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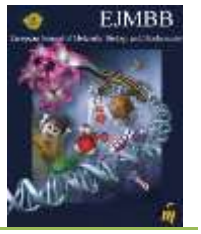

IMPACT OF ABNORMAL VISUAL FUNCTION ON READING ABILITY IN CHILDREN: AN ANALYSIS OF ERRORS, ACCURACY, AND SPEED

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ABSTRACT

Children with and without anomalous visual function will be examined to determine how abnormal visual function may affect reading ability. A total of 110 children with abnormal visual function (aged 6-11 year olds) and 562 children with normal visual function (NVF) participated in the study. As well as autorefraction, multiple measures were evaluated, including visual acuity, ocular alignment, near point of convergence, accommodation, stereopsis, and vergence. Our analysis of the oral reading used 34 words from a list of verbs. Errors were measured, accuracy was determined (percentage of success) and speed (words per minute - wpm) was measured to gauge reading abilities. The sociodemographic data was collected from 670 parents and 34 teachers.AVF-affected children made more errors (3.00 errors compared to 1.00 errors; p0.001), had lower accuracy (91.18% compared to 97.06%); and had slower reading speeds (AVF-24.71 wpm compared to NVF-27.39 wpm; p0.007). AVF=31.41 wpm; NVF=32.54 wpm; p=0.113) was not statistically significant differencing between the two groups in 3rd grade. Children with uncorrected hyperopia and astigmatism performed differently on reading tests (p=0.003). Students in the second, third, and fourth grades are less likely than students in the first grade to have reading impairments. Children with AVF had difficulty reading in the first grade. Increasing reading abilities diminish with age. AVF children might need an eye evaluation to be diagnosed as dyslexics due to their slow reading characteristics.

INTRODUCTION

Reading requires both visual and phonemic information to be integrated, so answering different questions prompts debate. For successful function in today's society, single image perception is essential for a successful visuo-cognitive process called reading [1]. Saccades, convergence, and fusion are associated with refractive index, accommodation, and visual acuity are all visual functions managed by the visual cortex when reading. Following this, repetition, linguistics, and assimilation are necessary for learning to read. Thus, reading is a combination of verbal and visuomotor processes, all aimed at providing a high level of reading accuracy [3].

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It has been suggested that the role of the eyes in reading contributes to many misconceptions about reading difficulties [4]. There is evidence that either impairment of the phonemic process or impairment of the visual process may impair a child's ability to read [5]. Additionally to health factors such as dyslexia, reduced intellectual ability, binocular vision anomalies, and speech sound disorders, family, social, physical, and economic circumstances have been linked to low levels of academic achievement and educational attainment.

Neither academic performance nor reading ability have been shown to be significantly impacted by abnormal visual function. Several authors argue that visually normal children without cognitive disturbances or speech sound disorders may be at an educational disadvantage compared to their visually challenged peers

[2,5,7,9-13]. It has been reported that visual function does not positively correlate with academic performance [14].
Study objectives include:

1. Attempt to compare the performance of children with and without anomalies in their visual function while reading (errors, accuracy, and reading speed).
2. Readability is compared across school grades, according to different visual functional anomalies and refractive errors.
3. Determine whether abnormal visual function influences reading performance, as well as other factors (e.g. teaching method, parent's academic credentials).

METHODS AND MATERIALS

In 11 mainstream schools, there are Portuguese primary schools were included in a cross-sectional study conducted in 2012. Six hundred and seventy-two typically developing children of Portuguese origin (6-11 years old) were sampled. Disabled children, those with neurocognitive disabilities, dyslexic children, and those with speech or language disorders were excluded. In addition to this, a questionnaire was sent out to 670 parents and 34 teachers to collect information about the teaching method, the academic qualifications of the parents, the kind of school (public or private), the age of the teacher and the number of years they've worked at the school, and also the grade of the child.

The Declaration of Helsinki was adhered to in this study. The National School of Public Health in Lisbon provided ethics approval for the study. The study was explained to all selected school administrators and they agreed to participate. To include a child's data in the study, informed consent was obtained from the parents. It was guaranteed that the information given would remain confidential. Orthoptists performed orthoptic assessments and autorefractions on all children:

A SureSightTM WelchAllyn® autorefractometer was used to screen for refractive error. Astigmatism and anisometropia were classified as two types of refractive errors, respectively: hyperopia and myopia [15].

Good-Lite® charts with Sloan letters serially spaced at 3 meters, as well as Good-Lite® charts with LogMar letters serially spaced at 40 cm, were used to measure distance and near visual acuity. The last line of the test requires that at least three of the five letters are correctly identified. Visual acuity was considered abnormal (near but not distance) if there was no difference between the two eyes in visual acuity. A decimal number was converted to a logarithmic value using decimal notation [19]:
(1)

Cover tests (CT) were performed at 6 meters and 33 cm from the eyes to detect heterotropias and heterophorias. A black paddle occluder was used as a cover during the CT scan. As targets, we used detailed fixation objects. As defined by [20], manifest strabismus is any degree of tropia at a distance or near fixation [21]. The magnitude of the deviation was assessed by a prism cover test.

Royal Air Force (RAF) rules were used to assess near point of convergence (NPC). Three measurements were taken and the mean was recorded in cm. When the NPC exceeds 10 cm, it is considered abnormal [21].

A RAF rule was used to assess NPAs. A diopter measurement was taken based on three measurements. As of 14.00D [22], NPAs were considered abnormal.
The Stereo Butterfly SO-005 test was used to assess stereoacuity at 40 cm, and abnormal measurements were recorded when the distance exceeded 60" [23].

The head was held straight at 6 m and 33 cm for the assessment of vergences (motor fusion). The targets were detailed fixation objects. With the help of prisms, we assessed motor fusion. The NPC > 10 cm requirement for a convergence insufficiency classification is combined with either the 18PD, the 12PD, or the 6PD criteria.
With a pen light, nine cardinal positions were measured for eye movement (versions and ductions).

As long as the orthoptic assessment and autorefraction results were normal, The vision function of children was considered normal. If glasses were previously prescribed, they were examined with optical correction. If abnormal visual functions were detected in children without prescribed glasses, they were referred to an ophthalmologist for further medical treatment.

With a list of 34 Portuguese words that have previously been used for reading assessment, error rates, accuracy, and reading speed were assessed [24]. A TES-1330 luximeter was used to measure room illumination for both groups of subjects in a quiet room. A distance of 40 cm was assigned to each child so they could read the 34 words. There was a restriction on how close the children could get to the page. Time was measured with a stopwatch as the task was completed. wpm (words read per minute) is the child's reading speed. This equation was used to calculate accuracy (A) based on the number of incorrect words read:

There are two types of words read: NCW and WR. It is based on three levels of performance, which have been published and validated [26]. The first level is independent reading (accuracy between 96% and 100%); the second level is instructional reading (accuracy between 90-95%); and the third level is frustration reading (accuracy between 90-95%).

Continuous variables were tested by Mann-Whitney, and continuous variables for more than three groups were tested by Kruskal-Wallis. P values less than or equal to 0.05 or 0.01 were considered statistically significant. In addition, we used a binary logistic regression technique to identify risk factors for failing to read well. Several variables were selected for inclusion in the model by following a step-by-step approach

(conditional). A 5% significance level was used in the Wald test to test the significance of the parameters [27,28].

RESULTS

One hundred and forty-two children have deficient vision (or 16.4%), while 562 have normal vision (mean age, 7.68 ± 1.19 years). The gender and age of the two groups did not differ significantly (p=0.675). Similarly, the degree of illumination, parents' educational qualifications, and professors' years of teaching experience did not differ between comparison groups (p=0.987). Similar teaching methods were used by both groups.

There were 110 children who had One hundred and seventy-seven percent of those, 17 of whom were manifest strabismus, 66 were unable to see distance objects at 0.1 logMAR, two were suffering from convergence insufficiency, and fifteen demonstrated stereoacuity above 60", while the remaining 10 had manifest strabismus as well as a visual acuity below 0.1 logMAR at distance. Of the children identified with strabismus 4 had an uncorrected refractive error. Of the children with visual acuity ≥0.1 logMAR at distance 15 had an uncorrected refractive error, mainly hyperopia (10.6%) and astigmatism (9.1%). Acuity for near and distance was abnormal in only two children. [29]

A total of 11 children with manifest strabismus have stereoacuities greater than 60" Approximately 400 inches (median). Additionally, two children had uncorrected refractive errors among the 17 children whose stereoacuity was >60" (median=80"). with a stereoacuity >60" (median=40") with strabismus.

Ability to read

In the abnormal visual function group, errors increased from 3 to 1 (AVF3.00; NVF1.00; p0.001), accuracy decreased from 91.18% to 97.06%, and reading speed decreased from 24 to 27 in the abnormal visual function group (AVF24.71; NVF27.39; p0.007). In a study of children with abnormal visual functions, 18.9% were accurate, while 40% were incorrect.

Additionally, we compared the reading performances of children in first through fourth grades. It was statistically significant that the percentage of errors and accuracy varied from group to group per grade with subjects with abnormal vision having a higher percentage of errors. There was no This was the only grade where reading speed did not differ statistically between groups (AVF=31.41wpm; NVF=32.54wpm; p=0.113).

According to Table 2, reading performance for individuals who have uncorrected refractive error and abnormal visual function is shown. Reading speed was fastest among children with visual acuities less than 0.1 logMAR. The average reading speed of children with strabismus at 0.1 logMAR versus children with strabismus and normal visual acuity was 26.34 wpm, which is lower than that of children with strabismus at 30.94 wpm. There were no significant differences between the groups in accuracy or reading speed (errors=0.994; accuracy=0.922; speed=0.652), despite all groups having nonsignificant differences in reading performance (errors=0.994; accuracy=0.922; speed=0.652).

In comparison to children without or corrected refractive errors, children with uncorrected hyperopia scored lower on A reading speed of 16.20 words per minute and accuracy of 88.24% are among the findings (Table 2). Uncorrected hyperopia was significantly different from uncorrected astigmatism, as was uncorrected hyperopia from children without refractive errors (p=0.003).

Additionally, we compared children's refractive status scores (0.50D, 1.00D, 2.00D and >2.00D) and spherical refractive status scores (1.00D, 2.00D, 3.00D, and >3.00D). The reading speed of students with spherical refractive scores greater than 24.25 wpm was significantly lower, with a median value of 3.00, a lower accuracy score of 91.18 percent, and higher errors (median of 3.00). When cylindrical refractive scores were above 2.00D, children had slower reading speeds (18.42 words per minute). Both children without and with corrected refractive errors showed no significant differences.

Children's reading performance was assessed by direct logistic regression by assessing seven factors: their visual function (normal/abnormal), the method of teaching, the academic qualifications of their parents, the type of school they attended, their age, their career years, and their grade. If the accuracy of your reading is less than 90%, you are considered to have a low reading performance. [26].

Based on the full logistic regression model, the likelihood of a low reading performance was significantly different from the likelihood of a low reading performance for non-low-performing children. A 39.3% sensitivity and 94.3% specificity were calculated for the model. 67.1% of the samples were positive, whereas 84.0% were negative. Statistically significant risk factors or predictors were identified at the An OR of 4.29 was found, with a 95% confidence interval of 2.49 to 7.38 (OR = 4.29, C.I. 95% (2.49; 7.38)). A child with a visual function anomaly is more likely to have a low reading performance. There was, however, a protective factor associated with children's grade (p0.001): [OR 2nd=0.17; C.I. 95% (0.09; 0.29); OR 3rd=0.08; C.I. 95% (0.04; 0.16); OR 4th=0.04; C.I. 95% (0.02; 0.09)]. Compared to the 1st grade, students in the 2nd, 3rd, and 4th grades were less likely to have low reading performance. In our model of reading performance, we examined the variables teaching methodology, parental academic credentials, school type (public versus private), teacher age, teacher experience, and child grade

Table 1: Grades and groups of children's reading performance.

Ability to read	An average minus a standard deviation		Median Average		Value P
	NVF^{+}	AVF^{++}	NVF^{+}	AVF^{++}	
Error rate	2.20 ± 3.24	4.40 ± 5.54	1.00	3.00	<0.001*
First	3.99 ± 4.36	11.10 ± 8.07	2.00	9.00	<0.001*
Grade-level errors					
Second	1.67 ± 1.88	4.26 ± 4.78	1.11	3.00	<0.002*
Third	1.27 ± 1.74	2.53 ± 3.11	1.11	2.00	0.004*
Fourth	1.17 ± 1.54	2.08 ± 2.74	1.11	1.00	0.035**
Inaccuracy (%)	91.05± 16.95	80.88 ± 26.33	97.14	91.36	<0.002*
Percentage accuracy					
First	78.71 ± 27.94	53.19 ± 29.25	91.18	60.29	<0.002*
Second	93.97 ± 9.65	83.48 ± 21.44	97.06	91.96	<0.002*
Third	95.32 ± 6.44	88.87 ± 22.32	97.06	94.36	0.001*
Fourth	95.46 ± 8.99	93.99 ± 5.44	97.06	94.25	0.036**
In words per minute, what is your reading speed?	28.47 ± 16.66	23.02 ± 15.25	27.39	24.69	0.007*
Graduation rate for reading					
First	13.87 ± 9.77	5.02 ± 5.14	12.77	3.36	<0.001*
Second	25.15 ± 12.99	17.45 ± 11.21	24.54	16.98	<0.001*
Third	34.19 ± 11.55	29.96 ± 12.36	32.25	31.36	0.113
Fourth	41.94 ± 14.77	38.21 ± 16.47	40.11	35.87	0.031**

Table 2: Uncorrected refractive errors and anomalies in the visual function affect reading performance.

Anomalies with the visual system	Ability to read	Standard deviation + mean	Indicator
As a result of 0.1 logMAR (n=66), visual acuity was measured.	Mistakes	4.63 ± 5.99	3.11
	Reliability	81.46 ± 24.57	91.26
	Time it takes to read	21.94 ± 15.55	20.47
A total of 17 people were diagnosed with strabismus	Inaccuracies	4.25 ± 5.47	1.36
	Efficacy	82.35 ± 26.23	94.36
	Time it takes to read	26.25 ± 16.77	30.47
Acute visual acuity combined with strabismus, ≥0.1 logMAR (n=10)	Anomalies	5.00 ± 7.52	3.11
	Reliability	68.82 ± 40.32	91.36
	Time it takes to read	20.71 ± 14.47	26.34
(n=2) Insufficiency of convergence	Inaccuracies	3.00 ± 0.00	3.14
	Reliability	91.18 ± 0.00	91.36
	Time it takes to read	29.30 ± 0.22	29.30
(n=15) Stereoacuity >60"	Mistakes	3.64 ± 3.36	3.00
	Efficacy	83.33 ± 24.41	91.18
	Time it takes to read	24.85 ± 16.36	23.86
Visually normal children	Mistakes	2.20 ± 3.14	1.00
	Reliability	91.05 ± 16.98	97.06
	Time it takes to read	28.32 ± 16.47	27.39
A non-corrected optical error	Ability to read	Mean ± Standard deviation	Median
(n=11) Hyperopia	Mistakes	5.11 ± 5.44	3.11
	Reliability	70.32 ± 35.69	88.32
	Time it takes to read	16.18 ± 12.88	16.52
Instability (n=9)	Mistakes	4.75 ± 5.87	2.11
	Reliability	71.57 ± 33.98	91.24
	Time it takes to read	19.34 ± 17.25	20.66
(n=5) Anisohyperopia	Mistakes	2.40 ± 2.87	2.00
	Reliability	92.94 ± 7.98	94.23
	Time it takes to read	30.42 ± 12.87	26.64

DISCUSSION

To better understand how visual function anomalies affect reading abilities in children, this study examined Anomalies of visual function in children who read. It is clear from the results that this population is afflicted with different levels of visual function, which may have a direct influence on reading skills.

A significant difference in reading performance was found between children with and without visual function anomalies. A visual anomaly may impede the development of reading skills and highlight the critical role that vision plays in reading acquisition. [30]

The disruption of visual perception could explain the observed connection between visual function anomalies and reading difficulties. It can be difficult for children to perceive and process written text accurately if they have visual anomalies, such as refractive errors, strabismus, or amblyopia. A person may have difficulty recognizing letters, decoding words, and reading fluently as a result.

Additionally, visual anomalies can interfere with eye movements and scanning patterns during reading. An atypical eye movement pattern is present in children with anomalies, including reduced fixation stability, shorter saccade lengths, and more regressions. When eye movement abnormalities are present, visual information cannot be processed and incorporated efficiently and fluently.

Additionally, reading comprehension processes may be affected by visual anomalies. Vision and eye movement difficulties may reduce engagement with texts, impair narrative structure tracking, and compromise content comprehension. Comprehending problems may arise even when basic decoding skills are intact due to these factors.

There are important clinical implications to be drawn from the findings of this study. For children to attain optimal reading outcomes, it is crucial that visual function anomalies are detected early and appropriately managed. The identification and treatment of visual anomalies that may affect reading development should be implemented through regular vision screenings and comprehensive eye examinations. Children with visual anomalies should be supported to achieve optimal reading skills by a multidisciplinary approach that involves prescription eyewear, vision therapy, and surgical interventions.

It may also be beneficial for children with visual anomalies to receive interventions that target both their visual function and reading skills. The performance of reading can be improved by vision therapy programs designed to improve eye movement, visual perception, and visual-motor integration. A comprehensive reading intervention program should also be implemented to facilitate the development of phonological awareness, decoding skills, and comprehension strategies.

The current study has some limitations that should be acknowledged. It may be difficult to generalize the results due to the limited sample size and the specific types of abnormalities that were examined. Researchers should investigate the relationship between specific visual function characteristics and reading abilities using larger and more diverse samples, taking into account a wider range of visual anomalies.

CONCLUSIONS

In order to maximize reading outcomes in children, it is crucial to detect visual function abnormalities early and manage them appropriately. To identify and correct visual anomalies that may impact reading development, regular vision screenings and comprehensive eye examinations should be implemented. In order to overcome visual obstacles to reading, children may need special eyeglasses, vision therapy, or surgical interventions.

Children with visual anomalies can benefit from interventions that target both their vision and their reading skills. Visual therapy programs can enhance reading performance by improving eye movements, vision perception, and visual-motor integration. Several evidence-based reading interventions should also be implemented to support reading development, including decoding skills, phonological awareness, and comprehension strategies.

The impact of visual function anomalies on reading performance requires further research. By using a larger and more diverse sample, a study can be made more generalizable. The longitudinal study of visual function anomalies can also provide insightful insights into how they affect reading skills and education as they mature.

REFERENCES

1. Blythe HI, Liversedge SP, Findlay JM (2010). The effective fusional range for words in a natural viewing situation. *See comment in PubMed Commons below Vision Res* 50, 1559-1570.
2. Thurston A, Thurston M (2013). A Literature Review of Refractive Error and Its Potential Effect on Reading Attainment in the Early Years of School. *Optom Vis Perf* 1, 25-31.
3. Huestegge L, Radach R, Corbic D, Huestegge SM (2009). Oculomotor and linguistic determinants of reading development: a longitudinal study. *See comment in PubMed Commons below Vision Res* 49, 2948-2959.
4. Granet D, Castro E, Gomi C (2006) Reading: Do the Eyes Have It? *American Orthoptic Journal* 56, 44-49.
5. Cornelissen P, Bradley L, Fowler S, Stein J (1992). Covering one eye affects how some children read. See comment in PubMed Commons below *Dev Med Child Neurol* 34, 296-304.
6. Anthony JL, Aghara RG, Dunkelberger MJ, Anthony TI, Williams JM, (2011).What factors place children with speech sound disorders at risk for reading problems? See comment in PubMed Commons below *Am J Speech Lang Pathol* 20, 146-160.

7. Basch CE (2011). Healthier students are better learners: a missing link in school reforms to close the achievement gap. See comment in PubMed Commons below *J Sch Health* 81, 593-598.
8. Carroll JM, Snowling MJ (2004). Language and phonological skills in children at high risk of reading difficulties. See comment in PubMed Commons below *J Child Psychol Psychiatry* 45, 631-640.
9. Grisham JD, Simons HD (1986). Refractive error and the reading process: a literature analysis. See comment in PubMed Commons below *J Am Optom Assoc* 57, 44-55.
10. Simons HD, Gassler PA (1988). Vision anomalies and reading skill: a meta- analysis of the literature. See comment in PubMed Commons below *Am J Optom Physiol Opt* 65, 893-904.
11. Eden GF, Stein JF, Wood MH, Wood FB (1995). Verbal and visual problems in reading disability. See comment in PubMed Commons below *J Learn Disabil* 28, 272-290.
12. Toledo CC, Paiva AP, Camilo GB, Maior MR, Leite IC, (2010) Early detection of visual impairment and its relation to academic performance. See comment in PubMed Commons below Rev Assoc *Med Bras* 56, 415-419.
13. Grisham D, Powers M, Riles P (2007) Visual skills of poor readers in high school. See comment in PubMed Commons below *Optometry* 78: 542-549.
14. Helveston EM, Weber JC, Miller K, Robertson K, Hohberger G, (1985) Visual function and academic performance. See comment in PubMed Commons below *Am J Ophthalmol* 99, 346-355.
15. Ying G, Maguire M, Quinn G, Kulp MT, Cyert L, (2011). ROC analysis of the accuracy of Noncycloplegic retinoscopy, Retinomax Autorefractor, and SureSight Vision Screener for preschool vision screening. *Invest Ophthalmol Vis Sci* 52, 9658-9664.
16. Myers VS, Gidlewski N, Quinn GE, Miller D, Dobson V (1999). Distance and near visual acuity, contrast sensitivity, and visual fields of 10-year-old children. See comment in PubMed Commons below *Arch Ophthalmol* 117, 94-99.
17. Langaas T (2011) Visual acuity in children:the development of crowded and single letter acuities. *Scandinavian Journal of Optometry and Visual Science* 4: 20-26.
18. Sonksen PM, Wade AM, Proffitt R, Heavens S, Salt AT (2008). The Sonksen logMAR test of visual acuity: II. Age norms from 2 years 9 months to 8 years. See comment in PubMed Commons below *J AAPOS* 12, 18-22.
19. Holladay JT (2004) Visual acuity measurements. See comment in PubMed Commons below J Cataract Refract Surg 30: 287-290.
20. Friedman DS, Repka MX, Katz J, Giordano L, Ibironke J, (2009). Prevalence of amblyopia and strabismus in white and African American children aged 6 through 71 months the Baltimore Pediatric Eye Disease Study. See comment in PubMed *Commons below Ophthalmology* 116, 2128- 2134.
21. Von-Noorden G, Campos E (2002). Binocular vision and ocular motility: theory and management of strabismus.
22. Duke-Elder S (1993). Duke-Elders's Practice of Refraction. New York: Churchill Livingstone.
23. Birch E, Williams C, Drover J, Fu V, Cheng C, (2008). Randot® Preschool Stereoacuity Test: Normative Data and Validity. *J AAPOS* 12, 23-26.
24. Rebelo J (1993). Dificuldades da leitura e da escrita em alunos do ensino básico. Rio Tinto.
25. Dusek W, Pierscionek BK, McClelland JF (2010). A survey of visual function in an Austrian population of school-age children with reading and writing difficulties. See comment in PubMed Commons below *BMC Ophthalmol* 10: 16.
26. Rasinski V (2003). The fluent reader: oral reading strategies for building wors recognition, fluency, and comprehension. New York, USA.
27. Cornelissen P1, Bradley L, Fowler S, Stein J (1994). What children see affects how they spell. See comment in PubMed Commons below *Dev Med Child Neurol* 36: 716-726.
28. Goldstand S, Koslowe KC, Parush S (2005). Vision, visual-information processing, and academic performance among seventh-grade schoolchildren: a more significant relationship than we thought? *Am J Occup Ther* 59: 377- 389.
29. Palomo-Alvarez C, Puell MC (2008). Accommodative function in school children with reading difficulties. See comment in PubMed Commons below *Graefes Arch Clin Exp Ophthalmol* 246, 1769-1774.
30. Palomo-Alvarez C, Puell MC (2010). Binocular function in school children with reading difficulties. See comment in PubMed Commons below *Graefes Arch Clin Exp Ophthalmol* 248, 885-892.