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Optometric disorders in children and adults with dyslexia

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Abstract

Optometric disorders are likely to increase the difficulties experienced by an individual who is struggling to read. There are some reports of a higher incidence of visual abnormalities in children with dyslexia, but there has been little investigation into adults. We therefore investigated the optometric status of a population comprising children and adults with dyslexia.

Fifty-four patients (27 with dyslexia, 27 controls) underwent extensive optometric testing. Measurements included visual acuity, cycloplegic refraction, accommodation and binocular vision testing. There was a higher proportion of individuals with dyslexia presenting with optometric problems compared to controls. For children with dyslexia, the most common diagnosis were hypermetropia [far-sightedness] (forty-one percent compared to eighteen percent of the control group) and accommodation insufficiency (thirty-five percent compared to no controls).

Untreated optometric disorders were present in both children and adults with dyslexia. The results strongly suggest that an optometric examination should be included in the management of this condition.

Key words: dyslexia, optometric disorders, hypermetropia, accommodation

Introduction

Clear vision is particularly important in visually demanding tasks, like reading. If a clear image is not formed on the child's retina, it may impact his or her engagement in close-up visual demanding activities and reduce the amount of practice in such activities. In children, this may lead to a lack of interest in school work and ultimately influence academic achievements (Kulp et al., 2016). Unfortunately, a number of children with reading difficulties often have additional visual deficits (Bowan, 2002; Palomo-Alvarez & Puell, 2008, 2009, 2010).

Although discrepancy exists between different professionals and authorities on the prevalence of dyslexia and reading difficulties, it is clear that a substantial part of the population has a reading problem. Using the common 1,5 standard deviation cutoff criteria for reading achievement, around 7% have dyslexia (Peterson & Pennington, 2012). In Norway, the reported prevalence is between 3 and 5% (Statped, 2018). There have been suggestions that dyslexia is caused by problems with vision but the weight of evidence suggests that optometric deficits are neither necessary nor sufficient to cause dyslexia. Nevertheless, neurodevelopmental problems like dyslexia are known to have a high degree of co-morbidity (Gooch, Hulme, Nash, & Snowling, 2014; Nicolson, Fawcett, & Dean, 2001), which suggests that optometric deficits will be over-represented in the dyslexic population (Evans, Drasdo, & Richards, 1994b; Wahlberg-Ramsay, Nordstrom, Salkic, & Brautaset, 2012; Ygge, Lennerstrand, Axelsson, & Rydberg, 1993). Moreover, it seems possible that an optometric deficit might exacerbate the reading problems experienced by an individual with dyslexia given the importance of vision in reading. The importance of good vision and the high possibility of co-morbidity would suggest that an optometric evaluation should be a central feature of dyslexia management. But it appears that in many countries (and certainly in Norway) there is no routine assessment of optometric status in an adult or child diagnosed with dyslexia.

The lack of optometric evaluation in dyslexia may partly be due to the rejection of causal hypotheses linking vision to the condition, and may also be due to a lack of consistency within existing studies. A number of studies have suggested that some optometric measures are poorer in individuals with dyslexia (e.g. (Evans, Drasdo, & Richards, 1994a), but there is no consistent agreement on which measure that are affected.

Visual acuity refers to the resolution ability, which improves as the child develops and reaches adult values (on average -0.1 logMAR) around the age of 11 years (Wang, et al., 2009). Most studies find similar visual acuity comparing dyslexics and controls (Bucci, Bremond-Gignac, & Kapoula, 2008; Buzzelli, 1991; Kapoula et al., 2007; Wahlberg-Ramsay et al., 2012), but there are a few reports that find reduced visual acuity in children with dyslexia as a group (Evans et al., 1994b; Ygge, Lennerstrand, Axelsson, et al., 1993). Stereoacuity, which is a measure of depth perception, is generally not affected in dyslexics

(Buzzelli, 1991; Wahlberg-Ramsay et al., 2012; Ygge, Lennerstrand, Rydberg, Wijecoon, & Pettersson, 1993).

To have good vision at near, two things must happen: accommodation and convergence. Accommodation is the eyes ability to focus, which happens by contraction of the ciliary muscle inside the eye, leading to an increase in the refractive power of the eye. If the child is not able to accommodate accurately, a blurred image will result and visual acuity decreases. Poor accommodation has been reported in groups of children with reading difficulties as well as with dyslexia (Borsting et al., 2003; Palomo-Alvarez & Puell, 2008; Wahlberg-Ramsay et al., 2012). It has been suggested that lag of accommodation can predict 6-8% of reading ability (Poynter, Schor, Haynes, & Hirsch, 1982), however, better accommodative facility (the ability to shift accommodation) has been found in children with dyslexia compared to normal readers (Buzzelli, 1991).

There is a similar mixed picture across studies on the near point of convergence. Convergence is when the eyes align towards an image at near, to make the image single. It has been suggested that symptoms caused by convergence insufficiency affect reading performance (Scheiman et al., 2015). Some studies have reported a more remote near point of convergence in dyslexia (Kapoula et al., 2007; Latvala, Korhonen, Penttinen, & Laippala, 1994) whereas others have reported no such difference (Wahlberg-Ramsay et al., 2012). Fusional vergence is the ability to maintain single vision with prism-induced vergence, and poor fusional vergence may lead to asthenopia (Scheiman & Wick, 2002). For fusional vergence, the findings are again not consistent. Castro found that children with dyslexia had poor positive (base-out) fusional vergence (Castro, Salgado, Andrade, Ciasca, & Carvalho, 2008) whereas others have found normal positive but reduced negative (base-in) fusional vergence (Bucci et al., 2008; Kapoula et al., 2007; Palomo-Alvarez & Puell, 2010). It has also been reported that children with dyslexia have reductions in both positive and negative fusional vergence (Bucci, Melithe, Ajrezo, Bui-Quoc, & Gerard, 2014; Evans et al., 1994b; Heim, Haugen, Helland, & Fostervold, 2004). Vergence facility is not often reported, but Buzelli (1991) reported poorer vergence facility in children with dyslexia compared to normal readers.

Both accommodation and vergence disorders can lead to poor visual acuity at near, or intermittent blurry or double vision, which will make reading hard. The same thing will happen if the child has a hypermetropic refractive error that exceeds the accommodative ability. Even low to moderate hypermetropia can affect reading: one experimental study performed on healthy 10-year old children found that induced hypermetropia of 2.50 diopters

(D) reduced reading performance significantly (Narayanasamy, Vincent, Sampson, & Wood, 2015). Other reports have found that uncorrected hypermetropia is associated with slow reading (Quaid & Simpson, 2013). Refractive errors do not appear to be more prevalent in children with dyslexia or reading disorders (Handler & Fierson, 2011), though it is important to note that studies do not always include cycloplegic refraction which is problematic, as hypermetropia can be underestimated (Morgan, Iribarren, Fotouhi, & Grzybowski, 2015).

On the basis of existing studies, it can be concluded that there is no singular optometric deficit associated with dyslexia. This supports the wide spread view that dyslexia is not caused by a visual deficit. The research literature does, however, raise the question of why some authors continue to suggest a causal relationship. Wahlberg-Ramsay et al suggested that the diverse findings of studies investigating the visual function of individuals with dyslexia are due to different methods, examiners, instruments and settings (Wahlberg-Ramsay et al., 2012). It is hard to understand why this should result in disparate reports of optometric disorders within the dyslexic population. Instead, we hypothesized that the prevalence of optometric deficit is higher in a dyslexic population because of the well-known phenomenon of co-morbidity.

It is well established that any small group identified with a neurodevelopmental disorder is subject to ascertainment and referral bias and this can explain the group differences found in existing studies. If our hypothesis is correct then it suggests that an optometric evaluation should be a core feature of dyslexia management - but we are not aware of such a perspective informing dyslexia care (at least in the UK or Norway) despite the obvious importance of vision to reading.

Reading disorders have a significant impact on quality of life for those families affected, and the economic costs for the society are substantial (Crawford, 2002; Nyden, Myren, & Gillberg, 2008). Most children with refractive errors, accommodative or binocular vision disorders are symptom-free after intervention with reading glasses for accommodative insufficiency, correct prescription for refractive error, and convergence exercises for convergence insufficiency (Abdi et al., 2008). Identifying refractive errors, accommodative or binocular anomalies in dyslexia populations is thus of high importance, since treatment would relieve symptoms and improve learning conditions for children that are affected.

Materials and methods

All participants gave informed consent prior to inclusion in the study. For children, parents signed the informed consent, and children gave additional verbal assent. The experiment was conducted in accordance with the Declaration of Helsinki (WMA, 2013), and was approved by the Regional Committees for Medical and Health Research Ethics.

Participants

Thirteen adults with dyslexia were recruited through the Norwegian Dyslexia Association, and twenty-three children with dyslexia were recruited through the local Educational and Psychological Counselling Service (PPT), a governmental body responsible for the investigation and counselling of children with learning difficulties. Age-matched control groups were recruited from the general population through advertising in the local newspaper and an information meeting with parents at school. Adults were defined as older than 18 years of age. Children were between 4^{th} and 6^{th} grade, an age were dyslexia is normally identified. Inclusion criteria were no developmental disorders besides dyslexia, no prematurity, no history of neurologic disease and no strabismus. Participants were healthy with no use of medication, and they had Norwegian as their primary language.

It is widely accepted that deficits in phonological processing are a core feature of dyslexia (Kirkby, Blythe, Drieghe, & Liversedge, 2011; Ramus et al., 2003). Although individuals with dyslexia had been previously diagnosed with dyslexia by psychological or pedagogical professionals, a linguistic test, Language 6-16 (Ottem & Frost, 2011) were used to confirm group affiliation. Language 6-16 has good reliability and validity as reported in a recent review (Arnesen, Braeken, Ogden, & Melby-Lervåg, 2018). Adults with dyslexia were included if the summarized score from Language 6-16 were below 1 standard deviation (SD) of the mean. Children with dyslexia were included if they had a phonological ability score on Language 6-16 below 1 SD of the mean. Control participants were included if they had no history of dyslexia or reading problems and scores within the normal range (mean ± 1SD) on all subtests on Language 6-16.

Ten adults (five females) and seventeen (three females) children were included in the dyslexia group, and ten adults (eight females) and seventeen children (seven females) in the control group. One adult and three children were excluded because they had attention disorders, one adult and one child were excluded because of possible neurological disease and one adult and two children were excluded because they had subscores on language testing within the normal range.

Optometric examination

Participants went through a detailed optometric examination including measurements of visual acuity, ocular refraction, accommodation and binocular vision. In order to provide optimal test results, participants were tested at mid-day, and breaks were allowed. The testing was done in an even-lit room and mean luminance levels were within photopic ranges, according to the Norwegian and European standard for visual acuity testing (NS-EN ISO 8596).

Visual acuity and stereopsis

Visual acuity (VA) were measured according to recommended procedures (Lovie-Kitchin, 2015). VA was measured at distance (6 m) with a Landolt C logMar Chart, monocularly and binocularly, and noted in logMAR. VA at near was measured binocularly with a Landolt C logMar Near Card. Stereoacuity was measured using the The Netherlands Ootech (TNO) random dot stereo test (Institute for Perception, Utrecht, the Netherlands), and recorded in seconds of arc.

Refractive errors

Subjective refraction was made with an emphasis on revealing the maximum hyperopic correction that maintained best visual acuity. An objective measure of refraction was additionally performed with the Nikon Auto Ref Keratometer NRK-8000, 30 minutes after installation of two drops of Cyclopentolate 1%.

Accommodation

Accommodation measures were completed with the result from the subjective refraction. The result from the cycloplegic refraction was used for accommodation measures in order to minimize the effect of any uncorrected hypermetropia if the cycloplegic refraction was more hyperopic than the subjective by > 0.75 D. Accommodation measures included accommodation amplitude (AA), positive relative accommodation (PRA), negative relative accommodation (NRA) and accommodative facility. To measure AA each participant was asked to look at the smallest line of letters on the RAF rule and to report when the letters became blurred. The participant was continuously instructed to "keep the target clear as long as you can". Measures were done binocularly and repeated three times with the mean value in diopters noted. Positive and negative relative accommodation was determined by adding lenses binocularly in a phoropter, while the participant looked at a line of small letters. Accommodative facility was measured using a flipper with ±1.00 D or ±2.00 D, selected on the basis of the accommodation amplitude result (Scheiman and Wick, 2002). For adults with an AA lower than three diopters, accommodative facility was not measured (this was the case for one control participant).

Binocular vision

Vergence measures were completed with the result from the subjective refraction. The vergence measures were: heterophoria at distance and near, fixation disparity, near point of convergence (NPC), vergence facility, positive fusional reserves distance and near, negative fusional reserves distance and near. Heterophoria was measured with The Howell phoria card at 33 cm and at 3 m (Wong, Fricke, & Dinardo, 2002), the phoria was noted in prism values. The modified OXO (Near Mallet unit) test was used at near (40 cm) to detect fixation disparity. The RAF rule was used to determine NPC. The participants were asked to look at the dot in the line and to report when the line became double, and continuously instructed to try and keep it simple as long as they could. Measures were conducted binocularly and repeated three times with the mean value in centimeters noted. Fusional reserves were determined at distance (6 m) and near (40 cm) using prism bars, and the break/diplopia value was noted. Vergence facility was measured using a flipper with 3Δ base in and 10 Δbase out.

Statistics

Statistical analysis was performed using the IBM© SPSS Statistics version 22 (Copyright IBM Corp. and other(s), 1989, 2013). Multivariate Analysis of Variance (ANOVA) was used to compare between-group differences with an α level of 5%. A chi-squared test were used to compare the prevalence of optometric deficits between groups.

Results

Optometric examination

Visual acuity and stereopsis

All participants had visual acuity (VA) equal to or better than 0.1 logMAR at distance (6m) and near (40 cm). Near visual acuity was worse in some children with dyslexia compared to controls, with 71 % of the children with dyslexia having a near visual acuity of 0.0 logMAR or better, compared to 94 % of controls. There were more adults (n = 10) and children (n = 15) with dyslexia who had stereo-thresholds (as measured by the TNO) ≥ 60'' compared to the control group (n = 6 and n = 9, respectively), the difference was significant for children and for adults and children combined (Table 1).

Refractive errors, accommodation and binocular vision

There were no significant differences in cycloplegic spherical refraction between dyslexia and controls (table 1). However, seven children with dyslexia had hypermetropia (41%) [far-sightedness] > 1.0 D, compared to three controls (18%), and there were only one child with myopia [near-sightedness]. Accommodation facility was lower in the dyslexia group compared to the control group, and the difference was significant for adults and for adults and children combined (Table 1). The near point of convergence was more remote in the dyslexia group and the difference was significant for adults and children combined (Table 1). Base-in near was significantly lower in the dyslexia group for children and for adults and children combined (Table 1).

Group	*Adults*			*Children*			Adults and Children combined		
Test	Control n=10 Mean (±SD)	Dyslexia n=10 Mean (±SD)	p	Control n=17 Mean (±SD)	Dyslexia n=17 Mean (±SD)	p	Control n=27 Mean (±SD)	Dyslexia n=27 Mean (±SD)	p
Age (years)	36.7 ± 11.0	33.7 ± 10.1	n.s.	10.0 ± 1.1	10.4 ± 1.3	n.s.		not relevant	
Distance VA (logMAR)	0.03 ± (0.06)	0.00 ± (0.00)	n.s.	0.06 ± (0.08)	0.09 ± (0.07)	n.s.	0.05 ± (0.07)	0.06 ± (0.07)	n.s.
Near VA (logMAR)	-0.03 ± (0.05)	-0.02 ± (0.04)	n.s.	-0.01 ± (0.04)	0.03 ± (0.05)	.029*	-0.01 ± (0.04)	0.01 ± (0.05)	n.s.
Cycloplegic Refraction	0.03 ± (1.65)	0.18 ± (1.68)	n.s.	0.63 ± (0.87)	1.06 ± (0.58)	n.s.	0.41 ± (1.25)	0.73 ± (1.20)	n.s.
Accommodation Facility	11.70 ± (7.32)	5.95 ± (2.92)	.042*	7.06 ± (3.21)	6.41 ± (3.61)	n.s.	8.78 ± (5.60)	6.24 ± (3.38)	n.s.
Near point of convergence	5.50 ± (0.92)	6.50 ± (1.63)	n.s.	5.56 ± (1.28)	6.47 ± (2.06)	n.s.	5.54 ± (1.16)	6.48 ± (1.91)	.048*
Base-In Near	9.70 ± (2.69)	9.20 ± (2.71)	n.s.	11.53 ± (3.18)	8.24 ± (3.21)	.006*	10.85 ± (3.14)	8.59 ± (3.07)	.011*
TNO	48.00 ± (14.70)	78.00 ± (54.00)	n.s.	45.00 ± (16.27)	60.00 ± (17.82)	.018*	46.11 ± (15.77)	66.67 ± (36.82)	.012*

Table 1. Descriptive data, table shows measures that were different between groups, * indicates significant difference (p<.05).

Optometric disorders and management

In order to determine the prevalence of optometric disorders within our dyslexic population, we created a binary classification of whether a clinically significant deficit was present or not based on the various measures we took. This has some difficulties because there is a lack of scientific consensus on the common clinical criteria for accommodative and binocular disorders (Cacho-Martinez, Garcia-Munoz, & Ruiz-Cantero, 2014). We selected criteria for a diagnosis of optometric disorders according to best available knowledge, based on the (Cacho-Martinez et al., 2014) review, together with our own clinical experience. Accommodation insufficiency (AI) was defined as an accommodation amplitude at least 2.0 D (1 SD) below Hofstetter's norms together with accommodation facility ≤ 3 cpm, or an accommodation amplitude at least 4.0 D (2 SD) below Hofstetter's norms (Marran, De Land, & Nguyen, 2006; Scheiman & Wick, 2002). Six children (35%) and one adult had AI compared to no controls. Convergence insufficiency (CI) was defined as exophoria near > far by at least 4 prism diopters, combined with a NPC ≥ 6 cm for break, sometimes referred to as ‘two-clinical sign CI’ (CITT Study Group, 2008). There were four participants with CI, two with dyslexia and two without dyslexia.

There were no other accommodative or binocular anomalies in either group than those detailed above. Participants with AI were prescribed near correction, participants with CI were prescribed eye exercises, and participants with refractive error were prescribed glasses. The prevalence of accommodative and binocular anomalies, refractive errors and optometric management are presented in Table 2.

A chi-squared test revealed that there was a significantly higher proportion of individuals with dyslexia presenting with optometric problems that needed intervention than controls (χ^2 (1) = 6.0, p = .014). Based on the odds ratio, the odds of participants with dyslexia having optometric intervention were 4 times higher compared to participants without dyslexia. Moreover, the prevalence of the disorders in our (small) sample is higher than expected from a random sample taken from the population. It has been reported previously that 13% of Norwegian children between 13 and 14 years old required daily use of a refractive correction (Heim et al., 2004). In our study, 59% of the participants with dyslexia needed daily use of a refractive correction (for AI and refractive errors).

Table 2. Prevalence of disorders and refractive errors across groups. Optometric intervention is optical correction or eye exercises according to condition, as described in text.

Group	Adults		Children		Adults and Children combined	
	Control n=10	Dyslexia n=10	Control n=17	Dyslexia n=17	Control n=27	Dyslexia n=27
Accommodation Insufficiency	0	1	0	6	0	7
Convergence Insufficiency	0	1	2	1	2	2
Hypermetropia > 1.0	1	1	3	7	4	8
Myopia < 0,50 D	2	1	1	0	3	1
Optometric intervention	3	4	6	14	9	18

Discussion

The current study tested the hypothesis that a population diagnosed with dyslexia would show a higher proportion of individuals with untreated (but treatable) optometric problems relative to a matched control population. In line with this hypothesis, we found an increased prevalence of optometric deficits in the dyslexic population. It is well-known that children with dyslexia are subject to referral bias in such studies, however, in this study, this effect was reduced by including all children that were considered for a diagnosis of dyslexia by the local Educational and Psychological Counselling Service in the study period.

Cycloplegic refraction revealed that the prevalence of hypermetropia > 1.0 D was higher in children with dyslexia compared to controls (41% vs. 18%). Several studies have failed to find any significant difference in refractive error between children with dyslexia and controls (Baraas & Demberg, 1999; Latvala et al., 1994; Wahlberg-Ramsay et al., 2012; Ygge, Lennerstrand, Axelsson, et al., 1993). However, Quaid and Simpson found that uncorrected hyperopia in children aged 6-16 years was related to slow reading (Quaid & Simpson, 2013), and Kulp et al found that uncorrected hypermetropia was associated with poor performance in early literacy skills in children aged 4-5 years (Kulp et al., 2016). There is a lack of studies reporting prevalence of refractive errors in Norwegian schoolchildren. One study found that hypermetropia > +0.50 D occurred in 13.2% of young adults between 20-25 years old (Midelfart, Kinge, Midelfart, & Lydersen, 2002). Another, more recent study, reported that 22% of 16-25 year olds had hypermetropia (SE ≥ +1.00 D) (Hagen, Gjelle, Arnegard, Gilson, & Baraas, 2015). In Sweden, it has been reported that 18% of schoolchildren between 6 and 16 years old with astenopia have hypermetropia > +1.50 D (Abdi & Rydberg, 2005). Our study suggests that there may be an increased prevalence of hypermetropia >1.00D in children with dyslexia aged 8-12 years (as would be hypothesized from the notion of co-morbidity). It can be proposed that the previous findings of less hypermetropia in children with dyslexia are due to the prevalent use of non-cycloplegic refraction in such studies (Morgan et al., 2015).

This study is limited by a low number of participants. However, care has been taken to match each dyslexia subject with a similar subject in the control group, recruited from the same local population. There was a larger number of boys in the dyslexia group than the control group (82% vs. 59%). There have been reports of higher prevalence of myopia in young adult females (Midelfart, Kinge, Midelfart, & Lydersen, 2004), and some studies suggests that gender differences in refractive error are present already at age 10-12 years (Rudnicka et al., 2016). Taking this into account, the finding of more hyperopia in the children with dyslexia could be due to gender differences in the groups.

Some children with dyslexia had reduced near visual acuity. Previous studies have reported both significant differences and no differences in near visual acuity in children with dyslexia (Wahlberg-Ramsay et al., 2012; Ygge, Lennerstrand, Axelsson, et al., 1993). Our study also found that a small group of children with dyslexia had decreased stereoacuity measured with TNO. It is possible that this finding is a result of a binocular instability that was not detected with the techniques available in this study. It is also possible that other factors contributed to this finding, such as inattentiveness. Reduced base-in prism at near was more prevalent in the dyslexia sample. This indicates an increased risk of limited divergence capacity at near in dyslexia, which has also been reported in other studies (Kapoula et al., 2007). Kapoula et al (2007) suggests that this divergence deficit is independent from relaxation of convergence and accommodation. We found that both accommodation infacility and reduced near point of convergence were more prevalent in children and adults with dyslexia. However, these measurements were not correlated, and neither did they correlate with base-in at near, in line with the findings of Kapoula et al (2007).

Our findings indicated that multiple measures of both accommodation and vergence can provide useful information about visual function in the patient with dyslexia. The comprehensive review we conducted for clinical criteria indicates that the most valid measures are AA and accommodation facility for diagnosing accommodation insufficiency and Convergence Insufficiency Symptom Survey for diagnosing convergence insufficiency. We suggest that near visual acuity, stereoacuity with TNO, and base-in at near is included in the optometric workup of the dyslexic patient. The prevalence of accommodation insufficiency was higher in children with dyslexia compared to controls (35% vs. 0%). This finding is in line with previous reports that accommodative anomalies are significantly correlated with reading ability (Heim et al., 2004).

Our findings suggest that many individuals with dyslexia have a co-occurring visual deficit, which may manifest in an accommodative or binocular anomaly. It should be recognized, therefore, that a portion of the dyslexic population have increased risk for co-morbidity of visual deficits. These deficits will make life harder for individuals with dyslexia and yet can be easily treated. Identifying refractive errors, accommodative or binocular anomalies in dyslexia populations is thus of high importance, and optometrists should include several measures in their examination of individuals with dyslexia.

Our results are consistent with the well-established phenomenon of neurodevelopmental co-morbidity where the presence of a disorder increases the probability of other deficits being present. The fact that some children with dyslexia had optometric problems whilst some individuals with optometric problems did not have dyslexia shows that optometric disorders are neither necessary nor sufficient features of dyslexia. This allows us to rule out simplistic monocausal hypotheses relating dyslexia to optometric problems.

Conclusion

This study demonstrates that some individuals with a diagnosis of dyslexia have untreated optometric difficulties – difficulties with the potential to aggravate reading problems. In children with dyslexia, hypermetropia and accommodation insufficiency were the most prevalent deficits. We suggest that all individuals with dyslexia should have an optometric examination so that identified problems can be treated. We recommend the use of cycloplegia when evaluating individuals with a diagnosis of dyslexia.

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