018 (Cronbach's  $\alpha = 0.78$ ).

### 2.5. Intervention program

**The Visual-Praxis-based Occupational Therapy program (VPOT):** The VPOT was applied for a duration of 8 weeks with twice-weekly sessions of 45 minutes. The VPOT consists of 6 tasks in total; 4 stations and 2 activities. In each session of the VPOT, all 6 tasks were done in "activity-station-station-station-station-activity" "sequence, without any breaks. Before starting the sessions, each task's rules

and contents were explained to the child in detail and an easy-to-understand manner (18).

**2.6. Statistical analysis**

All analyses were performed using SPSS v.26. In order to establish the homogeneity of the groups, both ages and genders of the participants were compared between groups at the baseline of the study. This comparison was made using the Chi-Square test for gender and Mann-Whitney U Test for ages due to the variable age not having a normal distribution. The participants' BOT-2BF mean scores were reported for all sub-tests and the total score. BOT2-BF results before and after the intervention program was compared in both of the groups separately. In order to see the differences in groups, the effect size for each sub-score and the total score were calculated with the post-intervention assessment results, using Cohen's d score.

**3. Results**

After obtaining the ethics committee approval, 74 patients were included in the study. Out of 74 patients, 60 patients were included in this study, after exclusion of 14 patients as per the exclusion criteria (Fig. 1).

A total of 58 individuals participated in this study. The participants were randomly assigned to one of the two groups. There were 29 participants in each group, and there were no drop-outs. The participants' mean age was 8.44±1.39 years, and there were 41 male participants (70.7%). There were no differences between the intervention and the control group regarding age (Table 1) and gender (Table 2).

**Table 1.** Baseline comparison of age between groups

	Intervention Group (X±SD)	Control Group (X±SD)	p
Age	8.72±1.60	8.96±1.17	0.318

**Table 2.** Baseline comparison of genders between groups

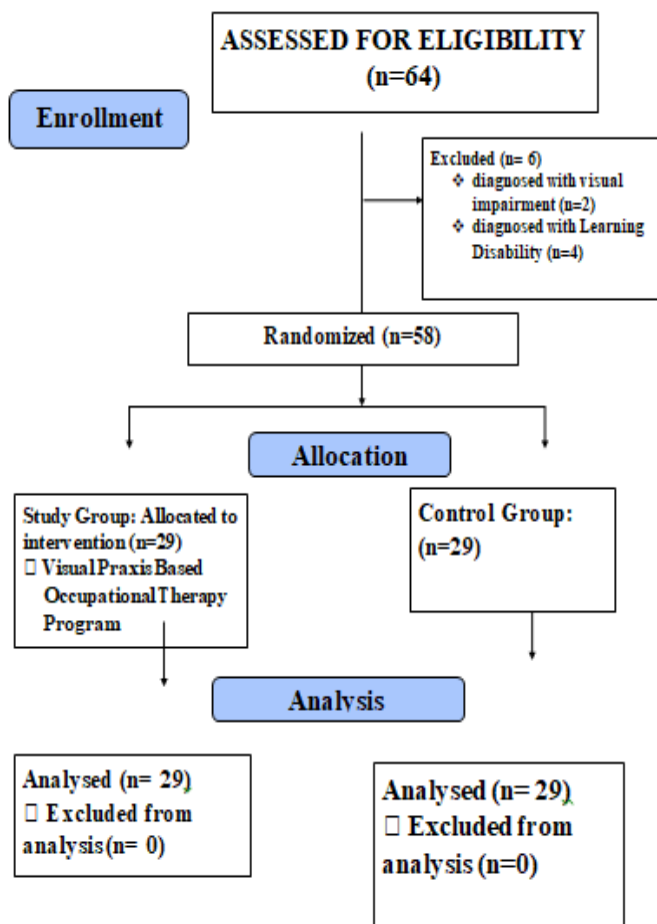
		Intervention Group	Control Group	Total	Chi-Square
Gender	Male	19	22	41	0.565
		65.5%	75.9%	70.7%	
	Female	10	7	17	
		34.5%	24.1%	29.3%	

When the BOT2-BF results for the intervention group were analysed, it was found that there were significant differences between pre- and post-intervention scores of all sub-scores and the total score. On the other hand, there were no significant differences between the pre- and post-intervention scores in none of the sub-scores or the total score of BOT2-BF in the control group. Additionally, the effect sizes which were calculated using the Cohen's d score – were between 0.54 and 1.16, which showed a medium to large effect size between the groups (Table 3) (19).

**4. Discussion**

In this study investigating the effects of the VPOT on the motor proficiency skills of children with ADHD, it was found that the VPOT was effective in improving all of the motor skills parameters (fine motor, gross motor, balance, coordination, etc.). Due to approaching the motor development aspect of ADHD within the context of motor proficiency and visual perception, this study can be considered to be one of the innovative and pioneer studies in the field and is positively unique regarding the usage of the intervention approach that was used.

According to the results of the study investigating the effects of a physical exercise-based rehabilitation program on the motor skills of children with ADHD, Pan et al. stated that significant improvements were achieved in locomotor skills and hand coordination while other motor proficiency skills did not improve (19). Vysniauske et al., based on the results of a meta-analysis investigating the effects of physical



**Fig. 1.** Consort Diagram

activity-based rehabilitation applications on the motor skills of children with ADHD uncovered that the studies including children with ADHD were focused on a single skill and usually were found to be effective in improving a specific motor proficiency skill (endurance, hand-eye coordination, fine motor skills), however, were not effective in improving many motor skill parameters simultaneously (20). While the results of our study are in accordance with the literature in

that they show the effectiveness of an intervention approach in improving motor skills of children with ADHD, they also are positively distinct in showing the effectiveness of the intervention program in improving all parameters of motor skills. We think that this difference was caused by the VPOT not focusing on a single aspect of motor skills and/or not focusing on a specific motor skill in every session, but rather utilizing a multi-skill training in each of the sessions.

**Table 3.** Comparison of BOT2-BF scores between pre- and post-intervention assessment in the Intervention and the Control groups

BOT2-BF Score	Intervention Group					Control Group					Effect Size (Cohen's d)	
	Pre-Intervention		Post-Intervention		p	Pre-Intervention			Post-Intervention			p
	Mean	Std. Dev.	Mean	Std. Dev.		Mean	Std. Dev.	Mean	Std. Dev.			
Fine Motor Precision	3.07	0.96	3.93	0.80	0.001*	3.45	1.02	3.49	0.99	0.33	0.58	
Fine Motor Integration	5.00	2.20	5.93	2.19	0.001*	5.93	2.45	5.82	2.16	0.58	0.54	
Manual Dexterity	2.00	0.85	2.90	0.56	0.001*	2.38	0.68	2.32	0.73	0.87	0.74	
Bilateral Coordination	4.00	1.65	5.34	1.56	0.001*	3.45	1.12	3.48	1.02	0.59	1.16	
Balance	2.48	1.18	3.00	0.96	0.001*	2.07	0.84	2.03	0.82	0.33	0.95	
Running Speed and Agility	3.28	1.56	3.90	1.45	0.001*	3.24	1.62	3.28	1.65	0.33	0.59	
Upper Limb Coordination	4.38	2.18	6.69	2.71	0.001*	5.17	2.70	5.10	2.64	0.54	0.57	
Strength	2.52	1.12	3.34	1.34	0.01*	2.52	1.43	2.57	1.35	0.79	0.59	
Total	27.31	7.35	5.45	6.39	0.001*	28.24	7.51	27.90	7.13	0.16	0.97	

\* p<0.05

In their study analyzing the motor skill problems of Iranian children with ADHD between 6 and 11 years of age, Lavasani et al. found that the most frequently experienced problems were; manual dexterity, balance, and bilateral coordination (21). In a study investigating the effectiveness of a neurofeedback-based rehabilitation program on the motor skills of children with ADHD between 5 and 12 years of age, Jahani et al. said that neurofeedback was an effective intervention method for increasing manual dexterity in the participants with a medium effect size. Sharon et al., on the other hand, found that an interactive metronome-based rehabilitation program was effective in improving the motor skills in children with ADHD and stated that the intervention method yielded significant improvements in bilateral coordination, and upper-extremity reaction time, and manual dexterity with a large effect size (22). When the results of our study were analyzed, it was seen that there were parallels between our results and various different applications in the literature regarding the intervention approach significantly improving the manual dexterity skills. However, while many other studies reported a large effect size regarding the improvements in manual dexterity, there was only a medium effect size in our study. We think that this situation arose from the difference between the tests used in order to assess manual dexterity skills.

In the results of their review study analyzing the motor control problems experienced by children with ADHD,

Kaised et al. stated that multi-layered studies were needed to improve balance due to balance being a highly complex concept, and the balance and coordination problems of the children with ADHD were influencing their motor control skills. In addition to this, they have emphasized the need for increasing the number of high-quality studies in this field (23). Bucci et al. reported that the visual attention-based applications for children with ADHD improved accurate and correct eye movements that, in turn, influenced the dynamic balance positively and therefore were effective methods that can be used in improving balance skills (24). In a study investigating the effects of an active vestibular stimulation-based rehabilitation program on the motor skills of children with ADHD between 7 and 12 years of age, Moghadam et al. showed that the method they applied was very effective in improving visual-motor integration and balance skills (25). The VPOT training program that we used in our study had similar effects to other intervention approaches in the literature regarding improving the balance skills of children with ADHD. In addition to the similarities to other intervention methods described in the literature, the VPOT yielded a large effect size regarding the improvements in the balance skills. This may have been caused by the VPOT's structure, which involves the simultaneous usage of visual, motor, and sensory skills, being in correspondence with the complex nature of balance skills, possibly yielding a heightened effect.

As a result of their study investigating the effects of physical activity on the symptoms shown by children with ADHD throughout the prognosis of the condition, Hoza et al. found that even a basic level of physical activity was effective in improving motor coordination (26). Meßler et al. similarly found that the High-Intensity Interval Training program was effective in improving bilateral coordination in children with ADHD between 8 and 13 years of age (27). The results of our study indicated that the VPOT was an effective treatment method for improving bilateral coordination. Especially due to lowered bilateral coordination being one of the most frequently reported problems in children with ADHD and the previous studies reporting the most rapid improvements in bilateral coordination, we think that our results are in accordance with the literature.

According to its prognosis, ADHD is considered to be a neurodevelopmental disorder usually characterized by bursts of anger and not being able to conclude an ongoing task. It was reported that the inability to follow a typical motor development process was underlying these behavioral problems. In our study, the VPOT training program was used with the aim of improving motor skills, and it was found to be effective. However, the behavioral effects of the said improvements were not assessed. When the skill and behavior-based dynamic structure of ADHD are considered, this can be interpreted as a limitation of our study.

In conclusion, the VPOT, which was developed considering the typical development of visual perception and praxis skills, was found to be effective in improving all of the parameters of motor proficiency skills (fine motor, bilateral integration, balance, etc.). It is stated that the problematic developmental areas experienced by children with ADHD have a high variation. When the developmental processes are taken into consideration, it can be understood that problems in motor skills affect the children's activities of daily living. In recent studies regarding this subject, the importance of comprehensive studies from this perspective was repeatedly emphasized. The VPOT training, which was developed by the researchers, is one of the first intervention approaches involving visual perception, motor, sensory and cognitive processes. In addition to that, we think that the usage of the VPOT in this study may provide a positive contribution to the literature towards a conceptual shift in developing new intervention approaches and may act as an incentive for future studies willing to integrate multiple developmental areas and conduct more comprehensive studies.

#### Conflict of interest

The authors declared no conflict of interest.

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None to declare.

#### Authors' contributions

B. K. and K.K. carried out the literature survey, applied for ethical approval, and contributed to the development of the data collection methods and analysis plans. B. K. applied the visual-based occupational therapy program. O.K. undertook the data collection process, which is the repeated evaluation process. E.T. and S.Ş. contributed to the analysis process, interpreted the data, and contributed to the development of the text. All the authors reviewed and edited the text and eventually approved the final version.

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