Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 8, 8630 – 8645

The effectiveness of perceptual-motor exercises on visual-spatial processing and reading performance in second grade primary school girl students with learning disorder

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Abstract

Special learning disorder is one of the most common childhood disorders. Children and teenagers with special learning disorders are found in every class and these students have problems, such as severe academic drop, dropping out of school, behavioral-emotional problems, lack of motivation and lack of interest in learning and reduced confidence unless their disorder is detected and treated in time. The present study was conducted to determine the effect of perceptual-motor exercises on visual-spatial processing and reading performance in second-grade primary school girl students with special learning disorders in three districts of Tabriz City. The method of this research was a quasi-experimental pretest-posttest research design with a control group. The statistical population included all second-grade primary school girl students with special learning disorder referred to the center for special learning disorder in District 3 of Tabriz in 2021-1402 which the size of the population was 224 people. The statistical sample of the current research was 30 students selected using the purposeful sampling method and randomly assigned to two experimental and control groups. Perceptual-motor interventions were implemented during 15 sessions for the experimental group in three 45-minute sessions per week. To respond to the assumptions of the research, data were collected and standard tests were used. The tools used included the educational package of the country's exceptional education and training called timely intervention in the education and rehabilitation of new students with special learning difficulties, Wechsler test 4 (small scale of block design, coding, cancellation and symbol search), reading diagnostic test by Shirazi and Nilipour (20111). The research data was analyzed by univariate analysis of covariance. Data were analyzed using SPSS software. The results of the posttest intergroup effects test by removing the pretest effect show that a there is a significant difference between the averages of the two experimental and control groups in the components of symbol search ($P<0.05$, $F=4.82$) and decoding ($P<0.05$, $F=4.68$) and cancellation ($P>0.05$, $F=15.98$) and block design ($P>0.05$, $F=13.62$). The comparison of effect sizes showed that the intervention of perceptual-motor exercises had the greatest effect on cancellation with an effect size of 0.354 and block design with an effect size of 0.295. Therefore, statistically, a significant difference was observed between the two experimental and control groups based on perceptual-motor exercises, and perceptual-motor exercises had an effect on all four components of visual-spatial processing; also, the results of the posttest inter-group effects test by removing the pretest effect show that there is a significant difference between the averages of the two experimental and control groups in the components of reading accuracy ($P<0.05$, $F=16.02$) and reading speed (0.5 $P>0$, $F=23/81$), reading error ($P>0.05$, $F=6.60$) and reading comprehension ($P>0.05$, $F=4.59$). The comparison of effect sizes showed that the intervention of perceptual-motor exercises had the greatest effect on reading speed with an effect size of 0.485 and reading accuracy with an effect size of 0.364. Therefore, statistically, there is a significant difference between the two experimental and control groups based on perceptual-motor exercises; according to the findings of this research and other related researches, it can be

concluded that motor skills develop cognitive abilities. Without having proper perceptual-motor skills, students will not be able to read, write and perform mathematical operations at the level that normal schools require. As a result, one of the appropriate and necessary solutions for correcting and repairing the special learning problems of such students is the design of a selected movement program based on education standards and finally the implementation of this plan in all levels of the primary education period.

Keywords: learning disorders, perceptual-motor, visual-spatial processing, reading.

1. INTRODUCTION

One of the fields that are particularly important in psychology is learning. Learning disorder is common childhood disorders. There are three types of learning disorders: a- reading disorder b- writing disorder c- math disorder (1). Learning disorder is a type of failure in one or more mental processes in various areas, such as speaking, listening, reading and writing. Despite the fact that these people do not have vision and hearing problems but they face problems in learning some concepts or course materials. (2)

Dyslexia or reading disorder is a term for children who have problems in reading, understanding, spelling and writing, despite having normal intelligence and without significant sensory deficits. These problems are in processing speed, short-term memory, and audio and visual perception (2). Visual-spatial abilities include the identification for bilateral integration (coordination) and superiority (lateral superiority) and allow the child to correctly judge the location of objects in the visual space in comparison with other objects and in relation to his body. Spatial perception is a process that is characterized by a person's ability to recognize the state and exact position of objects and people in relation to each other (3).

In perceptual and perceptual -motor problems, the child is not able to organize, change and use the received stimuli or information. These children are significantly different from their normal peers in fine perceptual-motor coordination. Perceptual skills are activities that a person shows during responding to the senses of sight, hearing, touch, taste or other sensory signs. Jengu, Hemati, Jafarzadeh Dashblag showed that play therapy has a significant effect on improving the speed of information processing and social/emotional processing in students with specific reading learning disorder (5). In their research, Naderi, Rostamian and Momeni showed that teaching perceptual-motor skills to students with specific learning disorder can improve the academic performance of students in reading, writing and math skills (6).

Cornoldi,Caprio,Giulio,Toffalini in a research showed that children differ with the type of learning difficulty, gender and performance (7). In the research that Christian T. Doabler, Ben Clarke, Derek Kost,Hank Fien, Keith Smolkowski, Meijia Liu, and Scott K. Baker, (8) and also in the research conducted by Bakker ,Dirk. J. & Hakvoort, Frans. J (9) on dyslexia, the etiology of this research showed that the right hemisphere of the brain plays an important role in learning to read. Rachel Sermier Dessemontet, Anne-Françoise de Chambrier , Catherine Martinet , Natalina Meuli , Anne-Laure Linder evaluated the effects of a phonics-based reading intervention program, treatment and experimental group students showed significant improvement in word and non-word reading designed by the researcher (10).

Two types of explanations can be proposed for the importance and necessity of research: first, based on what was stated, research variables are very important. The second explanation is that there is a lack of research in this field. Despite previous studies and research, the number of students with this disorder is increasing every year in schools, and it causes

them to drop out of school and have low self-confidence in all stages of their lives. The spread of COVID-19 and the presence of mental pressures resulting from this disease among families and the psychological effects on the family system have aggravated their problems, and the present research has been done to help such students and to diagnose and treat them in time.

The main goal of perceptual-motor exercises is to help the formation of basic concepts and by using appropriate methods and tools in children to lead them towards logical reasoning. The formation, development and stabilization of attitudes and conceptualization in a deep and fundamental way can lead to appropriate changes in the child's behaviors and attitudes. As a result, it is better to provide effective education for such children by avoiding superficial behaviors as well as direct and classical education. The effectiveness of perceptual-motor exercises on visual-spatial processing and reading performance of second-grade primary school girl students with learning disorder in Tabriz was the aim of this research, and its results can be used in schools, learning disorder centers, and counseling centers.

2. Research methodology

The current research method is quasi-experimental pretest-posttest research design with a control group. The statistical population of this research is all the female students referred to the Center for Special Learning Disorders in District 3 of Tabriz in 2021-2022, which is equal to 224 people. In the community under study, 30 students (due to the effectiveness of the research method) were selected using the purposeful sampling method and were randomly assigned to two experimental and control groups. The criteria for the subjects to enter the research were: 1 - Placement in the age range of 9-8 years 2- Diagnostic evaluation of students with special learning disorder by the center's expert instructor, via a two-session process of diagnostic reading and writing tests, Wechsler IQ test. 3- Having a reading and writing disorder at the same time. Informed consent of the student to participate in the research 5- Informed consent of the student's parents, and the criteria for the withdrawal of the subject are: 1- Absence in a maximum of two intervention sessions, 2- Lack of consent of the student or his parents to continue cooperation in the research.

After agreeing and coordinating with the director of the learning disorder center related to education, the evaluation and treatment sessions started in that center. In the first meeting, each client's presence was explained about the design and objectives of the research, the number of sessions, evaluation and treatment, the duration of each session, and the venue. Then, they were explained about the observance of ethical principles such as voluntary participation, confidentiality of information and not receiving negative consequences in case of lack of desire to continue cooperation, and then, if they expressed their desire, the research was started. Both the experimental group and the control group participated in two evaluation sessions, which included a pre-test and a post-test immediately after the end of the intervention. The experimental group received 15 individual treatment sessions three times a week for five weeks, while the control group received no intervention. Finally, in this research, to strengthen children's perceptual-motor skills, the educational package of perceptual-motor exercises was used in 15 sessions of 45 minutes for the subjects of the intervention group.

2-1 research tools

2-1-1 perceptual-motor exercises

To evaluate the determination of the level of basic skills and educational prerequisites and the intervention program, the educational package of the country's exceptional education called "Intervention during education and rehabilitation of new students with special learning disorder" was used, in which the examples of suggested educational and rehabilitation strategies, separately checklists and compliance with the hierarchy of

educational steps are provided. The content validity of this package is approved by the experts of the country's special education organization, which is currently used in the country's special schools. The intervention program of 15 sessions used in this research is according to Table 1.

Table 1. Intervention program of 15 sessions used in this research

Time	The teaching content of perceptual-motor games	Session
45 minutes	Familiarity with the method, explanation of the purpose and necessity of intervention for parents - Familiarity of the child with the coach and the playroom	1
45 minutes	Play with directions (left, right, up, down, etc...): Example 1: By placing a notebook or a book on the table and within the child's range of vision, objects such as pencils, erasers were placed in different directions (above - below - right and left, etc.) and the child was asked to find their position to each other Example 2: The child was asked to move an object in different directions relative to the table and his body. - Playing with moving beads (Example 3: Without help, the child passed the thread through the bead. The number of beads can be increased or threaded in a specific order (according to the pattern)- Crossing over tangled lines (straight and curved lines were drawn parallel to each other on the notebook and he was asked to move through the lines with a pencil (horizontal, vertical and rotational) without touching the edges).	2
45 minutes	(Connecting similar shapes): The child was asked to connect similar shapes between the shapes inside the sheet. - (moving - standing - turning). (threading the beads according to the pattern) - giving a two-part order	3
45 minutes	Scissoring - visual completion (completing the shape) - Li Li game - touch recognition of different body parts to strengthen proprioception	4
45 minutes	Touching objects and strengthening the proprioception with the sense of touch - crossing an obstacle - jumping - using the upper hand	5
45 minutes	Recognizing polygonal shapes and copying them, game of finding objects through the sense of touch	6
45 minutes	Walking on the board - maintaining balance and standing on one leg - stacking dominoes - recognizing sounds	7
45 minutes	Recognizing the shape from the context - practice writing with the help of the sense of touch - puzzle game - scissors - word game	8
45 minutes	Visual completion - use of the non-dominant hand - pencil movement game between thumb and fingers - word game	9
45 minutes	Puzzle game - Li Li game - Scissors - draw dotted line - word game (rhyme - beginning - end)	10
45 minutes	Visual completion - playing cards - completing the word - writing the word on sand or salt	11
45 minutes	Going through the maze by touching and coloring it - playing cards to improve visual skills - playing with words	12
45 minutes	Puzzle game - moving the pencil between the lines - completing the word -	13
45 minutes	Moving-jumping-crossing the obstacle-maintaining balance	14
45 minutes	Playing dominoes, playing cards, finding similar shape	15

2-1-2 Wechsler test

To measure the subjects' visual-spatial processing, Wechsler's intelligence test (block design, symbol search, coding, and cancellation) version 4 was used. Wechsler's intelligence scales are considered as one of the most widely used individual scales of intelligence structure, which, in parallel with the Stanford-Binet intelligence scales and the Woodcock-Johnson cognitive scales, develop

an intelligence profile and provide useful information in the fields of clinical-exceptional assessment (Afrooz, Kamkari, Shekarzadeh and Helat, 2013). The Wechsler IQ test has been examined in Iran by Dr. Kamkari and Dr. Abedi, as well as exceptional education. As a result, this test has been examined in terms of adaptation, standardization, validity, and reliability and its results are acceptable (Exceptional education, 2016). The Wechsler tests have a relatively long history in the field of cognitive and intelligence evaluation. The Wechsler IQ Scale for Children (WISC-IV), published in 2003 in its fourth edition by Pearson Psychological Corporation (TPC), is a self-administered clinical instrument used to assess the intellectual ability of children aged 6 years and 0 months to 16 years and 11 months.

The theoretical foundations of the new WISC-IV structure have been compiled based on neurocognitive models in the framework of the information processing approach. According to the 4 main factors of the Verbal Comprehension Index (VCI) include the subscales of similarities, vocabulary, comprehension, information, and inference. Perceptual Reasoning Index (PRI) includes subscales of block design, picture comprehension, logical reasoning, picture completion. Working Memory Index (WMI) includes subscales of digit span, number-letter sequence, arithmetic. Processing Speed Index (PSI) includes the subscales of coding, symbol search, cancellation, and is divided into 4 total scores to show abilities in intellectual functioning or 4 cognitive domains. In this research, two factors of the perceptual reasoning index and the bloxck design subtest which requires spatial processing, visual-motor coordination and the ability to use all skills in a fast and effective manner, and the processing speed index with the subscales of coding, symbol search, cancellation of the image is used.

Designing with blocks is the main subtest in the Perceptual Reasoning Index (PRI) and has 14 items or questions. To implement all the items, it is necessary for the child to pay attention and look at the built model or the picture in the question book and reconstruct the designs using red-white blocks within a certain time limit. In the block design subtest, time management, multi-dimensional visualization and most importantly spatial visual processing are very important. In this sub-test, the subject needs visual-motor coordination and simultaneous processing by using 9 red-white-white and red blocks to recreate the target image or plan. In the block design subtest, the highest score with time points is 68 and without time points, the maximum score is 50. From the index of processing speed, coding sub-tests have two forms A and B. In the coding sub-test, the subject copies symbols that are simple geometric shapes or pairs of numbers. With the help of the provided key, the child draws each symbol in the shape related to him or the space considered for it within the prescribed time limit. The time for this test is 120 seconds. In the encryption subtest, the maximum score is 65.

Symbol search is the main subtest in the processing speed. There are two forms of symbol search A and B (form A and B were used in this research due to the age of the subjects). In the symbol search subtest, the child carefully looks at the search group, which consists of a number of symbols or figures, and declares in a certain time limit (120 seconds) whether the symbol or symbols of the target group are found in the search group or not. In the symbol search subtest, the maximum score is 45 and the minimum score is zero.

Cancellation is a supplemental subtest or reserve in the processing speed. This test was created to measure selective visual attention and is a direct measure of processing speed. The cancellation scale consists of two parts. One of them is presented randomly and irregularly and the other is organized in the form of regular rows and columns. The child images the structured and unstructured sequence of shapes and marks or lines the target shapes in each of the two mentioned sequences and within a certain time limit (120 seconds). In the subtest of tracing the picture, the child carefully looks at the pictures that are arranged regularly or irregularly and identifies the target pictures in the prescribed time.

In this sub-test, we use sample questions by explaining the tasks of the child and explaining how to do the sub-test materials, then we give the child the opportunity to do the practice question and after we are sure that the child is well familiar with how to do the sub-test, we can proceed to the implementation of question number one. The picture of animals is a goal in this sub-test and the answer sheet is drawing picture in front of the child and the child's attention is paid to the pictures of animals on the top of the page and the row of pictures of animals is shown to the child from left to right, for example point to the question of the example and say, look at this row. In this row, there are both pictures of animals and pictures of other things. I draw lines on the pictures of animals and do not draw lines on any other pictures, and the child acts like the example. In the picture drawing subtest, the irregular maximum is 68 and the regular maximum is 68, and the total score of this test is 136. Samples of all four tests are available in the attachments.

At the end, all the obtained raw scores were converted into level scores. The WISC-IV internal reliability coefficients are equal to 0.94 and for each of the factors: 0.94 for verbal understanding, 0.92 for perceptual reasoning, 0.92 for numerical memory, 0.88 for processing speed and finally 0.97 for general intelligence. The validity of the test has also been checked using the method of exploratory and confirmatory factor analysis (Keshwarzi, 2019).

2-1-3 reading test

The reading diagnostic test of Sima Shirazi and Nilipour (2011) was used to collect data. The reading diagnostic test is an individual test composed of reading texts and supplementary tests. The supplementary tests consist of several tests, including the spelling test, the letter-phoneme correspondence test, the reading test of irregular words, the reading test of non-words, and the transcription test, which are provided in the booklet of texts and cards of irregular words and non-words with the manual and the answer sheet, it forms the body of this exam. With this test, the child's reading level can be checked and if there are any reading problems, it can be analyzed and differential diagnosis can be made to a large extent by using the general history sheet. After determining the average reading speed and accuracy of the student, by using the percentile table and comparing the child's score with it and determining his percentile, it is possible to comment on the child's reading status. In this test, the average and standard deviation scores and percentiles of accuracy and reading speed are obtained separately. The validity of this test was obtained by the method of peer forms, the text of the bird was implemented and scored for 1/3 of the subjects (237 people) and its correlation was obtained with two other texts (cooperation and chicken) in terms of accuracy and reading speed. The results indicate a high correlation of reading accuracy between the two texts of chicken and bird (87%) and a very high correlation of reading speed in these two texts (94%). The method of calculating the accuracy score is the sum of errors-20 and the reading speed (number of words per minute) through (51 divided by the time in seconds multiplied by 60) (60*51/s) and the percentage of correct answers by the method (number of correct answers divided by 5 multiplying by 100 (100*number of correct answer/5) and percentage of errors are obtained by counting errors divided by total errors multiplied by 100 (100*counting errors/ sum errors).

The validity of the test is the concept of the effectiveness of the test in measuring the target variable. Therefore, in the construction of the reading texts for this test, the Persian book was the first work criterion. The list of all the words in this book was thoroughly checked with their frequency and the opinions of three first-grade teachers and three linguists were asked for these texts, and then 605 first-grade children in 20 schools from 10 regions were studied experimentally, the results showed that all three texts are appropriate.

The purpose of the reading texts test is to estimate the child's oral reading status and analyze the type of his problems. According to the scores of reading accuracy, reading speed and the child's understanding of the read material, the child's reading level can be checked. This test is composed of 3 reading

texts. Many things were considered in creating the texts, the most important of which are the story and attractiveness of the texts, the appropriateness of the number of words and the syntactic structure and semantics of each text with the age of the child and the Persian book, the diversity of words in terms of syllabic structure and occurrence rate in Persian books. It has also been tried to choose the words from the Persian book as much as possible, but use them in unfamiliar sentences and stories so that the child does not read the text based solely on the benefit of his memory. (Sima Shirazi, Nilipour, 2011)

We pay attention to the reading time in each text and record the beginning and end of each text exactly in minutes and seconds so that we can accurately calculate the reading time at the end of the text. In this test, the high and low scores for reading accuracy, reading comprehension and reading speed are as follows:

The highest reading accuracy score is calculated 20. The sum of the child's errors is counted and subtracted from the highest score, i.e. 20, and the lowest score is zero. The highest score in speed (number of words per minute) is 51, which is recorded according to time, and 51 is divided by the time the subject spent reading in seconds, and the result is multiplied by 60. The lowest score is zero; the highest score in reading comprehension is 5, that is, the number of 5 questions asked from the text, and the number of correct answers divided by 5 and multiplied by 100 to determine the percentage of correct answers of the subject. And the lowest score is zero.

3. Data analysis

3-1 Statistical description of research variables

Table 2 shows the frequency distribution and percentage of students according to groups; so that the students of the experimental group form 50% of the statistical sample and the students of the control group form 50% of it. The number of subjects in each group is 15 people.

Table 2: Frequency distribution of students by group

No. (%)	Value	Field
50	15	Experimental
50	15	Control
100	30	Total

Table 3 shows the descriptive statistics of the research variables in the pre-test and post-test.

Table 3. Descriptive statistics of research variables based on pre-test-post-test

Posttest						Pretest							Group		
kurtosis	Skewness	Maximum	Minimum	SD	Mean	kurtosis	Skewness	Maximum	Minimum	SD	Mean	Number			
1.196	0.952	61	30	9.36	42.10	0.762	0.753	50	20	7.63	32.10	15	spelling	Dictation	
-0.204	0.163	16	6	3.54	12.10	-0.093	-0.261	17.50	4	4.35	10.45	15	Reading accuracy		
-0.507	0.102	42	11	9.30	30.18	-1.324	-0.058	27	12	5.27	16.88	15	Reading speed		
-0.352	0.932	19	2	5.47	11.13	0.033	-1.810	25	2.50	7.63	14.28	15	Reading error	reading	
0.014	01.501	4	1	1.62	2.40	0.921	-0.354	4	0	1.03	1.30	15	Comprehension		experiment
-0.120	-1.432	13	9	2.25	11.20	0.113	-0.245	13	8	1.45	10	15	Symbol search		
-0.582	0.630	15	7	2.84	11.80	-0.205	-0.365	15	6	2.55	10.40	15	Coding	Visual-spatial processing	
0.195	01.202	14	9	2.49	12.10	0.163	-0.378	13	8	1.37	10.50	15	Cancellation		
0.402	1.081	14	8	1.56	10.90	0.906	-0.113	13	8	1.42	9.40	15	Block design		
0.302	0.503	70	15	14.63	38.90	1.235	0.452	68	14	16.31	35.80	15	Spelling	dictation	
0.162	-1.436	19	5	5.20	12.15	0.171	-1.632	19	4.75	5.24	11.89	15	Reading accuracy		
1.960	2.402	47.07	12	6.14	14.469	1.503	2.221	35	10.60	5.41	16.99	15	Reading speed	Reading	
0.532	2.162	25	2.35	5.79	13.14	0.603	1.325	24	5	2.89	13.39	15	Reading error		
0.175	01.302	4	0	1.31	1.60	0.789	-0.562	5	0	1.03	1.40	15	Comprehension		
-0.427	01.189	13	7	3.43	10.50	-0.404	-0.425	13	7	1.58	10.40	15	Symbol Research		Control
0.096	0.019	15	6	2.47	10.70	0.163	-0.378	15	6	2.75	10.50	15	Coding	Visual-spatial processing	
1.365	2.254	17	7	2.85	10.90	0.310	1.153	16	7	2.69	10.70	15	Cancellation		
1.412	0.485	15	7	3.13	9.70	0.582	-0.362	15	6	2.45	9.40	15	Block design		

3-2 Examining the normality of research variables

The distribution of dependent variable scores in each community should be normal. In the present study, Kolmogorov-Smirnov test was used to check this assumption. According to Table 4, in the variables of visual-spatial processing, spelling, accuracy, reading speed, reading error, and reading comprehension, a significance level of more than 0.05 was obtained; And since if the significance level in the Kolmogorov-Smirnov test is greater than 0.05, it indicates a normal distribution, so all the variables have a normal distribution. The value of the significant level regarding the variables of symbol search, coding, cancellation, block design, spelling, reading accuracy and speed, and reading error and reading comprehension is respectively (0.717, 0.732, 0.377, 0.388, 144 0.0, 0.307, 0.311, 0.525, 0.091) that this value is greater than 0.05 and is not significant. Therefore, it can be said with confidence that the condition of homogeneity of the regression slope is established to perform covariance analysis.

Table 4: Kolmogorov-Smirnov test to check the normality of research variables

Significant level	Kolmogorov-Smirnov	Mean	Number	Variable	
0.109	0.145	10.75	30	Symbol search	Visual-spatial processing
0.200	0.126	11.30	30	Coding	
0.172	0.135	10.95	30	Cancellation	
0.087	0.149	10.05	30	Block design	
0.064	0.155	40.50	30	Spelling	
0.110	0.145	12.13	30	Reading accuracy	
0.098	0.147	22.32	30	Reading speed	Reading
0.200	0.108	12.21	30	Reading error	
0.168	0.136	2.05	30	Comprehension	

3-3 Checking the assumption of correlation coefficient between dependent variables

The result of the table of correlation coefficients 5 shows that there is a significant correlation between the dependent variables. Therefore, covariance analysis is possible.

Table 5: The results of the table of correlation coefficients between dependent variables

Variable			Symbol search	Coding	Cancellation	Block design	Spelling	Reading accuracy	Reading speed	Reading error	Comprehension
Visual-spatial processing	Symbol search	Correlation coefficient									
		Significant level									
	Coding	Correlation coefficient	0.439	1							
		Significant level	0.053								
	Cancellation	Correlation coefficient	0.253	0.419	1						
		Significant level	0.282	0.066							
	Block design	Correlation coefficient	**0.672	*0.540	0.173	1					
		Significant level	0.001	0.014	0.466						
Dictation	Spelling	Correlation coefficient	*0.497	0.177	-0.184	0.350	1				
		Significant level	0.026	0.456	0.438	0.130					
Reading	Reading accuracy	Correlation coefficient	0.069	0.391	0.216	0.177	0.227	1			
		Significant level	0.773	0.088	0.360	0.454	0.336				
	Reading speed	Correlation coefficient	0.311	0.080	-0.238	0.176	0.608**	0.257	1		
		Significant level	0.189	0.737	0.313	0.457	0.004	0.275			
	Reading error	Correlation coefficient	-0.190	-0.365	0.042	-0.507**	-0.173	-0.290	-0.197	1	
		Significant level	0.422	0.113	0.861	0.023	0.466	0.215	0.406		
	Comprehension	Correlation coefficient	0.374	0.094	-0.107	0.196	0.300	-0.132	0.579**	0.048	1
		Significant level	0.104	0.693	0.655	0.409	0.199	0.579	0.007	0.842	

3-4 The results of the research hypothesis testing process

The first hypothesis: perceptual-motor exercises had an effect on the visual-spatial processing of second-grade primary school girl students with learning disorder in Tabriz.

As Table 6 shows the average of the experimental and control groups in the variables of symbol search and coding, and cancellation and block design; Also, M-box test was used to check the equality of the variance-covariance matrix of the dependent variables, the results of which are as described in Table 7:

Table 6: Descriptive statistics of visual-spatial processing components in the post-test by group

SD	Mean	Number	Group	Variable
2.25	11.20	15	Experiment	Symbol search
3.43	10.50	15	Control	
2.84	11.80	15	Experiment	Coding
2.47	10.70	15	Control	
1.49	12.10	15	Experiment	Cancellation
2.85	10.90	15	Control	
1.56	10.90	15	Experiment	Block design
3.13	9.70	15	Control	

Table 7: Box test for equality of variance-covariance matrix

Significant level	*df2*	*df1*	F	M-box test
0.406	3748.21	10	1.04	12.33

As Table 7 shows, the level of significance is greater than 0.001, after the assumption, the equality of variance-covariance matrix has not been violated and the condition of the assumption of equality of variance-covariance matrix is established to perform covariance analysis; Also, to check the hypothesis of equality of variances, Levene's test was used, the results of which are presented in Table 8.

Table 8: Levene's test to check the assumption of equality of variances

Significant level	*df2*	*df1*	F	Dependent variable
0.077	28	1	2.37	Symbol search
0.232	28	1	1.49	Coding
0.512	28	1	0.440	Cancellation
0.524	28	1	0.415	Block design

As Table 8 shows, the significance level of the variables of symbol search, decoding and block design is greater than 0.05, according to the assumption of homogeneity of variances, if the significance level is greater than 0.05, then the assumption of homogeneity of variances has been observed.

To investigate the effect of perceptual-motor exercises in improving the visual-spatial processing of primary students, to keep the effect of the pre-test scores of the visual-spatial processing score in the children of the experimental group (the group that underwent perceptual-motor exercises) and the control group (the group that did not receive any program) and their post-test scores were compared using the analysis of covariance statistical test. The results are presented in Table 9.

Table 9: The results of multivariate analysis to investigate the effectiveness of perceptual-motor exercises on visual-spatial processing components

Eta2	Significant level	Df error	Df hypothesis	F	Statistic	Test
0.403	0.000	11	4	8.10	0.393	Wilks Lambda

According to the results of Table 9, considering that the significance level is equal to 0.000 which is less than 0.05, as a result, the multivariate effect was significant, which showed that the intervention of perceptual-motor exercises was effective on visual-spatial processing components. (p>0.05).

Table 10 results of the post-test inter-group effects test by removing the pre-test effect show that there was a significant difference between the averages of the two experimental and control groups in the components of symbol search (P<0.05, F=4.82) and decoding (0.05) > P, F=4.68) and drawing (P>0.05, F=15.98) and block design (P>0.05, F=13.62). The comparison of effect sizes showed that the intervention of perceptual-motor exercises had the greatest effect on cancellation with an effect size of 0.354 and block design with an effect

size of 0.295. Therefore, statistically, a significant difference was observed between the two experimental and control groups based on perceptual-motor exercises, and perceptual-motor exercises had an effect on all four visual-spatial processing components.

Table 10: Intergroup effects of visual-spatial processing components considering perceptual-motor exercises

Eta	Significant level	F	Mean squares	df	Sum squares	Dependent variables	Model
0.141	0.038	4.82	8.65	1	8.65	Symbol search posttest	Group
0.138	0.041	4.68	4.97	1	4.97	Coding posttest	
0.354	0.001	15.98	23.36	1	23.36	Cancellation posttest	
0.295	0.001	13.62	17.49	1	17.49	Block design posttest	
			1.80	24	43.08	Symbol search posttest	Error
			1.21	24	29.09	Coding posttest	
			1.46	24	35.09	Cancellation posttest	
			1.29	24	30.84	Block design posttest	
				30	2015	Symbol search posttest	Total
				30	25.05	Coding posttest	
				30	2379	Cancellation posttest	
				30	2199	Block design posttest	

Table 11 comparing the adjusted averages of the two groups shows that the average of all the components of symbol search, coding, cancellation and block design in the control group is lower than the experimental group, so they received perceptual-motor exercises on the visual-spatial processing of students of the experimental group who received this program had an effect compared to the children of the control group who did not receive this program.

Table 11: Comparison of the adjusted averages of the two experimental and control groups

Dependent variable	group	mean	SD	Low limit	Up limit
Symbol search	experiment	11.28	0.196	1.888	11.672
	Control	10.53	0.196	10.138	10.922
coding	experiment	11.68	0.228	11.224	12.136
	Control	10.72	0.228	10.264	11.176
Cancellation	experiment	12.14	0.172	11.796	12.484
	Control	10.82	0.172	10.467	11.164
Block design	experiment	10.93	0.189	10.631	11.009
	Control	9.78	0.189	9.591	9.969

The second hypothesis: perceptual-motor exercises had an effect on the reading performance of second-grade primary school girl students with learning disorder in Tabriz.

Table 12 shows the average of the experimental and control groups in the variables of accuracy and speed and reading error and comprehension in the post-test; Also, M-box test was used to check the equality of the variance-covariance matrix of the dependent variables, the results of which are as described in Table 13:

Table 12: Descriptive statistics of reading components in the post-test by group

SD	mean	number	group	variable
3.54	12.10	15	Experiment	Reading accuracy
5.20	12.15	15	Control	
9.30	30.18	15	Experiment	Reading speed
2.14	14.47	15	Control	
5.47	11.13	15	Experiment	Reading error
5.79	13.14	15	Control	
1.62	2.40	15	Experiment	Comprehension
1.31	1.60	15	Control	

As Table 13 shows, the level of significance is greater than 0.001, after the assumption, equality of variance-covariance matrix has not been violated and the condition of the assumption of equality of variance-covariance matrix is established to perform covariance analysis.

Table 13: Box test for equality of variance-covariance matrix

Significant level	dg2	df1	F	M-box test
0.283	3748.21	10	1.20	14.27

To check the assumption of equality of variances, Levene's test was used, the results of which are presented in Table 14.

Table 14: Levene's test to check the assumption of equality of variances

Significant level	df2	df1	F	Dependent variable
0.397	28	1	0.740	Reading accuracy
0.637	28	1	0.227	Reading speed
0.529	28	1	0.407	Reading error
0.251	28	1	1.37	Comprehension

As Table 14 shows, the significance level of the accuracy and speed variables and reading and comprehension error of the block is greater than 0.05. According to the assumption of homogeneity of variances, if the significance level is greater than 0.05, then the assumption of homogeneity of variances has been observed; Finally, to investigate the effect of perceptual-motor exercises in improving the reading performance of elementary school students, to keep the effect of the pre-test scores constant, the reading performance score in the children of the experimental group (the group that underwent perceptual-motor exercises) and the control group (the group that did not did not receive a program) and their post-test scores were compared using the analysis of covariance statistical test. The results are presented in Table 15.

Table 15: Results of multivariate analysis to investigate the effectiveness of perceptual-motor exercises on reading performance

Eta2	Significant level	Df error	Df hypothesis	F	statistic	Test
0.427	0.000	21	4	9.66	0.352	Wilks Lambda

According to the results of Table 15, considering that the level of significance is equal to 0.000, which is less than 0.05 (P<0.05, F=9.66), which indicates that the research hypothesis is approved.

Table 16 results of the post-test inter-group effects test by removing the pre-test effect show that there is a significant difference between the averages of the two experimental and control groups in the components of reading accuracy (P<0.05, F=16.02) and reading speed (0.5 P>0, F=23/81), reading error (P>0.05, F=6.60) and reading comprehension (P>0.05, F=4.59). The comparison of effect sizes showed that the intervention of perceptual-motor exercises had the greatest effect on reading speed with an effect size of 0.485 and reading accuracy with an effect size of 0.364. Therefore, statistically, there is a significant difference between the two experimental and control groups based on perceptual-motor exercises.

Table 16: Intergroup effects of visual-spatial processing components considering perceptual-motor

Eta	Significant level	F	Mean squares	df	Sum squares	Dependent variable	Model
0.364	0.001	16.02	9.01	1	9.01	Reading accuracy post-test	Group
0.485	0.000	23.81	1258.42	1	1258.42	Reading speed post-test	
0.203	0.017	6.60	154.01	1	154.01	Reading error post-test	
0.132	0.047	4.59	2.383	1	2.383	Comprehension post-test	
				24	7.63	Reading accuracy post-test	Error
				24	695.210	Reading speed post-test	
				24	124.45	Reading error post-test	
				24	7.20	Comprehension post-test	
				30	3158.51	Reading accuracy post-test	

				30	13602.140	Reading speed post-test	Total
				30	1542.17	Reading error post-test	
				30	127	Comprehension post-test	

Table 17 comparing the adjusted averages of the two groups shows that the average score of accuracy, speed and reading comprehension in the control group is lower than the experimental group, so perceptual-motor exercises on the reading performance of the experimental group students who have received this program have received compared to children in the control group who did not receive this program. Also, the average reading error in the control group was higher than the experimental group, which indicated the impact of the intervention on the reading error component.

Table 17: Comparison of the adjusted averages of the two experimental and control groups

Up limit	Low limit	SD	Mean	Group	Dependent variable
13.323	12.300	0.238	12.812	Experiment	Reading accuracy
11.952	10.929	0.238	11.440	Control	
35.600	25.833	2.277	30.717	Experiment	Reading speed
9.382	18.482	2.277	13.932	Control	
12.297	10.137	0.540	11.217	Experiment	Reading error
14.279	12.119	0.540	13.199	Control	
1.967	2.835	0.217	2.401	Experiment	Comprehension
1.996	1.128	0.207	1.562	Control	

4. Discussion and Conclusion

The present study was conducted to investigate the effectiveness of perceptual-motor exercises on visual-spatial processing and reading performance in second-grade primary school girl students with learning disorder in Tabriz City; The results of the research showed that there is a significant difference between the average posttest scores of the visual-spatial processing in the students of the experimental and control groups by keeping the effect of the pre-test scores constant. Therefore, perceptual-motor exercises had an effect on the visual-spatial processing of students in the experimental group who received this program compared to children in the control group who did not receive this program. The findings of this research are consistent with the research of Shahrezaei (14) and Rousselle,& Noel (15) on the effectiveness of the intervention on children's visual-spatial perception. Amani, Fatemeh (16) in a research titled "comparison of visual memory, visual-spatial perception and visual-motor abilities of children with mathematical disabilities with normal children" showed that normal students have a higher performance in visual memory (immediate and delayed), visual - spatial perception and visual-motor abilities compared to students with disabilities. Jangu, Elham, Hemti, Babak, Jafarzadeh, Dashblag, Hassan, in a research titled "The effectiveness of play therapy on improving the speed of information processing and social/emotional processing in students with specific reading learning disorder" with a sample size of 30 people showed that play therapy has a significant effect on improving the speed of information processing and social/emotional processing in students with specific reading learning disorder.

In explaining the findings of the present study, despite the findings of previous studies and perceptual-motor theories, perceptual-motor exercises are effective on visual-spatial processing. Perhaps it can be concluded that because this group of sample students had more problems in visual-spatial perception and the number of intervention sessions (10 sessions) for training these children was low. Perhaps by increasing the sessions and increasing the number and variety of perceptual-motor exercises, as well as examining the type of children's visual-spatial problems and preparing appropriate exercises for the type of problems of these children, as well as increasing the sample size, the results would be in line with the findings of previous studies. Perhaps another reason for this inconsistency between

the results is that these students themselves had severe problems in terms of perceptual-motor skills that required many practice sessions. Also, in most of the previous researches, the number of intervention sessions was more than this number.

Also, the results of the research showed that there was a significant difference between the average scores of the posttest of reading speed and accuracy and comprehension of the students of the experimental and control groups by keeping the effect of the pre-test scores constant. The calculated effect size indicates the effect of perceptual-motor exercises. However, there was no significant difference between the average post-test scores of reading errors in the students of the experimental and control groups by keeping the effect of the pre-test scores constant; The results of the present study are consistent with the findings of Zare and Taraj (17). Therefore, considering that the deficiency in movement skills, which is one of the effective factors in dyslexia, and perceptual-motor exercises lead to the improvement and correction of motor learning, for children to achieve optimal growth in the perceptual-motor field, the best way is compiling and carrying out programs based on the science of motor development and regular perceptual-motor activities from the first years of child development, especially preschool and elementary school courses, and this can only be achieved with the efforts of psychologists, officials, experts in education, physical education and sports sciences by scientific planning and optimal implementation to improve the perceptual-motor skills of students with learning disorders.

According to the findings and research, it can be concluded that motor skills develop cognitive abilities. Without having proper perceptual-motor skills, students will not be able to read, write and perform mathematical operations at the level that regular schools require. As a result, one of the appropriate and necessary solutions for correcting and repairing the learning problems of such students is the design of a selected movement program based on the standards of education and finally the implementation of this plan in all grades of the primary education period.

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