

Identification of difference of working memory and sensory processing styles in boys and girls with writing-learning disorder

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Abstract

Context: The main problems of children with learning disorder are in memory and their sensory processing and it causes children's academic performance not appropriate.

Aims: The aim of this study is to investigate of difference of working memory and sensory processing styles in boys and girls with writing-learning disorder.

Settings and Design: This was a descriptive and analytic study in the summer of 2018 at a learning disorders center in Gorgan City, Iran.

Materials and Methods: The study population was all girls and boys by the age of 8–10 years suffering from the writing-learning disorder. The available sampling method was used and 44 boys and 36 girls were chosen. The Dunn profile was obtained from the parents of the children. Daneman and Carpenter working memory, questions were asked from the children directly, and the information related to processing and storage in their memory were received. Furthermore, a demographic questionnaire was used.

Statistical Analysis Used: Data were analyzed using in descriptive statistics (mean, standard deviation, and frequency), independent *t*-test, and multivariate analysis of variance.

Results: There was a significant difference in the writing learning disorder among processing ($P < 0.006$) and storage ($P < 0.000$) of working memory subscales and the indoctrination associated with the physical state of the body motion ($P < 0.000$), multisensory processing ($P < 0.000$), and auditory processing ($P < 0.002$), of the sensory processing styles variable in both the girls and boys.

Conclusions: With regard to the results obtained, it can be concluded that the boy's group is in worse conditions in working memory and sensory processing styles, which requires special attention and more focused educational approaches.

Keywords: Sensory processing styles, Working memory, Writing learning disorder

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INTRODUCTION

Learning disorder is defined as a neurobiological disorder in cognitive processing like memory and language that is created due to brains' abnormal function and can disturb the educational function.^[1] In recent years, learning disorder including writing one is recognized as a type of learning disorder with regard to its increasing learning.^[2] Writing learning disorder is a structural and cognitive one that disturbs the individual in attaining cognitive processing skills in learning in the form of writing.^[3] Such type of disabilities will be distinguished at the time when the child's writing achievement at standardized test is less than their intelligence and education.^[4] The recent researches indicate that the weakness of the children with learning disorders in effective memory and encoding processes is more than attention or long-term memory.^[5] On the other hand, the individual's perception and reaction as to the education environment depend on sensory processing and his/her obtained inputs.^[6] If the sensory processing level is normal, then the child will be quiet, conscious, concentrated and ready to play and learning.^[7] The studies have shown that the sensory processing style is an important factor and disorders such as: hyperactivity, obsession, and sleeping disorders is related to high sensory processing and illnesses such as: anxiety, depression and stress is related to low sensory processing.^[8,9] On the other hand, learning disorders relates to high and low sensory processing.^[10] The children with sensory processing problems face the problems at school such as sensitivity to sound, crowd, physical touch, pictures, and books' words which is an important factor in more deficiency in learning problems^[11] and these beguiled inputs obtained from the environment disturbs the storage of basic information in memory.^[12] Working memory includes registered information at permanent memory that are currently in fully active state and involves the cognitive and underlying process of learning related to the information storage in mind and their recovery.^[13] The working memory denotes all temporary information that the individual has access to at any times.^[14] In addition, some studies have shown that it plays a significant role in learning disabilities.^[15]

The difference in brain processing of the individuals with learning disorder expresses some deficiencies in left semi-sphere,^[16] the children with learning disorder have a clear disorder in working memory.^[17] Processing rate, environmental inputs processing, and working memory could be mentioned among the cognitive factors contributing to the writing-learning disorder.^[18] There is a difference between the working memory in children with learning disorder based on the role of age and sex.^[19,20] There

is a relationship between motion and sensory coordination with working memory and there is a difference between girls and boys with writing disorder.^[21] In children with the writing-learning disorder, the girls' working memory was better than the boys' one.^[22] Some studies show that the intensity of working memory deficiency impacts on the background of learning disorder type in addition to paving the way for creating disorder in children.^[23,24] That there is a difference in the combination of processing sight and hearing senses between female and male children with learning disorder.^[25] Some studies revealed that a series of abnormal functions of brain processing are diagnosed that play a role in linguistic-auditory processing, especially quick reading and writing processing.^[26,27] Materials processing and quick automatic calling are two core processes that predict writing skills.^[28] Some individuals with learning disorders have structural differences in the brain's visual systems with common individuals.^[29,30]

Previous studies have investigated the difference in sensory processing in people with learning disabilities, but so far the research has not investigated the differences in sensory processing styles among girls and boys with learning disorder. Furthermore, previous studies have addressed the overall difference in the working memory of girls and boys with learning disorder, but the present study examines the dimensions of working memory, including processing and storage. In total, since memory abilities and sensory processing for effective response to situations, learning facilitation, social behavior, and daily functions of the individual are important, an investigation into working memory deficiencies and sensory processing styles in children with writing-learning disorder seem necessary both to better cognition of neuropsychological attributes of these individuals and to design efficient treatment methods with regard to comparing the gender, hence, paying attention to the above cases was the main goal of the present research is the identification of difference of working memory and sensory processing styles in boys and girls with writing-learning disorder.

MATERIALS AND METHODS

This was a descriptive-analytic study in the summer of 2018. This research was registered with the Institutional Ethics Code IR.IAU.AK.REC.1397.011 at Bandar Gaz Branch of Azad University.

The study population consists of all girls and boys aged between 8 and 10 suffering from writing disability in Gorgan City who were treated in a writing disability center. They were 150 individuals (69 boys and 81 girls).

According to the Cochran formula (using 5% error and 95% confidence) and also based reported a prevalence of learning disorder in boys (8.2%) and girls (4.3%),^[31] and taking into account this proportion of the percentages obtained in the Cochran formula, So 44 boys and 36 girls were selected by available sampling method.

The criteria for entering the research include: learning disability in boys and girls aged 8–10 years, the absence of psychiatric disorders along with the diagnosis of a psychiatrist based on the DSM-5 (The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition) criteria, completing the informed consent form for participation in the research by parents, and the exclusion criteria include incomplete completion of the study tools.

After explaining the research goals and the manner of cooperation of the individuals, the informed consent form was obtained from them. According to the research tools, Dunn profile (1999) was received from parents of children aged 8–10 years old, and in working memory tools area, the questions were asked directly from the children, and information related to processing and storage in memory were received.

In this study, we used the questionnaire that has been developed by Daneman and Carpenter to measure the working memory capacity.^[32] This questionnaire includes 27 statements which is classified in six sections, from the two-statement section through the seven-statement section. The main characteristic of this test is to measure two sections of working memory (processing and storage) concurrently while conducting a mental activity. The subject matters are asked in this test to listen carefully to a sequence of different and pretty difficult statements which were read to them in each step and then to do two mental tasks (processing and storage) concurrently in below order: (a) to distinguish the meaning and concept of the expressed statements correctly. (b) To memorize the last word expressed in the statements.^[33] The value of all the statements is unique (unit) in this test and one single grade (mark) will accrue to each correct response. Group measurer of this tool is from 7 years onward. The score for each subscale of processing and storage is separate from 0 to 27. Structure and content validity was confirmed by the developers and the reliability was 0.87 in Kouder Richardson method for subscale of processing, 0.9 for storage and 0.92 for the total.^[32] Content and structure validity was conducted by Asadzadeh on 84 students of Psychology and Educational Sciences School of Allameh Tabatabaei University, and the correlation coefficient between Wechsler memory test with subscale

of processing and storage is obtained equal to 0.88 and 0.84.^[33] The reliability of the test in the research on the high school's junior students of Zanjan City was obtained through Kouder Richardson for subscale of processing 0.85, storage 0.84, and 0.87 for total.^[33] The reliability in the present research was obtained through Kouder Richardson method for subscale of processing 0.82, storage 0.80, and 0.85 for total.

Sensory profile of Dunn children aged between 3 and 10 years old (1999) is the 125-item questionnaire which has been designed to describe the children's behavioral responses as visual, auditory, touch, motion, taste, and smelling drivers (stimulators) that are experienced as part of child's daily activity and include 9 subscales (auditory processing visual processing, vestibular processing, touch processing, multisensory processing, oral sensory processing, sensation processing associated with physical endurance/muscle consistency, and indoctrination associated with the physical state of the body motion). Likert scoring would be done from always (1) to never (5) based on response, respectively, from 1 to 5.^[34] In each of the 8 subscales, the minimum score is 14 and the maximum is 70, but for auditory processing, minimum score is 13 and the maximum is 65. This profile was conducted on the children aged at 3–14 years at the first place and was investigated by Dunn on the children with behavioral problems as well at the second step and its validity was confirmed.^[34] The profiles' main validity was confirmed by the developers in content and structure method and its reliability has been reported to be 0.77 and 0.91.^[34] In Iran, Bahri confirmed the content and structure validity and the reliability was obtained between 0.86 and 0.95 for the subscales and 0.96 for the total with regard to Cronbach's alpha coefficient.^[34,35] The reliability was obtained between 0.84 and 0.92 for the sub-scales and 0.93 for the total in Cronbach's alpha method at the present research.

The data normalization was confirmed using the Kolmogorov–Smirnov test. The data were finally analyzed using descriptive statistics (mean, standard deviation, and frequency) and inferential statistics (independent *t*-test and multivariate analysis of variance) using the SPSS 24 software (IBM, Armonk, NY, USA) at a significant level of 0.05.

RESULTS

The data disruption was normal, and the assumptions of MANOVA include Box test and Levene's test have been confirmed.

Table 1 shows demographic information includes age and parent's job of boys and girls with written learning disorder.

According to Table 2, the values resulted from the descriptive indicators and *t*-test in two groups of the working memory subscales and processing styles are presented. Furthermore, mean of processing, storage, auditory processing, visual processing, vestibular processing, multisensory processing, sensory-oral processing, and indoctrination associated with the physical state of the body motion in girls group was more than boys and between two group was a statistically significant difference ($P < 0.01$). However, mean of touch processing, sensory processing associated with the physical endurance/muscle consistency, and indoctrination of activity state that

affecting the motion in boys group was more than girls and between two groups was a significant difference ($P < 0.01$).

According to Table 3, the results indicate that in aggregate, there is a significant difference in the writing disability according to the multivariate analysis of variance among processing ($P < 0.005$) and storage ($P < 0.000$) of working memory subscales and the indoctrination associated with the physical state of the body motion ($P < 0.000$), multisensory processing ($P < 0.000$), and auditory processing ($P < 0.001$), of the sensory processing styles variable in both the girls and boys with writing disability. Table 3 shows that there was no significant difference between the two groups in other subscales of sensory processing styles. In addition, according to the results of multiple sensory processing, the induction associated with the physical state of motion, memory storage, auditory processing, and memory processing, respectively; show the highest possible effect of the test in the two groups associated with these visible components.

Table 1: Demographic information of boys and girls with writing-learning disorder

Variable	Frequency (%)	
	Boys	Girls
Age		
8 years old	10 (22.72)	14 (38.88)
9 years old	19 (43.18)	16 (44.44)
10 years old	15 (34.09)	6 (16.66)
Parent's job		
Employed father	33 (75)	29 (80.55)
Employed mother and father	11 (25)	7 (19.44)

DISCUSSION

The aim of this study was identification of difference of working memory and sensory processing styles in boys and

Table 2: Results of comparison mean and standard deviation of working memory subscales and sensory processing style between boys and girls with writing-learning disorder

Variable	Mean±SD		P
	Boys	Girls	
Processing	20.28±6.88	24.19±7.29	0.001
Storage	18.36±6.01	23.12±6.23	0.001
Auditory processing	31.66±5.77	35.47±6.41	0.001
Visual processing	34.32±5.67	34.97±7.54	0.007
Vestibular processing	34.53±6.12	35.69±7.01	0.006
Touch processing	34.47±5.66	29.58±5.77	0.003
Multisensory processing	34.61±5.11	37.91±6.42	0.001
Sensory-oral processing	33.87±7.09	34.93±6.27	0.006
Sensory processing associated with the physical endurance/muscle consistency	34.41±5.33	30.08±5.32	0.001
Indoctrination associated with the physical state of the body motion	34.19±7.02	36.68±6.41	0.001
Indoctrination of activity state that affecting the motion	35.17±5.87	34.81±6.56	0.005

SD: Standard deviation

Table 3: Results of multivariate analysis of variance in working memory and sensory processing style between boys and girls with writing-learning disorder

Source of dispersion	Variables	Sum of squares	Mean of squares	Variance analysis	P
Group	Processing	409.12	409.12	7.857	0.005
	Storage	591.203	591.203	16.011	0.000
	Auditory processing	379.610	379.610	9.691	0.001
	Visual processing	10.873	10.873	0.235	0.626
	Vestibular processing	36.034	36.034	0.791	0.370
	Touch processing	3.106	3.106	0.079	0.781
	Multisensory processing	619.219	619.219	18.192	0.000
	Sensory-oral processing	43.184	43.184	1.204	0.269
	Sensory processing associated with the physical endurance/muscle consistency	44.437	44.437	0.964	0.325
	Indoctrination associated with the physical state of the body motion	506.871	506.871	17.281	0.000
	Indoctrination of activity state that affecting the motion	3.583	3.583	0.082	0.772

girls with writing-learning disorder and showed that there was a significant difference in working memory and sensory processing styles in boys and girls with writing-learning disorder. Some studies have shown that processing rate of working memory in male and female children with learning disabilities is different,^[36] active avoidance system, passive avoidance system,^[37] shutdown avoidance system and conflict system in teenagers is different.^[38] There is a difference between the working memory in children with learning disorder in boys and girls and the situation of memory, and sensory processing of the girls is better than the boys.^[19,20] In explanation of these results, it can be pointed out that based on biological perspective, a better neurological, and brain structural differences in the girls, which causes the improvement of interactions with the social environment consistently, can increase the disorders improvement rate in interaction with parent or teacher and both the girls and boys have some differences in terms of brain structure and some of these differences are in motions coordination and especially in hearing senses. There is a difference between girls and boys with writing disorder in the intensity of the deficiencies of working memory and sensory processing.^[21,39] The difference between the activity amount of brain processing systems in the two genders creates difference in determining their disorders' intensity as well, the activity amount of brain activation system is more in individuals with internal control resource and this amount is higher in the boys in comparison to the girls, and the activity amount of behavioral inhibition system is more in individuals with external control resource and this amount is higher in the girls in comparison to the boys. In conflict-escape system, understanding the external control center showed a higher average and the girls' average in escape was more than in boys, and so was the boys' average in conflict.

It seems that stimulation facilitation and low sensory threshold in the boys predict the emotional-sensory processing positively, but the reductions of esthetics sensitivity do it negatively.^[40,41] The finding of this research indicates the point that the two genders have some differences in senses' processing. In addition, it refers to some differences in the rate of processing and memory storage in the gender in line with this explanatory approach, the findings of which are in line with these issues. On the other hand, based on the sociocultural perspective, the cause of many behaviors and even feedbacks related to physical biology can be perceived from cultural environments, and the humans are affected by them, therefore, based on this explanatory approach, cultural differences in our society, which suggests that the girls perform the behaviors and assignments more carefully than the boys, makes itself clear in the disorders, too. It is suggested that new

therapeutic interventions be designed (developed) to repair the cognitive and sensory functions in collaboration with parents in children with written-learning disorder.

Among the limitations of this research can be pointed to a limited population of children with learning disorder in Gorgan City, which can be generalized only to this target group. Another limitation was the nonuse of the census sampling method. The methodology constraint, with regard to the type of case study being control, was that it is hard to consider causality based on collected information, and the findings may be due to multiple interactions between psychological and situational variables.

CONCLUSIONS

The results of this study showed that there is a significant difference in working memory and sensory processing styles in males (boys) and females (girls) children with written-learning disorder, and the girls' situation is better than the boys in terms of sensory processing and working memory storage. These cognitive and processing failures (deficiencies) can justify a high degree of difficulties of the children with learning disorder in the fields such as reading, writing, and calculation. The result of this study is indicative of more deficiencies of cognitive and sensory functions of the males (boys) with written-learning disorder than the females (girls).

Conflicts of interest

There are no conflicts of interest.

Authors' contribution

All authors contributed to this research.

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Nil.

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