Research Article

Comparing Sensory Processing and Perceived Motor Competence between Three Groups of Students with Special Learning Disabilities

Navid Mirzakhani Araqi[1], Zahra Pashazadeh Azari[1], Behzad Mohammadi Orangi[2], Alireza Akbarzadeh Baghban[3], Ebrahim Mahmoudi[4], Saeedeh Shahriarpour[1*]

1. Department of Occupation Therapy, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
2. Department of Motor Learning, School of Physical Education and Sport Sciences, Kharazmi University, Tehran, Iran.
3. Department of Biostatistics, Proteomics Research Center, School of Allied Medical Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran.
4. School of Physical and Occupational Therapy, McGill University, Montreal, Quebec, Canada.

Use your device to scan and read the article online

Citation: Mirzakhani Araqi N, Pashazadeh Azari Z, Mohammadi Orangi B, Akbarzadeh Baghban A, Mahmoudi E, Shahriarpour S. Comparing Sensory Processing and Perceived Motor Competence between Three Groups of Students with Special Learning Disabilities. Journal of Modern Rehabilitation. 2022; 16(3):280-289. https://doi.org/10.18502/jmr.v16i3.10152

http://dx.doi.org/10.18502/jmr.v16i3.10152

Article info:
Received: 03 Jul 2021
Accepted: 08 Aug 2021
Available Online: 01 Jul 2022

Keywords:
Specific learning disorder; Sensory processing; Perceived motor competence

ABSTRACT

Introduction: Identifying the contributing factors to a specific learning disorder and comparing these factors in different types of this disorder will lead to using more proper interventions in the future. Therefore, this study aimed to compare sensory processing skills and perceived motor competence between three groups of students with specific learning disabilities (reading and writing disorders, math disorders, and combination disorders).

Materials and Methods: The present study was a cross-sectional descriptive-analytical study. The participants were 48 children (16 in each group, aged 8-12 years). They were selected from Chaharmahal and Bakhtiari Province, Iran, by the simple convenience sampling method. The participants' sensory processing was measured with sensory profile 2 and their perceived motor competency with Marsh perceived motor competence questionnaire.

Results: The results showed a significant difference between the three groups in the sensory sensitivity, low registration sensory patterns and processing of tactile, and body position senses ($P < 0.05$). However, no significant differences were observed between groups in other components of sensory processing and perceived motor competence ($P > 0.05$).

Conclusion: The results indicate that therapeutic interventions in the group with reading and writing disorders should focus on increasing sensory registration and processing of tactile and body position senses and reducing sensory sensitivity in the mathematical group.

*** Corresponding Author:**
Saeedeh Shahriarpour, MSc.
Address: *Department of Occupation Therapy, School of Rehabilitation, Shahid Beheshti University of Medical Sciences, Tehran, Iran.*
Tel: *+98 (913) 7327586*
E-mail: *sshahriarpour2013@gmail.com*

1. Introduction

According to the Diagnostic and Statistical Manual, the Fifth Edition, the specific learning disorder (SLD) is diagnosed when the students perform poorly on standardized tests for reading, writing, and math relative to their age, education, and IQ [1]. These students often have deficits in information regulation, visual and auditory perception, memory, and attention, which leads to problems in talking, writing, reading, addition, and subtraction, as well as social, emotional, and motor issues [2, 3]. SLD also leads to disappointment, low self-esteem, and dropout [4, 5]. According to studies conducted globally among children, the prevalence of learning disorders is between 5.3% and 6% [6], and based on the Silver and Hagin study is 8.2% in male and 4.3% in female students [7]. It is also 10%-20% between Iranian students based on Jalil Abkenar (2013) study [8]. In recent years, the prevalence of this disorder in students has increased by about 38% [9] and seems to involve several other factors. Children with SLD may suffer from various cognitive and motor disabilities. But these defects are different in various dimensions, and one group of SLD children may suffer more from one defect (for example, movement) and the other from another defect (for example, sensory processing). Therefore, it is imperative to pay attention to the different groups of SLD and its associated problems in children because each problem needs specific solutions.

Learning disorders have three essential groups: reading disorder, math disorder, and written expression disorder [6]. According to the American Psychiatric Association, dyslexia is diagnosed when a student, despite his or her high cognitive ability and effective classroom experience, has difficulty in recognizing words correctly or fluently, deciphering and spelling out. Dyscalculia occurs when a student's numerical information processing, learning and performing calculations, and mathematical reasoning are deficient. Finally, in dysgraphia, a person has difficulty with correct spelling, grammar, marking, and organizing written expression [1]. In many people with writing learning disabilities, several abnormal brain processing functions are involved in auditory language processing, especially written processing and rapid reading [10, 11], and therefore reading and writing disorders are commonly seen together.

Some studies suggest that sensory processing may affect SLD, and this problem is seen in different groups of disorders [12-14]. The findings also show that perceived motor competence is low in these people. Perception and reaction of the individual in the environment depend on sensory processing and received sensory inputs [15]. According to recent research in Neuropsychology and Neuroscience, learning disorder is associated with high and low sensory processing [16]. Sensory processing is a neural process consisting of three stages: recording, regulation, and internal organization of sensory inputs. These activities occur in all organisms and are necessary for effective learning, comprehension, and function [17]. Based on sensory profile 2, sensory processing includes the sensory systems (auditory, visual, touch, movement, body position, and oral sensory processing), sensory processing patterns (sensory seeking, sensory avoidance, sensory registration, and sensory sensitivity), and the behavioral part (conduct, social-emotional and attentional responses associated with sensory processing) [18].

If a defect occurs in one or more sensory systems, it has an adverse effect on developmental, behavioral, emotional, motor, and cognitive abilities, which is known as sensory processing disorder [19]. This disorder is divided into three groups: sensory modulation disorder (sensory over-responsivity, sensory under-responsivity, and sensory seeking), sensory-based motor disorder (postural dysfunction and dyspraxia), and sensory discrimination disorder [20]. Children with learning disorders have weak ability to receive and integrate information from different senses than normal children. It can be due to two reasons: the inability to transfer information from one pathway to another perceptual pathway and the inability to integrate two perceptual pathways [21]. These children show extreme responses to sensory stimuli and process information differently than normal individuals [22]. These severe responses in school lead to sensitivity to sound, congratulation, physical contact, pictures, and words in books, which is an essential factor in worsening their learning difficulties [23].

Different types of sensory processing disorders are seen among the three groups of SLD. As shown by Basharpour's (2012) study, based on sensory profile questionnaire 1, the components of tactile sensitivity, sensory seeking, auditory information filtering, auditory-visual sensitivity, and the overall score of sensory processing vary between groups [24]. Therefore, it seems that the sensory processing disorder in different groups of learning disorders has different effects on a person's life. Recognizing these differences will help therapists identify the category with the most problems and take action to help the SLD children.

Defects in integration and sensory processing are important factors in motor problems of SLD children [25]. Based on studies, motor skills defects affect social skills, adjustment and adaptive skills, physical endurance, communicational delay, and development of language [26]. According to Delacato [2], Kephart [27], and Barsch [28], one of the main reasons for slow learning is weak motor competency. Also, in 2006, the International Committee of Learning Disorder recognized defect and delay in motor competence as one of the essential factors in learning disorder assessment [29]. In these students, proper connections between perception and movement are not formed during critical periods of development; thus, the child does not know how to communicate between the limbs and their locomotor systems [2, 30]. It means that the person has low perceived motor competence, which refers to one's self-perception in the face of motor tasks and is directly related to one's self-confidence [31]. High perceived motor competence leads to a positive self-concept in the individual [32]. Students with learning disorders are often characterized by low adaptability and negative self-concept. They often suffer from anxiety and lack of self-confidence. They blame themselves for repeated failures due to low perceived motor competence [5, 33]. However, the status of perceived motor competence is not evident among the three groups of SLD.

Based on previous studies and theoretical foundations, the three groups of SLD children have low sensory processing and motor competence. However, previous studies have examined the problems of these three groups to compare sensory processing in these students. However, not all components of sensory processing have been examined, and it is neither clear what kind of deficiency is most prevalent in each group nor is there any information about the perceived motor competence of these students. Therefore, in this study, we want to compare the three groups of SLD by considering all components of sensory processing and perceived motor competence. Therefore, by conducting this study, it is possible to predict which group has more problems, and then the therapists can work in a more specialized way.

2. Materials and Methods

The present research is a descriptive, comparative, cross-sectional study. The research was approved by Shahid Beheshti University of Medical Sciences, and the ethical code (IR. SBMU.RETECH.1399.894) was obtained from the Ethics Committee of this university, and then informed consent was taken from the students' parents.

Study subjects

The study population consisted of 48 students with SLD that are selected by the simple convenience sampling method. Then, they were divided into 3 groups of "reading and writing disorders (dictation)," "math disorder," and "composition disorder." They were referred to the Learning Disorder Centers of Exceptional Education in Chaharmahal and Bakhtiari Province, Iran, in the academic year 2020-2021. Then, the diagnostic test of Wechsler intelligence test of exceptional education organization or Stanford-Binet intelligence test was performed on them. Considering the type I error of 5%, the type II error of 20% (test power 80%), and the size effect of 0.48, the sample size was determined using PASS software v. 11.

The inclusion criteria were as follows: aged 8-12 years, diagnosis of a learning disorder in the form of reading and writing disorder (dictation), math disorder and composition disorder based on assessment and student educational file, lack of any other disorders such as attention deficit hyperactivity disorder and developmental coordination disorder based on student health record at school, and lack of any vision and hearing problems based on student health record at school.

Study questionnaires

Sensory profile 2 (children form)

This questionnaire is a standardized tool for measuring children's sensory processing abilities at home and community, which was designed and developed by Dunn in 2014. It can be used for the age range of 3-14 years [34]. The questionnaire is scored on a 5-point Likert scale (almost always, often, sometimes, rarely, seldom) and has different sections (sensory seeking, sensory sensitivity, sensory avoidance, sensory registration, auditory processing, visual processing, touch processing, movement processing, body position processing, oral processing, conduct, social-emotional and attentional responses associated with sensory processing). The tool has five cut-off points that include "much less than others," "less than others," "similar to others," "more than others," and "much more than others." The scores are calculated for each section separately, each with its points [34]. Shahbazi prepared the Persian version of this questionnaire in 2021, and the alpha coefficient for different parts of this test was in the range of 0.67-0.91, and the intra-class correlation coefficient was in the range of 0.72-0.95, indicating very good stability of scores in the first and second positions [35].

Marsh perceived motor competence questionnaire

Marsh prepared this questionnaire in 1992 to measure the self-perception of girls aged 8-12 years [36]. Bahram and Shafizadeh evaluated its reliability in Iran in 2004 [37], which was 0.73. Also, the content validity ratio and content validity index of the items were calculated to be ≥ 87% and ≥ 75%, respectively. This questionnaire has 9 questions, with scores from 1 to 5, with 1 indicating the lowest perceived motor competence and 5 indicating the highest. Its total score ranges between 9 and 45. The tool measures children's and adolescents' perceived motor competence [37].

Data analysis

Raw data were extracted for statistical operations. First, the normality of data distribution was demonstrated using the Kolmogorov-Smirnov test. Then, an analysis of covariance (ANCOVA) was used to compare the three groups after eliminating the differences and adjusting the confounding effect of the age variable. In the next step, the Tukey method was used to compare different variables between groups in pairs.

3. Results

The Kolmogorov-Smirnov test showed that the data have a normal distribution (P> 0.05). The mean and standard deviation of the age of the three groups of reading and writing (dictation), mathematics, and composition are presented in Table 1.

According to the ANOVA test results, there was a significant difference between the three groups regarding age (P=0.000, F=12.178). Therefore, ANCOVA was used to eliminate these differences and adjust for the confounding effect of age.

In this study, we considered sensory processing, sensory systems, and patterns of sensory and behavioral parts. The sensory systems include auditory, visual, touch, movement, body position, and oral processing. Sensory patterns included sensory seeking, sensory avoiding, sensory sensitivity, and sensory registration and the behavioral part included conduct, social-emotional and attentional responses associated with sensory processing. Based on the results of the ANCOVA test in the sensory part, there was a significant difference between the three groups in touch processing (P=0.002, F=7.288) and body position processing (P=0.010, F=5.147). But the differences in auditory processing (P=0.113, F=2.291), visual processing (P=0.190, F=1.725), movement processing (P=0.596, F=0.523), and oral processing (P=0.084, F=2.623) were not significant.

Also, in terms of sensory patterns, there was a significant difference between the three groups in sensory sensitivity (P=0.012, F=4.889) and sensory registration (P=0.003, F=6.757). But no significant differences were observed in sensory seeking (P=0.293, F=1.260) and sensory avoidance (P=0.056, F=3.079). In the behavioral part, none of the variables including conduct responses related to sensory processing (P=0.241, F=1.469), social-emotional responses related to sensory processing (P=0.105, F=2.370) and attention responses related

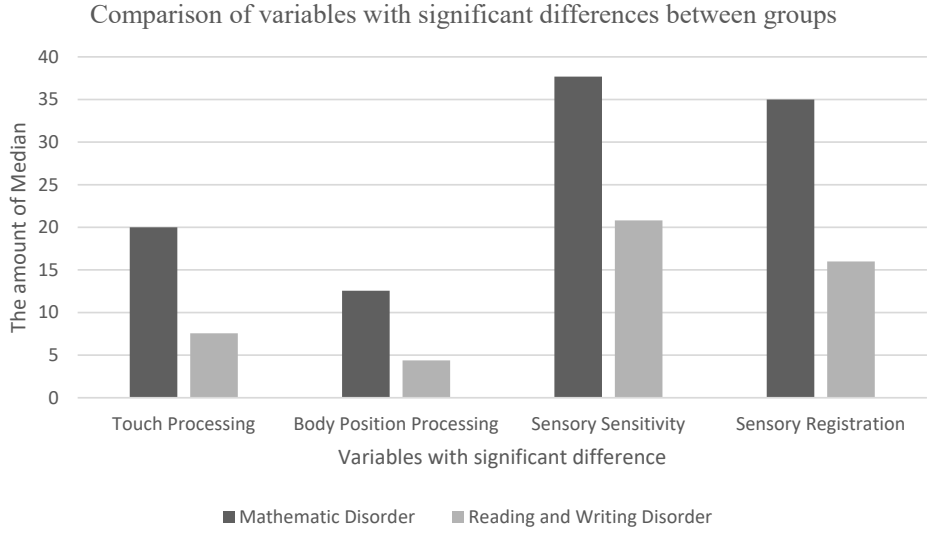

Figure 1. The average value of variables with significant differences between the two groups of mathematics and reading and writing

Table 1. Mean±SD of subjects' age (y) in all groups

Learning Disorder Group	Mean±SD
Reading and writing (dictation)	8.20±0.566
Mathematic	9.81±1.109
Composition	9.50±1.155

JMR

to sensory processing (P=0.073, F=2.781) showed no significant differences between the three groups. Also, no significant difference was observed between the three groups in the perceived motor competence variable (P=0.921, F=0.082).

Table 2 presents the results of the Tukey test for the variables whose differences were significant. As is evident in the variables of touch processing (P=0.001) and body position processing (P=0.008), the differences are significant between the two groups of mathematics and reading and writing (dictation).

Also, in terms of sensory processing patterns, the sensory sensitivity (P=0.010) and sensory registration (P=0.002) variables are significantly different between the two groups of mathematics and reading and writing (dictation) (Figure 1).

According to Figure 1, in the sensory systems, processing the two senses of body position and touch, and in the patterns of sensory processing, the two patterns of sensory sensitivity and low sensory registration are seen more in the mathematical group and less in the reading and writing group (dictation).

4. Discussion

This study aimed to compare sensory processing and perceived motor competence among three groups of students with SLD (reading and writing, math, and composition).

The results of the present study showed that in sensory systems, the two senses of touch and body position processing, and in the sensory patterns processing, sensory registration and sensory sensitivity are significantly different between the three groups of reading and writing

Table 2. Tukey test results for comparison between the three groups

Dependent Variable	Disorder 1	Disorder 2	MD	SE	Sig.
Touch processing	Mathematics Disorder	Reading and writing (dictation) disorder	12.438	3.283	0.001
		Composition disorder	7.563	3.283	0.066
	Reading and writing(dictation) disorder	Composition disorder	-4.875	3.283	0.308
Body position processing	Mathematics Disorder	Reading and writing (dictation) disorder	8.188	2.611	0.008
		Composition disorder	2.563	2.611	0.592
	Reading and writing(dictation) disorder	Composition disorder	-5.625	2.611	0.090
Sensory sensitivity	Mathematic Disorder	Reading and writing (dictation) disorder	16.875	5.475	0.010
		Composition disorder	5.938	5.475	0.529
	Reading and writing (dictation) disorder	Composition disorder	-10.938	5.475	0.124
Sensory registration	Mathematic Disorder	Reading and writing (dictation) disorder	19	5.261	0.002
		Composition disorder	12.625	5.261	0.053
	Reading and writing (dictation) disorder	Composition disorder	-6.375	5.261	0.453

Abbreviations: MD, median; Sig., significance.

JMR

(dictation), mathematics, and composition. These variables were seen more in the group of mathematical disorder than in the group of composition disorder and in the group of composition disorder were more than in the group of reading and writing (dictation) disorder. Of course, the differences between mathematics and reading and writing (dictation) groups are significant, and the variances among composition and other groups are not. Also, in the behavioral part of sensory processing and perceived motor competence, no significant difference was observed between the three groups.

So far, few studies have compared cognitive, physical, and psychological variables between different types of learning disorders. However, such studies focus their interventions on the specific problem in each disorder and may result in faster and more valuable results. In this regard, Basharpour et al. (2012) compared sensory processing between the three groups of reading and writing disorders, mathematics, and composition. They reported a significant difference between the three groups consistent with the present study. However, in their study, touch sensitivity was higher in the reading and writing disorder group and lower in the mathematical group than in the other two groups. Auditory information filter and visual/auditory sensitivity were also significantly lower in the reading and writing disorder group than in the mathematic disorder group. However, in our study, the processing of touch and body position senses and the pattern of sensory registration were less in the reading and writing (dictation) group and more in the mathematical group than in the other two groups. These differences can be attributed to cultural differences in the study populations or measurement tools [24].

The tactile system plays a vital role in physical, mental, and emotional behaviors, and tactile processing is necessary not only for visual differentiation, motor planning, and body awareness but also for academic learning, emotional security, and social skills [38]. Process discretion and low response in the sense of touch cause the person to experience low body awareness and are unaware of the touch until the tactile stimulation is severe. This condition causes physical harm to self, other people, and animals without realizing it [38]. Body position processing also requires a proprioceptive sense, which its function is to increase the body's awareness of motor control and motor planning. This sense helps us trust our bodies and feel safe and comfortable [38]. Improper proprioceptive processing causes a person to have difficulty in touch, balance, body and mouth movements, and to rely on objects and people or deal with them constantly due to incoherence. It also has dyspraxia and is more attached to familiar tasks, and avoids new challenges [38]. Somatosensory systems, especially tactile and proprioception, help perform movements, and interaction of the tactile system with movement affects movement control [39].

Since writing is a mechanical act, measuring the motor system predicts dictation ability [40] and two proprioception and vestibular senses are necessary for optimal movement. Also, the writing skill needs visual perception, memory, visual-motor coordination, body position sense, proper physical strength, and eye-hand integration [41]. It is noteworthy that reading learning has a strong relationship with writing ability [42]. The reading performance also requires visual attention and visual processing, and teaching visual perception skills improves the reading performance of dyslexic students [43, 44]. It can now be said that the set of skills of visual perception, perception of body position, necessary strength, and skill of hand and eye-hand integration requires the integration of senses, including touch, visual, proprioception, and vestibular. Because of the defects in these senses, in the group with reading and writing (dictation) disorders, the decrease in touch processing and body position was more than in the other two groups with disorders.

Since the composition group has a set of reading and writing (dictation) and mathematic disorders, there are more problems than the group with a mathematic disorder in terms of situational responses, muscles tone adjustment, eye movements, crossing the midline of the body, coordination, and discrimination of the two sides of the body, growth and movement coordination and considering that the set of these capabilities requires the integration of the three underlying senses of vestibular, proprioception, and tactile [45]. So, predictably, the processing of touch and body position in the mathematical disorder group is more than in the composition group, but the difference is not significant.

Low sensory registration in people with reading and writing (dictation) disorders compared to the other two groups can be attributed to the high sensory threshold and inactivity of the person's response, which is associated with a slow response that requires more time to respond [46]. In fact, with a decrease in sensory registration, the level of arousal is much more fluctuating than normal and has severe oscillations toward over-responsibility or under-responsibility [47]. Because of this problem, a student with reading and writing (dictation) disorder often seems inattentive in the classroom and needs intense stimulus to become aware of the environment, such as the teacher's loud noise or hitting the desk and

blackboard or teacher's touch that causes consciousness along with increasing anxiety [48].

Students with a combination of two or three learning disorders have poor memory and attention ability [49], and given that low sensory registration along with high sensory threshold and lack of attention to stimulus, the composition group that has a set of mathematic, reading, and writing (dictation) disorders, shows a lower rate of sensory registration than the group with mathematic disorders. However, the difference is not remarkable.

Sensory sensitivity was another different processing pattern between the three groups, which was observed more in the mathematic disorder group and less in the reading and writing disorder group. According to Dunn's 4-factor model, people with a mathematics disorder have a low sensory threshold that makes them more vulnerable to stimuli and causes them to react more and become more aroused. Therefore, these people tend to pay attention to any environmental stimuli in the classroom and lose their focus with the least amount of stimuli. These results are interpreted so that in these students, with increasing sensory sensitivity, emotional self-regulation is faced with difficulty and lack of response inhibition leads to anxiety and depression [50].

It is noteworthy that math disorder is associated with selective attention [51]. People with this disorder have fundamental problems in cases such as verbal problem solving, recognizing obvious information in problems, using self-regulatory and monitoring strategies, and maintaining attention until the end of the task [52]. Selective attention refers to two aspects, focusing on one source of information and ignoring others [53]. It should be noted that high sensory sensitivity causes distraction because the sensory threshold is low, and any stimulus, even with low intensity, draws attention and reduces the focus ability. That is why the composition group with a set of math, reading, and writing disorders, experiences a higher degree of sensory sensitivity than the group with reading and writing (dictation) disorder; of course, it is not considerable.

The lack of differences in variables such as auditory, visual, movement, and oral processing and sensory seeking and avoidance patterns between the three groups indicates that sensory processing problems are similar in some factors in all three groups, and programs and interventions should be considered due to the differences raised in the above for all three groups. On the other hand, perceived motor competence was another variable considered in this study, and the results showed no difference between the three groups. According to studies [54], learning disorder is associated with low motor competence, and based on the study results, which did not show a significant difference between the three groups of disorders, perceived motor competence is a major problem in people with a learning disorder that needs special attention in all groups. Motor competence, whether real or perceived, is related to cognitive, psychological, and physical factors, and according to Stoden (2008) [55] and Harter's (1996) [56] models, motor competence by promoting one's self-esteem leads to activity continuing that is helpful for health, avoiding obesity and isolation, and most importantly for a better understanding of the situation and perception of movement. It can be said that improving motor competence helps a person perceive the situation and perform the right movement, which requires proper sensory processing. In this regard, motor competence and sensory processing are related, and perhaps trying to improve motor competence will improve sensory processing in these people, because the correct image of a person of ability and competence, puts the person in the right position to make decisions, focus, receive the right sense and attention and finally the appropriate sensory processing, which is suitable for problem solving of people with learning disorder.

Therefore, it is better to use a set of sensory integration interventions in the group with reading and writing (dictation) disorder to improve touch processing and body position and increase sensory registration to reduce their learning difficulties.

In general, among children with SLD, there is a decrease in tactile processing and body position and a low sensory registration pattern in the group with reading and writing (dictation) disorders, which strongly affects the performance of these people. Also, often a high rate of stimuli, especially tactile and proprioception stimuli, are needed in the form of sensory integration interventions to achieve good physical and motor control and better learning. In addition to specific sensorimotor interventions to promote the specific problems of each disorder, combined interventions to promote other factors, especially perceived motor competence, help reduce the problems of children with a learning disorder.

The strength of this study is comparing sensory processing and perceived motor competence between the three groups of SLD. As a result, motor or other interventions require particular expertise for each disorder, and even different groups of a disorder in various items require special interventions to reinforce a particular problem. One of the limitations of this study was that

the instrument used to measure sensory processing was sent to parents. Therefore, participants may have difficulty understanding the questions, but by constantly calling and explaining each item, the researchers tried to solve this problem. Due to the epidemic situation and the prevalence of COVID-19 disease, access to the samples was difficult. Therefore, it was impossible to match the groups regarding gender, age, demographic variables, socioeconomic classes, and parent-related variables. We also tried to eliminate the differences between the groups by using appropriate statistical tests. Finally, because the specific sample was selected from Chaharmahal and Bakhtiari Province, and there may be specific cultural differences, the generalization of the results to other geographical areas should be made with caution.

Other limitations that should be considered in future studies are the type of learning disorder. The absence of other disorders was determined based on the information in the educational file, but it is better to use specific tests in future studies to diagnose these cases. The study should be performed in the broader population and longitudinally for several years to achieve better and more accurate results. Given that students often show reading and writing (dictation) disorders together and individuals with separate writing (dictation) disorders did not reach the quorum for research, it is suggested that the sensory processing of students with writing (dictation) disorders be measured separately. It is also suggested to study and compare the sensory processing abilities of the two groups of girls and boys in other sections as well as in the population of students with visual and hearing impairments.

In general, the results of this study show that learning disorders in different items have various problems in sensory processing, which requires particular interventions for each disorder. Also, considering that there is no significant difference between the groups in motor competence, it needs to be reinforced in all groups of learning disorders, and this issue is related to motor interventions. Because motor competence shows the most variability with motor interventions, and motor competence is related to various cognitive, physical, and psychological factors, other problems may be solved with motor interventions. However, this result comes from the heart of this fundamental study, which must be confirmed by experimental research.

Ethical Considerations

Compliance with ethical guidelines

The research project was ethically approved by Shahid Beheshti University of Medical Sciences (IR. SBMU. RETECH.1399.894). The students' parents were informed about the purpose and benefits of the research then they signed the written content. Also, they were allowed to leave the study whenever they wanted, and if desired, the research results would be available to them.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Data collection and writing the original draft: Saeedeh Shahriarpour, Alireza Akbarzadeh Baghban, and Ebrahim Mahmoudi; Review, editing, and supervision: Behzad Mohammadi Orange, Navid Mirzakhani Aragi, and Zahra Pashadeh Azari.

Conflict of interest

The authors declared no conflict of interest.

References

[1] American Psychiatric Association. Diagnostic and statistical manual of mental disorders. Virginia: American Psychiatric Association; 2018. [Link]

[2] Gerald W, Loughlin MC. Learning disabilities: concepts and characteristics [N. Monshi Tosi, Persian Trans]. Mashhad: Institute Press Astan Quds Razavi; 1990. [Link]

[3] Ganji M. Pychopathology according to DSM-V. Tehran: Nashre sokhan Published; 2013.

[4] Rafei H, Rezai F. Copeland-Sadok (Psychiatry abstract). Tehran: Arjmand Published; 2006.

[5] Kathlyn L. Read learning disorder. quick reference to occupation therapy. Austin, TX: Pro-ed; 2001. [Link]

[6] Rayner K, Pollatsek A, Ashby J, Clifton C. Psychology of reading. New York: Psychology Press; 2012. [DOI:10.4324/9780203155158]

[7] Silver AA, Hagin RA. Disorders of learning in childhood. New York: Wiley; 2002. [Link]

[8] Jalilabkenar S, Ashori M. [The applications for teaching students with learning disabilities (impairments in reading, writing and spelling (Persian)]. Special Education. 2013; 13(3):31-40. [Link]

[9] Jin Chang G. Emotional disorders and learning disabilities in primary classes [M. Narimani, N. Noorani Degarmandrogh, Prsian Trans). Ardebil: Nik Amooz ; 2002. [Link]

[10] Bogon J, Finke K, Schulte-Körne G, Müller HJ, Schneider WX, Stenneken P. Parameter-based assessment of disturbed and intact components of visual attention in children with developmental dyslexia. Developmental Science. 2014; 17(5):697-713. [DOI:10.1111/desc.12150] [PMID]

[11] Wolf M, Bowers PG, Biddle K. Naming-speed processes, timing, and reading: A conceptual review. Journal of Learning Disabilities. 2000; 33(4):387-407. [PMID]

[12] Solan H, Groffman S. Understanding and treating developmental and perceptual motor disabilities. The treatment and management of children with learning disabilities Springfield, IL: CC Thomas, l9S2: I68-217. 1982. [Link]

[13] Dunn W, Bennett D. Patterns of sensory processing in children with attention deficit hyperactivity disorder. OTJR: Occupation, Participation and Health. 2002; 22(1):4-15. [DOI:10.1177/153944920202200102]

[14] Ayres AJ. Sensory integration and praxis tests (SIPT). Oregon: Western Psychological Services (WPS); 1996. [Link]

[15] Eskandari B, Pouretamad H, Habibi Asgar Abad M, Mazaheri Tehrani M. [The effectiveness of interventional sensory processing styles on increasing parent self-efficacy and parent-child relationship in children with autistic spectrum disorder (Persian)]. Journal of Except Education. 2016; 1(138):14-21. [Link]

[16] Jerome EM, Liss M. Relationships between sensory processing style, adult attachment, and coping. Personality and Individual Differences. 2005; 38(6):1341-52. [DOI:10.1016/j.paid.2004.08.016]

[17] Brown T, Morrison IC, Stagnitti K. The convergent validity of two sensory processing scales used with school-age children: Comparing the sensory profile and the sensory processing measure. New Zealand Journal of Occupational Therapy. 2010; 57(2):56-65. [Link]

[18] Dunn W. Child sensory profile–2 user's manual. Bloomington, MN: Pearson. 2014. [Link]

[19] Ahn RR, Miller LJ, Milberger S, McIntosh DN. Prevalence of parents' perceptions of sensory processing disorders among kindergarten children. American Journal of Occupational Therapy. 2004; 58(3):287-93. [PMID]

[20] Machado, Ana Carolina Cabral de Paula. Sensory processing during childhood in preterm infants: a systematic review. Revista Paulista de Pediatria, 2017, 35: 92-101. [Link]

[21] Mansurnejad Z, Kajbaf MB, Molavi H. [The effetiveness of fernald's multi- sensory training on dysgraphia and dictation in second grade primary students (Persian)]. Journal of Social Psychology (New Findings in Psychology). 2012; 7(24):99-111. [Link]

[22] Armstrong S, Nicolson R. Sensory processing profile of children and adults with learning difficulties. InPoster session presented at: British Dyslexia Association International Conference. February 2018, United Kingdom. [Link]

[23] Jagiellowicz J, Xu X, Aron A, Aron E, Cao G, Feng T, et al. The trait of sensory processing sensitivity and neural responses to changes in visual scenes. Social Cognitive and Affective Neuroscience. 2011; 6(1):38-47. [DOI:10.1093/scan/nsq001] [PMID] [PMCID]

[24] Basharpoor S, Issazadeghan A, Ahmadian L. [The deficits of sensory information processing in childrenwith learning disabilities. (Persian)] Journal of Learning Disabilities. 2012; 2(1):25-42. [Link]

[25] Kinnealey M, Miller L. Sensory integration. Learning Disabilities In: Willard and Spackman's Occupational Therapy Eds HL Hopkins, HD Smith JB Lippincott Co. Philadelphia. 1993:474-89. [Link]

[26] Aqdassi L, Sadeghi S, Pouretemad HR, Fathabadi J. A Family-based telerehabilitation program for improving gross motor skills in children with high functioning autism spectrum disorder. Journal of Modern Rehabilitation. 2021; 15(3):173-82. [DOI:10.18502/jmr.v15i3.7738]

[27] Shabani M. [Growth and motor development (Persian)]. Shahrod: Bonyane-e-lome Tehran; 2003. [Link]

[28] Sharifi Daramadi P. [An introduction to the education of exceptional incapable children of theory to practice (Persian)]. Tehran: Ravan Sanji; 2001. [Link]

[29] Rostami S, Hemayattalab R, Sheikh M. Effect of a selective physical training on development of fine motor skills in students with learning disability. International Journal of Sport Studies. 2015; 5(11):1227-33. [Link]

[30] Sadati Firoozabadi S, Abasi S. [The effectiveness of sensorimotor integration in improving motor skills in students with learning disabilities (Persian)]. Motor Behavior. 2017; 8(26):105-18. [Link]

[31] Goodway JD, Ozmun JC, Gallahue DL. Understanding motor development: Infants, children, adolescents, adults. Boston, MA: mcgraw-hill; 2012.

[32] Poulsen AA, Desha L, Ziviani J, Griffiths L, Heaslop A, Khan A, et al. Fundamental movement skills and self-concept of children who are overweight. International Journal of Pediatric Obesity. 2011; 6(2-2):e464-71. [PMID]

[33] Ludwing VH. What is nonverbal learning disability? The Exceptional Parent. 2004; 34(8):49-52.

[34] Dunn W. Sensory profile 2. United States of America: Pearson Institute; 2014.

[35] Shahbazi M, Mirzakhany N, Alizadeh Zarei M, Zayeri F, Daryabor A. Translation and cultural adaptation of the Sensory Profile 2 to the Persian language. British Journal of Occupational Therapy. 2021; 84(12):794-805. [DOI:10.1177/0308022621991768]

[36] Marsh HW. Content specificity of relations between academic achievement and academic self-concept. Journal of Educational Psychology. 1992; 84(1):35-42. [DOI:10.1037/0022-0663.84.1.35]

[37] Shafizade M, Bahram A. Determine the validity and reliability of self-concept questionnaire and study the factors af-

fecting it in students of different educational levels in Tehran. Ministry of Science and Research Publications. 2004; 2:45-51.

[38] Kranowitz CS. The Out-of-sync child has fun, revised edition: Activities for Kids with Sensory processing disorder. New York: Penguin Publishing Group; 2006. [Link]

[39] Taub E. Movement in nonhuman primates deprived of somatosensory feedback. Exercise and Sport Sciences Reviews. 1976; 4:335-74. [DOI:10.1249/00003677-197600040-00012] [PMID]

[40] Berninger VW. Understanding the" Graphia" in Developmental Dysgraphia: A Developmental Neuropsychological Perspective for Disorders in Producing Written Language. 2004. [Link not found]

[41] Abdulkarim WF, Abdulrauf MS, Elgendy AA. The effect of a multi-sensory program on reducing dyspraxia and dysgraphia among learning disabled students in Rafha. Journal of Educational Sciences and Psychology. 2017; VII(1):51-65. [Link]

[42] Tan LH, Laird AR, Li K, Fox PT. Neuroanatomical correlates of phonological processing of Chinese characters and alphabetic words: A meta-analysis. Human Brain Mapping. 2005; 25(1):83-91. [DOI:10.1002/hbm.20134] [PMID] [PMCID]

[43] Talcott JB, Witton C, Hebb GS, Stoodley CJ, Westwood EA, France SJ, et al. On the relationship between dynamic visual and auditory processing and literacy skills; Results from a large primary-school study. Dyslexia. 2002; 8(4):204-25. [DOI:10.1002/dys.224] [PMID]

[44] Same Siahkalroodi L, Alizadeh H, Kooshesh M. [The impact of visual perception skills training on reading performance in students with dyslexia (Persian0]. Advances in Cognitive Science. 2009; 11(2):63-72. http://icssjournal.ir/article-1-40-en.html

[45] Szmalec J. Effectiveness of sensory integration dysfunction in children with learning difficulties. Prima Educatione. 2019; 3:121-9. [DOI:10.17951/pe.2019.3.121-129]

[46] Brown C, Tollefson N, Dunn W, Cromwell R, Filion, D. Adolescent/adult sensory profile. London: Pearson; 2002. [DOI:10.1037/t56705-000]

[47] Mahmoudi E, Mirzakhany N, Tabatabaee SM, Fallah S, Shahbazi M. The relationship between sensory processing disorder and quality of sleep in children with autism spectrum disorder and learning disorder from 6 to 14 years' old. Journal of Clinical Physiotherapy Research. 2019; 4(3):e18. DOI:10.22037/jcpr.v4i3.29465]

[48] Dove S, Dunn W. Sensory processing in students with specific learning disabilities: Findings and implications for assessment and intervention planning. Journal of Occupational Therapy, Schools, & Early Intervention. 2008; 1(2):116-27. [DOI:10.1080/19411240802312798]

[49] Rajabi S, Pakizeh A. [A comparison of the memory and attention profiles of students with and without learning disabilities (Persian)]. Journal of Learning Disabilities. 2012; 1(3):63-84. [Link]

[50] Sadoughi Z, Vafaei M, Rasoulzadeh SK. [The association of sensory-processing sensitivity with parenting styles and indices of psychopathology (Persian)]. Advances in Cognitive Science. 2007; 9(1):23-32. [Link]

[51] Tafti MA, Boyle JR, Crawford CM. Meta-analysis of visual-spatial deficits in dyslexia. International Journal of Brain and Cognitive Sciences. 2014; 3(1):25-34. [Link]

[52] Pedrotty D. Math disability in children: An overview [Internet]. 2010 [Updated 2010 July 20]. Available from: [Link]

[53] Naemi AM. Developmental psychology (1) developments from fertilization to the end of childhood. Sabzevar: Shariatifar Publisher; 2017.

[54] Bruininks VL, Bruininks RH. Motor proficiency of learning disabled and nondisabled students. Perceptual and Motor Skills. 1977; 44(3 Pt 2):1131-7. [PMID]

[55] Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C, et al. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Quest. 2008; 60(2):290-306. [DOI:10.1080/00336297.2008.10483582]

[56] Harter S. The development of self-representations. In: Damon W, Eisenberg N, editors. Handbook of child psychology: Social, emotional, and personality development. New York: John Wiley & Sons, Inc;1998. [Link]