Technology based Ergonomics Solutions for Children with Dyslexia

Swati Bawa Sawhney[1] & Dr. Namrata Arora Charpe[2]

_____

1.Research Scholar, Banasthali Vidyapith and Assistant Professor, Bharati College, University of Delhi, India.
2.Associate Professor, Banasthali Vidyapith, India.

Abstract

The study aims to work on a technology based ergonomic solution for children with dyslexia. "Dyslexia is among one of the three types of learning disability or in other words a language processing disorder, in which individuals experience challenge in learning to read and write, although it is not associated with low level of intelligence" (*Madeira J et.al, 2015*). Dyslexia is a disorder with a neural origin that causes lack of ability in reading and writing despite normal intellect and sensory abilities. The current paper is sub-part of the main study and focuses on children with dyslexia studying in class IV- VIII in government schools in Delhi. Children diagnosed as dyslexic by psychological assessment by special educator at school were selected for the study. The children with dyslexia were screened using Dyslexia Screening Test (2014) by Harp Learning Institute on individual basis. The study covers 30 children with Dyslexia studying in government schools of North-West Delhi. The screening tool includes areas such as alphabet recognition, differentiation between letter 'b' and 'd', letter reversal, matching figures, matching words, copying figures, word recognition, memorization, reversed words, rhyming words, understanding instructions, word and sentence repetition and reading. The study reflects on the key areas where children are lacking with regard to English language for which technology-based intervention is required.

Keywords: *Children with Dyslexia, Technology, Ergonomics and Sensory Abilities.*

1. INTRODUCTION

Dyslexia is a disorder with a neural origin that causes lack of ability in reading and writing despite normal (or above) intelligence and sensory abilities.

"Dyslexia among children is a specific and significant loss in reading abilities who otherwise possess adequate intellect and motivation" (*Suvarna R et.al, 2013*).

"Dyslexia is one of the learning disability or in other words a language processing disorder, in which people have difficulty in learning to read and write, although it is not associated with a low level of intelligence" (*Madeira J et.al, 2015*).

Dyslexia is one of the most common learning disabilities, and nearly 70% - 80% of students diagnosed with Learning Disability have deficits in reading. It has a worldwide incidence of 5-20%. Dyslexia is found among 15% of the Indian population i.e. nearly 228,994,454 students in recognized schools (*PIB, 2015*).

"Diagnosing dyslexia at an early stage is important to mitigate the child having to go through a stressful childhood. Early detection helps to direct the child with dyslexia to targeted assistance, which has shown promising results" (*Heim, 2004*). "Although dyslexia has been known for the last ten decades and is spread among a significant population, unfortunately it often goes undiagnosed" (*Oglethorpe, 2002*).

According to a ruling of the Delhi High Court (September 2012) all government, private and public schools are mandated to equip themselves to handle children with various disabilities including learning disability. As a positive measure, it was observed that Specific Learning Disability (SLD) has been recently included in the Person with Disabilities Act and Diagnostic and Statistical Manual of Mental Disorders (DSM V).

1.1 Assessment of Dyslexia

According to PIB (2015), it has been reported that often dyslexia among children gets undiagnosed due to lack of awareness among parents and teachers and also because of absence of screening tools in Indian languages. Based on the above needs, Dyslexia Assessment for Languages of India (DALI) was developed in 2015 at the National Brain Research Centre in India, under the project supported by the Department of Science and Technology, Government of India. "DALI is prepared for children studying in grade 1 to 5 for screening and assessment of children who are at risk of dyslexia. The assessment is carried out in the native language using age appropriate and culturally valid psychological tests" (*PIB, 2015*)

In addition, there are other screening tools available to identify children with dyslexia. "These procedures examine performance in a range of activities such as visual ability, auditory memory, phonological discrimination, sequencing, automaticity, laterality and others" (*Mortimore, 2007*). They include tests such as:

- Dyslexia Screening Test by Pearson
- Lucid Research's LADS
- Dyslexia Screener
- Nimham's Neuropsychological Battery for Children

"Being a learning disability, dyslexia is a lifelong condition. It is not a disease and it has no cure so far, but it is possible to minimize its effects through age-appropriate dyslexic re-education programs" *(Suvarna R et.al, 2013).*

1.2 Cognitive ergonomics

Cognitive ergonomics is a scientific discipline that studies, evaluates, and designs tasks, jobs, products, environments and systems and how they interact with humans and their cognitive abilities. It is defined by the International Ergonomics Association (IEA) as "concerned with mental processes, such as perception, memory, reasoning, and motor response, as they affect interactions among humans and other elements of a system. Cognitive ergonomics is responsible for how work is done in the mind, meaning, the quality of work is dependent on the persons understanding of situations. Situations could include the goals, means, and constraints of work (*Erik. H, 2010*). The relevant topics under cognitive ergonomics include mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training as these may relate to human-system design" (*IEA, 2014*). Cognitive ergonomics studies cognition in work and operational settings, in order to optimize human well-being and system performance. It is a subset of the larger field of human factors and ergonomics.

So, the current study proposes to understand and identify key areas for which technology based ergonomic solution for children with dyslexia in the age group of 9-12 years attending school can be prepared.

2. REVIEW OF LITERATURE

According to Rello et.al. (2019), "People with dyslexia have, despite their general intelligence, difficulties for reading and writing through their whole life. Therefore, web technologies can help people with dyslexia to improve their reading and writing experience on the web. The study introduces the main technologies and many examples of tools that support a person with dyslexia in processing information on the web, either in assistive applications for reading and writing as well as using web applications/games for dyslexia screening and intervention".

Alobaedy et.al. (2018) studied "assistive applications designed for children with dyslexia and found two categories of virtual assistants used in the analyzed assistive applications, which are girl-like and animal-like objects. The girl-like object is used by 83.3% of the analyzed works. Further the study proceeded with the on-site experiment to collect dyslexic children's preferences. The result showed that boy-like objects are much more preferable, depending on their gender, which contradicts with previous works that present girl-like objects as avatar most of the time".

Perera et.al (2016) revealed that "modern computational technologies play a significant role in enhancing the conventional dyslexia detection techniques as well as in discovering novel approaches for dyslexia detection. The study covers the modern technologies that are being used and examines the existing gaps in the dyslexia detection procedures in order to benefit future research".

Hamid et.al (2015) presented a study of "computer-based learning model to support students with dyslexia interesting, user-friendly, attractive and supportive. The work is crucial to provide a basis for developing a computer-based learning model that addresses dyslexia language-based learning difficulties that considers both students cognitive and emotion. In addition, the study also explores the uses of machine learning (ML) approach to improve effectiveness of the learning process".

Jenny et.al (2012) offered a "new concept called in education called Artificial Education. Though the term artificial education might disturb many educators, parents and students, it is important to understand what it is and the potential it has for the educational success of all learners. This is a short introductory article on what artificial education refers to, and how intelligent or expert systems can assist students and teachers at the elementary level".

3. METHODOLOGY

Locale of the study: The research was carried out in Delhi.

Sample and its selection: For the study, 30 school going special children in the age group of 9-12 years was selected for the study. Already diagnosed children with dyslexia by psychological assessment by a special educator were selected.

The screening of 30 children with dyslexia was carried out using Dyslexia Screening Test (2014) by Harp Learning Institute covering three government schools in North-West Delhi. The screening tool includes areas such as alphabet recognition, differentiation between letter 'b' and 'd', letter reversal, matching figures, matching words, copying figures, word recognition, memorization, reversed words, rhyming words, understanding instructions, word and sentence repetition and reading. The study was carried out to measure the reading skills among children. In this, children were given various tasks with regard to phonological

awareness, memorization, identification, reading levels and so on. Each child's correct responses were recorded for each and every item. Reading Speed is also measured as the number of error-free words divided by reading time, where error-free words are the number of read words minus errors made in reading them (*Suvarna R et.al, 2013*).

4. DATA ANALYSIS PROCEDURE

The students were assessed using 'Dyslexia screening test' and the scores for each item were assessed by counting the number of mistakes done by the child. It was done based on the answer key given as part of the tool. At the end of the tool, a cumulative score is calculated based on the items missed by the child or in other words by counting the number of correct responses given by the child. As per the answer key, it is acceptable for the child to make 5-7 mistakes between 2nd to 8th grade in the entire tool. If any child makes more mistakes than the given norms, the child can be considered as Dyslexic.

For the purpose of analysis for the current paper, 18 items covered under the dyslexia screening test are sub-divided into 4 major sub-heads. The sections are as follows:

1) Alphabet awareness and reversal: covers item no.1, 2, 3, 6, 9, 11, 12 and 13. This section covers child's awareness regarding alphabets, understanding letter reversal, identification of required words, decoding the words and rhyming words.

2) Matching games: covers item no. 4, 5 and 7. This section covers identification of matching figures and matching words.

3) Copying figures / memorization: covers item no. 8, 10 and 15. This section covers copying the figures, memorizations of letters and observing & drawing figures.

4) Reading: covers item no.15, 17 – 18. This section covers reading 3 letter words, repeating the given words in a sequence and repeating sentences.

5. RESULT

The result section has been divided into various sections covering the meta-analysis, demographic profile of the children selected for the study and scores of children achieved after conducting the Dyslexia Screening Test.

5.1 Demographic profile of children

The data covers the background information regarding children covered under the study. It includes the age and sex of children studying in government schools of Delhi.

Table 1: Age and Sex of children with Dyslexia

Age group and Sex of the child		
Row Labels	**Female**	**Male**
9-year-olds		4
10-year-old	5	2
11-year-old	3	4
12-year-old	10	2
Grand Total	18	12

The sample children fall in the age bracket of 9 to 12 years i.e. class IVth to class VIIIth. The above data reveals that majority of the sampled children were females i.e. 60% (18 girls). Whereas the remaining 40% of sampled children were boys. In addition, it can also be reported

that the majority of the girls (33.33%) fall in the age bracket of 12-year-old. Whereas, in case of boy's majority are of 9 and 11-year-old respectively.

5.2 Recognition of dyslexic characteristics

This section covers the skills revealed by children with dyslexia and also highlights the areas where invention is required. This section reflects the correct responses given by children.

5.2.1 Phonological awareness

Phonological awareness refers to phonetics/ sound of each letter which helps the child to form words and later form sentences. It is one of the school readiness skills which prepares the child for reading readiness and generally emphasized in the age group of 5 and above. With regard to children with dyslexia this skill can be delayed as they find it challenging to identify and memorize letters and its phonetics.

5.2.1.1 Alphabet recognition
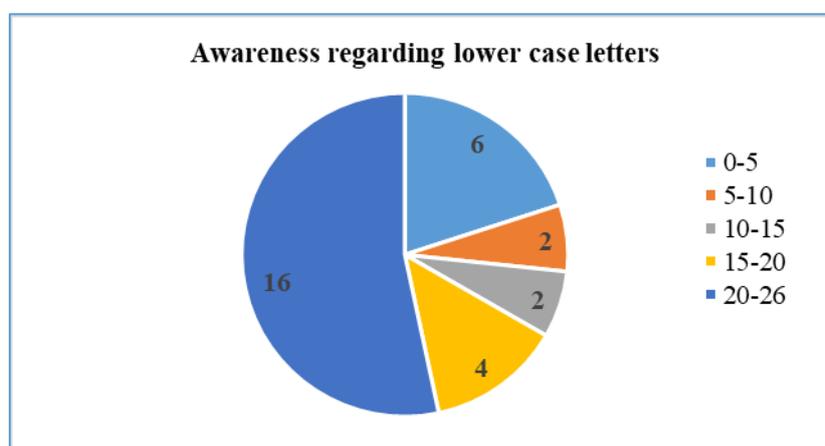
Figure 1: Awareness regarding lower case letters

To understand dyslexic characteristics among the 30 selected children, they were given the Dyslexia Screening Test (2014) by Harp Learning Institute. When children were asked to write alphabets in lower case letters, it was a mixed response found among children. The above range signifies the correct responses given by children. It was found that among the common errors made by children, they were mixing upper- and lower-case letters, though the question clearly says they need to write in lower case letters. There was also error while confusing letters such as letter b and d, p and q and so on.

The above data reveals that 16 out of 30 children (53.3%) which is more than half of the sample demonstrated very good mastery in writing lower case letters as they were able to write above 20 letters correctly. In addition, it was found that 20% of the children were able to write only five or below alphabets correctly, reflecting that one-fifth of the learners have poor writing ability and require remedial instruction and practice. Around, 13.3% (4) of the children gave correct responses in the range of 15–20, indicating good performance.

On the contrary, 6.7% of the children with dyslexia gave correct responses in the range of 10-15 and 15-20 similarly, showing low to below-average performance. Further, it can be concluded that they all need support as none of them were able to write entire 26 alphabets correctly, so this highlights the need for intervention as they are studying the standard IV to class VIII.

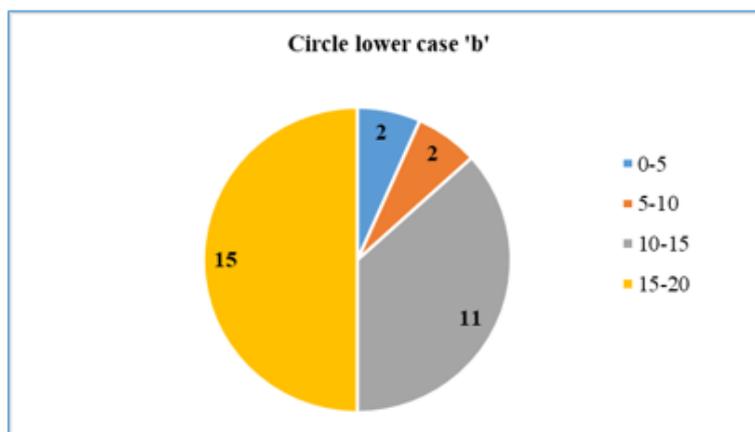### *5.2.1.2 Recognition of lower-case letter 'b'*

Figure 2: Recognition regarding lower case letter 'b'

When children with Dyslexia were asked to circle lower case letter 'b' from a mix box of letters such as letter b, d, p and q, it was found that a very large majority of the children (86.6%) gave 10–20 responses correctly, indicating that they were able to identify and circle the letter 'b'. Rest of the 4 children (13.33%) gave correct responses in the range of 0-10, indicating confusion with letter recognition.

5.2.2   Letter and word reversals

Understanding reversals among words and letters is one of the crucial skills which children with dyslexia finds challenging and need to master with practise. In this section, children were given various opportunities to practise these skills such as identifying letter reversals and words with reversed letters. The questions moved from simple to complex tasks for children.

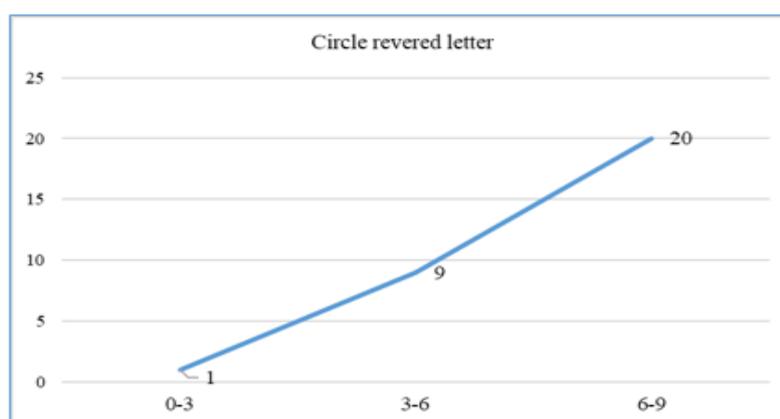### *5.2.2.1 Letter reversal*

Figure 3: Identification of Reversed Letters

When the children were asked to mark reversed letters, the children got confused and was able to do correctly in half of the attempts. Out of 9 responses, 66.7% (20) children gave correct responses in the range of 6–9, indicating that most of them were correctly able to identify reversed letters. Around, 30% of children with Dyslexia scored between 3–6, showing

moderate ability with occasional errors. Only 3.3% scored between 0–3, reflecting very minimal difficulty among a small number of children. Overall, 96.7% of students scored above 3, suggesting a strong visual discrimination skill for identifying reversed letters. It can be concluded that this task is considered to be easier for students.
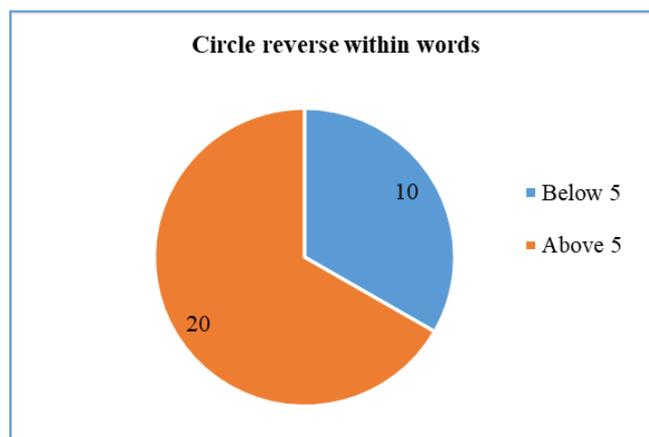
5.2.2.2 Identifying reversed letters within words

Figure 4: Identification of Reversed Letters within words

With regard to circle reverse letter within the words, it was found that positively 66.7% (20) children with Dyslexia were able to give correct responses between 5 to 11. Around 33.3% children were able to give 'below 5' correct responses which reveals that children found it challenging when letters were embedded in words. It can be concluded that task appears more challenging than identifying isolated letters, requiring greater visual attention and word-level processing.

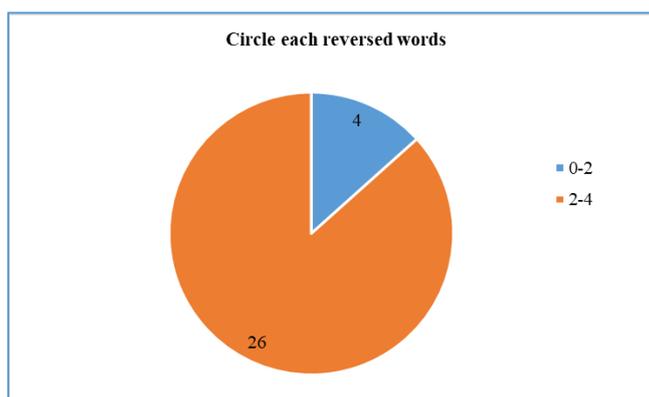### 5.2.2.3 Identification of reversed words

Figure 5: Identification of Reversed words

With respect to third task related to letter reversal, it was found that 86.7% (26) of children with dyslexia scored between 2–4, showing that the majority could correctly identify reversed words. Around 13.3% scored between 0–2, indicating that a small group faced difficulty in recognizing reversed words. Overall performance suggests good development of visual perception and word recognition skills. In other words, it can be concluded that most students demonstrate strong visual discrimination skills, additional practice is needed for complex word-level tasks.

5.2.3 Matching Exercises

In this section, children with dyslexia were asked to do perform on various matching exercises again moving from simple to complex activities, which includes matching figures.
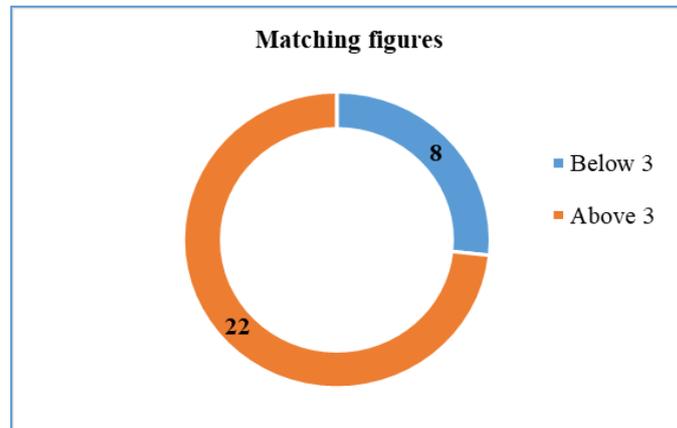
5.2.3.1 Matching figures

Figure 6: Matching the given figures

In this question, the child is expected to match the left figure from the set of four figures given on the right. This activity includes figures such as upward and downward arrows, alphabets like b, d, p and q which can be confusing for the child. Positively, it was found that above 70% children (22) were able to match the items which shows good visual discrimination and matching ability among children. Further, around 27% children were able to give below 3 correct responses, which shows with practise these children can also do better.

In addition to the above item, children were also asked to match the word given on the left from the set of three words given on the right. Here also, positively majority i.e. above 75% of the children were able to perform accurately based on looking at the letters, though many of them were not able to read the given words. This reflects that children are able to do visual discrimination but lack early reading and word recognition skills. Rest of the children (23.3%) were able to give one correct response.

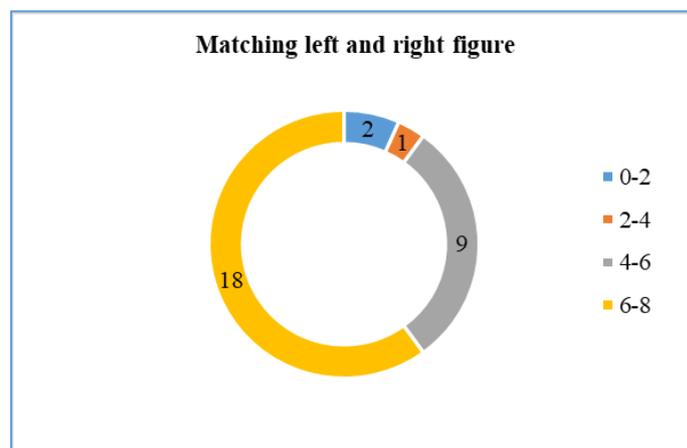### *5.2.3.2 Matching left and right figures*

Figure 7: Matching left and right figures

In the given question, children were required to look at the figure on the right and circle the one on the left that matches. It was found that 60% (18) of children scored between 6–8, indicating high proficiency in matching figures from left to right. The findings indicate well-developed spatial perception and visual matching skills among majority of the children with dyslexia. Rest of the 40% of children (12) were able to give below 6 correct responses indicates they can also improve with practise.

5.2.4 Memorization Activities

In this section, children were asked to do various memorization activities which includes joining dots in a particular sequence, remembering letters and writing it once it is hidden and re-creating the figures shown earlier.

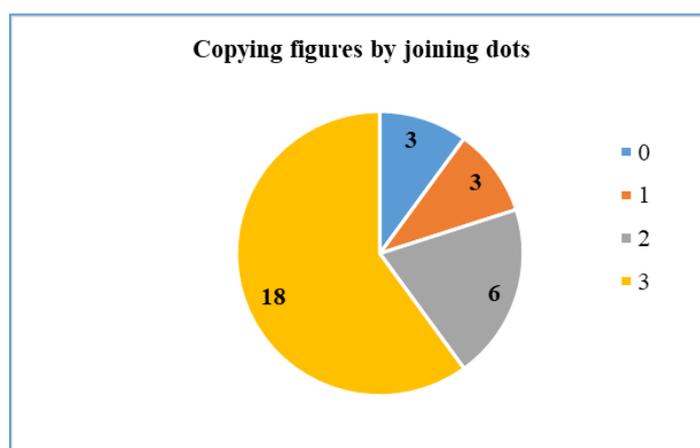### *5.2.4.1 Copying figures by Joining dots*

Figure 8: Copying figures

In this question, the child is required to copy the figures from the bottom to the dots on top. It was found that 60% (18) of children with Dyslexia achieved the maximum score of 3, indicating strong visual memory and motor coordination. On the other hand, rest of the 40% of children were able to give two or one correct responses and few (3 children) were not able to understand the instruction and perform the given task.

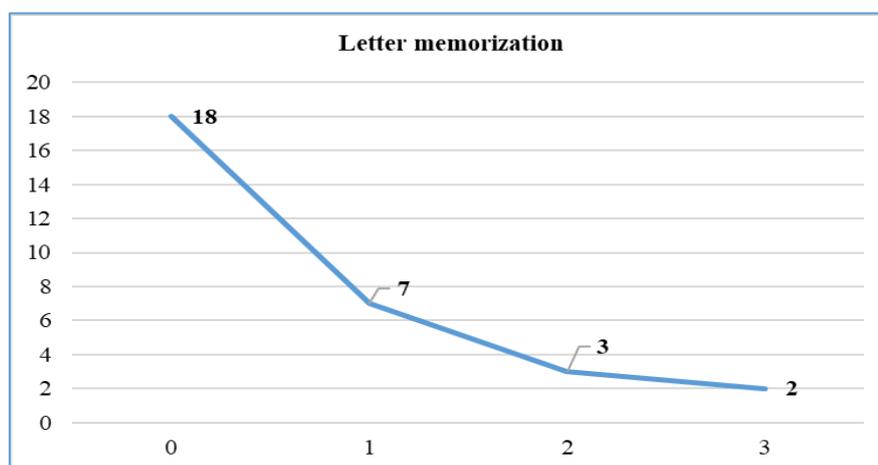### *5.2.4.2 Letter Memorization*

Figure 9: Letter memorization

Memorization is considered to be a challenging task for children with Dyslexia. In this question, children were expected to look at the letters at the left and cover them up and copy them from memory on the line. It was found that 60% of the children scored 0, indicating significant difficulty in memorizing letters.

Around, 23.3% scored 1, reflecting minimal recall ability. Only 16.7% scored 2 or above, showing that letter memorization is a challenging area for most students. The above line diagram suggests a need for focused interventions to strengthen letter recall and memory skills.
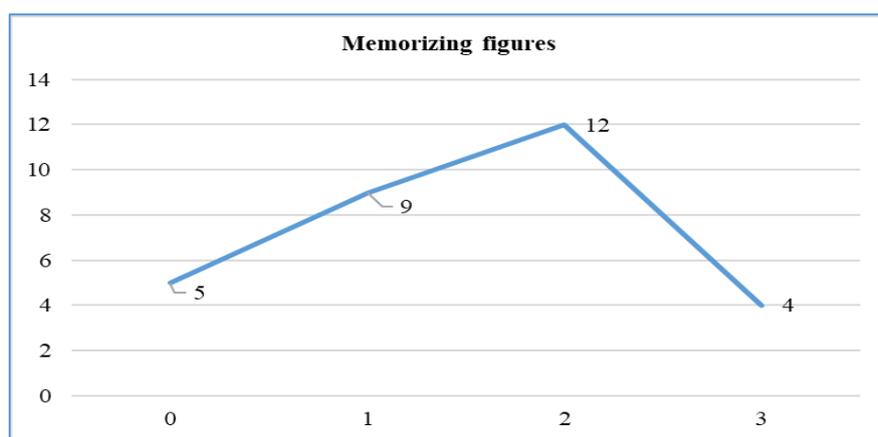
5.2.4.3 Memorizing figures

Figure 10: Figures memorization

With regard to figure memorization, the researcher was required to hold card #1 for 5 seconds and take it away and have the student reproduce it on one of the blank cards. Same instruction to be repeated for figure 2 and 3 with increase in time as 10 seconds and 15 seconds respectively. It is found that 40% of children with Dyslexia were able to give correct response for 2 activities out of 3, indicating moderate ability in memorizing figures.

Only 13.3% children were able to accomplish all three tasks correctly, reflecting strong visual memory. Around 16% children were not able to understand the instruction and attempt the given task, reflecting difficulty in figure memorization.

Overall performance in memorizing figures was better than letter memorization but weaker than copying figures.

5.2.5   Reading Activities

This section covers most crucial task of reading for children with dyslexia. These skills require a child to master phonetic awareness along with binding it together to form words and later form sentences. In this part, various activities were provided to children to perform such as reading three letter words, identification of a particular three-letter word from a pool of words, guessing blinking words, identifying rhyming words and so on.

5.2.5.1 Reading words

In this question, the child was expected to read the words out loud and the researcher was required to mark mistakes. It was found that 60% of children with dyslexia scored below 5, indicating that a majority experienced difficulty in reading three-letter words. In addition, 23.3% children scored between 5 –10, showing emerging reading ability with frequent errors.

Only 16.7% children gave above 10 correct responses, reflecting adequate to good reading proficiency.
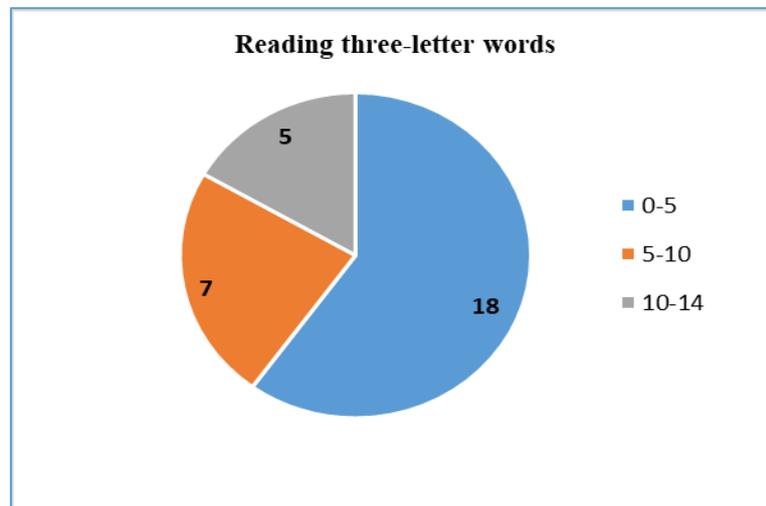
Reading three-letter words

Figure 11: Reading words

It can be concluded that three-letter word reading skills are weak for most students and require systematic phonics support.

5.2.5.2 Reading and repeating
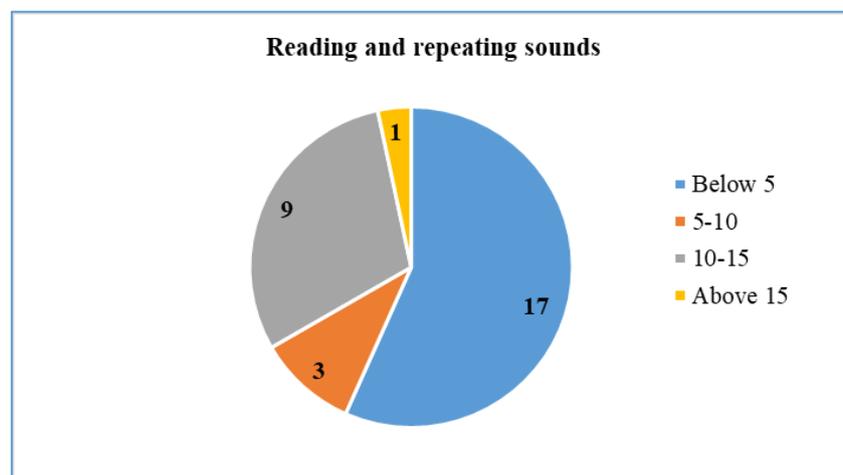
Reading and repeating sounds

Figure 12: Reading and repeating

In this question, the researcher was required to read the words out loud and the child was expected to repeat those words back. It was found that 56.7% (17) of children with Dyslexia gave less than 5 correct responses, indicating poor phonemic awareness and sound repetition ability. Around 30% scored between 10–15, showing moderate proficiency in recognizing and repeating sound segments.

Only one child scored above 15, demonstrating strong sound blending and repetition skills. It can be concluded that being a complex activity, most of the children were struggling with this activity which reflects need for remediation. The wide spread of scores indicates significant variation in phonological processing abilities among students.

As a summary, performance was low in both reading three-letter words and repeating sound segments, indicating weak early literacy and phonics foundations. Children performed slightly better in sound repetition than in word reading, suggesting that phonemic awareness precedes word-level reading. The results highlight the need for structured phonics instruction, repeated oral reading practice, and sound-blending activities.
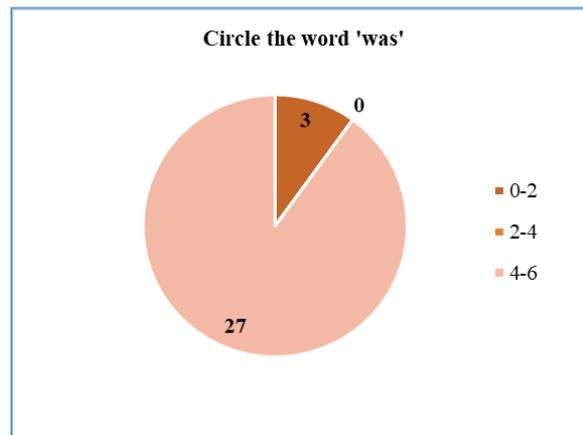
5.2.5.3 Word recognition

Figure 13: Word recognition

In this question, the child was asked to circle the word 'was' from the box which includes many other confusing words like why, raw, saw, win and way. It was observed that majority of children (90%) correctly identified the word *"Was"*, indicating strong basic word recognition skills. Only 10% (3) showed difficulty in the given task and were able to mark below 2 correct responses out of 6.

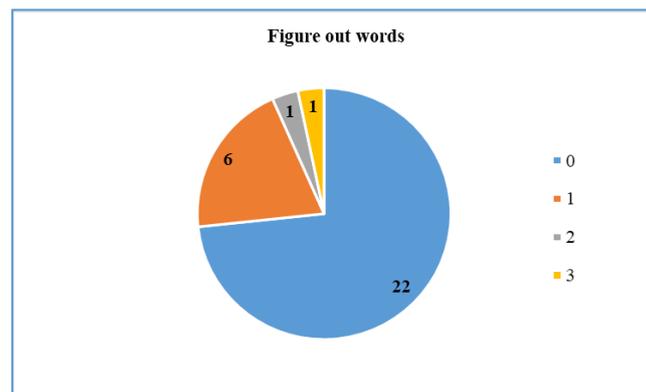### 5.2.5.4 Figure out words

Figure 14: Blinking Text words identification

In this question, the child was expected to look at each of the three words and figure out what it is and write the word on the line. This task measures how quickly and accurately a child can process written words. It was found that above 70% of the children with Dyslexia were unable to identify any blinking-text words, showing significant difficulty with visual word recognition. Only a very small proportion (6.6%) could correctly identify two or more words. It can be concluded that children with Dyslexia show slow decoding skills or difficulty forming stable word images. It also reflects slow speed of word processing.
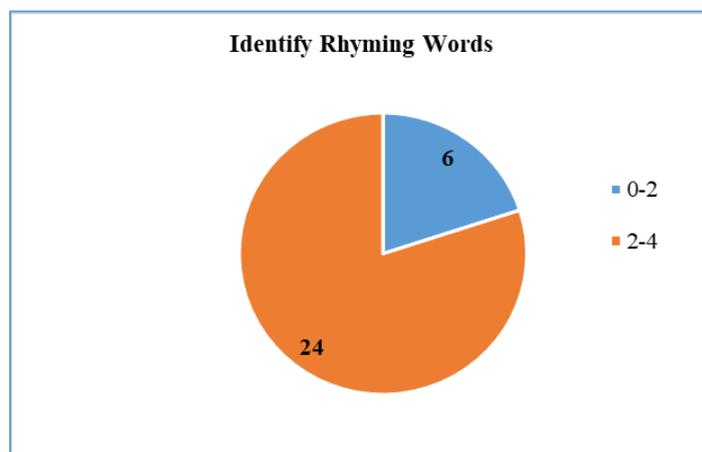
5.2.5.5 Rhyming words

Figure 15: Identification of rhyming words

In the given question, the researcher is expected to read each word out loud and have the child circle the words that rhyme with the word gut. It was found that majority of children with dyslexia (80%) successfully identified rhyming words with *"gut"*, indicating good phonological awareness.

However, 20% (6 children) still showed limited ability and may need additional practice in rhyming skills. It can also be inferred as the researcher was expected to read the given words, the task became easy for children and they were able to perform well.

5.2.5.6 Sentence repetition
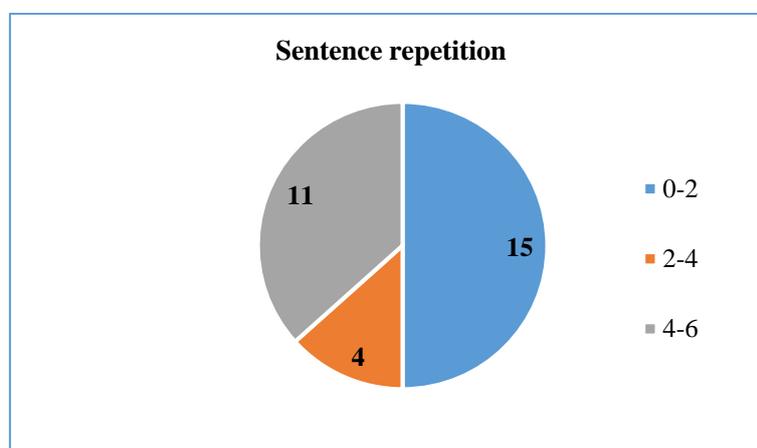
Figure 16: Sentence repetition

In this question, the researcher is required to read sentences to the child and the child is required to repeat these words exactly back. It was found that 50% of the children were able to give below 2 correct responses, indicating considerable difficulty in repeating sentences accurately.

About 36.7% (11) of children demonstrated good sentence repetition skills, while 13.3% (4) showed partial ability. This suggests that sentence-level auditory memory and language processing skills are still developing among children.
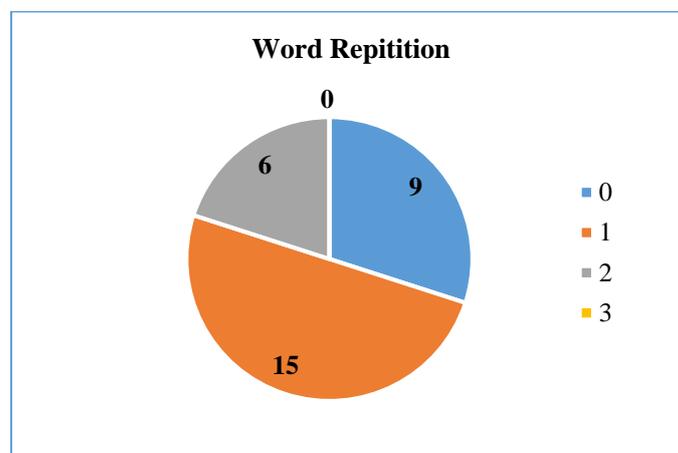
5.2.5.7 Repeating words

Figure 17: Word repetition

In this question, the researcher is required to read each word out loud and the child is required repeat them back. It was found that 80% of children with Dyslexia were able to repeat only one word correctly, but none could repeat all three words in the correct order. This indicates challenges in short-term auditory memory and sequencing, especially when the number of words increases. Results highlight the need for targeted activities such as sentence repetition, rhythmic repetition, and memory-based language activities.

5.2.6   Understanding verbal instruction

In this section, children were given various set of instructions to draw complete the drawing. This activity is very useful in understanding language processing ability among young children.
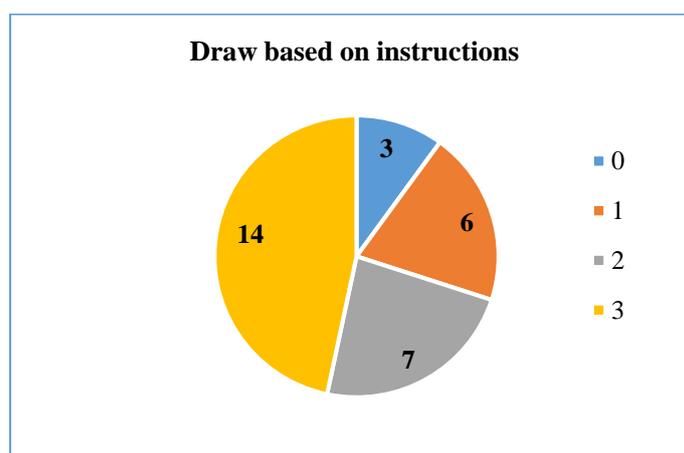
Figure 18: Following verbal instructions

In this question, the child is required to draw vertical or horizontal or diagonal line based on following verbal instruction. It was found that nearly half of the children with dyslexia (46.7%) were able to correctly follow all three verbal instructions, demonstrating good listening comprehension and ability to translate verbal directions into actions. About 23.3% followed two instructions accurately, while 20% could follow only one instruction. A small group (10%) was unable to follow any instruction, indicating difficulty with understanding verbal directions involving spatial concepts.

5.3 Meta Analysis

This section covers details of the studies conducted in the past few years covering characteristics related to children with dyslexia:

Table 2: Meta Analysis

S.No.	Keywords (Characteristics of Children with dyslexia)	Year	Studies [N (%)]
1.	Phonological Processing	2010-2025	5 (17%)
2.	Verbal Short-term memory	2007-2025	4 (13%)
3.	Spelling consistency	2010-2026	4 (13%)
4.	Rapid naming difficulty	2013-2025	3 (10%)
5.	Speech developmental delay	2017-2026	3 (10%)
6.	Performance on Neuro-psychological task	2011-2025	3 (10%)
7.	Reading Errors	2011-2016	3 (10%)
8.	Pseudo-word repetition and syllable repetition	2009	2 (7%)
9.	Comorbidity with ADHD, developmental delay, emotional disorder	2010-2021	2 (7%)
10.	Phrase/ Sentence Comprehension	2012	1 (3%)

Meta-analysis was performed through several research databases such as PubMed, PsycINFO, and Cochrane Library. The majority of the research is focused on 'Phonological Processing' (17%), Verbal Short-term memory (13%), Spelling consistency (13%) among children with dyslexia from 2007 to 2026. At the same time, very few studies have been conducted on Pseudo-word repetition and syllable repetition (7%), Comorbidity with ADHD, developmental delay, emotional disorder (7%) and Phrase/ Sentence comprehension (3%) with regard to children with dyslexia from 2009 to 2021. Meta-analysis was carried out to understand the overall trends and effects of outcomes related to Dyslexia, which evaluates key developmental domains related to understanding dyslexia and related challenges. It includes pool effect size, omnibus test and random effect model of heterogeneity assessment.

A pool effect size refers to the weighted average of effect size from various studies. The omnibus test suggests that, across domains, the outcome studied has meaningful effects, and the heterogeneity test measures the variation in study outcomes. The present meta- analysis consists of 1500 children across 30 studies who were diagnosed with children with dyslexia.

Table 3: Result of Statistical Model

Statistical Model Result	
Omnibus test of model coefficient	
Chi-square (χ^2)	12.84
Df (Degree of freedom)	3
p-value	.005

The significant Omnibus Test (χ^2 (3) = 12.84, p = .005) of Model Coefficients demonstrates that the included studies collectively showed a meaningful overall effect, supporting the effectiveness of the intervention. This shows that the intervention consistently helped to support reading ability among children with dyslexia.

6. DISCUSSION AND CONCLUSION

It can be concluded that children with dyslexia are very different in terms of their reading and writing capabilities. It can be reflected that though many children were able to perform well on task given to them but still there were many who require support. As observed by the

researcher, majority children were not able to read the question and attempt the test independently, though they were able to do the task once it was explained by the researcher.

Further, Meta-analysis was also caried out through several research databases such as PubMed, PsycINFO, and Cochrane Library. The majority of the research is focused on 'Phonological Processing', Verbal Short-term memory, Spelling consistency among children with dyslexia from 2007 to 2026. At the same time, very few studies have been conducted on Pseudo-word repetition and syllable repetition, Comorbidity with ADHD, developmental delay, emotional disorder and Phrase/ Sentence comprehension with regard to children with dyslexia from 2009 to 2021. Meta-analysis was carried out to understand the overall trends and effects of outcomes related to Dyslexia, which evaluates key developmental domains related to understanding dyslexia and related challenges.

Looking at the challenges faced by the sampled children based on the conducted research and the meta-analysis, the study proposes a technology based ergonomic solution for children with dyslexia. Based on the identified key areas such as recognition of letters, phonetics, letter memorization, rhyming words, matching exercises, sequencing etc. for which intervention needs to be planned for school going children with dyslexia in the age group of 9-12 years.

The proposed intervention tool will include the concept explanation and activities related to words' structure to develop child's understanding regarding beginning of words; rhyming words, letter sequencing in words and structure of syllable in words and so on. Each of the exercises will consists of a question and a number of answers (words), out of which 1 will be the correct answer. As the child progresses the score will be +1 and -1 respectively. From here, the game will progress from simple to complex depending on the performance of the child. The exposure to failure will be minimal taking into consideration the possibility of low self-esteem among children with dyslexia. So, all children will always have the opportunity to move into the next level. The proposed tool will include set of 10 activities for the child each day. The 10 activities per day will include exercises to be taken up by the child with regard to story reading, rhyme recitation, grammar exercise, activities for physical domain and one fun activity like maze, drawing, joining dots and so on.

References

1) Hollnagel, Erik (10 November 2010). "Cognitive Ergonomics: it's all in the mind". Ergonomics. 40 (10): 1170–1182. doi:10.1080/001401397187685. What is Ergonomics? International Ergonomics Association

2) Rauschenberger M., Baeza–Yates R., Rello L. (2019) Technologies for Dyslexia. In: Yesilada Y., Harper S. (eds) Web Accessibility. Human–Computer Interaction Series. Springer, London

3) Z. Jamaludin, H. Husni, M. M. Alobaedy (2018), In Search for A Viable Pedagogical Agent in Assistive Applications for Dyslexic Children, School of Computing, Universiti Utara Malaysia Sintok, Kedah, Journal of Fundamental and Applied Sciences, 10(6S), 1757-1770, ISSN 1112-9867", http://www.jfas.info

4) Rabbia Tariq and Seemab Latif, A Mobile Application to Improve Learning Performance of Dyslexic Children with Writing Difficulties, Journal of Educational Technology & Society, Vol. 19, No. 4 (October 2016), pp. 151-166, Published by: International Forum of Educational Technology & Society, https://www.jstor.org/stable/jeductechsoci.19.4.151"

5) The British Dyslexia Association, "Dyslexia Style Guide," 2012. [Online]. Available": http://www.bdadyslexia.org.uk/common/ckeditor/filemanager/userfiles/About_Us/policies/Dyslexia_Style_Guide.pdf.

6) "Instrumental Music for Dyslexics: A Teaching Handbook, By Sheila Oglethorpe (2002)", https://books.google.co.in/books?id=uTu_KakTTykC&lpg=PP2&ots=5zGOuryJzC&dq=undiagnosed%20dyslexia&lr&pg=PP2#v=onepage&q=undiagnosed%20dyslexia&f=false

7) "Hamid A. et.al (2015) A study of computer-based learning model for students with dyslexia, 2015 9th Malaysian Software Engineering Conference (MySEC)" https://ieeexplore.ieee.org/abstract/document/7475234

8) Adel, A. M., Zaidan, S. F., & Javadi, A. H. (2021). Phonological deficit traits in verbal language of dyslexics. In Dyslexia. IntechOpen. https://doi.org/10.5772/INTECHOPEN.99871

9) Cruz-Rodrigues, C., Barbosa, T., Feng, S. C., Alves, M. R., Kida, A. S. B., Mello, C. B., & Miranda, M. C. (2014). Neuropsychological characteristics of dyslexic children. Psicologia: Reflexão e Crítica, 27(3), 539-546. https://doi.org/10.1590/1678-7153.201427315

10) Agustin, I. G. A. A. D., Suarni, N. K., & Tirtayani, L. A. (2024). Application of cooperative learning model integrated reading and composition (CIRC) assisted by flashcard media to improve reading comprehension ability of dyslexic students in elementary schools providing inclusion education. Inovasi: Jurnal Diklat Keagamaan, 18(1). https://doi.org/10.52048/inovasi.v18i1.489

11) Cashell, G. T. W. (1969). Special problems: Congenital dyslexia. Journal of the Royal Society of Medicine, 62(6), 604-608. https://doi.org/10.1177/003591576906200613

12) Zavadenko, N. N. (2021). Dyslexia as the most prevalent form of specific learning disabilities. Russian Journal of Child Neurology, 16(3), 146-158. https://doi.org/10.46563/2686-8997-2021-2-3-146-158

13) Fragel-Madeira, L., Carvalho, L. R., Silva, A. C., & Linden, R. (2015). Dyslexia: A review about a disorder that still needs new approaches and a creative education. Creative Education, 6(11), 1116-1131. https://doi.org/10.4236/CE.2015.611116

14) Snowling, M. J. (2001). Dyslexia: Diagnosis and training. In International Encyclopedia of the Social & Behavioral Sciences (pp. 3987-3991). Elsevier. https://doi.org/10.1016/B0-08-043076-7/02354-8

15) Pinto, M. G., Silva, P. A., & Grilo, M. (2011). Neurocognitive profile of children with developmental dyslexia. Developmental Medicine & Child Neurology, 53(Suppl. 4), 32-33.

16) Afrida, Yusuf, Y. Q., & Basri, M. (2019). Visual and cognitive media: The language acquisition of children with dyslexia in Aceh. Indonesian Journal of Applied Linguistics, 8(3), 699-708. https://doi.org/10.30575/2017/IJLRES-2019010409

17) Temple, C. M., & Marshall, J. C. (1983). A case study of developmental phonological dyslexia. British Journal of Psychology, 74(4), 517-533. https://doi.org/10.1111/J.2044-8295.1983.TB01883.X

18) Khosrovian, S., Pirzad Jahromi, G., Hooshyari, Z., Heidari, M., & Abdekhodaie, M. S. A comparative analysis of brain wave patterns in children with and without dyslexia. International Journal of Body, Mind and Culture, 12(4). https://doi.org/10.61838/ijbmc.v12i4.900

19) Salazar, D. C., Castillo, J. C., & Benavides, M. S. (2021). Dislexia: Revisión de manifestaciones sintomatológicas y signos en etapas escolares. Tempus Psicológico, 4(2), 89-110. https://doi.org/10.30554/TEMPUSPSI.4.2.3377.2021

20) Jing, J., Yan, G., & Zhao, S. (2012). Studies related to dyslexia in Chinese characters. In Dyslexia - A Comprehensive and International Approach. IntechOpen. https://doi.org/10.5772/33223

21) Henrique, A. R. S. (2009). Dificuldades específicas de aprendizagem: A dislexia [Specific learning difficulties: Dyslexia]. Universidade Portucalense Infante D. Henrique.

22) Rodrigues, S. D., & Ciasca, S. M. (2016). Dislexia na escola: Identificação e possibilidades de intervenção [Dyslexia at school: Identification and intervention possibilities]. Revista Psicopedagogia, 33(100), 86-97.

23) Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading-spelling patterns. Developmental Medicine & Child Neurology, 15(5), 663-687. https://doi.org/10.1111/J.1469-8749.1973.TB05180.X

24) Liu, L., Wang, J., Wu, H., Zhu, Z., Qin, W., & Yu, C. (2026). Alternations of gray matter lateralization and structural covariation in the children with developmental dyslexia and isolated spelling deficit. Brain Research Bulletin, 220, 111718. https://doi.org/10.1016/j.brainresbull.2026.111718

25) Maiella, M., Marinelli, C. V., Angelelli, P., & Notarnicola, A. (2025). A statistical learning-based clustering model with features selection to identify dyslexia in school-aged children. Dyslexia, 31(1), e70013. https://doi.org/10.1002/dys.70013

26) Soriano-Ferrer, M., & Figueredo, S. E. (2017). Developmental dyslexia in Spain. In Dyslexia - A Comprehensive and International Approach. IntechOpen. https://doi.org/10.5772/INTECHOPEN.69009

27) Greene, J. (2013). Computer assisted (language) learning (CA (L) L) for the inclusive classroom. Proceedings of the IADIS International Conference on Cognition and Exploratory Learning in Digital Age (CELDA), 315-322.

28) Eroğlu, G., Öztürk, M., Koçak, O. M., Yener, G., & Öktem, F. (2026). Theta and Beta1 frequency band values predict dyslexia classification. Dyslexia, 32(1), e70021. https://doi.org/10.1002/dys.70021

29) Kwon, M., Yoo, H., & Kim, J. (2024). Exploring dyslexia through fundamental cognitive mechanisms. Journal of Learner-Centered Curriculum and Instruction, 24(5), 673-688. https://doi.org/10.22251/jlcci.2024.24.5.673

30) Estrela, A., & Cruz-Santos, A. (2007). Dislexia e perturbações associadas: Memória e atenção [Dyslexia and associated disorders: Memory and attention]. Gailivro.

31) Ahadi, H. Linguistic and metalinguistic characteristics of Persian-speaking children with dyslexia.

32) Mitchell, D. J., Furl, N., Scerif, G., & Summerfield, C. (2025). The balance between stability and plasticity of the visual word form area in dyslexia. Nature Communications, 16(1), 1234. https://doi.org/10.1038/s41467-025-67054-3

33) Jumani, N. B., & Saeed, M. (2011). Effectiveness of remedial techniques on the performance of special students in the subject of English. Journal of Language Teaching and Research, 2(3), 697-704. https://doi.org/10.4304/JLTR.2.3.697-704

34) Schulte-Körne, G. (2010). The prevention, diagnosis, and treatment of dyslexia. Deutsches Ärzteblatt International, 107(41), 718-727. https://doi.org/10.3238/ARZTEBL.2010.0718

35) Thambirajah, M. S. (2010). Developmental dyslexia: Clinical aspects. Advances Psychiatric Treatment, 16(5), 380-387. https://doi.org/10.1192/APT.BP.108.006239

36) Nicolson, R. I., Fawcett, A. J., & Dean, P. (2001). Developmental dyslexia: The cerebellar deficit hypothesis. Trends in Neurosciences, 24(9), 508-511. https://doi.org/10.1016/S0166-2236(00)01896-8

37) Benli, E. D., Yener, G. G., Öner, Ö., Öktem, F., & Munir, K. (2025). Differential functional connectivity between silent reading and resting-state fMRI and their relationships with reading performance in children with and without dyslexia. International Journal of Developmental Neuroscience, 85(1), e70072. https://doi.org/10.1002/jdn.70072