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## ORIGINAL ARTICLE

# Visual and binocular status in elementary school children with a reading problem

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### KEYWORDS

Binocular vision;  
Reading difficulty;  
Pediatrics;  
Vision and learning

### Abstract

**Purpose:** This descriptive study provides a summary of the binocular anomalies seen in elementary school children identified with reading problems.

**Methods:** A retrospective chart review of all children identified with reading problems and seen by the University of Waterloo, Optometry Clinic, from September 2012 to June 2013.

**Results:** Files of 121 children (mean age 8.6 years, range 6–14 years) were reviewed. No significant refractive error was found in 81% of children. Five and 8 children were identified as strabismic at distance and near respectively. Phoria test revealed 90% and 65% of patients had normal distance and near phoria. Near point of convergence (NPC) was <5 cm in 68% of children, and 77% had stereoacuity of  $\leq 40$  seconds of arc. More than 50% of the children had normal fusional vergence ranges except for near positive fusional vergence (base out) break (46%). Tests for accommodation showed 91% of children were normal for binocular facility, and approximately 70% of children had an expected accuracy of accommodation.

**Conclusion:** Findings indicate that some children with an identified reading problem also present with abnormal binocular test results compared to published normal values. Further investigation should be performed to investigate the relationship between binocular vision function and reading performance.

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### PALABRAS CLAVE

Visión binocular;  
Dificultad lectora;  
Pediatria;  
Visión y aprendizaje

### Estado visual y binocular en niños de primaria con dificultades lectoras

### Resumen

**Objetivo:** Este estudio descriptivo aporta un resumen de las anomalías binoculares observadas en niños de primaria en los que se identificaron problemas de lectura.

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**Métodos:** Revisión retrospectiva de las historias clínicas de todos los niños en los que se identificaron problemas de lectura, examinados en la Universidad de Waterloo, Clínica de Optometría, desde Septiembre de 2012 a Junio de 2013.

**Resultados:** Se revisaron las historias de 121 niños (edad media 8,6 años, rango 6-14 años). No se encontró ningún error refractivo significativo en el 81% de los niños. Se identificaron cinco y ocho niños con estrabismo de visión lejana y cercana, respectivamente. La prueba de foria reveló que el 90% y 65% de los pacientes padecían foria en rango de normalidad para lejos y cerca. El punto próximo de convergencia (PPC) fue <5 cm en el 68% de los niños, y el 77% reflejó estereogudeza  $\leq 40$  segundos de arco. Más del 50% de los niños tenía rangos de vergencia fusional normal, excepto para el punto de rotura de vergencia fusional positiva de cerca (46%). Las pruebas de acomodación reflejaron que el 91% de los niños tenía una flexibilidad binocular normal, y aproximadamente el 70% de los niños tenía una precisión de acomodación con arreglo a lo previsto.

**Conclusión:** Los hallazgos indican que algunos niños con dificultades lectoras identificadas presentan también alteraciones en los resultados de las pruebas binoculares, en comparación a los valores normales publicados. Deberá investigarse más con respecto a la relación entre la función de la visión binocular y el rendimiento lector.

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## Introduction

Reading is a multifactorial process that is influenced by psychological, physiological, environmental, sociological and linguistic factors.<sup>1,2</sup> From an optometrist's perspective, a decrease in reading ability may be associated with poor visual acuity, unstable binocular vision, or ocular disease.<sup>3</sup> It is therefore important that people with poor reading comprehension receive a comprehensive oculo-visual assessment.

A thorough case history is one of the critical components of an oculo-visual assessment. More so than with adults, the case history from a younger population may be inconclusive or unreliable. Younger children may be unaware of their visual problems, or are unable to describe their associated symptoms. In these cases, observations from parents and teachers such as eye rubbing, close working distance, or avoidance of near work, provide additional information.

In cases where the patient is wearing their full refractive correction and shows no signs of ocular disease, but describes symptoms of asthenopia, an investigation of the binocular vision system is of particular importance. Literature has shown an association between poor reading performance and binocular vision disorders. These disorders include poor pursuits,<sup>4</sup> abnormal convergence,<sup>4</sup> low amplitude of accommodation,<sup>5</sup> accommodative infacility,<sup>5,6</sup> poor fusional vergence reserves, and abnormal fixation disparity.<sup>7</sup> In Ontario, Canada, children who read below their expected grade may be eligible for an Individual Education Plan (IEP) provided by their local school board. An IEP is a special education plan designed to modify the curriculum for a particular student in order to assist the student in achieving his or her learning goals.<sup>8</sup>

The current manuscript investigates the prevalence of visual and binocular vision anomalies in a cohort of school children who have an IEP for reading (ReIEP).

## Methods

The University of Waterloo Optometry Clinic provides full eye examinations to children with an IEP for reduced reading efficiency (defined as a 2 or more grade level reduction from expected grade)<sup>9</sup> enrolled in 5 (of 103) elementary schools within Waterloo Region, Ontario, Canada. These children were identified by their classroom teacher based on their performance on the PM Benchmark Reading Assessment (Nelson Education).<sup>9</sup> We retrospectively collected refractive and binocular vision data from 121 files of children aged 6–14 years examined between September 2012 and June 2013. Patient consent and study process received ethics clearance from the University of Waterloo, Office of Research Ethics which follows the tenets of the Declaration of Helsinki.

## Visual and binocular vision tests

All vision and binocular tests were administered by 3rd year optometry students and verified by the first author, a registered optometrist. Where indicated, alternate test charts and targets were used based on the child's age and level of comprehension, as shown in Table 1.

All visual and binocular functions were assessed with the child's habitual correction (if applicable). For visual acuity, varying test charts were used based on the child's ability. Stereoacuity was measured using the Randot® Stereoacuity Test (Stereo Optical Company, Chicago, USA). Accuracy of saccadic function was measured using 2 lettered targets, and the child was asked to alternate fixation between the 2 targets, 5 times. Saccades were classified as either accurate, undershoot, or overshoot. The Broad-H test was used to assess extra ocular motility, and classified as restricted or unrestricted. The unilateral and alternating cover test at distance (6 m) and near (0.4 m) determined the presence

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