

A Comparison of Memory and Mental Development between Dyslexia and Normal Children

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ABSTRACT

Introduction: The purpose of this study was to compare the memory and mental development between dyslexia and normal children in Khoy city.

Material and Methods: This is causal-comparative study. The population of this research included all normal and dyslexic female students who were third- or fifth-graders (aged 9-12 years) from primary schools in Khoy city, Iran, in the academic year 2013-2014. The sample consisted of 100 students into the two groups as dyslexic and normal groups that 50 students were selected for each group and then were examined. Sampling of dyslexic students was non-random available sampling from the center of learning disorders and for normal group was multi-stages cluster random sampling. The measurement tools were Wechsler Memory Scale and mental development scale of Piaget. The data were analyzed using analysis of variance.

Results: The results indicated that in mental development scores; there was a significant difference between dyslexia and normal students ($P < 0.001$), as well as in working memory scores, there was a significant difference between dyslexia and normal students ($P < 0.001$).

Conclusion: Dyslexia students have lower capacity in terms of memory and mental development than normal students that poor capacity of working memory and mental holding may contribute problems in reading specially dyslexia in elementary students.

Keywords: Working memory; Mental development and dyslexia; Piaget; Development theory

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Introduction

Dyslexia, also known as reading disorder, is characterized by trouble with reading despite normal intelligence. It does not just affect reading and writing, but there are some everyday skills and activities that child may be struggling with because of this learning issue including social skills, listening comprehension, and time management. Some children do not seem to struggle with early reading and writing. But later on, they have trouble with complex language skills, such as grammar, reading comprehension, and more in-depth writing (1).

Dyslexia can also make it difficult for people to express themselves clearly. It can be hard for them to structure their thoughts during conversation. They may have trouble finding the right words to say. It's important to keep in mind, however, that struggles with reading and other issues can lead to frustration and low

self-esteem. The stress of dealing with schoolwork can make kids with dyslexia lose the motivation to keep trying. Children with learning disabilities gradually face emotional difficulties and will have antisocial behavior so that leads to the other problems such as feeling inferior around other kids and so child may stop trying to make new friends or may avoid group activities (2). These children may know many words and use them in their speech, but they are not able to understand and identify the writing symbols (3). In particular, dyslexia is a disorder in making mistakes on similar words, guessing words according to the beginning and the ending letters, reflecting or backward reading of words, severe problems in spelling words, aversion in learning of reading and the difficulty in identifying the part to the whole (4). Almost 80% of students who have difficulty in learning have disabilities in reading (5, 6).

Investigation on the causes of dyslexia made and introduced a number of factors, one of those factors was working memory and its effects on dyslexia that attracted many attentions in recent years. A lot of researches on dyslexia showed the impact of working memory on dyslexia (7-11). The results showed that people with disabilities in reading had poorer memory performance than average in span tasks including the span of working memory (12). MacDonald et al. (13) expanded their reasoning and claimed that important mediator factor between reading span and comprehension was working memory. The limited capacity of working memory can be considered one of the causes of dyslexia.

The previous studies reported that students with dyslexia have difficulty in information processing including encoding of phonemic system that was the most common symptom and dyslexia involves deficits in subsystems of working memory, such as phonological loops, visuospatial sketchpad, and central executive functioning (14-17). This assumption in its strongest form means that we can learn something only if we have processed it in working memory. Combining the two words together by a mental image, rehearsal and practice transfer information to the long-term memory. Long-term memory has limited capacity but it is vulnerable to failure of recovery. Recently, there are many studies in the case of encoding, recognition (free recall, recalling by clues and identification), practical, and verbal memory in multi-channel assignments (18-20). That means if several systems such as auditory, visual, tactile, taste and hearing system to be involved during the encoding so recall and recognition tasks can be done better and practical assignments may result in a rich and multi-channel encoding (14, 21, 22).

Because working memory is used to process and store information during cognitive tasks like reading task so holding information in mind becomes important. For example in task of comprehension of text, reading sentences, holding them in mind and integrating information to uncover meaning relies on working memory capacity. Holding in mind is a term that has been defined by Piaget, i.e., the knowledge that the value of an object is constant until nothing cut or add to it, remains constant (10). According to Piaget, children in sensory-motor and pre-operational period have not reached yet the concept of mental holding. In addition, mental holding has the various types including mental holding of number, quantity, level, liquid, solid, and weight.

According to Piaget, mental holding requires three types of logical reasoning including returnable; this ability is "this is same and compensation." Returnable reasoning means that child can return his thinking flow back to the beginning point. This is the same means that the children realize that object despite changes in

appearance will be the same as the first. Compensation means that children understand changes in the appearance of the objects compensate (complete) each other. Piaget concluded that mental ability to hold information is created simultaneously based on the experiences of children in everyday activities. In his opinion, in many cultures, children learn mental holding without any direct teaching. According to Piaget direct teaching for child without development capacity is useless (23). In the area of mental holding, study on children with learning disabilities and comparing their mental holding ability with the general population is rare. Therefore, in this study, we examine and compare these constructs in dyslexic children and normal people.

Early identification of children with learning disorders helps teachers and parents to take action to resolve their learning problems and prevent academic failure which is considered as the main educational system problem. To promote techniques and reduce costs, prevention is recognized as the first priority like importance of prevention in all diseases, injuries and mental and physical disorders. In case of happening learning problems, conditions require the second type of prevention including early detection and providing timely and effective intervention (24).

The diagnosis of learning disorders should be done during elementary school years, and then treatment will be provided. Therefore, inexpensive and easy tool and valid and reliable criteria and validity for early detection are a fundamental necessity. According to studies and researches of educational experts and researchers of exceptional education in our country, on average, 12% of school-age children are exceptional students. Of this number, about 3% of students have learning disabilities (12, 25-29). Since investigation of differences and similarities of these students and normal students in the areas of cognitive, social, emotional aspects is necessary, this study presents comparative study of memory and mental development between students with dyslexia and normal students.

Materials and methods

This is causal-comparative study. The population of this research includes all normal and dyslexic female students who were third- or fifth-graders (aged 9-12 years) from one primary school in Khoy city, Iran, in the academic year 2013-2014. The sample consisted of 100 students into the two groups as dyslexic and normal groups that 50 students were selected for each group and then were examined. Sampling of dyslexic students was non-random available sampling students from the center of learning disorders and for normal group was multi-stage cluster sampling.

Diagnosis criteria

All the dyslexic children who were third- or fifth-

graders (aged 9-12 years) from primary schools in Khoy city, Iran in the academic year 2013-2014 were diagnosed according to criteria defined by International Statistical Classification of Diseases and Related Health Problems - 10 issued by the World Health Organization (30).

Inclusion criteria

Several inclusion criteria were (1) having normal intelligence, (2) having healthy visual system and (3) having healthy auditory systems. According to information of school educational documents, passing at least 6 months in school in each grade. The children were physically healthy and had no history of neurological disease, head injuries, or psychiatric disorders. Informed consent was obtained from each subject and their parents before initiating testing.

Tool

Wechsler memory scale

Wechsler memory scale which is used as an objective scale to assess memory is the result of 10 years of research in the field of practical, simple and immediate memory. It gives information to distinguish organic disease from functional disorder of memory. We used working memory subscale (form A) which includes general information, orientation (time and place), mental control, forward recall, backward recall, and vision memory. Garvosi et al. (2001), quoted by Zarbakhsh et al. (31), supports the use of Wechsler memory scale as reliable, validated instrument to measure memory. Reported reliability of this test is about 0.80 (32). In this study, reliability has been obtained through Cronbach's alpha about 0.77.

Mental development tests

For mental development, Piaget system was used as tools for measuring students' cognitive development. Conservation (holding in mind) refers to the ability to determine that a certain quantity will remain the same despite adjustment of the container, shape, or apparent size. For conservation of weight, the task involves two lumps of clay and balance. The experimenter places two equal balls of clay onto either side of a balance and shows that the weights are the same. The experimenter then molds one ball of clay into an oblong shape and asks the child if the two pieces of clay will still weight the same amount. For conservation of number, the task designed to test children involves a set of several marbles. These marbles are placed into two parallel lines that are the same length. Then, the researcher spreads out the marbles in one line, longer than the other. Finally, the researcher asks "Is there the same number or a different number in both lines of marbles?" The conservation of volume task involved showing a child two beakers A1 and A2, both of which were identical and which contained the same amount of colored (typically blue) liquid. Then, liquid from the second glass A2 was poured into two taller, thinner glasses B1 and B2. The child was then asked whether

there was still the same amount of liquid in both the new glasses (B1 and B2) as in the first glass A2 (33-36).

When the child responds to questions, they were asked to defend or justify their ideas. Scores of the children are on a simple 0-1-2 point system.

- 0 - Pre-operational logic
- 1 - Right answer; no justification
- 2 - Gives answer and justifies their reasoning.

This tool is studied by Ahghar and Esmaeili (37) in a research project. Reliability coefficient by retest is reported for substance, weight and volume as, 0.99, 0.99 and 0.95 respectively and Cronbach's alpha is reported as 0.95, 0.87 and 0.79 for substance, weight and volume. In this research, reliability is obtained through Cronbach's alpha test for the substance, weight and volume as 0.87, 0.85 and 0.88, respectively.

Results

Data were analyzed using SPSS software (version 19; SPSS Inc., Chicago, IL, USA) and results were presented in both descriptive and analytical statistics. The descriptive statistics for each of the variables (memory and holding in mind) in two groups were shown in the analytical section (Tables 1 and 2), and assumptions were analyzed using multi-way analysis of covariance (Tables 3 and 4).

Table 1. SD of memory and its dimension by groups

Variables	Dyslexic	Normal
	Mean \pm SD	Mean \pm SD
General information	1.64 \pm 0.75	3.28 \pm 1.83
Orientation	2.36 \pm 0.48	3.80 \pm 1.58
Mental control	2.36 \pm 1.07	3.28 \pm 1.88
Forward recall	3.68 \pm 1.40	4.84 \pm 1.59
Backward recall	3.36 \pm 1.25	4.40 \pm 1.60
Total scores of digit	7.04 \pm 2.37	9.24 \pm 3.15
Vision memory	5.24 \pm 1.20	7.40 \pm 2.46
Total	18.64 \pm 4.85	25.84 \pm 10.58

SD: Standard deviation

Table 1 shows the mean and standard deviation in scores of students with dyslexia and normal for memory test and its dimensions.

Table 2. Mean \pm SD in scores of students in mental holding (n = 100)

Variable	Group	Mean \pm SD	Minimum score	Maximum score
Substance	Dyslexic	1.460 \pm 0.645	1	3
	Normal	1.720 \pm 0.833	1	3
Weight	Dyslexic	1.880 \pm 0.627	1	3
	Normal	2.660 \pm 0.981	1	3
Volume	Dyslexic	1.700 \pm 0.735	1	3
	Normal	2.160 \pm 0.817	1	3
Total score	Dyslexic	5.04 \pm 1.08	3	4
	Normal	6.54 \pm 1.87	5	9

SD: Standard deviation

Table 2 shows the mean and standard deviation in

scores of dyslexic and normal in mental holding and its dimensions.

Table 3. Results of multiway analysis of variance of dyslexic and normal subjects in memory

Variables	SS	FD	F	Significant
General information	56.25	1	27.52	0.001
Directing	34.81	1	22.27	0.001
Mental control	17.64	1	7.68	0.001
Forward recall	38.44	1	17.77	0.001
Backward recall	18.49	1	8.85	0.001
Total scores of digit	73.96	1	18.48	0.001
Vision memory	110.25	1	14.40	0.001
Total scores of memory	134.89	1	20.44	0.001

Table 3 shows that there are significant differences between dyslexic and normal students in total score of memory and its dimensions ($P < 0.001$). Comparison between two groups showed that dyslexic students achieved lower scores than normal students in these dimensions.

Table 4. Results of analysis of variance for mental holding and its dimensions in dyslexic and normal groups

Variance source	SS	DF	F	Significant
Substance	1.690	1	3.12	0.085
Weight	15.21	1	22.12	0.001
Volume	5.29	1	9.13	0.001
Total	56.25	1	24.86	0.001

Table 4 shows that in total score of mental holding, there is a significant difference in weight and volume dimension between two groups ($P < 0.001$). The means (Table 2) shows that dyslexic students achieved lower scores in these dimensions than normal group.

Discussion

Dyslexia is the most common learning disability and it is characterized by low reading abilities in children who have adequate intelligence, typical schooling, and sufficient socio-cultural opportunities (38, 39). This problem was defined in Diagnostic and Statistical Manual of Mental Disorders IVth edition (DSM-IV) as subtype of learning disorder but in DSM-V it defined as a conditions of specific learning disorders and it does not specifically define dyslexia, justifying this decision by stating that "the many definitions of dyslexia meant those terms would not be useful as disorder names or in the diagnostic criteria and difficulty distinguishing homophones is a diagnostic used for some forms of dyslexia." Numerous studies have examined whether dyslexia involves deficits in subsystems of working memory and holding in mind (14-17). Observations of children in classroom combined with teacher reports have highlighted the major signs of working memory problems in learning difficulties like dyslexia due to activities such as reading and writing require large number of data to be held in mind (40, 41).

Learning is step by step process that relies on

successful completion of learning activities for accumulation of knowledge. Children with poor working memory like dyslexic students fail in classroom in reading text because loads of working memory exceed their capacities (42, 43).

The results showed that there are statistically significant differences between dyslexic and normal students' mental holding. This finding is consistent with findings of research by Bishop (42). To explain this finding, it can be said that dyslexia is defined as a neurobiological disorder in language and cognitive processing that is resulted from abnormal function of brain. Dyslexic children get and process information in a manner different from normal children because of brain dysfunction. Failure of information processing in dyslexic children in areas such as decoding or word recognition, reading comprehension, calculation, mathematical reasoning, spelling or writing expression and as the same degree failure in spoken language were specified (5, 43, 44). Researchers reported deficiencies in various kinds of information processing in children with learning disabilities especially in dyslexia (41). Piaget believes that mental ability to hold information is created simultaneously based on the experiences of children in everyday activities. A major difference between a child in Piaget's "preoperational" stage (3-4 years) and one in the "concrete operations" stage (5-7 years) is that the older child can simultaneously hold more than one thing in mind and inhibit the strongest response of the moment. For example, children 4 years of age fail tests of liquid conservation. They do not attend to both height and width (45).

Results also showed that there is a significant difference between two groups in memory function. Our findings support the notion that the enlargement of working memory supply may contribute to reading effectiveness and focused reading. It is important to note that the effectiveness of the training was more pronounced. The findings of the study are consistent with finding of Swanson and Sachse-Lee (5), Palladino et al. (6), De Jong (7), McNamara and Wong (8); Mabbott and Bisanz (26), Meyer et al. (27). Our findings reveal that children with learning disabilities have low sensitivity to different types of visual and auditory sensory information. This makes poor in receiving the current stimulus efficiently and storing information in their memory for future use. Second, if there is not such a good storing in memory due to lack of receiving stimulus and lack of appropriate retrieval cues, recall or retrieval of information in memory is done by difficult.

It seems essential that parents of children with dyslexia and all school coaches who are dealing with these children try to provide early diagnosis and provide a rich environment and necessary training for the development of mental abilities and cognitive potential of children to reduce the severity of the damage on cognitive function in children. It is clear

that the development of physical, intellectual, social and emotional dimensions of child are necessary for learning so that progress in one area may lead to progress in others (45). Therefore, it is necessary that development of physical, mental, social and emotional aspects considered as whole.

Small sample population, lack of previous research in the field of mental development of children with dyslexia, limitation of sampling within city of Khoy, non-random sampling method, and limitation of sampling into elementary school are limitations of this study.

It is recommended that future researches may pay attention on:

1. Research in other cities with more samples

2. Carrying out similar studies in other groups of exceptional children such as gifted or attention deficit hyperactivity disorder children, ... and comparing them with normal children in other parts of the country with different age groups and different educational levels

3. Research in other age groups and other educational courses and comparing them with each other

Researches in accordance with socioeconomic level of family and demographic characteristics.

Conclusion

Our findings emphasized the relationship between larger working memory capacities and better reading skills. Hence, this study has important practical implications in that children with dyslexia may benefit from working-memory training. Future research should investigate how effective cognitive rehabilitation is associated with increasing capacity of working memory in dyslexic children. It is clear that more research in this direction is necessary.

Conflict of Interests

Authors have no conflict of interests.

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