The treatment of scholastic learning disabilities through the diverse visual therapy modalities: What is the scientific evidence?

(Translated from 'Diverses modalités de traitement des troubles d'apprentissage scolaire par thérapie visuelle: quelles sont les evidences scientifiques?' Amélie Ganivet, OD, M. Sc., Isabelle Denault, OD, Rosanne Superstein, MD FRCSC, Nicole Fallaha, MD FRCSC; Canadian Journal of Optometry, Vol 76, Issue 2, pp15-22)

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Abstract

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Background

Learning disabilities are specific and common dysfunctions that impede the normal development of learning processes. According to Statistics Canada, in 2006, 3.2% of Canadian children between the ages of 5 and 14 years were affected by some sort of learning disability, which translates to about one child per class. [1] Several hypotheses regarding the aetiology of learning disabilities have been put forth in the last few decades. Learning disabilities are not well understood, therefore the multitude of treatment options available for learning disabilities are unproven scientifically. Along these lines, diverse visual therapies are sometimes suggested in order to treat these disorders. [2, 3] Out of concern to help these patients focus their resources and effort in order to achieve their learning goals, it is incumbent upon doctors to recommend these therapies based on evidence-based science. [3, 4]

With an underlying genetic basis, learning disabilities are chronic and result from some impediment in neuropsychological processes. [5-7] Theses disorders, therefore, are not caused by intellectual deficiency, sensory deficits, an unsuitable scholastic context, or a lack of personal interest. Affected children generally possess average to higher than average reasoning ability even while they might demonstrate difficulty acquiring, understanding, organising and processing information. [4, 5, 7] The following are the principle learning disabilities: Dyslexia, Attention Deficit/Hyperactivity Disorder (ADHD), dysphasia, dysgraphia, dyspraxia, dyscalculia, and troubles related to Autism Spectrum Disorder (ASD). Dyslexia is the most commonly encountered disorder, affecting 80% of those with learning disabilities and up to 5-17% of the general population. [4-8] As a consequence, dyslexia will be the learning disability of principal concern in the present article.

Several hypotheses have been issued that implicate visual limitations as possible causes of dyslexia and learning disabilities. Despite the fact that there is some divergence of opinion that persists, the most widely accepted hypothesis today refers to a state where there is a "deficit in the phonological processing component of language that renders difficult the use of alphabetic code in the decoding of written words". [4] Visual problems sometimes encountered would be in fact attributable 5to a lack of experience in reading. [9-12] A recent study even shows how a reading treatment program based in phonology improved not only reading ability, but also visual function. [9] As such, the visual anomalies sometimes raised in discussion would be more likely a cause of reading disabilities, and not the cause. [3, 4, 6, 8, 10, 13]

Given dyslexia is considered a phonological disorder of language and not a visual dysfunction, publications from the American Academy of Pediatrics as well as the Canadian Society of Paediatrics recommend treatment based on decoding, fluency, vocabulary, and understanding, but also more specifically on phonemic awareness and its practice. [3-5, 7, 9, 14, 15] Being of a chronic nature, learning disabilities will not resolve over time. Still, in order to establish an intervention plan revolving around the specific needs of each child and designed to maximise learning, early intervention supported by a scientific approach is favoured. [7]

Visual Therapies in the Treatment of Learning Disabilities: State of Understanding.

Certain vision problems can interfere with the process of reading thereby creating learning difficulties that may be reversed following correction of the underlying visual impediment. As a consequence, it is of primary importance that all children having a problem or learning difficulties have a comprehensive vision examination to assess vision and eye health as soon as trouble is suspected. [3, 6, 16]

Nonetheless, it has been shown that children struggling with dyslexia or other learning disabilities have no higher rate of anomalous visual function or ocular health than those who are not affected by such conditions. [4, 6, 8, 14, 17-19] Their learning in subjects such as mathematics and French might be laborious, they will often succeed in other spheres of development requiring visual aptitudes. At this time, there is no medically based scientific proof that shows that subtle errors in refraction or mild visual impediments might cause or exacerbate the depth of the learning disability, diminish visual function, or even attenuate the response to the diverse educational therapies. [3, 4, 17, 20] The hypothesis that children who participate in visual therapies will become more receptive to the diverse teaching programs is unfounded. [2, 4, 6, 15, 20, 20-23]

Visual Acuity, Refraction, and Training Glasses

Children starting to learn to read and write are given texts whose letters are quite large. The higher the grade, the smaller the letters become while visual demand increases. Despite the fact that good vision is important, optimal visual acuity is not of primary importance to discern characters used in early learning. Nowhere can be found proof demonstrating that early readers burdened with myopia, or light to moderate hypermetropia and/or astigmatism have greater difficulty learning or reading compared to other children. [1] Small degrees of hyperopia are considered normal in young children and are generally pathologically insignificant. On the contrary, low hyperopia constitutes a normal step in the development of the eye. Children have unique visual needs based on their visual demand and the development of their optical system. [24-28] Refractive needs of children cannot be extrapolated as a function of adult needs. At this time, there are no rules to specify exactly what degrees of ametropia require optical correction; recommendations are rather based on clinical experience and the differing consensus presented by renowned professionals in optometry and in paediatric ophthalmology. [24, 25, 27]

Children an accommodative capacity that exceeds that of adults. In fact, children between 6 and 10 years of age have on average 12.00D of accommodative function. [4, 25, 30] They can, therefore, generally compensate for a moderate hyperopia without visual difficulties. The average refractive state of white children in the United States is in the range of 2.00D in the first 5 years of life. [4] This degree of hyperopia typically progressively abates into adolescence. This is why light to moderate hyperopia often does not need to be corrected, because it has little impact on visual ocular or visual function. [24, 25, 27]

It appears there is no increased probability of dyslexia among children with uncorrected hyperopia. In the absence of a decrease in visual acuity, there would be no correlation between reading abilities, scholastic performance, and the degree of hypermetropia. [31] At 6 years of age, children show insignificant changes in visual acuity provided hyperopia does not exceed 4.00D; fewer than 1% of children have a higher hyperopia. [25] An elevated hyperopic refractive error can engender visual discomfort than can be considerable. As such, these children, those who find tasks requiring prolonged visual effort tedious, can develop compounded learning difficulties. However, these would be reversed given correction of the visual problem. Conversely, a child with a high uncorrected hypermetropia and who is also burdened by dyslexia or some real learning disability might notice an improvement in comfort, visual acuity, and even scholastic performance following correction of his hyperopia, his learning disability having perhaps been amplified by his difficult vision. All the while, the learning disability will surely persist due to its primarily neurological and not sensory nature.

Children burdened with uncorrected myopia will observe a decrease in visual acuity at distance and, as a consequence, can experience difficulty seeing the board in class. Nevertheless, these children typically do not have difficulty with near vision especially with mild to moderate myopia. In spite of their visual condition, there is no correlation between mild myopia and scholastic achievement. [25] The visual needs of the child must be determined as a function of their age when and if optical correction is required. [25] In addition, studies have demonstrated that under-correction otherwise employed to lessen progression of myopia is without foundation. [25] It is likewise the case concerning the hypothesis that states use of a bifocal segment can reduce myopic progression. This hypothesis has proven itself to be clinically unfounded. [4, 20, 25, 32, 33]

Among school-aged children, astigmatism less than 1.50D produce only minimal visual degradation and would not cause amblyopia if symmetric. [24, 26] Oblique astigmatism, however, would be a greater visual disturbance. In general, astigmatism correction of more than 1.00-1.50D is recommended for school-aged children. Nevertheless, as is with hypermetropia and astigmatism, the decision to not correct would not be the cause of the learning disability. [4, 25]

Amblyopia is characterised functionally by a reduced visual acuity that is not improved by optical correction. This weakness in vision in its own right causes a difficulty in distinguishing letters in close proximity to one another. Among children affected by bilateral amblyopia, it is possible their level of reading might be slower, but these children will have no more dyslexia than others. [1] In addition, children suffering with nystagmus, bilateral cataracts, or ocular health anomalies can also have a variable reduction in visual acuity. [4] Nevertheless, children suffering with a moderate to severe visual disability are able to learn to read with adequate optical correction and suitable low vision aids. In this way, in general, ocular diseases have no impact on a child's ability to read correctly.

In summary, there exists no correlation between achievement in reading and moderate uncorrected refractive anomalies. Referring to factual medicine, it is not only useless but also inadequate to prescribe weak correction in order to forward the treatment of dyslexia and learning disabilities. [4, 6, 20] Nevertheless, it is essential to perform a complete visual examination including assessment of the cycloplegic refractive state for any child with a diagnosed or suspected learning disability and this, in order to detect all possible refractive errors requiring optical correction following standards generally accepted by the profession.

Saccades and Fixation

Saccades serve to decode the environment by means of brief and rapid eye movements between two zones. Called upon during reading, they might be followed by a correction saccade in cases of imprecision, such as when a word or group of words were misunderstood. Contrary to some beliefs, saccadic measurements in adults with or suspect of having dyslexia are not different. [4, 11, 17, 18, 34-38] Saccades and fixations among children with learning disabilities are imprecise compared to children of a similar age, but the nature of the link to causality has not been clearly established. According to recent studies, saccades and fixations in dyslexic readers are similar to those who were selected as a function of level of ability rather than limitations by age. [9, 13, 39, 40]

To this day, the phonological deficit hypothesis is the most widely accepted explanation for dyslexia. [3, 4, 6-9] From this fact, training based on phonemics would allow for improvement of visual functions while improving on the level of reading. In this way, the previously discussed visual troubles, themselves attributable a lack of experience in reading, would be the consequence and not the cause of dyslexia. [9-12, 40] Children affected by dyslexia will often lose their place while reading, confuse certain sounds, and show difficulty reading words that are infrequently used or more complicated. Reading is slow, more so than due to a simple difference between the higher demand and the child's capacity. These difficulties demand a considerable investment of energy for reading and understanding and, as a consequence, engender anomalies of pursuits and saccades. Improvement in the level of reading would allow improvement of saccades and fixations, but there is insufficient scientific proof to confirm that exercising saccades and pursuit movements could help a dyslexic reader to develop a higher level of reading. [2, 4, 10, 23, 35, 40, 41]

In the end, the majority of people suffering with a disability either in ocular motility or ocular movement have normal reading and comprehension. In effect, many children born with significant strabismus, nystagmus, or some ocular disease affecting ocular movements excel with regards to their academic results and their level of reading. [3, 23, 42, 43] As such, dyslexia would not be the result of an oculomotor deficit, but rather the result of some disability at the level of central information processing which leads to difficulty in decoding and comprehension. As a consequence, it engenders longer fixations and a greater frequency of corrective saccades when the level of reading required exceeds the capacity of the reader.

Accommodation

Accommodation is the capacity to concentrate and to achieve precise optical focus. It ensures clearly focused objects with varying viewing distances. Accommodative amplitudes are generally at their maximum during infancy to age 10, with the accommodative power diminishing naturally with age afterwards. [44] It is therefore rare to observe insufficient accommodation in a child. An accommodative defect might still arise in a child with uncorrected high hypermetropia with a history of viral infection, cerebral or ocular trauma, brain stem pathology, or as a secondary effect from taking medications. [4] The hypothesis that dyslexic children and children with learning disabilities have weak accommodation has lead many professionals to promote the use of bifocals as compensation. Even though certain studies have demonstrated slightly lower accommodative amplitude in dyslexic children compared to normal children, accommodative amplitudes remained in a normal range for their ages. [8, 45] As such, there is no significant difference in accommodative capacity between patients with a reading disability and those who read at a normal level. [8, 13] In addition, there is no scientific proof that an increase in

magnification improves reading efficacy. One study even showed that correcting for insufficient accommodation had no significant impact on ocular movements and fluidity during reading. [46] As a consequence, all therapy seeking to diminish accommodative effort in a child with a learning disability under the pretext that this trouble is the cause of said disability is unfounded scientifically. [2, 4, 6, 20]

Binocular Vision

Perfect oculomotor equilibrium is rare in the paediatric population and in general. Most individuals will present with an asymptomatic mild esophoria or exophoria that are considered within normal limits. [4, 17, 19] Several studies have investigated binocular function and accommodation in children with scholastic learning disabilities and dyslexia. No causal relationship could be found. [17, 19, 47]

Convergence insufficiency is a condition where there is difficulty in correctly fusing an object situated at near distance. Where the convergence effort is hard to overcome, this can provoke diverse symptoms of visual discomfort such as visual fatigue, headache, blurry vision during reading, diplopia with near vision, difficulties concentrating during prolonged periods of near work. In addition, certain factors such as lack of sleep, sickness, general fatigue can aggravate the problem. [4] The prevalence of convergence insufficiency would be about 3% to 5% of the population. [4] Nonetheless, given differences between diagnostic criteria, some studies report results that may differ. Accommodative difficulty and convergence insufficiency are both liable to interfere with reading comfort [3, 8, 45] These visual concerns should be treated if they are considered problematic according to criteria put forth for the general population. From this, treatment of convergence insufficiency can help at the level of reading comfort and work at near distances by allowing an easier and more prolonged reading. [20, 48] Equally, if an individual's reading difficulties are secondary to an anomalous accommodation or convergence, these would disappear once the visual trouble is treated. Nonetheless, since these visual troubles are not the cause of dyslexia, treating these would have no impact on the capacity to decode and understand while reading. [4, 6]

Just as with the majority of children, those with learning disabilities love to play video games. Use of video games requires good eye-hand coordination, concentration over a prolonged period, efficient accommodation, active convergence as well as strong visual perception. As a consequence, if these deficits were the major cause of reading disabilities, these children would reject these tasks that also require intensive use of visual capacities. [4, 6]

Lenses and Coloured Filters

The use of coloured lenses or filters in order to improve comfort and performance in reading in individuals with learning disabilities is very controversial. Some are of the opinion that using lenses or yellow filters allow improvement in control of visual attention and ocular movements in some children by cerebral stimulation. Use of blue lenses or filters, for its part, would improve concentration and consequently, reading. [49, 50] Others advance that the control of accommodation and convergence would be influenced by a sensitivity to certain wavelengths of light, creating visual stress during reading. Use of certain coloured filters corresponding to these different wavelengths of light would allow for a reduction of this stress and more efficient reading. [49, 51-53] Nevertheless, several studies have determined that the appropriate choice of most beneficial colour filter for each individual would be inconsistent and non-repeatable. [6, 54-59] Other studies have ruled that the use of coloured lenses or filters had no beneficial effect on visual function and reading performance. [55, 60] As no consensus can

be established at this time, use of coloured filters in order to treat children with learning disabilities remains for the moment clinically unjustified. [4, 6, 14, 54, 56-59, 61-63]

Prism

Use of prism in patients with learning disabilities has been studied. Some assert that base-up prism could be used to treat exophoria or convergence insufficiency, while base-down prism would be employed in the treatment of esophoria or convergence excess. [20] Base-down prism would also be used in order to facilitate adaptation for individuals for whom low hypermetropic correction would be prescribed. [20]

Others claim that full heterophoric correction would permit the lessening of visual fatigue during reading. According to this hypothesis, low heterophoria necessitate a compensatory effort in order to maintain adequate binocular vision: They should therefore be completely corrected using prism. [64-65] Still, many refute this hypothesis and recommend against using prism, as it does not improve reading performance. [66, 67] The beneficial effects reported could, for their part, be attributable to a placebo effect. [66, 67]. At this time, there is no established scientific evidence to encourage the use of prism to improve reading in children with learning disabilities. [4, 6, 20, 21, 57, 66, 67]

Discussion

Dyslexia appears to be a difficulty in decoding and understanding written language of neurobiological origin. It corresponds to a deficit in the processing of the structure of the sound of written or spoken language (phonological defect). [6] It consists of a persistent and chronic disorder where the causes are multifactorial and under the influence of genetics. [6]

Oculo-visual impediments can interfere with the process of learning to read, but they are not the cause of dyslexia or learning disabilities. In fact, inasmuch as vision is fundamental to reading, the brain must analyse the visual images transmitted. Statistically, children with dyslexia or associated learning disabilities have the same level of visual function and the same level of ocular health as those children without such conditions. [3, 8, 18, 19] There is no scientific proof at this time that vision therapy, therapeutic lenses, pursuit or saccadic exercises, perceptual exercises, magnifying glasses, coloured filters or lenses, or prism can significantly improve the performance of a child who has learning disabilities. [2, 4, 6, 7, 14, 20-22, 57, 68] These approaches can lead to false hopes to parents and others participating in the child's care, possibly delaying some other treatment with potentially greater benefit for the child. Furthermore, the costs of these therapies is substantial and the time required is not insignificant. Studies supporting the improvement of learning via these therapies are in fact not scientifically controlled, or based on anecdotal cases. [2, 4] The purported benefits would more likely be secondary to the effects of other more traditional educational therapies that are often implemented in conjunction with vision therapy, or the placebo effect in the case of the latter.

Conclusion

Early detection of children with learning disabilities and the subsequent referral to appropriate professionals are essential in order to provide the necessary support to these children and their families. It is of primary importance that these children have a complete vision examination with cycloplegia in order to ensure they do not have visual impediments that may be interfering with visual function and could as a result amplify the symptoms of dyslexia/learning disabilities. A multidisciplinary approach is favoured for these children. In addition to the evaluation of vision, an evaluation of health, of

development, of audition and, if necessary, medical and/or psychological intervention should be implemented. [4, 6, 13, 14, 20, 21] In closing, dyslexia and learning disabilities are complex problems, sadly with no simple solutions. Nevertheless, it is recommended that all proposed therapies be scientifically justified in order to create realistic expectations and to favour the development of the child.

Bibliography

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