DOI: 10.22122/jrrs.v16i.3564 Published by Vesnu Publications

Reading Dysfunction and Dyslexia, Effectiveness of Convergence, Accommodative Facility, and Saccades: A Systematic Review

Hanieh Falahati[1], Amanullah Soltani[2], Mitra Kamyabi[2], Hamdaleh Manzari-Tavakoli[2]

Review Article

Abstract

Introduction: Dyslexia is a combination of problems that affect the learning process in one or more areas, including reading, writing, and spelling and may be associated with problems with processing speed, memory, visual-auditory perception, motor skills, and speech. Skills like comprehension and distinction of letters and sounds, communication between phonograph and writing, naming and representing letters, memory, movements, and visual and cognitive factors are concomitantly involved in this complex cognitive process. The aim of this study is to review the research available on the effectiveness of convergence, accommodative facility, and saccades on reading failure.

Materials and Methods: The articles concerning dyslexia, reading disorder, phonological processing, effectiveness of convergence, saccade, and accommodative facility published between 2010 and 2020 at Google Scholar, Pubmed, and ScienceDirect databases, as well as in Persian dissertations and journals indexed in Scientific Information Database (SID) and Magiran. "Reading disorder, Dyslexia, Convergence, Accommodative facility, Saccade, Visual function, Visual perception, Visual processing, Adaptive effectiveness, Phonology recognition", and their combinations according to Medical Subject Headings (MeSH) were used as the main keywords. The results of 18 articles were analyzed in the present study.

Results: There was a significant relationship between the disorder of accommodative facility and eye movements, saccade, and dyslexdia, in a way that improving visual interventions, visual and motor perception skills, rehabilitation of basic visual functions, and saccades enhanced the accommodative facility of visual functions and reading function of students. In other words, to prevent problems or poor performance of children and students with dyslexia, more attention should be paid to these skills.

Conclusion: It seems that processing of the vision perception plays an important role in reading impairment, and people who have received convergence exercises, accommodative facility, and saccade movements, including training in visual-motor perception skills, perform better in reading.

Keywords: Dyslexia; Phonological processing; Convergence effectiveness; Saccade; Accommodative facility

Citation: Falahati H, Soltani A, Kamyabi M, Manzari-Tavakoli H. **Reading Dysfunction and Dyslexia, Effectiveness of Convergence, Accommodative Facility, and Saccades: A Systematic Review.** J Res Rehabil Sci 2020; 16: 262-71.

Received: 31.05.2020 Accepted: 12.07.2020 Published: 05.12.2020

Introduction

According to the 5th Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), dyslexia is a subset of Specific Learning Disorder (SLD). People with dyslexia read words incorrectly, slowly, or with difficulty, and have difficulty understanding the meaning of what they have read and spelling words (1).

Reading is a complex cognitive process and requires visual cues, attention to phonetic cues, and regular phonology-based decoding (2). The ability to read requires basic skills such as the development of language skills, motor skills, visual skills, auditory skills, the ability to distinguish between visual and auditory skills, and finally, the ability to pay attention and focus (3). In this definition, reading impairment has been transferred from the category of special developmental disorder to the category of learning disability and the term dyslexia has been changed to reading disorder. Accordingly, reading disorder impairs a child's reading development such as reading speed, accuracy, and comprehension in terms of

1- PhD Student, Department of Psychology, School of Humanities, Islamic Azad University, Kerman, Iran
2- Assistant Professor, Department of Psychology, School of Humanities, Islamic Azad University, Kerman, Iran
Corresponding Author: Amanullah Soltani, Email: amanallahsoltani@iauk.ac.ir

chronological age, intelligence, and educational level, hence significantly impairing educational achievement and daily life activities that require reading skills (1). A significant number of children with learning disabilities score normal and sometimes higher than normal on intelligence quotient (IQ) tests, as a result, reading difficulties are not expected in these children (4).

Dyslexia refers to the failure to acquire reading skills despite adequate intelligence, education, and a good social background (5), which is faced by about 5% of children worldwide (6,7) and 10% of children in Iran (8). There is general agreement on the neurological and genetic basis of this disorder (6,7), but despite various studies, there is still no agreement on the neurological or cognitive basis of dyslexia (9).

People with dyslexia face difficulty in most of their courses due to reading disorders. Children with dyslexia, despite a high level of natural intelligence in most situations, cannot make good educational progress and continue to study with difficulty or often drop out of school, which in turn causes many social, economic, cultural, and emotional-psychological damage for them and society (5).

Today, reading problems are one of the most common features and characteristics of children with learning disabilities and are related to the brain's ability to process and recognize information. Reading is a cognitive process and requires the recognition of visual cues, attention to phonetic cues, and regular decoding based on phonology (10). On the other hand, it is a complex action of mental flow and requires the coordinated and simultaneous activity of different senses. The educations achievement of students depends on their ability to read (11). So far, various causes have been reported for dyslexia (3). Some researchers have pointed to phonological disorders and considered the core of the problem of dyslexia in the language system, especially in the area of phonological analysis, and have shown that phonological awareness in children with dyslexia is lower than that in normal children (3,12). Another group has emphasized cerebellar disorders, which can lead to cognitive impairments such as imbalances and impairments in motor skills, phonological skills, and rapid information processing (3,13). On the other hand, the study of the brain structure of these people shows anatomical and metabolic differences in the cerebellum compared to that of the healthy people. Despite this evidence, a coherent relationship between the cerebellum and the language has not yet been established (12,15). Some other researchers also consider visual impairment to be the main cause (16-21).

Learning disabilities cover a wider range of educational problems and require attention to the social, familial, emotional, and behavioral domains of the child's life within the family context (18,22). Learning disabilities are the most important cause of poor educational performance and impairs learning the courses in a large number of students every year (22). The most important factors associated with such problems are deficiencies in areas such as attention and concentration, visual perception, and spatial communication, and children facing these problems have difficulty in communication between their own body organs and others, hand-eye coordination, spatial orientation, recognition of right and left sides and up and down, and the sequence of letters and words (23).

One of the first hypotheses raised about the etiology of dyslexia was the existence of visual perception defects. According to this hypothesis, the responsibility of the analysis of most of the information when reading is on visual perception, and the person must process visual stimuli in a desirable and optimal way; However, children with dyslexia have major problems in processing visual perception (5-26). Research shows a strong relationship between visual skills and reading outcomes, especially comprehension (9,26).

In addition to the accuracy of the visual system that is responsible for receiving visual information, this information must also be processed properly. This part of the visual system function is referred to as visual information processing, which includes a series of visual cognitive skills. Neurologically, individuals with dyslexia have a specific pattern of cognitive abilities. The most important cognitive traits of these individuals that affect reading and writing are visual processing and short-term memory (27). Visual information processing skills will create the ability to organize, classify, and interpret visual stimuli, and interpret what has been seen (16,26).

Regarding visual interventions and visual functions (28), the basis required for reading, sharpness, accommodation, saccade movements of the eye (29), convergence (19), and motor coordination of the eyes can be mentioned. The results of studies suggest that if there is a significant reduction in sharpness, reading ability will be impaired (19,28,29).

Children with reading difficulties also have difficulty with classroom activities (17,22,23) and often have doubt about their educational self-efficacy, which is the result of their frequent failures in classroom activities and the cause of their apathy to all issues related to education to the extent that many of them drop out of school and prefer hard, exhausting, and even false jobs to continuing their

education (11). Due to the importance of reading, treatments to improve dyslexia and reading disorders in children and adolescents have gained importance, including the effectiveness of convergence, accommodative facility, and saccade movements. The aim of this study was to review the research literature on reading impairment, reading disorder, convergence effectiveness, accommodative facility, and saccade movements.

Materials and Methods

This study was a review in which original research articles were used with the target population of students with dyslexia. The articles were experimental or quasi-experimental with experimental and control groups that examined the effectiveness of convergence, accommodative facility, and saccade movements. To conduct the study, the articles published on dyslexia and the effectiveness of convergence, accommodative facility, and saccade movements were searched in PubMed, ScienceDirect, Scientific Information Database (SID), and Magiran databases, in addition to the Google Scholar search engine.

Inclusion criteria for the study included valid articles indexed in the abovementioned databases that examined dyslexia and reading disorders, effectiveness of convergence, accommodative facility, and saccade movements (Figure 1).

The keywords of Reading Disorder, Dyslexia, Convergence, Accommodative Facility, Saccade Movements, Visual Function, Visual Perception, Visual Processing, Intercourse Effectiveness, Phonology Recognition, and a combination of them based on the keywords registered in Medical Subject Headings (MeSH) to search for studies published between 2010 and 2020. To combine the keywords, the boolean operators “AND” (used to combine the words searched and retrieve words that contain both words) and “OR” (used to broaden the search to contain at least one of the words) were used. The aim was to retrieve all studies except qualitative studies and narrative reviews. The references used in all qualitative studies and systematic reviews were examined by cross-reference method.

In the Magiran and SID databases and Google Scholar search engine, the terms Reading Disorder, Dyslexia, Convergence, Visual Perception, Visual Processing, Intercourse Effectiveness, and Phonological Processing were used for the search. In the search using the combination operators, the two terms of Reading Disorder and Dyslexia were used as the main terms and other words as the compound words (operator "AND": reading disorder and saccade movements, operator "OR": reading disorder OR dyslexia OR visual processing).

In the Google Scholar search engine and PubMed and ScienceDirect databases, the terms Reading disorder, Dyslexia, Convergence, Accommodative facility, Saccade movements, Visual function, Visual perception, Visual processing, Intercourse effectiveness, and Phonology recognition were used for the search. In the search using the combination operators, the two terms of Reading disorder and Dyslexia were used as the main terms and other words as the compound terms. For example, in the PubMed database, the PubMed page was directly opened via http://www.ncbi.nlm.nih.gov/pubmed, and the Basic Search and Advanced search methods, and also, the AND and OR operators were used. For instance, for the word Dyslexia considering the search limits including full text availability (Text availability: Full text), free access (Free), Article type: Clinical Trial, and publication in 10 last years (Publication date: 10 years), 50 items were found. A search using the term Saccade movements, 12 items were found, and a search with the combined operator AND (Dyslexia AND Saccade Movements) found no results. All findings were reviewed in terms of content, 2 of which were considered as related articles.

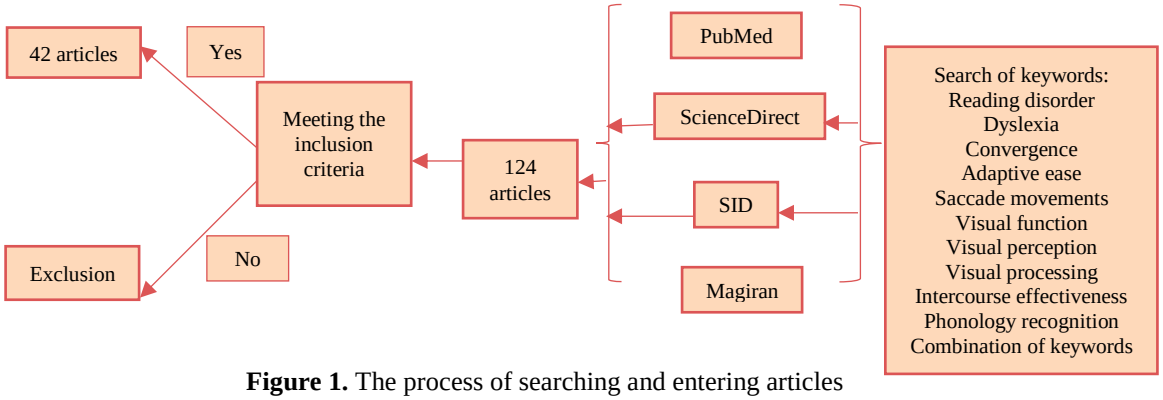

Figure 1. The process of searching and entering articles

Based on the study strategies, nearly 3,000 articles were found in the aforementioned databases. Of these articles, considering the titles and abstracts and the inclusion and exclusion criteria and after eliminating the repetitive and unrelated articles, 124 ones whose abstracts or full text were available were included in the study. First, the researcher reviewed the abstracts separately, and finally, the results of 42 articles, which were in line with the purpose of the study, were selected to review the full text. Then, the effectiveness of convergence, accommodative facility, and saccade movements in dyslexia and reading disorder were investigated. The studies found in the field of dyslexia and weakness of convergence, accommodative facility, visual functions, perceptual visual skills, visual-motor perception, and saccade movements were reviewed and the information related to the articles was tabulated and reviewed by the professors and psychologists. Finally, 18 articles were approved for analysis in the present study (Table 1), of which 4, 2, 2, 2, and 8 included visual function and perception, accommodative facility, convergence, saccade movements, and visual perception skills, respectively. The quality assessment of the studies was based on DSM-5 and their validity and reliability were assessed by the professors and clinical psychologists.

Results

The search performed resulted in 124 articles. After reviewing the titles and abstracts and during the steps of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA), 18 of the most relevant ones were adopted to be used in the present study. All articles used contained the full text (Figure 2).

From all the available articles, due to the wide field of learning disability and dyslexia, in the present study, only the accommodative facility, biological dimensions of dyslexia, visual and motor perception skills, visual interventions, visual and motor factors, emotional-behavioral problems of children with dyslexia, ocular abnormalities and reading disorders, visual perception and dyslexia, phonological or phonetic processes, and convergence comorbidity disorder were discussed. The articles that were ultimately used and analyzed in this review are presented in table 1.

Discussion

The aim of the present study was to review the available studies on the effectiveness of convergence, accommodative facility, and saccade movements on dyslexia. The results revealed that the development of children with dyslexia in reading such as speed, accuracy, and comprehension of reading, significantly increased by strengthening visual skills through convergence, accommodative facility, and saccade movements, which in turn is effective in educational progress and daily life activities that require reading skills.

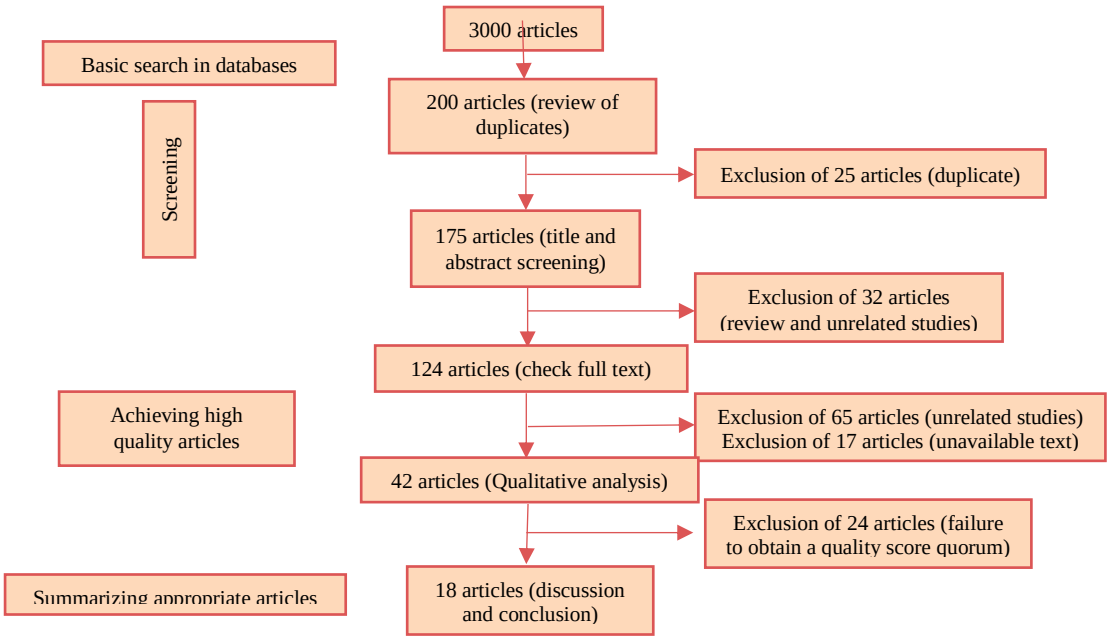

Figure 2. Dropout of articles in different stages based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) flowchart

Table 1. Details of the studies included in the analysis of the present review study

References	Type of study	Scope	Number and age group of participants	Study objective	Outcome
Soltani et al. (26)	Cross-sectional and analytical	Dyslexia	35 children with dyslexia and 35 normal children from primary schools	Evaluation of visual perception skill of developmental dyslexics and comparison of this skill with normal children	The visual perception skill of the children with dyslexia was not significantly different from that of the normal children.
Aghaei Sabet et al. (10)	Quasi-experimental	Dyslexia	10 primary school students with dyslexia (score less than 25 in the reading ability assessment test), 10 primary school students from skilled readers (score above 75 in the reading ability assessment test)	The effect of visual interventions on reading performance improvement	Visual intervention improved reading performance by improving reading-related impaired visual functions.
Biscaldi et al. (29)	Quasi-experimental	Dyslexia	186 individuals aged 8 to 26 years	Assessing dyslexia and reading disorder in saccade movement reactions of individuals	Individuals with dyslexia were weaker in controlling saccadic movements than those without dyslexia.
Tahmasbi et al. (12)	Quasi-experimental	Dyslexia	20 children with dyslexic aged 7 to 11 years old	Assessment of accommodative facility reinforcement exercises as well as Nejati cognitive rehabilitation software (basic visual function enhancement exercises)	After the intervention, a significant increase in reading accuracy and comprehension scores and a significant decrease in the reading error score were reported in the experimental group.
Same Siahkalroodi et al. (30)	Quasi-experimental	Dyslexia	Two groups of 30 students with dyslexia in the third grade of primary school	The effect of teaching visual perception skills on improving reading performance in students with dyslexia	Teaching visual perception skills improved the reading performance of students with dyslexia and, as a result, made significant improvements in their ability to read and comprehend. Therefore, these trainings are recommended for students with dyslexia who have difficulty in visual perception.
Mahmoudi and Badami (31)	Quasi-experimental	Dyslexia	22 children aged 8 to 10 years	The effect of sports vision exercises on visual perception and motor skills of children with dyslexia aged 8 to 10 years	Exercise vision training improved visual perception and motor skills of children with dyslexia.
Mirtaheri et al. (32)	Causal-comparative	Dyslexia	Male and female elementary school students (7 to 12 years old)	Comparison of eye movements (fixation and saccade) of students with and without dyslexia in visual perception tasks	There was no significant difference in eye movements of the students with or without dyslexia in visual perception tasks, but considering the difficulty levels of the tasks, the two groups showed significant differences in the duration of fixation and saccade. The difficulty of the tasks caused a change in strategy on eye movements that the students with dyslexia did not benefit from.
Joo et al. (33)	Quasi-experimental	Dyslexia	20 people aged 26 to 46 years with reading disorder	Assessing visual processing disorder of adults in reading text and determining the effect of visual improvement exercises	People with dyslexia had difficulty with visual processing, and exercises to improve their visual system improved their reading performance.
Momeni Moghadam et al. (34)	Quasi-experimental	Reading disorder and dyslexia	74 subjects aged 12 to 25 years with symmetry failure referred to Al-Zahra Ophthalmology Center in Zahedan, Iran.	Assessment of dyslexia and visual convergence	In a patient with convergence disorder, the results of one of the tests may be within the normal range, but the person may still have the disorder.
Harandi et al. (5)	Quasi-experimental	Reading disorder	95 students with reading disorder (cluster sampling)	The effect of parenting and visual function on improving the reading of students with reading disorder	Parenting styles and visual function improved reading performance in children with reading-specific learning disabilities.

Table 1. Details of the studies included in the analysis of the present review study (continue)

References	Type of study	Scope	Number and age group of participants	Study objective	Outcome
Hasanirad et al. (35)	Quasi-experimental	Reading disorder	40 third grade elementary school students	Comparison of visual perception skills and selective attention of elementary school students with and without reading disorder	There was a significant difference between visual perception skills (in all five sub-skills) and the selective attention skill of the third grade elementary school students with and without reading disorder.
Grisham et al. (9)	Quasi-experimental	Reading disorder	20 children aged 7 to 11 years with reading difficulties	Assessing the accommodative facility disorder in children with reading difficulties	Characteristics of eye movements of people with reading difficulties included increased number of forward fixations along a line of text, increased number of recurrences, and longer fixations compared to normal individuals.
Raghuram et al. (36)	Observational prospective and uncontrolled	Reading disorder	31 girls and 31 boys aged 9 to 16 years	Evaluation of vision and its defects in children with reading disorders	Visual dysfunction in children with reading disabilities was higher at school age than in children without reading disabilities.
Ramezanzadeh Chafochaei (37)	Quasi-experimental	Learning disability (reading and mathematics)	26 students without the disability and 26 students with learning disabilities in the third and fourth grades of elementary school	Comparison of visual-motor skills of normal students with those of students with special reading and math learning disabilities	Visual-motor skills of normal students were higher than those of students with reading and math disorders.
Taghizadeh et al. (38)	Causal-comparative	Learning disabilities (dyslexia, mathematics)	Two groups of 16 second- to fifth-grade elementary school students with learning disabilities	Comparison of executive functions of visual function of visual-spatial working memory, planning, organizing, and computational and reading errors in children with learning, reading, and mathematics disabilities and normal children	Executive actions were not effective in learning disability, but executive action of visual-spatial working memory was considered as an effective factor in learning disability and the overall improvement of this action was effective in correcting errors.
Ebrahimi and Kamyabi (39)	Experimental	Learning disabilities (Reading and mathematics)	30 elementary students with learning disabilities	Evaluation of the effect of visual perception games on improving reading and arithmetic performance	Play therapy improved reading and mathematics skills in elementary school students with learning disabilities.
Ashrafzadeh et al. (6)	Quasi-experimental	Learning disorders (reading disorder)	202 fourth to sixth grade students with learning disabilities	The effect of cognitive and metacognitive strategies of the visual performance of the students with learning disorders based on motivational beliefs and mediation of learning styles.	Metacognitive strategies explained the motivational beliefs of the students more than the cognitive strategies of the visual performance did, which indicates the fundamental importance of the role of metacognitive strategies in students' motivational beliefs with learning disabilities.
Sharif et al. (40)	Quasi-experimental	Visual convergence weakness	160 18-30 year-old students of Faculty of Rehabilitation, Iran University of Medical Sciences, Tehran, Iran	Evaluation of visual convergence weakness in students	Given the significant prevalence of convergence weakness among students, due to its annoying symptoms when studying and working with computers and the impossibility for the students to avoid these activities, screening and treatment seem essential.

In a study on the ease of adaptation in children with reading difficulties, Grisham et al. concluded that the characteristics of eye movements, including increasing the number of forward fixations along a line of text, increasing the number of recurrences, and longer fixations in people with reading disorders is higher than those in normal people (9). Additionally, in the study of convergence disorder, the mean values of near point near-convergence and near-positive fusional reserves were abnormal in most people with convergence disorder compared to healthy individuals, reinforcing the possibility that despite convergence disorder, the results of some tests in the assessment of affected individuals may be in the normal range (19,40). In another study, the significant prevalence of poor convergence among students of the School of Rehabilitation, Iran University of Medical Sciences, Tehran, Iran confirmed the importance of screening and treatment of this disorder in students. This disorder causes annoying symptoms during activities such as reading and working with the computer; while avoiding this group of activities is not possible for the studying population (40). The results of further research on children with reading difficulties indicated that there was a significant association between the accommodative facility disorder and eye movements, including an increase in the number of forward fixations along a line of text, an increase in the number of recurrences, and longer fixations, compared to the normal individuals, and the exercises enhancing the accommodative facility and convergence improved the performance of children with dyslexia (7,18,19,28,29,34,40).

Numerous other studies have confirmed the existence of such problems. For example, in comparing the control of saccadic eye movements in children with dyslexia and children in the control group, a significant relationship was observed between the control of saccadic movements and reading disorder (18,29). Reading problems are associated with visual impairments (41-43). It seems that practice and experience can lead to faster saccade movements (29,38). Visual intervention may improve reading performance by improving reading-related impaired visual functions (10). On the other hand, there is a significant relationship between the control of saccade movements and reading disorder (30,36,39,44) and after performing visual interventions, visual functions and, consequently, students' reading performance were strengthened (21,22,25,30,31,33,35-39,41-45).

Some researchers, based on the study of the role of genes in reading disorders (32) and twins and families (7), have strongly stated that learning disorders, especially reading disorders, are the result of gene transfer (5,32,46). Different parts of chromosomes 1, 2, 3, and 18 (47), in addition to chromosomes 6 and 15 that were identified earlier (7,46), are involved in this disorder (5). The risk of having a son with dyslexia from a father with dyslexia is estimated at about 40% (11). Phonological dyslexia and impairment in writing skills and phonological encoding are said to have strong inherited traits, and research has focused on symptoms on chromosome 6 (5,11,32,33,46). The results of studies show that in addition to various factors such as visual perception (12), executive functions (33), parenting style of parents (5,7,34), and genes (46, 5) are also effective in causing learning disabilities.

The visual function parenting styles improve reading performance in children with special learning disabilities such as reading (7), but careless parenting style has a negative effect on children's reading performance and makes children with reading disabilities more vulnerable (5,34). In their study, Mahmoudi and Badami found that metacognitive strategies explained the motivational beliefs of students more than the cognitive strategies of visual function did, indicating the fundamental importance of the role of metacognitive strategies in the motivational beliefs of students with learning disabilities (31). Therefore, it can be concluded that with their parenting style, parents play a role in children's dyslexia; Because sometimes due to environmental pressures and inattention of others to the special abilities of these students, psychological and behavioral problems are added to their previous problems, which in turn leads to their apathy and reduced motivation to all issues related to education (7,34).

The basic visual function rehabilitation program has been shown to improve the reading ability of children with dyslexia (12). Moreover, sports vision training in children aged 8 to 10 years led to the improvement of visual perception skills and motor skills in them (35). By intervening in visual and motor perception skills and performing perceptual-visual and motor exercises, a significant increase in reading accuracy and comprehension scores and a significant decrease in reading error score were observed. In other words, the basic visual function rehabilitation program improved the reading ability of children with dyslexia and sports vision exercises also improved the visual perception and motor skills of these children. Studies have even suggested that teaching visual perception skills improves the reading performance of learnable students with mental disabilities (11,12,30,31,33,35-39,44,45). Given the results of the studies mentioned, rehabilitation and

sports programs lead to eye coordination and by strengthening visual function and perception, can play an effective role in improving reading performance and text comprehension (11,44,47,48).

Comparison of visual perception skills and selective attention of third grade elementary school students with and without reading disorder showed that visual perception skills (in all five sub-skills) and selective attention skills contribute to dyslexia and reading disorder. Because these skills are less common in students with reading disabilities than in normal students (37); A finding that was not confirmed by comparing visual perception skills in children with developmental dyslexia and normal children (26). Comparing the two studies, it can be concluded that visual skills are effective on reading disorders and dyslexia, but do not affect developmental dyslexia (related to developmental disorders) (26,37).

In another study, the visual-motor skills of normal students and students with special reading and math learning disabilities in the third and fourth grades of elementary school were examined. A pairwise comparison of the groups using the Scheffe post hoc test showed that there was a significant difference between the visual-motor skills of the students with arithmetic disorder and those with dyslexia, but no significant difference was observed between the groups of arithmetic disorder and dyslexia (45). Given the abovementioned studies, it is necessary to pay more attention to these skills in order to prevent the decline in performance of children and students.

Although executive actions do not seem to be effective in learning disabilities, the executive actions of visual and spatial working memory (WM) are considered as effective factors in learning disabilities and overall improvement of these actions is effective in correcting errors (33). Optimizing the performance of the visual system of individuals with dyslexia who have difficulty processing vision leads to improved reading performance in them (39); the finding that was confirmed by improving reading and mathematics skills of elementary school students with learning disabilities through play therapy with visual perception games (36).

The results of various studies have shown that attention to visual interventions increases the rate of improvement of temporal reading performance (12,30,31,33,35-39,41-45). Therefore, although visual impairment may not be the main cause of dyslexia, it can lead to reading impairment.

Limitations

Among the limitations of the present study was the lack of full access to some articles (exclusion of 17 articles due to lack of full access to the text of the article).

Recommendations

It is suggested that due to the importance and effect of dyslexia and reading disorders to find more effective exercises in increasing accommodative facility, convergence, and saccade movements, more research be accomplished in this field.

Conclusion

On the basis of this review, it seems that there is a direct relationship between the effectiveness of convergence, accommodative facility, and saccade movements with dyslexia and reading disorder, and it may be possible to help children with reading disorders and dyslexia through strengthening convergence, accommodative facility, and saccadic movements.

Acknowledgments

The present study was the results of articles searched from the domestic and international databases and performed with ethics code IR.IAUK.REC.1398.1.95381, which was approved by the Kerman Branch, Islamic Azad University, Kerman, Iran. The authors would like to appreciate the Clinical Council and the Vice Chancellor for Research of the Kerman Branch, Islamic Azad University and all the professors who cooperated in the implementation of this project.

Authors' Contribution

Hanieh Falahati: study design and ideation, study support, executive, and scientific services, providing study equipment and samples, data collection, manuscript preparation, analysis and interpretation of results, specialized manuscript evaluation in terms of scientific concepts, approval of the final manuscript to be sent to the journal office, responsibility for maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments; Amanullah Soltani: study support, executive, and scientific services, providing study equipment and samples, analysis and interpretation of results, specialized manuscript evaluation in terms of scientific concepts, approval of the final manuscript to be sent to the journal office, responsibility for maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments; Hamdaleh Manzari-Tavakoli: study support, executive, and scientific services, providing study equipment and samples, analysis and interpretation of results, specialized manuscript evaluation in terms of scientific concepts, approval of the final manuscript to be sent to

the journal office, responsibility for maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments; Mitra Kamyabi: study support, executive, and scientific services, providing study equipment and samples, analysis and interpretation of results, specialized manuscript evaluation in terms of scientific concepts, approval of the final manuscript to be sent to the journal office, responsibility for maintaining the integrity of the study process from the beginning to publication, and responding to the referees' comments.

Funding

The present study was based on articles searched from internal and external databases with the financial support of the first author. Kerman Branch, Islamic Azad University did not comment on data collection, analysis, and reporting, manuscript preparation, and final approval of the article for publication.

Conflict of Interest

The authors declare no conflict of interest. Hanieh Falahati attracted the budget for the basic research-related study from the first author and has been studying as a PhD student at the Kerman Branch, Islamic Azad University since 2016. Dr. Amanullah Soltani, the First Supervisor, has been working as an assistant professor at the Kerman Branch, Islamic Azad University since 2001, Dr. Mitra Kamyabi, the Second Supervisor, has been working as an assistant professor at the Kerman Branch, Islamic Azad University since 2012, and Dr. Hamdaleh Manzari-Tavakoli, Consultant Professor of this research, has been working as an assistant professor at the Kerman Branch, Islamic Azad University since 2004.

References

1. American Psychiatric Association. Diagnostic and statistical manual of mental disorders. 5th ed. Arlington, VA: APA; 2013.
2. Glover JA, Bruning RH. Educational psychology: Principles and applications. Trans. Kharazi A. 4th ed. Tehran, Iran: Nobahar Publications: 2012.p. 75-80. [In Persian].
3. Shayan N, Akhvan Tafti M, Ashayeri H. Impact of Davis Dyslexia Correction Method on the improvement of the adult dyslexics' reading Skills. Journal of Educational Psychology Studies 2011; 7(12): 23-46. [In Persian].
4. Rutter M, Yule W. The concept of specific reading retardation. J Child Psychol Psychiatry 1975; 16(3): 181-97.
5. Harandi V, Soltani A, Manzari Tavakoli A, Zeinadini Z. The role of marital satisfaction and parenting style in function reading in children with specific learning disorder. Middle Eastern Journal of Disability Studies 2018; 8: 62. [In Persian].
6. Ashrafzadeh S, Andishmand V, Manzari H. Explaining the cognitive and metacognitive strategies of students with learning disabilities based on motivational beliefs and mediation of learning styles. Middle Eastern Journal of Disability Studies 2020; 10(0): 24. [In Persian].
7. Gilger JW, Pennington BF, Defries JC. Risk for reading disability as a function of parental history in three family studies. Read Writ 1991; 3(3): 205-17.
8. Seyyedsharbati M, Zarei HA, Hoseininasab D. Comparative of visual-spatial working memory perception in Normal Students and special learning disabilities Students. Journal of Rehabilitation Medicine 2021; 9(2): 54-60. [In Persian].
9. Grisham D, Powers M, Riles P. Visual skills of poor readers in high school. Optometry 2007; 78(10): 542-9.
10. Aghaei Sabet S, Pouretemad H, Jafarzadehpur E, Hassanabadi H. Improvement of reading performance through vision therapy. Adv Cogn Sci 2013; 15(3): 1-11. [In Persian].
11. Pirzadi H, Ghobari Bonab B, Shokoohi Y, Yaryari F, Hasanzadeh S, Sharifi A. The impact of teaching phonemic awareness by means of direct instruction on reading achievement of students with reading disorder. Aud Vestib Res 2017; 21(1): 83-93.
12. Tahmasbi T, Nejati V, Ghssemi Broumand M, Tabatabaee SM. Effect of basic visual functions rehabilitation on reading ability in dyslexic children. Journal of Rehabilitation Medicine 2014; 3(1): 32-41. [In Persian].
13. Ministry of Education. Literature review: An international perspective on dyslexia. New Zealand: Ministry of Education; 2007.
14. Charles W. Thoughts on the research of the reading vision association. J Behav Optom 2012; 13(6): 153-6.
15. Ciuffreda KJ. The scientific basis for and efficacy of optometric vision therapy in nonstrabismic accommodative and vergence disorders. Optometry 2002; 73(12): 735-62.
16. Garzia RP, Borsting EJ, Nicholson SB, Press LJ, Scheiman MM, Solan HA. Optometric Clinical Practice Guideline: Care of the Patient with Learning Related Vision Problems. St. Louis, MO: American Optometric Associatio; 2010. p. 6341-7881.
17. Facoetti A, Lorusso ML, Paganoni P, Umilta C, Mascetti GG. The role of visuospatial attention in developmental dyslexia: Evidence from a rehabilitation study. Brain Res Cogn Brain Res 2003; 15(2): 154-64.
18. Whitsell LJ. Learning disorders as a school health problem. Neurological and psychiatric aspects. Calif Med 1969; 111(6): 433-45.
19. Mazow ML, France TD, Finkleman S, Frank J, Jenkins P. Acute accommodative and convergence insufficiency. Trans Am Ophthalmol Soc 1989; 87: 158-68.
20. McConkie GW, Rayner K. The span of the effective stimulus during a fixation in reading. Percept Psycho 1975; 17(6): 578-86.
21. Metsing TI, Ferreira JT. Visual deficiencies in children from mainstream and learning disabled schools in Johannesburg South Africa. S Afr Optom 2015; 67(4): 176-184. 2021.

22. Palomo-Alvarez C, Puell MC. Binocular function in school children with reading difficulties. Graefes Arch Clin Exp Ophthalmol 2010; 248(6): 885-92.
23. Quaid P, Simpson T. Association between reading speed, cycloplegic refractive error, and oculomotor function in reading disabled children versus controls. Graefes Arch Clin Exp Ophthalmol 2013; 251(1): 169-87.
24. Tikdari A, Soltani A, Razavi vS, Manzari Tavakoli H. The effects of working memory training on mathematics performance and working memory capacity in students with dyscalculia. Middle Eastern Journal of Disability Studies 2020; 10(0): 229. [In Persian].
25. Tabrizi M, Tabrizi A, Tabrizi N. Treatment of reading disorder. 17th ed. Tehran, Iran: Faravaran Publications; 2019. p. 13-9. [In Persian].
26. Soltani M, Sima Shirazi I, Moradi N, Lorizadeh MR. Investigating and comparing visual visual perception skills in children with developmental and normal dyslexia in Ahvaz. J Res Rahabil Sci 2008; 3(1): 27-32. [In Persian].
27. Hammond J, Hercules. Understanding dyslexia: An introduction for dyslexic students in higher education. Edinburg, UK: SHEFC National Coordinator; 2018. p. 56-98.
28. Wajuihian S, Naidoo K. Visual factors and dyslexia: A research review. African Vis Eye Health 2010; 69(2): 58-68.
29. Biscaldi M, Gezeck S, Stuhr V. Poor saccadic control correlates with dyslexia. Neuropsychologia 1998; 36(11): 1189-202.
30. Same Siahkalroodi L, Alizadeh H, Kooshesh M. The impact of visual perception skills training on reading performance in students with dyslexia. Adv Cogn Sci 2009; 11(2): 63-72. [In Persian].
31. Mahmoudi S, Badami R. The effect of sports vision exercises on motorfundamental skills and visual perceptual skills of 8-10-year-old dyslexic children. Adv Cogn Sci 2017; 19(2): 43-51. [In Persian].
32. Mirtaheri G, Fathabadi J, Sharifi M, Sadeghi Firoozabadi V. Comparison of eye movements of students with and without dyslexia in visual perception tasks. Journal of Exceptional Children Empowerment 2019; 9(4): 29-40. [In Persian].
33. Joo SJ, White AL, Strodtman DJ, Yeatman JD. Optimizing text for an individual's visual system: The contribution of visual crowding to reading difficulties. Cortex 2018; 103: 291-301.
34. Momeni Moghadam H, Ansari H, Yekta AA, Ehsani M, Samandar M, Mokhtari S. The survey of diagnostic tests in patients with convergence insufficiency referring to Alzahra (pbuh) ophthalmology center of zahedan in 2007. Horizon Med Sci 2007; 13(2): 5-11. [In Persian].
35. Hasanirad M, Arjmandnia AA, Bagheri F. Comparative study of visual perception and selective attention skills of primary school students with and without reading disability. Journal of Exceptional Children Empowerment 2017; 7(20): 24-33. [In Persian].
36. Raghuram A, Gowrisankaran S, Swanson E, Zurakowski D, Hunter DG, Waber DP. Frequency of visual deficits in children with developmental dyslexia. JAMA Ophthalmol 2018; 136(10): 1089-95.
37. Ramezanzadeh Chafochaei Z. Comparison of motor vision skills of normal students with students with special learning disabilities and mathematics in the third and fourth grades of elementary school [PhD Thesis]. Tehran, Iran: Islamic Azad University; 2014. [In Persian].
38. Taghizadeh H, Soltani A, Manzari Tavakoli H. Comparison of executive functions visual-spatial working memory, planning, organizing and calculation errors in children with learning disabilities and children account normal failure. Journal of Health Breeze (Family Health) 2017; 5(3): 1-13. [In Persian].
39. Ebrahimi M, Kamyabi M. The effect of visual perception games on improving reading and arithmetic performance of primary school students with learning disabilities. Proceedings of the 1st National Conference of Exceptional Children from the Perspective of Educational Psychology, Cognitive Science and Pathology; 2020 Nov 13; Ahvaz, Iran. [In Persian].
40. Sharif Z, Mirzajani A, Jafarzadehpur E. Prevalence of convergence insufficiency in a population of university students. Journal of Paramedical Science and Rehabilitation 2014; 3(1): 47-52. [In Persian].
41. Karimi H, Sabouri G, Ghasemi Gheidari A, Nemati Z. Frostig visual perceptual activities on improving the effectiveness of advanced reading students with Special learning disorder dyslexia: a single subject. Journal of Exeptional Children 2019; 19(3): 115-28. [In Persian].
42. Pourfaramand M, Taher M. The effectiveness of visual skill-based computer games on visual-auditory-spatial perception and reading tracking speed of students with special learning disabilities. Journal of Learning Disabilities 2021; 10(2): 7-24. [In Persian].
43. Rezaee F, Hosseini R, Mazinani M. A new classification model fuzzy-genetic algorithm for detection of learning disability of dyslexia in secondary school students. Tech Edu J 2019; 13(2): 439-48.
44. Heidari Kh, Faramarzi S, Abedi A, Ghamarani A. Designing the comprehensive diagnostic test of dyslexia (CDTD) and investigating its validity and reliability for primary school students of Isfahan in 2015-2016. Journal of Paramedical Science and Rehabilitation 2019; 8(2): 17-28. [In Persian].
45. Zarrin Azami Z, Jafarzadehpur E, Mirzajani A, Khabazkhoob M. Comparison and measurement of velocity of saccadic eye movements between expert and novice basketball referees by dynamic electero-oculogram technique. Journal of Paramedical Sciences and Rehabilitation 2016; 5(1): 30-7. [In Persian].
46. Becker N, Vasconcelos M, Oliveira V, Santos FCD, Bizarro L, Almeida RMM, et al. Genetic and environmental risk factors for developmental dyslexia in children: systematic review of the last decade. Dev Neuropsychol 2017; 42(7-8): 423-45.
47. Stein JF, Richardson AJ, Fowler MS. Monocular occlusion can improve binocular control and reading in dyslexics. Brain 2000; 123 (Pt 1): 164-70.
48. Stein JF, Nicolson RI, Fawcett AJ. A visual defect in Dyslexia? In: Fawcett A, Nicolson R, editors. Dyslexia in children: Multidisciplinary perspectives. New York, NY: Harvester Wheatsheaf; 1994.