American Journal of
Biomedical Science & Research

www.biomedgrid.com
ISSN: 2642-1747

Review Article

Using User Experience Design Principles (UX/UI) to Configure an Eye-Tracking Framework that will Help Those with Dyslexia Learn and Interact Better

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To Cite This Article: *Anuja Chatterjee and Tapan Kumar Chatterjee*. Using User Experience Design Principles (UX/UI) to Configure an Eye-Tracking Framework that will Help Those with Dyslexia Learn and Interact Better. Am J Biomed Sci & Res. 2025 26(3) AJBSR.MS.ID.003447,*
DOI: 10.34297/AJBSR.2025.26.003447

Received: March 20, 2025; **Published:** March 27, 2025

Abstract

Dyslexia is a neurodevelopmental disorder that affects an individual's ability to read, spell, and process language despite having normal intelligence and adequate educational opportunities. It is characterised by difficulties in phonological processing, decoding words, and fluency in reading, often resulting in challenges with written communication. Dyslexia is not related to vision problems but rather to differences in brain function, particularly in regions responsible for language processing. Early diagnosis and interventions, such as structured literacy programs and assistive technology, can help individuals with dyslexia improve their reading skills and academic performance. Dyslexia can also impact organisation, time management, and memory. It's not a result of poor intelligence or lack of effort; with proper support and accommodations, individuals with dyslexia can succeed academically and professionally. The new investigation aims to have a user-centred design approach to guide the eye-tracking system's development, ensuring that dyslexic students are kept at the forefront of the design process.

Introduction

Dyslexia can be identified by navigating the system with eye-tracking technology [1]. And to help them navigate the education system with virtual and augmented reality [2,3]. In dyslexia, it is difficult to learn and decode words and become fluent; those with dyslexia also fail to generalize, that is, to read novel words they have never seen before [4-6]. It is commonly known that dyslexia results from issues with phonological representation in the brain [4,5]. However, research has found that these issues are more than singular to phonological topics [7]. It is essential to identify the dyslexic student from the other students in early school days [8,9]. Some even have problems with letter position coding. Research indicates that as the number of dyslexic pupils rises, so does the demand for effective teaching strategies and approaches [10,11]. Insufficient technology is available to support dyslexic pupils and learning-disabled students during the learning process. The purpose of this study is to improve learning and help dyslexic students. To create a user-friendly system and make it easier for such students to catch up with their peers easily. New research intends to use several different methodologies to develop a design solution that will generate an eye-tracking system to help students with dyslexia have a better learning experience.

User Research and Needs Assessment

i. To determine the main obstacles to reading comprehension and visual processing, interview dyslexic students, teachers, and cognitive scientists.

ii. Conducting ethnographic research to create a user journey and understand pain points and needs.

iii. Perform an eye-tracking needs assessment to comprehend problems like delayed saccades (eye movements between points), re-fixations, and poor focus on words and phrases (Figure 1).

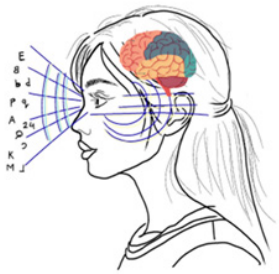

Figure 1: Figure of Dyslexia (Eye tracking)

Types of Dyslexia

i. Phonological Dyslexia - Difficulty breaking down words into smaller sound units.

ii. Surface Dyslexia - Trouble recognising words by sight and relying heavily on phonetics.

iii. Rapid Naming Deficit - Difficulty quickly naming seen objects, letters, or numbers.

iv. Double Deficit Dyslexia - A combination of phonological and rapid naming difficulties.

Characteristics of Dyslexia

i. Difficulty recognising letters or words

ii. Trouble with spelling and writing

iii. Slow or inaccurate reading

iv. Challenges in understanding and remembering written material

v. Struggles with phonemic awareness (identifying and manipulating sounds in words)

Genetic Basis of Dyslexia

1. Hereditary Nature: Dyslexia tends to run in families, suggesting a strong genetic component. Studies indicate that if a parent has dyslexia, their child has a 40-60% chance of developing it.

2. Identified Genes: Several genes, including DYX1C1, KIAA0319, DCDC2, and ROBO1, have been linked to dyslexia. These genes are associated with brain development, particularly in areas related to language and reading.

3. Brain Structure Differences: Individuals with dyslexia often show variations in the left hemisphere of the brain, particularly in the temporal lobe, occipital lobe, and parietal lobe, which are crucial for reading and phonological processing.

Genetic Dyslexia Affects the Brain

1. Phonological Processing Impairment: Difficulty recognising and manipulating sounds in words.

2. Disrupted Neural Pathways: Differences in connectivity between brain regions involved in reading.

3. Impaired Working Memory: Challenges in holding and processing information while reading or writing.

Neuronal Changes in Dyslexia

1. **Abnormal Neuronal Migration**

During fetal brain development, neurons migrate to their designated locations. In dyslexia, some neurons fail to migrate properly, leading to differences in the arrangement of brain cells. This is observed in areas like the left perisylvian region, which includes language-processing centres.

2. **Structural Differences in the Brain**

a) Reduced Gray Matter: Dyslexic individuals often show reduced gray matter volume in the left temporal lobe, affecting phonological processing.

b) Reduced White Matter Integrity: White matter pathways, like the arcuate fasciculus, which connect language areas (Broca's and Wernicke's areas), are less developed, leading to ineffi-

cient communication between reading-related brain regions.

3. Altered Brain Function and Connectivity

a) Brain imaging studies reveal reduced activation in key reading areas in dyslexic individuals: Left Temporal and Parietal Lobes (Phonological Processing): Weakened activity here impairs the ability to decode sounds in words. Occipito-Temporal Cortex (Visual Word Form Area - VWFA): Reduced efficiency in recognising words and letters quickly.

b) Overactivity in the Right Hemisphere: The brain compensates by engaging the right hemisphere, which is less efficient for reading tasks.

4. Impaired Neural Plasticity

Dyslexic brains show differences in synaptic plasticity, meaning they may struggle more with forming strong connections for reading and spelling. However, with training and interventions, the brain can rewire and improve reading skills through neuroplasticity (Figure 2).

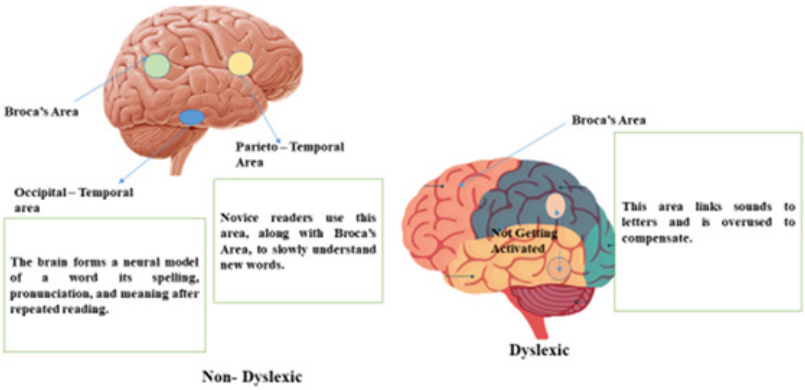

Figure 2: Non Dyslexic Brain vs Dyslexic Brain When Reading.

Treatment

A. Educational Accommodations

1. Multisensory instruction: Using visual, auditory, and kinesthetic approaches to learn.

2. Individualized education plans (IEPs): Tailored plans to address specific learning needs.

3. Assistive technology: Text-to-speech software, speech-to-text software, and other digital tools.

B. Instructional Strategies

1. Phonics-based instruction: Emphasizing sound-letter relationships.

2. Orton-Gillingham approach: A structured, sequential approach to reading and spelling.

3. Wilson Reading System: A phonics-based program for reading and spelling.

C. Therapies and Interventions

1. Speech therapy: Addressing speech sound difficulties and language development.

2. Occupational therapy: Improving organizational, time management, and motor skills.

3. Cognitive training: Enhancing working memory, attention, and processing speed.

D. Self-Help Strategies

1. Compensatory strategies: Using assistive technology, note-takers, or audiobooks.

2. Organization and time management: Using planners, reminders, and breaking tasks into smaller steps.

3. Self-advocacy: Developing confidence and communicating needs to teachers, employers, and peers.

E. Other Interventions

1. Dyslexia tutoring: One-on-one instruction tailored to individual needs.

2. Dyslexia-friendly environments: Creating a supportive and inclusive learning environment.

Current Research

Recent research on dyslexia has advanced our understanding of

its genetic foundations, neurobiological mechanisms, and effective interventions. Research concerns students with dyslexia who find it challenging to decode and understand [4,5,7] instructions and theory as quickly as their peers and to help them navigate the system with eye-tracking technology [1]. Some students find it more difficult than others to access at significant intellectual, emotional, and social costs to themselves. And to help them navigate the education system with virtual and augmented reality [2,3]. Some students find it more difficult than others to access at significant intellectual, emotional, economic, and social costs to themselves. It is suggested that as many as 10 per cent of the population is affected by dyslexia [7]. Traditional methods of learning can create barriers for dyslexic learners as they are text-heavy, and this significantly reduces engagement [4,6]. Current research wants to understand the reading patterns of dyslexic students. Current studies can create models to understand the hurdles faced by the learners by observing eye movements like fixations, regression, and more prolonged gaze. When difficulty is detected, the interface can auto-adjust by offering tools like audio playback or simplified reading prompts. The research will investigate haptic or visual clues in the application to alert or encourage students who might get nervous otherwise. If eye tracking shows frequent shifts away from the reading material, the system might prompt the student with inspiring messages or interactive elements to regain focus. Research can investigate the ratio of text to interaction so students can learn optimally [3]. Both eye-tracking and conventional cognitive training demonstrated a significant improvement in total learning [11]. Eye-track data can be used to understand dyslexic students' learning obstacles and make customisable learning paths that adjust the pace, content complexity, and format, offering a more personalised experience [2,8]. In different parts of the world, various research will discover the causes and solutions for dyslexic diseases [15-25].

New Research Development

Development of Prototypes

Produce both low-fidelity and high-fidelity. These are prototypes for an instructional tool with eye-tracking capabilities that provide instant feedback. Based on the student's reading performance, the tool will employ eye-tracking data to modify reading materials, such as adjusting font size, giving auditory prompts, or highlighting text [12-14].

UI Design Considerations

With less text and a distinct visual hierarchy, concentrate on developing an interface that is easy for dyslexic pupils to use. Eye-friendly typefaces, color palettes, and layouts will be employed to increase readability.

i. To evaluate how successfully the tool solves reading difficulties, examine quantitative data from the eye-tracking device, such as fixation duration, saccade patterns, and re-fixations.

ii. Evaluate the eye-tracking tool's perceived benefits, simplicity of use, and user satisfaction by qualitatively analysing user interviews and survey responses.

Genetic Discoveries

A significant study published in Nature Genetics identified 42 genetic variants associated with dyslexia. This large-scale genome-wide association study involved collaboration between institutions like the University of Edinburgh, the Max Planck Institute for Psycholinguistics. The findings highlight that genetic risk factors for dyslexia are similar across sexes, providing deeper insight into its hereditary nature.

Technological Interventions

Integrating Artificial Intelligence (AI) in educational settings is emerging as a supportive tool for students with dyslexia. AI-powered applications, such as chatbots and word prediction programs, assist students in overcoming reading and writing challenges, enhancing their learning experiences. Schools are increasingly adopting these technologies to provide personalized support, aligning with mandates from educational authorities to ensure accessibility.

Addressing Misconceptions in Diagnosis

A study by Durham University revealed that nearly half of professionals assessing dyslexia in children might be influenced by myths, such as the misconception that dyslexic individuals see letters and words jumbled. The research emphasises the need for evidence-based assessments and consistent guidelines to avoid misdiagnosis and ensure early identification, which is crucial for practical support.

Contribution to Sociological Studies

New Research will positively change the educational world, especially for those with learning disabilities. The technology is new and has not been explored in this area. The research will investigate the possible application of UX/UI design principles and eye-tracking technology for developing an accessible and engaging learning environment for dyslexic students. The research seeks to provide new insight into how these technologies may fundamentally change education for neurodivergent learners through user experience and unique challenges in learning by dyslexic individuals. As a result, the outcome of this study could dramatically enhance accessibility in educational settings and further contribute more broadly to integrating new technologies generally for the support of dyslexic learners.

Conclusion

Dyslexia is a neurological condition that affects reading, writing, and spelling abilities but does not impact intelligence or creativity. Early diagnosis, intervention, and tailored educational strategies can help individuals with dyslexia succeed. The technology is new and has not been explored in this area. The research will investigate the possible application of UX/UI design principles and eye-tracking technology for developing an accessible and engaging learning environment for dyslexic students. Several eye-tracking

images can be analysed with the help of AI technology, and early detection will improve the process of learning of dyslexic students. With the proper support, such as structured literacy programs, assistive technology, and accommodations, people with dyslexia can overcome challenges and thrive academically and professionally. Greater awareness and understanding of dyslexia can lead to more inclusive environments that support the strengths and potential of those affected.

Acknowledgement

None.

Conflict of Interest

None.

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