Role of the ophthalmologist in the management of dyslexia (specific learning difficulties)

Frank Martin, Lindley Leonard, Craig Donaldson, James Elder, Glen Gole and Geoffrey Lam

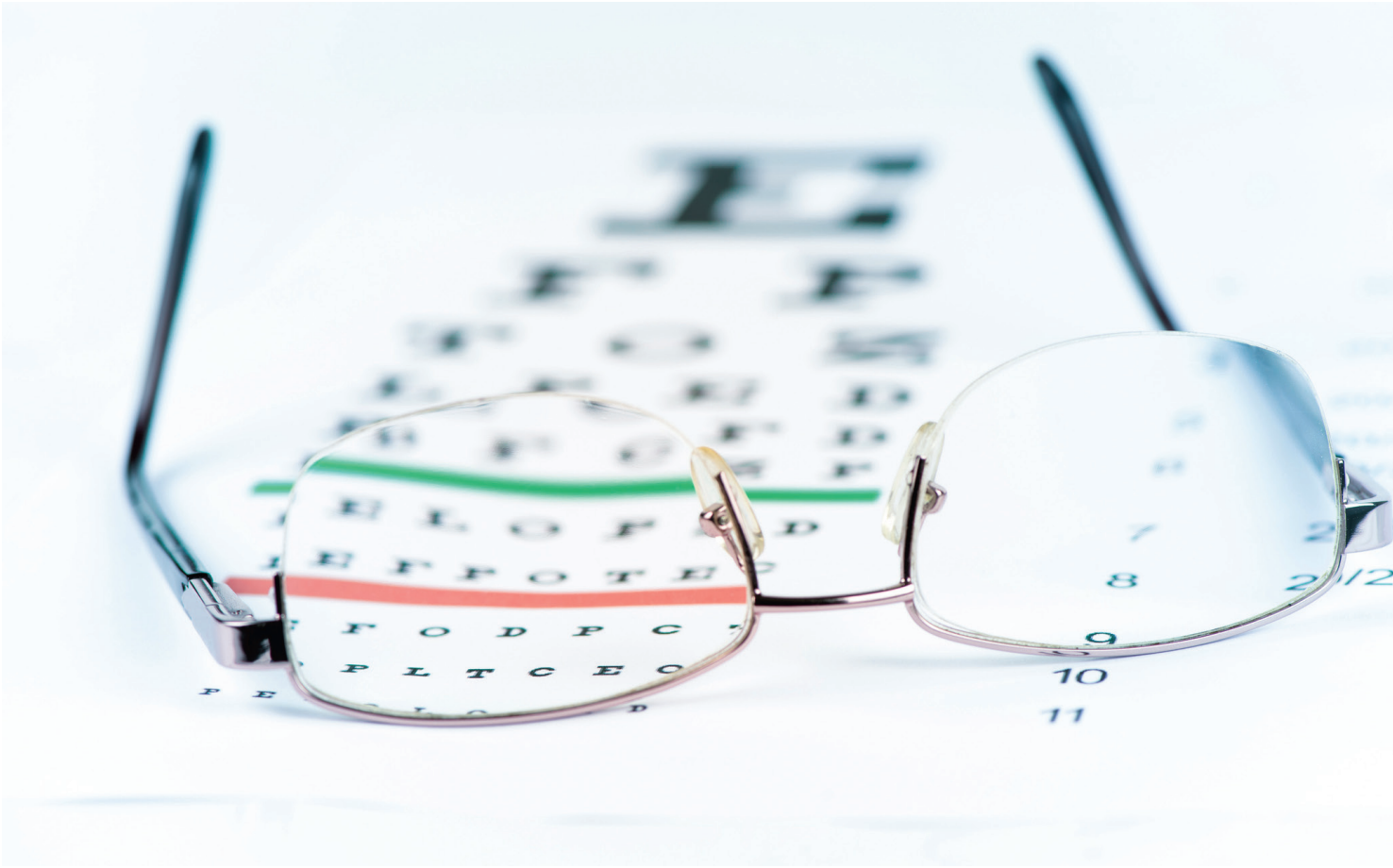
The role of the ophthalmologist in the management of children with dyslexia is above and beyond a full eye examination. The ophthalmologist needs to understand the process of learning to read, the theories of dyslexia, and controversial and non-controversial therapies. This understanding will in turn allow the ophthalmologist to guide parents towards appropriate science-based remedial intervention for their child.

Reading difficulty/specific learning difficulty/developmental dyslexia is defined as being unable to read at the level that would be expected taking into account the home background, the educational opportunities and the child's intelligence. It is a common problem, with mild to moderate dyslexia occurring in 10-16% of children and severe in 2-4%. Males and females are equally affected and difficulties with reading fluency are similar across languages. There are also a number of comorbidities associated with dyslexia; approximately 15% of children with reading disability have attention deficit hyperactivity disorder (ADHD) and of children diagnosed with ADHD, 35% have a reading disability.

Learning to read

The process of reading involves extracting meaning from print. The phonological model of reading is the most widely accepted. Reading is a decoding skill while spelling and writing are encoding skills. In alphabet-based languages (such as English) there is a sequence that allows reading to proceed: symbol (letter or grapheme) –> sound (phonemes) –> words and meanings (semantics). To understand the process of reading, we need to be aware that this involves phonemes which are the smallest meaningful segment of language. A different combination of 44 phonemes produces every word in the English language. As an example, the word 'cat' is broken up into three phonemes – kuh/aah/tuh. The phonological module automatically assembles phonemes into words. These are known as letter sound rules. The process of reading is not a single skill; it requires many sub-skills, including letter recognition, word recognition, letter-sound rules and word comprehension.

Children go through several stages as they learn to read. There is good evidence that the brain is 'rewired' as a child learns to read. In immature readers, the reading process is bi-hemispheric and has significant involvement of frontal, temporal, parietal and occipital lobes while in more mature and skilled readers the left hemisphere is predominant, with mainly frontal and occipital lobe involvement with relative bypassing of the temporal and parietal lobes. Early language exposure by being read to influences subsequent learning to read; it appears this early experience helps the child understand many basic language rules before the more formal process of learning to read commences. In the initial stages of learning to read the child learns a small sight vocabulary, they then learn how to sound out, then use sounding out to build up a bigger sight vocabulary, and then they eventually give up sounding out as they become a fast and fluent reader.



When a child reads aloud, they can either recognise the word in their mental dictionary or apply the letter-sound rules. The English language is amongst the most difficult languages to learn to read as there are so many irregular words where sounding out does not give meaning or sense to the word. An example of an irregular word is 'yacht'; no amount of sounding out will correctly allow the reader to read this word aloud. Irregular words need to be identified by prior exposure. However, regular words such as 'trout' can be read by applying the letter-sound rules.

Dyslexia

Reading difficulties can be divided into a primary form (dyslexia) and secondary forms that may be the result of visual or hearing disorders, intellectual disability, life experience and/or educational deficits. Lyon et al have defined dyslexia as "… a receptive language-based learning disability that is characterised by difficulties with decoding, fluent word recognition, and/or reading-comprehension skills. These difficulties typically result from a deficit in the phonologic component of language that makes it difficult to use the alphabetic code to decode the written word. Secondary consequences may include reduced reading experience that can impede growth of vocabulary, written expression, and background knowledge." (Lyon GR, Shaywitz S, Shaywitz B. A definition of dyslexia. *Ann of Dyslexia. 2003*;53(1):1-14.)

The most compelling theory for dyslexia is that it is due to an abnormality of brain function. In the brain the inferior frontal gyrus is the phoneme producer, word analysis occurs in the parietal-temporal region and word form and automatic detection of words occurs in the occipital-temporal area of the brain. Neuroanatomical changes with an absence of normal asymmetry between the left and right hemisphere of the brain in dyslexic children have been documented in a number of studies. Functional neuroimaging (fMRI) for normal readers as compared to dyslexic children have also been performed and show a difference in brain function between the two groups. After successful remedial treatment this difference is no longer present. The review of evidence strongly supports the view that dyslexia is due to brain dysfunction.

This is further supported by the neuropsychological studies that have shown that dyslexia is a language based disorder with a primary underlying deficit involving problems in phonological processing. Phonological difficulties probably interact with other neurocognitive risk factors.

The neurobiological nature of dyslexia has been supported by the finding that 23%-65% of children with dyslexia have a dyslexic parent and 40% a dyslexic sibling. Six candidate genes have been identified for dyslexia.

A number of alternative theories have been proposed to explain dyslexia. These include abnormalities of visual function and eye movements. Although the ability to read involves vision, the process itself fundamentally includes

parts of the brain beyond the visual pathways; vision is only one of the initial steps. Children with severe visual impairment and nystagmus may have some difficulty learning to read but this is a secondary form of dyslexia. Most visual impairment, refractive errors and abnormalities of binocular vision and accommodation/convergence have been shown to have no significant effect on the ability to learn to read. There is a lack of good evidence in the literature to support that visual dysfunction is the cause of reading difficulties such as dyslexia.

It has been suggested that abnormalities of saccadic (rapid) eye movements underlie dyslexia. In normal reading, as the child reads there are forward saccades of the eyes with fixation pauses. There are also regression or backward saccades as the child tries to extract meaning from print. The eyes also undergo small vergence adjustments. In the child learning to read and the child with reading difficulties, there are shorter saccades, longer fixation pauses and an increased number of regressions as the reader has increased difficulty in understanding the text. As reading develops, the saccades lengthen, the fixation pauses are shorter and the number of regressions is decreased. The eye movements in the child with dyslexia are similar to that of the child learning to read. The so-called abnormal eye movements observed in dyslexic children are the result, not the cause, of the reading difficulty.

Effects of the magnocellular (transient) visual system have also been blamed for dyslexia. The magnocellular visual system responds to rapid changes in visual stimulation whilst the parvocellular mediates colour vision and perception of fine spatial details. The magnocellular system in dyslexia is thought to not be able to suppress the parvocellular system. The evidence for this theory is based on contrast sensitivity studies and is equivocal.

Controversial therapies

There have been a number of controversial treatments proposed for dyslexia. These include vision training, combined with neurodevelopmental training, Irlen tinted lenses and fringe therapies such as the Lawson anti-suppression device.

Vision training is based on the premise that reading is primarily a visual task. Vision training involves muscle exercises, ocular pursuits, tracking exercises, training glasses (with or without bifocals or prism) and these are often combined with neurodevelopmental training. Eye exercises have been shown to improve convergence insufficiency, help develop fine stereoscopic skills and improve visual field recordings after brain damage. There is no clear scientific evidence published in mainstream literature to support the use of eye exercises in other conditions including learning disabilities and dyslexia. The American Optometric Association has stated that vision training does not directly treat learning disabilities but improves visual efficacy to make the student more responsive to educational instruction. There is, however, no evidence that children participating in vision therapy are more responsive to education instruction than children who do not participate. Claims of reading improvement have not been subjected to well-controlled prospective clinical trials.

Irlen clinics dispensing the Irlen tinted lenses claim instantaneous improvement in reading performance, comprehension and distance judgment. The efficacy of Irlen tinted lenses is based on anecdotal evidence. Controlled trials have shown no difference in outcomes in children given tinted lenses.

Therapies including the Lawson anti-suppression device, syntonics, applied kinesiology, megavitamins and mega oils, the use of trace elements and psychostimulants have all been claimed to improve the reading of dyslexics. The Lawson anti-suppression device, as used in the Alison Lawson clinics, offers a quick fix with 10 one-hour treatments aimed at stimulating the visual cortex. This treatment is based on a false premise that the visual cortex is responsible for reading. There are no controlled trials to support the claims of efficacy of any of the fringe therapies. Their claim to success is based on anecdotal evidence.

Rational management of dyslexia

Non-controversial, well researched management involves early diagnosis based on comprehensive evaluation by an educational psychologist, the exclusion of any sensory deficit and correction of the deficit with appropriate glasses, appropriate orthoptic eye exercises and hearing aids, if indicated, followed by appropriate remedial educational input.

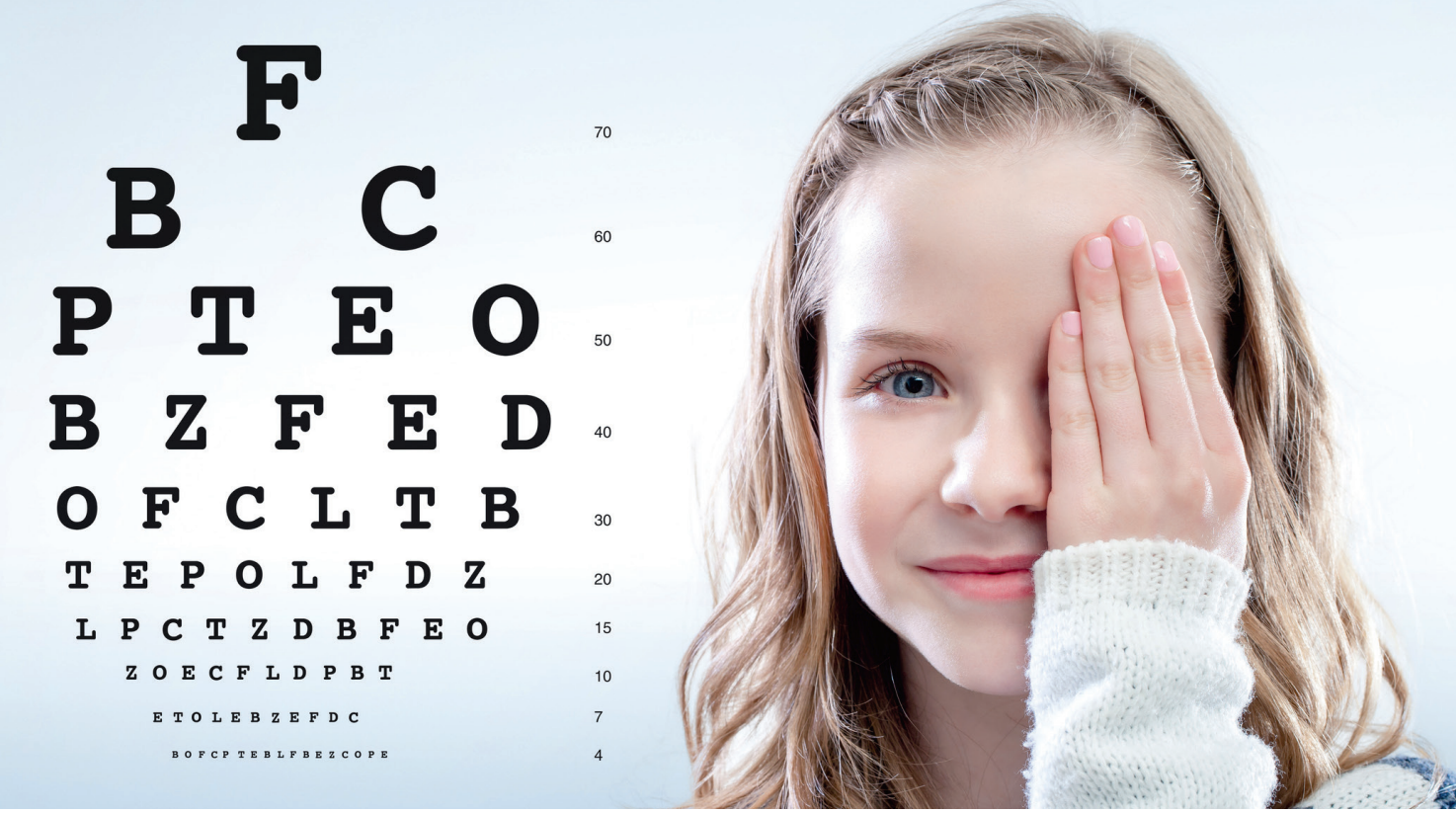
There is good evidence that appropriate educational interventions make a major difference to dyslexia. Regardless of the severity of the dyslexia, education interventions make some difference.

- Dyslexia is a brain dysfunction.
- Management must be based on science. Remedial reading intervention is currently the best management.
- There is no credible evidence to support claims for treatments such as vision training/therapy with or without combined neurodevelopmental training, Irlen tinted lenses and the Lawson anti-suppression device.
- The ophthalmologist has a role in the diagnosis and correction of vision deficits. They should help guide the parents towards appropriate remedial assistance for their child.

The role of the ophthalmologist

Ophthalmologists are often consulted by parents of children who have been experiencing difficulty with reading. Visual problems can interfere with the physical aspects of reading, therefore the visual system should be assessed to rule out any ocular disorder before specific treatment is initiated for learning difficulties. Reading discomfort can be related to uncorrected refractive errors and to disorders of ocular motility, binocular function (especially convergence), or accommodation. If eye conditions are diagnosed at the time of the visit, they should be treated appropriately. Treatment may include glasses for refractive error or convergence exercises for convergence insufficiency. However, if the eye examination does not reveal any major pathology, the parents should be counselled about their child's learning deficiency and reassured that subtle ocular deficits are not the cause of reading difficulties.

Eye professionals should not



be considered the expert in reading education. A variety of trained specialists are available for children in need of help and there is an enormous body of literature regarding reading and learning from the educational perspective. Effective intervention remediates the underlying problem in phonemic awareness.

The role of the ophthalmologist is to take an accurate history, including questions about development and the family history; perform or arrange for a full orthoptic workup; perform cycloplegic refraction and ophthalmoscopy to exclude eye disease; correct refractive error and treat ocular muscle imbalance (convergence insufficiency etc). The ophthalmologist should explain to the parents of the child the process of reading, the theories of dyslexia and the controversial and non-controversial therapies whilst working with a multidisciplinary team to ensure that the child receives appropriate remedial treatment.

In conclusion, reading is a complex process requiring a number of sub-skills. Parents of dyslexic children are looking for a quick fix but understand common sense.

- Dyslexia is best explained by the theory of brain dysfunction.
- Management must be based on science, not on arbitrary and capricious dogma.
- There is no credible evidence to support claims for treatment not based on appropriate remedial reading intervention.
- All children with dyslexia must have a thorough orthoptic and ophthalmic examination.
- The ophthalmologist has a role in diagnosis and correction of sensory deficits relating to vision, and must guide the parents towards appropriate remedial assistance for their child.
- As doctors, ophthalmologists have a responsibility to help families make the best use of limited resources. We should steer families away from unproven interventions that consume resources and thus interfere with the implementation of proven methodologies such as educational and language based therapy.

The Royal Australian and New Zealand College of Opthalmologists (RANZCO) has endorsed the joint statement from the American Association of Paediatrics, American Association of Paediatric Ophthalmologists and Strabismus, the American Association of Certified Orthoptists and the American Academy of Ophthalmologists on 'Learning Disabilities, Dyslexia and Vision'. This statement was reaffirmed by the groups in 2014 and has appended to it a references and resource list for professionals and parents of children with dyslexia.

References

A detailed reference list is available on request from: eye2eye@ranzco.edu.

We would like to thank Eye2Eye, the newsletter of RANZCO, for their kind permission to reproduce this important article.