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Original Article

Comparison of working memory and sensory profile in boys and girls with writing disability

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Abstract

Background and aims: Children with learning disabilities mainly have problems in cognition and sensations. Therefore, this study aimed to compare working memory and sensory profile in boys and girls with writing disability.

Methods: To this end, this descriptive study applied a comparative method to collect the required data. Statistical population of the study included all girls and boys within the age range of 8-10, who were suffering from writing disability during their treatment in a writing disability center in Gorgan during the summer of 2018. In addition, a stratified random sampling method was used and 50 boys and 58 girls were selected from each group accordingly. Based on the research tools, the Dunn profile (1999) was obtained from the parents of the children. In the area of Daneman and Carpenter working memory (1980), children were directly questioned in order to obtain information related to processing and storage in their memory. Finally, data were analyzed by SPSS software using multivariate analysis of variance analysis.

Results: Based on descriptive findings (i.e., mean and standard deviation), the following data were obtained regarding the intended parameters in boys and girls as processing (50.32±6.93, 54.22±7.45), storage (48.47±6.08, 53.17±6.07), indoctrination associated with the physical state of body motion (34.28±7.09, 36.91±6.48), multisensory processing (34.68±5.21, 37.94±6.57), and auditory processing (31.74±5.84, 35.52±6.59), respectively. In addition, the results indicated a significant difference in the writing disability among the processing ($P<0.006$) and storage ($P<0.000$) of working memory subscales and 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 profile in both girls and boys with writing disabilities.

Conclusion: In general, the boys had a worse condition concerning their working memory and sensory processing styles that require special attention and more focused educational approaches.

Keywords: Writing disability; Working memory; Sensory profile

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Introduction

A learning disorder is defined as a neurobiological problem in cognitive processing like memory and language, which is created due to the abnormal function of the brain and can disturb the educational function (1). In recent years, learning disability including writing has been recognized as a type of learning inability with regard to its increasing learning (2). In addition, writing-learning disability is a structural and cognitive problem that disturbs the individual in attaining cognitive processing skills in learning as writing (3). Such types of disabilities are distinguished at the time when the likelihood of the child's writing achievement is lower in a standardized test compared to his/her intelligence and education (4). The recent studies 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 to the education environment depend on sensory processing and his/her obtained inputs (6). The child is quiet, conscious, concentrated, and ready to play and learn if the sensory processing level is normal (7). Some previous studies showed that sensory processing style is an important factor, and disorders such as hyperactivity, obsession, and sleeping disorders are related to high sensory processing, while illnesses like anxiety, depression, and stress are related to low sensory processing (8,9). On the other hand, learning disorders relate to high and low sensory processing (10). The children with sensory processing problems face such issues as sensitivity to sound, crowd, physical touch, pictures, and the words of the books, which are considered an important factor in more deficiency in learning problems at school (11), and these beguiled inputs

obtained from the environment disturb the storage of basic information in the memory (12). Meanwhile, active memory includes registered information at the permanent memory that is currently in the fully active state and involves the cognitive and underlying process of learning related to the information storage in the mind and its recovery (13). Further, the active memory denotes all temporary information that the individual has access to at any time (14). In addition, some studies demonstrated that active memory plays a significant role in learning disabilities (15).

Swanson and Jerman (16) found that the difference in brain processing of individuals with learning disorders expresses some deficiencies in left hemisphere., Investigating the relationship between a learning disorder and working memory, Shokouhi-Yekta et al found that children with learning disorders have a clear disability in their working memory (14). Furthermore, the processing rate, environmental inputs processing, and working memory could be mentioned among the cognitive factors contributing to the writing-learning disorder (18). Peng and Fuchs (19) and Brandenburg et al (20) reported that there is a difference between the working memory in children with learning disorder based on the role of age and gender. Rodak and Alloway (21) showed that there is a relationship between motion and sensory coordination with working memory, while there is a difference between girls and boys concerning the writing disorder. Moreover, Alloway and Temple (22) found a difference between working memory skills and learning in female and male children with the writing-learning disorder, indicating that the girls' (females') working memory was better than that of the boys. The results of some studies like Mammarella et al (23) and Maehler and Schuchardt (24) indicated that the intensity of working memory deficiency affects the background of learning disorder type and paves the way for the emergence of the disorder in children. Based on the findings of Leong et al (25), there was a difference in the combination of processing the seeing and hearing senses between female and male children with learning disorders. Additionally, some other studies revealed that a series of abnormal functions of brain processing have been diagnosed that play a role in linguistic-auditory processing, especially in quick reading and writing processing (26,27). According to Kirby et al, material processing and quick automatic calling are two core processes that predict writing skills (28). Some individuals with learning disorders have structural differences regarding the visual systems of their brains with common individuals (29,30).

In general, memory abilities and sensory processing are important for an effective response to situations, learning facilitation, social behavior, and daily functions of the individual. Thus, an investigation into working memory deficiencies and sensory processing styles in children with a writing-learning disability seems necessary for better understanding the neuropsychological attributes of these individuals and designing the efficient treatment methods with regard to the gender. Hence, considering the above-mentioned issues, the present research mainly sought to compare working memory and sensory profile in boys and girls with writing disabilities.

Methods

The population of this descriptive-comparative study included all girls and boys with writing disabilities within the age range of 8-10, who were treated in a writing disability center in Gorgan in 2018. Overall, 150 individuals (including 69 boys and 81 girls with writing disability) were enrolled, out of whom 108 ones were selected by a stratified random sampling method (the sample number of each group was determined based on the population number of each gender group) and based on the Krejcie and Morgan Table. Finally, 50 boys and 58 girls were selected to increase the external validity of the research. Considering the research instruments, Dunn profile (1999) was received from 8-10-year-old children's parents, and concerning the active memory tool area, the children were directly questioned in order to obtain information related to processing and storage in memory. The inclusion criteria included learning disability in boys and girls aged 8-10 years, the absence of psychiatric disorders, along with the diagnosis of a psychiatrist based on DSMV (Diagnostic and Statistical Manual of Mental Disorders) criteria, and the completion of an informed consent form for participation by parents. In addition, the exclusion criteria were the incomplete completion of the study tools. The written informed consent was obtained from the parents after explaining the research goals and their cooperation procedure. Following the completion of the final tools, the data were finally analyzed by multivariate analysis of variance method using SPSS software, version 24 at the significance level of 0.05.

Active memory questionnaire was developed by Daneman and Carpenter to measure the working memory capacity (31). The above test includes 27 statements, which are classified into six sections ranging from the two-statement part through the seven-statement part. Measuring two sections of working memory (i.e., processing and storage) concurrently, while conducting a mental activity, is considered as the main characteristic of this test. The subjects are asked to carefully listen to a sequence of different and pretty difficult statements in each step and then to do two mental tasks (i.e., processing and storage) concurrently including correctly distinguishing the meaning and concept of the expressed statements and memorizing the last word expressed in the statements (32). The value of all the statements is unique (unit) in this test and one single grade (mark) accrues to each correct response. Group-measurer of this tool is from 7 years onward. Similarly, structure and content validity was confirmed by the developers and the reliability was 0.87,

0.9, and 0.92 for the Kuder-Richardson method for the sub-scales of processing, storage, and the total. Content and structure validity was determined by Asadzadeh (32) evaluating 84 students of psychology and educational science school of Allameh Tabatabaei University, and the correlation coefficient was obtained by 0.88. In addition, the reliability of the test in the research on junior high school students of Zanjan was obtained through Kuder-Richardson for the sub-scale of processing, storage, and total as 0.85, 0.84, and 0.87, respectively. Using Kuder-Richardson method, the reliability of the instrument in the present research was estimated as 0.82, 0.80, and 0.85 for the subscales of processing, storage, and total, respectively.

Sensory profile of Dunn (1999) for children aged 3 to 10 years old is the 125-item questionnaire designed to describe the children's behavioral responses as visual, auditory, touch, motion, taste, and smelling drivers (stimulators) that are experienced as part of a child's daily activity. Further, these responses include nine sub-scales (e.g., auditory, visual, vestibular, touch, multisensory, oral sensory, and sensation processing associated with physical endurance/muscle consistency, along with the indoctrination related to the physical state of body motion). Likert scoring ranged from always (1) to never (5) based on the response from 1 to 5, respectively (33). This profile was conducted on the children aged 3-14 years at the first place and was investigated by Dunn (33) on children with behavioral problems at the second step as well, and its validity was confirmed accordingly. The main validity of the profiles was confirmed by the developers concerning the content and structure method. Furthermore, its reliability was reported as 0.77 and 0.91, respectively, by the Cronbach α method for each section at the population of 1037 on-growing children (i.e., 424 girls and 510 boys), and the groups were considered at the age interval of 120 children (33). Bahri (34) confirmed the content and structure validity in Iran, and the reliability was obtained between 0.86 and 0.95 for the sub-scales and 0.96 for the total with regard to the Alpha Cronbach coefficient. The reliability was obtained between 0.84 to 0.92 for the subscales and 0.93 for the total in the Alpha Cronbach method at the present research.

Results

Regarding the demographic information of the boys, 11, 23, and 16 cases were eight, nine, and 10 years old. Moreover, the girls were within the age range of 8 (n=19), 9 (n=21), and ten (n=18) years old. Additionally, 36 cases in the boy group had merely employed fathers, while 14 other children had employed parents. Finally, in the girl group, 47 children had merely employed fathers, whereas 11 children had employed parents.

Table 1 represents the values resulted from the descriptive indicators in both groups of working memory subscales and processing styles.

Due to the insignificance of the covariance homogeneity of Levene's test and the Box's test (0.521) related to the equality of the covariance matrices (Table 2), we could say that the data are consistent and the assumptions of multivariate analysis of variance (MANOVA) are observed as well.

Based on the result provided in Table 3, there was a significant difference in the writing disability according to the multivariate analysis of variance 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 profile in both girls and boys with writing disabilities. As shown in Table 2, no significant difference was observed between the two groups concerning the other subscales of sensory profile. Eventually, given the results of multiple sensory processing, the induction associated with the physical state of motion, memory storage, auditory

Table 1. Descriptive statistics of working memory and sensory profile in boys and girls with writing disability

Variable	Boys Suffering from Writing Disability		Girls Suffering from Writing Disability	
	Mean ± SD	*P* Value	Mean ± SD	*P* Value
Processing	50.32±6.93	0.002	54.22±7.45	0.001
Storage	48.47±6.08	0.011	53.17±6.07	0.008
Auditory processing	31.74±5.84	0.016	35.52±6.59	0.001
Visual processing	34.38±5.93	0.014	35.01±7.61	0.007
Vestibular processing	34.62±6.14	0.001	35.75±7.14	0.006
Touch processing	34.51±5.85	0.001	29.63±5.81	0.015
Multisensory processing	34.68±5.21	0.001	37.94±6.57	0.004
Sensory-oral processing	33.92±7.17	0.002	35.02±6.39	0.012
Sensory processing associated with physical endurance/muscle consistency	34.50±5.43	0.001	30.15±5.40	0.002
Indoctrination associated with the physical state of the body motion	34.28±7.09	0.001	36.91±6.48	0.003
Indoctrination of activity state affecting the motion	35.22±5.91	0.001	34.87±6.74	0.004

Table 2. The covariance homogeneity of Levene's test of working memory and sensory profile in boys and girls with writing disability

Variable	*F*	*df1*	*df2*	*P* Value
Processing	0.571	1	106	0.900
Storage	0.486	1	106	0.972
Auditory processing	0.721	1	106	0.676
Visual processing	0.713	1	106	0.689
Vestibular processing	0.816	1	106	0.519
Touch processing	0.384	1	106	0.998
Multisensory processing	0.727	1	106	0.665
Sensory-oral processing	0.575		106	0.895
Sensory processing associated with physical endurance/muscle consistency	0.677	1	106	0.749
Indoctrination associated with the physical state of the body motion	0.646	1	106	0.789
Indoctrination of activity state affecting the motion	0.554	1	106	0.919

Table 3. The results of multivariate analysis of variance regarding working memory and sensory profile in boys and girls with writing disability

Source of Dispersion	Variables	Sum of Squares	Mean of Squares	Variance Analysis	*P* Value
Group	Processing	409.284	409.284	7.844	0.006
	Storage	591.244	591.244	16.017	0.000
	Auditory processing	379.621	379.621	9.682	0.002
	Visual processing	10.904	10.904	0.230	0.623
	Vestibular processing	36.046	36.046	0.803	0.372
	Touch processing	3.117	3.117	0.077	0.782
	Multisensory processing	619.300	619.300	18.183	0.000
	Sensory-oral processing	43.192	43.192	1.206	0.275
	Sensory processing associated with physical endurance/muscle consistency	44.469	44.469	0.971	0.327
	Indoctrination associated with the physical state of the body motion	506.897	506.897	17.278	0.000
	Indoctrination of activity state affecting the motion	3.601	3.601	0.078	0.780

processing, and memory processing demonstrated the highest possible effect of the test in both groups associated with these visible components.

Discussion

Generally, the results revealed that there was a significant difference between female and male children with writing-learning disorder in terms of working memory and sensory processing styles. This is in line with the findings of Fathi Ashtiani et al (35), which indicated that the processing rate of working memory in male and female children with learning disabilities was different. Similarly, Amiri and Mousazadeh (36) found that active and passive avoidance systems, as well as shutdown avoidance system and conflict system, varied in teenagers. In addition, Peng and Fuchs (19) and Brandenburg et al (20) found a difference between the working memory in children with learning disorders among boys and girls and reported that the situation of memory and sensory processing of the girls was better than that of the boys. Likewise, Rodak and Alloway (21) showed a difference between girls and boys regarding writing disorders with the intensity of the deficiencies of working memory and sensory processing. Wolf et al (26) also demonstrated that girls with learning-writing disorders suffered from a lower cognitive deficiency as compared to boys, and the differences concerning hormonal and nervous system between the two genders were considered as the basic determinant for the existence of processing and the cognitive situation of the girls. Shaheedeh and Aghayousefi (37) reported that the difference between the activity amounts of brain processing systems among both genders creates a difference in determining the intensity of their disorder. In addition, the activity amount of the brain activation system was higher in individuals with an internal control resource and among the boys in comparison to the girls. They further concluded that the activity amount of the behavioral inhibition system was more in individuals with an external control resource, while this amount was higher in the girls in comparison to the boys. In the conflict-escape system, understanding the external control center showed a higher average and the girls' average in the escape was more compared to the boys, and thus the boys' average was different. Leong et al (25) found a difference in the composition of auditory and visual senses (eyesight) processing between male and female children with learning disorders. In this regard,

Kasaeian et al (13) also indicated that the performance of working memory and the sustained attention of the students with writing-reading disabilities was significantly weaker than that of the normal students. It seems that stimulation facilitation and low sensory threshold in the boys positively predict the emotional-sensory processing, but a reduction in aesthetics sensitivity leads to a negative prediction (38).

Alloway and Temple (22) observed a difference between working memory skills and learning in female and male children with writing-learning disorders and concluded that the girls' working memory functioned better compared to that of the boys. Several studies reported that the intensity of working memory deficiency influences the background of learning disorder type and leads to the emergence of disorders in children (23,24), which is in line with findings of other studies by Shiran and Breznitz (39) and Milton (40). According to the biological perspective, a better neurological and brain structural difference in the girls, which consistently causes the improvement of interactions with the social environment, can increase the improvement rate of disorders in interaction with the parent or teacher. Furthermore, both girls and boys have some differences in terms of the brain structure, some of which are in motion coordination, especially in auditory sense. The finding of this research indicates that both genders have some differences in sense processing. In addition, refered to some differences in the rate of processing and memory storage among the genders in line with this explanatory approach, the findings of which are in line with these issues. On the other hand, based on the socio-cultural perspective, the cause of many behaviors and even feedbacks related to physical biology can be perceived from cultural environments, and humans are affected by Such cultural environments. Therefore, based on this explanatory approach, the cultural difference in our society, which suggests that girls perform the behaviors and assignments more carefully than the boys, is manifested in the disorders as well. Therefore, new therapeutic interventions are suggested to be designed to repair the cognitive and sensory functions in children with written-learning disorders in collaboration with their parents.

The current research has some limitations. For example, the study included a limited population of children with learning disorders in Gorgan, which can be generalized only to this target group. Moreover, this research was a case-control study; therefore, it is hard to consider causality based on the collected information, and the findings may be due to multiple interactions between psychological and situational variables.

Conclusion

Based on the results of this study, a significant difference was observed regarding working memory and sensory processing styles in male and female children with the written-learning disorder, and the girls had a better situation compared to the boys in terms of sensory processing and working memory storage. These cognitive and processing failures can be attributed to a high degree of children's difficulties with learning disorders in such areas as reading, writing, and calculation. Eventually, the result of this study represented that boys with written-learning disorders had more deficiencies respecting cognitive and sensory functions compared to the girls.

Conflict of interests

None.

Ethical considerations

This research was registered with the institutional ethics code IR.IAU.AK.REC.1397.016 at Bandar Gaz Branch University.

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