



READING SPEED IN AMBLYOPIA: A REVIEW

¹SIMRAN RAJAN SHET PARKAR

¹DEPARTMENT OF OPTOMETRY, ACHARYA INSTITUTE OF ALLIED HEALTH
SCIENCES, BANGALORE, KARNATAKA

ABSTRACT

Amblyopia, colloquially called "Lazy Eye," is a visual ailment characterized by reduced visible acuity in a single or both eyes, regularly with no apparent structural anomalies. This review delves into the tricky courting between amblyopia and studying overall performance. Amblyopia's occurrence is on the rise globally, particularly in Europe and North America, highlighting the urgency to understand its broader implications on a fine of lifestyles. Reading, a fundamental talent crucial for cognitive improvement and social participation, is substantially impacted in amblyopic people. Research suggests that people with amblyopia experience reduced studying velocity, accuracy, and fluency, with said deficits in the amblyopic eye. Factors contributing to these studying challenges encompass sensorimotor deficits, such as impaired stereoacuity and vergence instability. Various evaluation methods, inclusive of smartphone applications and eye-monitoring experiments, have been employed to quantify reading velocity in amblyopia. The evaluation similarly explores cutting-edge intervention strategies, emphasizing the significance of early detection and interdisciplinary strategies. Ultimately, this evaluation underscores the importance of the need for comprehensive assessment and targeted interventions to ameliorate analyzing problems in individuals with amblyopia, thereby improving their average well-being and excellent of life.

KEYWORDS: Reading Speed, Amblyopia, Reading

INTRODUCTION

Amblyopia termed as “Lazy eye” has been varying as per advancement in the studies.¹ According to Amblyopia Treatment Study, “A developmental disorder of spatial vision, amblyopia is clinically defined as decreased best-corrected visual acuity (BCVA) in one, or less frequently both eyes, in the absence of any obvious structural anomalies or ocular disease;” having at least 3 lines of difference between two eyes.² With recent advancement Lisa Asper et al. revised the definition as “A visual cacophony of deficits in contrast sensitivity, spatial localization, fixation, ocular motility, accommodation, crowding, attention, motion perception and temporal processing in addition to visual acuity loss.”² Clinically, amblyopia has been defined as BCVA reduction to $<6/9$ in Snellen optotype monocularly or two lines difference or more in BCVA between the eyes in LogMAR optotype.³

A global study inferred that amblyopia is the leading cause of vision impairment among children and young adults with an increase in prevalence from 99.2 million in 2019 to 175.2 and 221.9 in 2030 and 2040 respectively. Geographically, Europe (2.90%) and North America (2.41%) showed a higher prevalence of amblyopia than Asia (1.09%) and Africa (0.72%). Considering ethnicity, the highest prevalence of amblyopia was seen in Hispanics (4.74%) followed by Europeans (2.48%), Africans (1.99%), and Asians (1.38%). Age-wise, children account for 0.2-5.4% whereas adults account for between 0.35-3.6% of amblyopia.⁴ Among the Indian population it accounts for 1.1% of which ametropia (50%) and anisometropia (40.9%) are the major cause.⁵

This review aims to provide a comprehensive overview of the current state of knowledge regarding reading speed in amblyopia. By examining the existing literature, research findings, and clinical insights, this review seeks to elucidate the factors influencing reading performance in individuals with amblyopia, evaluate the effectiveness of intervention strategies, and identify opportunities for future research.

Approximately 50% of cases have prominent anisometropic amblyopia that is caused by an unequal refractive error between the two eyes. This difference produces a poorly focused image in one retina than in the other is caused by dry eyes. Notably, anisometropic amblyopia is often associated with strabismus, a condition that causes visual anomalies.⁶ In contrast, mixed amblyopia accounts for 27% of cases and is characterized by a combination of anisometropic and strabismic features. Strabismic amblyopia, contributing to 19% of the cases, is predominantly associated with visual nonconformity, whereas unstimulated amblyopia, representing 4% of the cases, is associated with developmental amblyopia great in relation.⁷

Recent research has highlighted how sensorimotor deficits in amblyopia, particularly affect tasks based on visual coordination such as reading. A major feature of amblyopia is impaired stereoacuity interocular suppression and increased vergence instability in amblyopia types relationships. These interconnections between anatomical deformities highlight the complexity of amblyopia and the importance of comprehensive assessment and management strategies.⁸⁻¹⁰

IMPORTANCE OF READING

Reading is an essential skill that is necessary for learning, achievement, and personal development. It is recognized as a foundational skill for writing and is crucial in the modern age due to the increased demand for critical evaluation of information. National and international literacy surveys have highlighted the importance of reading, especially in the context of education and economic development.¹¹ Reading is not only a passive activity but also involves active mental processing to decode written messages. It is a complex construct that requires various skills and strategies for comprehension.¹² Literacy skills, including reading, are vital for individuals to actively participate in social life and improve their quality of life.¹³ The ability to read from an early age has a significant impact on a child's cognitive and emotional development, and parents play a crucial role in fostering this skill.¹⁴

Low reading speed has a significant impact on the quality of life.¹⁵ It affects the ability to read and participate in day-to-day activities, leading to decreased independence and confidence.¹⁶ Patients with low reading speed may experience difficulties in academic and adaptive skills, increased anxiety, and overestimation of social competence.¹⁷ In individuals with bilateral neovascular age-related macular degeneration (nAMD), low reading speed is associated with difficulties in near-vision tasks and reduced vision-related quality of life.¹⁸ For dyslexic patients, slow letter and word processing contribute to lower reading speed, affecting their ability to read fluently.¹⁹ Improving reading speed can lead to an increase in independence, mental ability, confidence, and overall quality of life.

METHODS OF ASSESSING READING SPEED

Methods of assessing reading speed include the use of smartphone-based applications,²⁰ the International Reading Speed Texts (IReST),²¹ and eye-tracking experiments.²² The smartphone-based application, GDRS-test, was found to accurately detect differences in reading speed between individuals with visual impairment and healthy individuals.²³ The IReST, originally tested in a younger British population, was evaluated in a normal Canadian population and found to have slower reading speeds compared to the standards.²⁴ Eye-tracking experiments have identified various eye-movement measures such as fixation time, saccade frequency, and glissade measures as potential indices for measuring reading speed. These methods provide valuable tools for assessing reading speed in different populations and can contribute to the improvement of reading ability assessments.

FACTORS INFLUENCING READING SPEED IN AMBLYOPIA

For academic achievement, reading is fundamental a vision-reliant ability that requires progressive and regressive saccadic movement.²⁵⁻²⁸ From school to leisure, along with various activities of daily living; all the aspects of modern life are virtually affected by loss of ability to read.^{27,28} Academic performance and learning are detrimental with slower reading which in turn is the result of increased saccades.^{25,29-32}

Studies on reading speed in amblyopia have established that among amblyopes amblyopic eye has a lower reading speed than the non-amblyopic eye³³⁻³⁵ even when compared to the visually normal individuals and in both monocular and binocular conditions. Along with the reading speed accuracy³³⁻³⁵ and fluency³⁰ was also seen to be hampered in the fellow eye of amblyopes.

In addition to this, when the impact of office-based vergence/accommodation therapy on reading skills in symptomatic convergence insufficiency was evaluated, reading comprehension and reading composite were seen to be improved among the early responders to the therapy.³⁶

INTERVENTION STRATEGIES AND REHABILITATION

Intervention strategies and rehabilitation to improve reading speed in amblyopia have been explored in several studies. One study found that strabismic and anisometropic amblyopes have slower reading speeds compared to controls, which is attributed to fixation instability during reading.³⁷ Another study focused on reading interventions for autistic children and reported improvements in reading skills such as comprehension, vocabulary, fluency, and phonological awareness. These interventions included interactive and shared reading, visualization strategies, vocabulary and main idea instruction, video modeling, and tablet-based technology.³⁸ Additionally, a case study demonstrated the effectiveness of low-intensity psychological intervention, Problem Management Plus, in improving the mental state of an amblyopic individual with depressive and anxiety symptoms.³⁹ Furthermore, a study on amblyopic patients found that oculomotor dysfunction and visual acuity and stereoacuity deficits contribute to reading difficulties, highlighting the importance of understanding these difficulties for effective intervention.⁴⁰

CLINICAL IMPLICATIONS AND RECOMMENDATIONS

Measuring reading speed in amblyopes has important clinical implications. It can be used to evaluate visual function and identify visual perception deficits in amblyopic patients. Reading difficulties in amblyopes have been attributed to fixation instability, which affects accurate forward saccades during reading. Amblyopic children have been found to read more slowly and have more saccades compared to non-amblyopic children. Dichoptic amblyopic eye best-corrected visual acuity deficits, which reflect binocular dysfunction, have been associated with impaired eye-hand coordination and slow reading. Additionally, oculomotor dysfunction, visual acuity deficits, and stereoacuity deficits contribute to reading difficulties in amblyopic patients. Therefore, measuring reading speed can provide valuable information about visual function, binocular dysfunction, and oculomotor abnormalities in amblyopic patients, which can guide treatment strategies and interventions to improve reading performance and academic achievement.

Advocate for the inclusion of comprehensive vision screenings, including assessments of visual acuity, binocular function, and oculomotor skills, as a standard practice in early childhood healthcare and educational settings. Early detection allows for timely intervention and improved outcomes.

CONCLUSION

Amblyopia, poses significant challenges to both reading speed and quality of life. This study highlights the importance of early identification, interdisciplinary collaboration, and evidence-based interventions in addressing the complex nature of amblyopia-related reading challenges as we seek to facilitate reading outcomes better to enhance the well-being of individuals with amblyopia, and a variety of this population. Continued research and new strategies are needed to better meet the needs.

REFERENCES

1. Kanonidou, E. (2011). Amblyopia: a mini review of the literature. *International ophthalmology*, 31(3), 249-256.
2. Chen, A. M., & Cotter, S. A. (2016). The amblyopia treatment studies: implications for clinical practice. *Advances in ophthalmology and optometry*, 1(1), 287-305.
3. *British Journal of Ophthalmology* 2020;104:1164-1170 Asper L, CrewtherD, CrewtherSG. Strabismic amblyopia: Part 1: psychophysics. *Clin Exp Optom* 2000; 83: 49–58.
4. FuZ,HongH,SuZ, et al Global prevalence of amblyopia and disease burden projections through 2040: a systematic review and meta-analysis.
5. Ganekal, S., Jhanji, V., Liang, Y., & Dorairaj, S. (2013). Prevalence and etiology of amblyopia in Southern India: results from screening of school children aged 5–15 years. *Ophthalmic epidemiology*, 20(4), 228-231.
6. Webber AL, Wood J (2005) Amblyopia: prevalence, natural history, functional effects and treatment. *Clin Exp Optom* 88:365–375
7. Birch, E. E., Kelly, K. R., & Giaschi, D. E. (2019). Fellow eye deficits in amblyopia. *Journal of binocular vision and ocular motility*, 69(3), 116-125.
8. . Birch EE, Subramanian V, Weakley DR. Fixation instability in anisometric children with reduced stereopsis. *J AAPOS* 2013;17:287-90.
9. Gonzalez EG, Wong AMF, Niechwiej-Szwedo E, Tarita-Nistor L, Steinbach MJ. Eye position stability in amblyopia and in normal binocular vision. *Invest Ophthalmol Vis Sci* 2012;53:5386-94.
10. Subramanian V, Jost RM, Birch EE. A quantitative study of fixation stability in amblyopia. *Invest Ophthalmol Vis Sci* 2013;54:1998-2003.

11. Engin, PULLUK. (2022). Reading. doi: 10.4324/9780429437991-47
12. Stanly, Johnson, Jeyaraj. (2023). Ispitivanje čitanja na engleskome jeziku u odnosu na vrstu zadatka i koheziju teksta. doi: 10.17234/diss.2022.8191
13. Sibel, Pekkolay. (2022). The Importance of Literacy. Scholars journal of arts, humanities and social sciences, doi: 10.36347/sjahss.2022.v10i01.002
14. Najmi, Laili, Hasibuan., Malida, Putri. (2022). Menerapkan Dan Meningkatkan Mutu Belajar Baca Pada Anak Di Panti Asuhan. doi: 10.55123/abdisoshum.v1i2.546
15. Helly, Shah., Kinnari, Kalaria., Dipali, Satani., Tejal, A., Desai. (2021). Evaluation Of The Reading Speed Of Near Visual Acuity After Providing Low Vision Intervention. Indian Journal of Applied-Basic Medical Sciences, doi: 10.48165/IJABMS.2021.233714
16. Nhung, X., Nguyen., Dorothea, Besch., Karl, U., Bartz-Schmidt., Faik, Gelisken., Susanne, Trauzettel-Klosinski. (2007). Reading performance with low-vision aids and vision-related quality of life after macular translocation surgery in patients with age-related macular degeneration.. Acta Ophthalmologica Scandinavica, doi: 10.1111/J.1600-0420.2007.00963.X
17. Nanda, Rommelse., Marjolein, Luman., Rogier, A., Kievit. (2020). Slow processing speed: a cross-disorder phenomenon with significant clinical value, and in need of further methodological scrutiny.. European Child & Adolescent Psychiatry, doi: 10.1007/S00787-020-01639-9
18. Petra, Rossouw., Maria, M, Guichard., Katja, Hatz., Katja, Hatz. (2020). Contrast sensitivity and binocular reading speed best correlating with near distance vision-related quality of life in bilateral nAMD.. Ophthalmic and Physiological Optics, doi: 10.1111/OPO.12736
19. Anwasha, Banerjee., Shreyasi, Datta., Monalisa, Pal., D., N., Tibarewala., Amit, Konar. (2015). Electrooculography based reading speed analysis as an assistive tool. Biomedical Engineering: Applications, Basis and Communications, doi: 10.4015/S1016237215500167
20. Diamantis, Almaliotis., Georgios, P., Athanasopoulos., Stavroula, Almpanidou., E., Papadopoulou., Vasileios, Karampatakis. (2022). Design and Validation of a New Smartphone-Based Reading Speed App (GDRS-Test) for the Greek Speaking Population. Clinical optometry, doi: 10.2147/OPTO.S370215
21. D., Lamoureux., Vishaal, Bhambhwani. (2023). Reading Speed Using the International Reading Speed Texts in a Normal Canadian Cohort. Cureus, doi: 10.7759/cureus.38196

22. Ádám, Nárai., Kathleen, Kay, Amora., Zoltán, Vidnyánszky., Béla, Weiss. (2021). Predicting Reading Speed from Eye-Movement Measures. doi: 10.1007/978-3-030-68796-0_33
23. (2022). Reading Speed In School-Age Children With Intermittent Exotropia: Evaluated With International Reading Speed Texts. doi: 10.21203/rs.3.rs-1363508/v1
24. Kaleb, D., Walton. (2019). Determining a reading speed based on user behavior.
25. Birch, E. E., & Kelly, K. R. (2017). Pediatric ophthalmology and childhood reading difficulties: amblyopia and slow reading.
26. Kanonidou, E., Proudlock, F. A., & Gottlob, I. (2010). Reading strategies in mild to moderate strabismic amblyopia: an eye movement investigation. *Investigative ophthalmology & visual science*, 51(7), 3502-3508.
27. Rayner, K. (1986). Eye movements and the perceptual span in beginning and skilled readers. *Journal of experimental child psychology*, 41(2), 211-236.
28. Booth, R. W., & Weger, U. W. (2013). The function of regressions in reading: Backward eye movements allow rereading. *Memory & cognition*, 41(1), 82-97.
29. Kelly, K. R., Jost, R. M., De La Cruz, B., Hunter, J. S., Dao, L., Beauchamp, C. L., ... & Birch, E. E. (2019). What causes slow binocular reading in amblyopic children?. *Journal of American Association for Pediatric Ophthalmology and Strabismus {JAAPOS}*, 23(4), e9-e10.
30. Kelly, K. R., Jost, R. M., De La Cruz, A., Dao, L., Beauchamp, C. L., Stager Jr, D., & Birch, E. E. (2017). Slow reading in children with anisometric amblyopia is associated with fixation instability and increased saccades. *Journal of American Association for Pediatric Ophthalmology and Strabismus*, 21(6), 447-451.
31. Kelly, K. R., Jost, R. M., De La Cruz, A., & Birch, E. E. (2015). Amblyopic children read more slowly than controls under natural, binocular reading conditions. *Journal of American Association for Pediatric Ophthalmology and Strabismus*, 19(6), 515-520.
32. Birch, E. E., Castañeda, Y. S., Cheng-Patel, C. S., Morale, S. E., Kelly, K. R., Beauchamp, C. L., & Webber, A. (2019). Self-perception of school-aged children with amblyopia and its association with reading speed and motor skills. *JAMA ophthalmology*, 137(2), 167-174.
33. Repka, M. X., Kraker, R. T., Beck, R. W., Cotter, S. A., Holmes, J. M., Arnold, R. W., ... & Pediatric Eye Disease Investigator Group. (2008). Monocular oral reading performance after amblyopia treatment in children. *American journal of ophthalmology*, 146(6), 942-947.

34. Stifter, E., Burggasser, G., Hirmann, E., Thaler, A., & Radner, W. (2005). Monocular and binocular reading performance in children with microstrabismic amblyopia. *British Journal of Ophthalmology*, 89(10), 1324-1329.
35. Stifter, E., Burggasser, G., Hirmann, E., Thaler, A., & Radner, W. (2005). Evaluating reading acuity and speed in children with microstrabismic amblyopia using a standardized reading chart system. *Graefes Archive for Clinical and Experimental Ophthalmology*, 243(12), 1228-1235.
36. Scheiman, M., Chase, C., Borsting, E., Mitchell, G. L., Kulp, M. T., Cotter, S. A., & CITT-RS Study Group. (2018). Effect of treatment of symptomatic convergence insufficiency on reading in children: a pilot study. *Clinical and Experimental Optometry*, 101(4), 585-593.
37. Tamara, Wagnanski-Jaffe., Michael, Belkin., Oren, Yehezkel. (2022). Reading performance improvement in amblyopic children using dichoptic eye-tracking training and an eye-tracking-based 30 second reading test. doi: 10.1016/j.jaapos.2022.08.226
38. Basharat, Hussain., Muhammad, Tahir, Khalily., Brian, Hallahan. (2023). Psychological intervention for a person living with amblyopia: a case study from home-based integrated care.. doi: 10.47391/JPMA.7304
39. Kelly, L., Coburn., McKayla, R., Kurtz., Daphne, L., Rivera., Rajesh, K., Kana. (2022). Behavioral and neurobiological evidence for the effects of reading interventions on autistic children: A systematic review. *Neuroscience & Biobehavioral Reviews*, doi: 10.1016/j.neubiorev.2022.104748
40. Basharat, Hussain., Muhammad, Tahir, Khalily. (2023). Psychological intervention for a person living with amblyopia: a case study from home-based integrated care. *Journal of Pakistan Medical Association*, doi: 10.47391/jpma.7304

