

Exploring Relationship between Near Phoria, Reading Speed, Comprehension and Effect of Vision Therapy: A Systematic Review

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Abstract:

Aim: To evaluate the relationship between near phoria and reading speed, comprehension and to assess the effectiveness of vision therapy.

Method: A comprehensive review of research papers investigating the effects of near phoria on reading performance was conducted. The studies involved utilized various research designs, including randomized controlled trials, observational studies, cohort studies, and case-control studies. Consistently used Binocular Vision tests used in the studies included the cover test, near point of convergence, positive and negative fusional vergence, vergence facility, accommodative facility, and stereopsis assessment. Reading performance was assessed using tools such as the Wechsler Individual Achievement Test (WIAT-III), Gates-MacGinitie Reading Test (GMRT), AIMSweb Reading Curriculum-Based Measure (R-CBM), and International Reading Speed Text (IReST). Selective Vision therapies included office-based vergence/accommodative therapy, home-based exercises, prism therapy, and computer-based visual training programs to improve convergence and accommodation.

Results and Conclusion: The findings ruled-out a significant negative correlation between near phoria and reading performance. Individuals with binocular vision anomalies displayed slower reading speeds, increased fixation durations, and reduced comprehension compared to those with normal BV ($p < 0.05$). Studies indicate that convergence insufficiency and accommodative dysfunction contribute to ineffective reading, characterized by frequent reversions and loss of place while reading. Vision therapy such as vergence and accommodative exercises, prism therapy, and computer-based training, have shown improvements in reading fluency and eye coordination; however, their direct effect on comprehension is still inconclusive. Existing gaps in studies include insufficient studies on the sustained impact of therapy, the academic consequences of near phoria, and to standardize evaluation methodologies for reading and comprehension. Acknowledging these gaps will enhance understanding and optimizing vision therapy for improved reading outcomes.

Keywords: Near phoria, reading speed, reading comprehension, binocular vision anomalies, convergence insufficiency, vision therapy.

1. Introduction

Reading is a compound task that depends on the effective coordination of various static and dynamic visual functions.¹ Reading speed, also known as reading rate, refers to the number of words a person can read correctly per minute. It's a component of reading fluency, which encompasses accuracy, pace, and expression. Reading speed is influenced by factors like the reader's purpose, expertise, and

text difficulty.² Reading is one of the most fundamental skills necessary for academic achievement, professional success, and overall personal development. It involves fluency, comprehension, and speed, which are critical components that vary across individuals due to cognitive and physiological differences.³ Near phoria is a binocular vision disorder where the eyes exhibit a latent misalignment, noticeable only when binocular vision is disrupted, such as during near work. This condition can manifest as either exophoria or esophoria. Exophoria is characterized by the eyes tending to drift outward during near tasks, often caused by weak convergence ability. It is a hallmark of convergence insufficiency, a condition that can lead to symptoms like double vision, headaches, and difficulty focusing on close-up tasks.⁴ On the other hand, esophoria is defined by an inward drift of the eyes when focusing on near objects. It is commonly linked to hyperopia, where excessive convergence occurs due to increased accommodative demand. Esophoria often results in eyestrain, blurred vision, and reduced reading efficiency.⁵ Near phoria is a binocular vision disorder characterized by the inability of the eyes to maintain alignment during close-up tasks such as reading.⁶ Unlike overt eye alignment issues such as strabismus, near phoria often goes undiagnosed, despite its significant impact on reading efficiency. The condition can cause increased eye strain, reduced reading speed, and impaired comprehension.⁵ Left untreated, these symptoms can further exacerbate academic underperformance and lower quality of life. Vision therapy offers a non-surgical approach to treating near phoria by enhancing binocular coordination and efficiency. It mitigates symptoms like eye strain and reading inefficiency, ultimately improving quality of life.⁷ While vision therapies have shown promising results in near phoria and improving visual function,⁸⁻⁹ their long-term effects on reading performance remain unclear.¹⁰⁻¹⁵ This study aims to evaluate reading speed and comprehension in college students, explore the correlation between near phoria and reading performance, assess the efficacy of vision therapies, and determine if improvements are sustained over time after therapy cessation. By addressing these objectives, this research seeks to enhance understanding of the role of visual function in reading and the potential benefits of vision therapies for academic performance.

2. Literature Review

2.1 Impact of Binocular Vision Anomalies on Reading Performance

Reading performance is greatly impacted by binocular vision disorders such as near phoria and convergence insufficiency (CI), which result in slower reading speeds and decreased comprehension. Children with CI or accommodative dysfunction read 20% more slowly than their counterparts ($p = 0.01$) and had 30% more regressions, according to Choi, Park, and Lee (2018).¹¹ This led to worse comprehension scores ($p < 0.05$). Similarly, Kim and Alvarez (2012) found that reading performance was hampered by greater regressions and eye strain among those with near phoria, who read at 120 words per minute (wpm) as opposed to 160 wpm in controls ($p = 0.03$).¹²

It was discovered that those who were affected had 40% more fixation instability ($p = 0.01$), which was linked to a 25% slower reading speed ($p < 0.05$) and is frequently linked to near phoria (Kim, 2020).¹³ Furthermore, Kim, Lee, and Park (2019) discovered that children who struggled with reading had 28% more saccadic movements and 34% longer fixation durations ($p < 0.01$), underscoring the effect of near phoria and associated visual dysfunctions on reading efficiency.¹⁴

2.2 Effectiveness of Vision Therapy in Improving Reading Performance

In order to improve reading performance and treat binocular vision abnormalities, vision therapy (VT) has been investigated as an intervention. Following an 8-week vergence therapy program, Nivar and Gabrielle (2015) showed a 25% decrease in regressions and a 15% increase in reading speed ($p = 0.02$), suggesting improved eye coordination and tracking.⁹

Furthermore, Shin, Park, and Maples (2013) showed that VT produced notable improvements in near point of convergence ($p = 0.02$) and a 30% decrease in symptoms ($p = 0.01$), with benefits that persisted for an year.⁸ The CITT Study Group (2019) observed no statistically significant increase in reading comprehension ($p = 0.45$) despite improvements in visual efficiency, indicating that although VT improves eye alignment and reduces symptoms, it might not immediately improve.¹⁰

3. Research Methodology

The association between near phoria, reading speed, comprehension, and the impact of vision therapy was investigated in a systematic review. Using keywords like "near phoria," "vergence," "reading speed," and "vision therapy," the literature was found in databases like PubMed, Google Scholar, PsycINFO, and the Cochrane Library, with an emphasis on research conducted between 1991 and 2021. Screening for literature review papers were done using inclusion criteria pertaining to vision therapy and reading outcomes, two reviewers independently reviewed complete texts, abstracts, and titles. Important information was selected, such as the study's design, participant information, interventions, and results. A narrative synthesis and, when appropriate, a meta-analysis were used in the review to assess how vision treatment affected near-phoria reading skills.

4. Methods

The reviewed studies investigated conditions like dyslexia, convergence insufficiency, and binocular vision abnormalities, with a primary focus on children aged 7–17 years, while some also included adults (CITT Study Group 2019).

4.1. Diagnostic Tests

- Convergence Insufficiency Symptom Survey (CISS) was used in CITT Study Group (2019) to measure symptom severity in convergence insufficiency (CI). Participants rated symptoms like eye strain and headaches, providing a baseline for VT outcomes.
- Positive Fusional Vergence (PFV) and Near Point of Convergence (NPC): Nivar & Gabrielle (2015) assessed convergence ability before and after VT.
- Remote Eye Tracker was used by Kim (2020) to measure fixation stability in abnormal phoria, finding 40% higher instability in affected individuals ($p = 0.01$), correlating with slower reading speed.
- Oculomotor Pattern Analysis: Kim et al. (2019) analyzed fixation duration and saccadic movements, presenting 34% longer fixations and 28% greater saccades in poor readers ($p < 0.01$).

- Accommodative Facility Testing: Shin et al. (2013) used lens flippers to assess focusing ability, showing a 25% improvement in accommodative facility after VT ($p = 0.03$).
- Standardized Reading Tests: Palomo-Álvarez & Puell (2010) measured reading speed and comprehension errors; findings were- children with CI read 17 wpm slower and made 5 more errors ($p < 0.05$).
- Asthenopia Assessment: Cohen et al. (2010) evaluated eye strain and its impact on reading, showing high asthenopia reduced reading speed to 100 wpm (vs. 150 wpm in controls, $p = 0.01$).

4.2. Vision Therapy (VT) Protocols

Vergence/Accommodative Therapy: CITT Study Group (2019) conducted a 16-week program, improving PFV from 10 to 18 prism diopters ($p < 0.001$) but couldn't improve reading comprehension ($p = 0.45$). 311 children with convergence insufficiency, aged 9 to 14, were enrolled in the Grp & Scheiman (2019) study. Weekly in-office vergence/accommodative treatment and daily 15-minute at-home activities (such as pencil push-ups and computer-based tasks) were part of a 16-week vision therapy program. Improvements in reading competence, symptom reduction (CISS), and positive fusional vergence (PFV) were among the outcome. Vision therapy for Convergence Insufficiency and Accommodative Insufficiency was implemented by Shin et al. (2013), the study used 12-week sessions, reducing symptoms by 30% ($p = 0.01$) and improving NPC from 12 cm to 6 cm ($p = 0.02$). Oculomotor VT conducted in Bonilla-Warford & Allison (2004) study improved reading speed by 25% ($p < 0.05$) with exercises targeting eye tracking. Vergence Facility Training done by Kim & Alvarez (2012) conducted 6 weeks of training, increasing reading speed by 15% ($p = 0.04$). Data were analyzed using t-tests, ANOVA, and correlation analyses.

5. Result

Reading comprehension and speed are severely hampered by binocular abnormalities like near phoria and convergence insufficiency (CI), as the reviewed research repeatedly showed. The studies' main conclusions are outlined below.

5.1. Reading Speed and comprehension

When compared to controls, those with visual impairments such near phoria or CI showed poorer reading speeds. Participants with near phoria read an average of 120 words per minute (wpm), while the control group read an average of 160 wpm ($p = 0.03$), according to Kim and Alvarez (2012). Similarly, children with convergence insufficiency read 17 words per minute more slowly than children with adequate convergence ($p = 0.01$), according to Palomo-Álvarez and Puell (2010). Cohen et al. (2010) also discovered that those with high asthenopia read at 100 words per minute, while people with low asthenopia read at 150 words per minute.

Visual anomalies were associated with higher comprehension errors. Children with visual abnormalities, such as accommodative dysfunction or CI, had 15% worse comprehension scores than their fellow students without visual difficulties ($p < 0.05$), according to Choi, Park, and Lee (2018). High asthenopia participants created six comprehension errors each passage, while the control group made two ($p = 0.02$), according to Cohen et al. (2010).

Individuals with visual abnormalities frequently experienced fixation instability and increased regressions. According to Kim (2020), people with abnormal phoria had 40% more fixation instability than individuals with normal eye alignment ($p = 0.01$). A 25% slower reading speed was significantly associated with this instability ($p < 0.05$). In addition, Kim and Alvarez (2012) found that near phoria sufferers had 4.2 regressions each passage, while the control group had 2.1 ($p < 0.01$).

5.2. Vision Therapy Results

Convergence insufficiency (CI) symptoms can be effectively reduced by vision therapy (VT), which also increases visual efficiency and may help with reading speed, according to some research. Office-based vergence/accommodative therapy significantly increased near point of convergence (NPC), positive fusional vergence (PFV) ($p < 0.001$), and decreased symptoms such as eye strain and fatigue, according to Scheiman et al. (2019).

Improvements in fluency and visual alignment were observed in relation to reading speed, however the results were conflicting. Although some participants displayed higher reading speeds and smoother eye movements, there were no consistent, statistically significant increases in reading speed ($p > 0.05$). Furthermore, when compared to the placebo group, Scheiman et al. (2019) did not find any significant improvement in standardized reading comprehension scores ($p = 0.45$).

6. Discussion

This systematic review emphasizes how reading speed and comprehension are significantly impacted by binocular vision (BV) abnormalities including near phoria and convergence insufficiency (CI). Reduced understanding, increased regression rates, and slower reading speeds are common characteristics of people with these abnormalities. For instance, Kim and Alvarez (2012) discovered that people with near phoria made 4.2 regressions per passage, compared to 2.1 in controls ($p < 0.01$), and read at 120 wpm, as compared to 160 wpm in controls ($p = 0.03$). Palomo-Álvarez and Puell (2010) also found that children with CI made five additional comprehension errors per passage ($p < 0.05$) and read 17 words per minute more slowly. These results highlight how important BV is to reading efficiency.

Reading skills can be improved and BV abnormalities can be addressed using vision therapy (VT). After 12 weeks of VT, Shin, Park, and Maples (2013) found improvements in near point of convergence (NPC) from 12 cm to 6 cm ($p = 0.02$) and a 30% reduction in symptoms ($p = 0.01$). However, VT did not significantly increase reading comprehension ($p = 0.45$), according to The CITT Study Group (2019). This suggests that although VT enhances visual function, its influence on higher-order cognitive processes may be restricted.

7. Conclusion

The systematic study emphasizes how reading speed and comprehension are significantly impacted by binocular vision (BV) abnormalities including near phoria and convergence insufficiency (CI).

Studies such as Kim and Alvarez (2012) and Palomo-Álvarez and Puell (2010) demonstrate that individuals with these abnormalities read more slowly and make more mistakes in their understanding. According to the CITT Study Group (2019), VT had no apparent impact on reading comprehension ($p = 0.45$), suggesting that its influence on higher-order cognitive functions was restricted. Limited studies have been conducted on the impact of near phoria on reading speed, and long-term consequences on visual function. Little is known about the long-term effects of therapy on visual function and reading speed, as well as how it affects adults and elderly populations. To fill these gaps, more research is required.

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