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# Learning disorders, dyslexia, and vision

## BACKGROUND

Learning and reading disorders are common presentations in the primary care setting. Concern for the welfare of children with such disorders can lead parents and clinicians to engage with a wide range of diagnostic and treatment procedures, many of which are controversial or without clear scientific evidence of efficacy. One of these procedures implicates ocular vision and/or visual processing as a causal factor and advocates visual training as a treatment device.

## OBJECTIVE

This article aims to provide general practitioners with a brief summary of the evidence for visual deficits in the learning disorders and the efficacy of visual therapies in their treatment.

## DISCUSSION

Although ocular/visual processing deficits do exist in those with learning disorders – particularly reading, they also exist in typical children, and current consensus holds they are not causal factors. Current consensus also holds that visual therapies are not an evidence based treatment for reading or learning disorders.

**Learning disorders are common presenting complaints to paediatric and other primary care services, learning disorder clinics, and special education settings. Reasons for learning failure in childhood include: intellectual impairment, sensory deficits, emotional disturbances, and socio-cultural opportunity. In addition, there is a significant minority of children who present with anomalies of development in reading, writing, and mathematics. Of the learning disorders, dyslexia (or specific reading disorder) is the most common, affecting 80% of all those identified as learning disabled.<sup>1</sup>**

Dyslexia is characterised by an unexpected difficulty in reading, often accompanied by impairment in spelling and writing, in otherwise typical children.<sup>1,2</sup> Inability to read and comprehend represents a major obstacle to learning and may have long term educational, social, and economic implications. Understandably, parental concern and the concern of educators for the welfare of children with reading disorders has led to a proliferation of diagnostic and remedial treatment procedures, many of which are controversial or without clear scientific evidence of efficacy. One of these procedures implicates ocular vision, visual stress, and/or visual processing in reading disorders as a causal factor and advocates visual training as a treatment device.

This article covers one component of a much broader field. There are a range of additional unconventional therapies

used for reading and other disorders such as exercise programs,<sup>3</sup> dietary supplements,<sup>4</sup> and sensory processing training<sup>5</sup> that may be relevant to clinical practice.

## The role of the eyes in reading

There is no disputing that ocular vision (the eyes) and processing within the primary visual cortex and extrastriate cortical areas are necessary for decoding written text (reading). Reading requires efficient visual abilities, including the ability to process the spatial location of letters while the eyes move across text. These processes must be coordinated with the perceptual and memory aspects of vision, which in turn must combine with word level decoding and linguistic processes. To provide reliable information, this must occur with precise timing.

Over the past century many have attributed reading problems to one or more subtle ocular or visual abnormalities. Perhaps the first to do so was the neurologist Samuel Orton,<sup>6</sup> who wrote about the difficulty dyslexic children had with reversible letters and words (eg. b/d, god, dog). Since that time, Orton's view has been shown to be incorrect<sup>7</sup> and the consensus among experts is that reading disorders are on the continuum of language impairment.<sup>8</sup> A core deficit in phonological processing is thought to interact with other language skills (eg. semantic and syntactic knowledge) to affect the ability to establish links between printed text (letters) and sounds.<sup>9</sup>

## Evidence for visual abnormalities in reading disorders/dyslexia

### Ocular deficits

It is well documented that the eye movements of dyslexics differ from those of skilled readers.<sup>10</sup> While reading, the dyslexic exhibits longer duration of eye fixation, shorter saccades and a higher proportion of regressions (backward) saccades than controls.<sup>11</sup> However, research has demonstrated that abnormalities in eye movements occur specifically in reading tasks. When dyslexic people and controls are compared on visual tasks that require similar perceptual and ocular motor demands to reading, there are no differences between eye movements of the groups.<sup>11</sup> Hence the divergent eye movement patterns of dyslexics during reading reflect difficulties in the reading process rather than a primary impairment of ocular motor control.<sup>11</sup> This conclusion is supported by studies that have demonstrated that the eye movements of a dyslexic person do not differ from younger, reading age matched controls<sup>12</sup> and that when a dyslexic person is given reading level texts, their eye movements are comparable to controls.<sup>13</sup>

It has also been claimed that dyslexic children have problems with smooth pursuit eye movements (visual tracking) relative to controls.<sup>14</sup> However, this effect has not been replicated in well controlled studies.<sup>15-17</sup> That pursuit movements play no role in reading also questions the relevance of this finding. Dyslexia has also been attributed to poor ocular dominance which, it has been suggested, may make it difficult to identify or correctly sequence letters.<sup>18</sup> However, independent studies have been unable to replicate the results of ocular deficits in dyslexic children.<sup>19,20</sup>

Although a dyslexic person makes different eye movements to controls when reading, there is no evidence that they have statistically poorer ocular health than typical children. At best, these visual factors are now considered correlates rather than causes of reading difficulties. Given the heavy involvement of certain ocular movements and processes in reading, it may even be that early and efficient reading leads to a concomitant improvement in ocular control. Visual deficits may therefore be a corollary of poor reading rather than a causal factor.<sup>11</sup>

### Visual stress

Visual perceptual problems in the form of Irlen-Meaers syndrome have also been associated with reading difficulties.<sup>21</sup> 'Irlen-Meaers' is used to define problems with processing full spectrum light efficiently. Although there are competing hypotheses of the cause of visual stress, cortical hypersensitivity to pattern glare is generally more favoured at present.<sup>22</sup> Irlen-Meaers is not an ocular visual problem but a perceptual problem that manifests as light sensitivity, inadequate background accommodation, poor print resolution, restricted span of recognition, and lack of sustained attention.<sup>21</sup> The theory is that Irlen-Meaers causes print to become distorted, which affects word reading and comprehension in turn. Irlen-Meaers is also claimed to affect reading efficiency such that sufferers can only read for short periods and are prone to reading related headaches.<sup>21</sup>

Irlen-Meaers has been reported to be more prevalent in dyslexic populations,<sup>23</sup> however, the relationship between reading and visual stress remains controversial. Visual complaints in general are made by many healthy children and Irlen-Meaers also exists in skilled readers.<sup>24</sup> The current consensus is that reading disorders and Irlen-Meaers are separate conditions and the latter may be an additional contributing factor in some reading disorders.<sup>25</sup>

### Visual processing

Reading difficulties have also been attributed to deficits in visual processing within the cortical and extra-striate visual systems. Deficits in transient or magnocellular visual processing have been implicated,<sup>18</sup> as have impairments in visual attention.<sup>26</sup> Although significant differences have been found between dyslexic and control groups, these differences exist in only 30% of dyslexics.<sup>27</sup> Furthermore, visual processing deficits are found in skilled readers, suggesting that a visual processing deficit is neither necessary, nor sufficient for dyslexia.<sup>27</sup>

## Visual therapies

### Behavioural vision therapy

Behavioural vision therapy involves eye exercises, eye-hand coordination tasks and other exercises designed to improve the individual's motor memory activity. There is a paucity of well controlled scientific studies on the efficacy of this

treatment. Although there are a limited number of studies that have reported improvements in oculomotor control and convergence reading in response to vision therapy<sup>28,29</sup> few have reported concomitant improvements in reading ability. Those that have been plagued by methodological problems including lack of random allocation; poorly matched controls or in some cases, lack of a treatment control group; no checks on treatment adherence; and lack of controls over additional educational intervention, making it difficult to interpret the data in terms of a positive effect for occlusion.<sup>29,30</sup> Furthermore, critics have demonstrated that when more appropriate statistical analyses were conducted, there were no benefits of visual therapy for the dyslexic child.<sup>31</sup> Therefore, although in widespread use, behavioural vision therapy has limited evidence for efficacy.

### Tinted lenses

Coloured or tinted (Irlen) lenses and overlays are also propagated as effective therapy for reading and learning disorders. Although there are a small number of studies that have reported benefits from use of tinted lenses in reading/learning disorders<sup>32</sup> these studies are typically plagued by methodological concerns, including no controls on other therapies/intervention or poorly matched intervention groups. Furthermore, there has been a general failure to replicate the effects of significant benefits of tinted lenses/overlays within independent laboratories,<sup>32,33</sup> and even within the same laboratories.<sup>34</sup> There is some data demonstrating that in children and adults with symptoms of Irlen-Meaers syndrome (small) effects on reading rate occur in response to tinted overlays.<sup>23</sup> However, this effect has been demonstrated in subjects who are typically adequate readers and provides no support for claims that coloured lenses/overlays specifically assist children with reading/learning disorders.

In response to concerns regarding the use of visual therapies, a number of influential bodies have conducted reviews and released policy statements for their members. The joint statement of the Committee on Children With Disabilities, American Academy of Pediatrics, American Association for Pediatric Ophthalmology and Strabismus, and the American Academy of Ophthalmology<sup>35</sup> states the following in regard to visual therapy: 'No scientific

evidence supports claims that the academic abilities of children with learning disabilities can be improved with treatments that are based on 1) visual training, including muscle exercises, ocular pursuit, tracking exercises, or 'training' glasses; 2) neurological organisational training (laterality training, crawling, balance board, perceptual training); or 3) coloured lenses'.<sup>35</sup>

A more recent review<sup>36</sup> by the American Academy of Ophthalmology concluded that there was no scientific evidence that supports behavioural vision therapy, orthoptic vision therapy, or coloured overlays as effective treatments for learning disorders. Claims of improvement after visual therapy have typically been based on poorly controlled studies and testimonials. Reported benefits can often be explained by the traditional educational strategies with which they are usually combined.<sup>35</sup> The review goes on to note that eye movements and visual perception are not critical factors in the reading impairment found in dyslexia. Furthermore, they state that the majority of individuals with known ocular motility and eye movement defects read normally and that even individuals with severely misaligned eyes can excel in reading and academics.

### The risks

Although unlikely to cause harm, these controversial treatments may give a false sense that the reading or learning disorder is being addressed, thus delaying proper instruction. There are direct costs associated with treatments as well as potential indirect costs such as loss of wages and time for working parents. Time required for the therapeutic activities may also impact on family and study activities.

### The role of the GP

Although the evidence to support a causal role for ocular or visual processing deficits in the aetiology of reading disorders is limited, general practitioners should not ignore the presence of ocular or visual processing deficits which may contribute to more general functional impairment. Patients who present with symptoms of visual strain or fatigue, mild eye coordination or focus problems, double vision or strabismus ('crossed' or turned eyes) and amblyopia ('lazy eye') should be referred to an ophthalmologist experienced in paediatric care. If there is no evidence of an

ocular deficit or visual processing impairment (reversals of letters and words do not count), the child can be more effectively helped by a detailed study by neurodevelopmental and educational specialists. Educators, psychologists, and speech pathologists, provided they have special training in disorders of learning and reading, will ultimately play a key role in providing assistance for the child with reading disorders/dyslexia.

### Summary of important points

- Current consensus holds that visual therapies are not an evidence based treatment for reading or learning disorders.
- Visual screening can be accomplished by the GP. Any child who cannot pass the recommended vision screening test should be referred to an ophthalmologist or optometrist with experience in the care of children.
- Children with educational problems and normal vision screening should be referred for neurodevelopmental and educational evaluation and appropriate special educational evaluation and services.

Conflict of interest: none declared.

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