Eleventh Turville Memorial Lecture

Reading with vision

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In the normal course of optometric practice, the interested practitioner will sometimes come across children who are inexplicably failing to do as well at school as is expected of them. The severity of their failure may range from being hardly noticeable, other than by zealous parents, to major disability, causing considerable concern to parents, child and teachers alike. One of the most common threads linking these children together is that they are usually particularly poor at reading, and are failing to achieve standards expected of their age group. Consequently they fall behind their peers and often exhibit signs of poor self-esteem and even behavioural problems.

In many cases, the optometrist is but one port of call on the road to finding a reason for the child's failing, and he or she must be competent to examine for the subtle visual anomalies that can lead to educational under-achievement, and to be able to advise on the best approach to take to overcome these difficulties. This responsibility is an onerous one, for failure to detect a problem — which usually will be both subtle and complex, will shift attention away from the eyes and the visual system, and it may not return.

Of course there are many causes of reading difficulty, and it has to be said that any expert will tend to see a problem from his own point of view: the teacher will see an educational one, the psychologist, a behavioural one, and we will see a visual one. Our responsibility can be seen (a) to detect and advise on visual problems, and (b) to refer on where appropriate to other disciplines if we suspect another professional can better help the child.

Educational under-achievement is an umbrella term to cover a multitude of difficulties, and I want to look more specifically at children who are described as having 'Specific learning disability', or more simply as dyslexic. It is unfortunate that no formal definition exists that enables us to categorise the problem. Indeed, almost every authority to write on the subject puts forward a new name or definition. It is, however, becoming increasingly common now to use the two terms specific learning disability and dyslexia synonymously, and for the terms to apply to children who:

(a) Show failure to learn at an expected rate (eg, reading or spelling is 18 months or more behind the average for the age).

(b) Show evidence of average, or above average intelligence.

(c) Have had ample educational opportunity.

(d) Exclude mental retardation, emotional disturbance and demonstrable defects of vision (eg partial sight), hearing and motor function.

The later aspect is of particular interest to us, since the large majority of dyslexic children have 6/6 vision and no major refractive problem. Many, however, do show problems in tracking, eye/hand co-ordination and visual-perceptual skills and it is these that I wish to concentrate on.

Incidence of dyslexia

How common is dyslexia, and how often are we likely to come across a child with problems? Official estimates vary, but suggest that between 5 and 15 per cent of all school age children experience significant reading problems. This means that in excess of three-quarters of a million children at the very least in British schools are affected, or on average two children in every classroom.

Over the last two years I have carried out a survey of all children seen in my optometric practice. Out of a total of 169 children seen in the first phase of the study, 22 per cent reported difficulty with reading that was acknowledged by and being tackled by schools. Of these children, 84 per cent also had problems with binocular vision, compared with under 20 per cent of normal or good readers. (In the study as far as possible children were excluded if they came because of my interest in these problems). Of especial note is that all the poor readers had taken, and passed on school eye tests.

It is interesting to compare the incidence with a disease such as glaucoma. Now I do not for one moment wish to rate glaucoma in any sort of order, but current figures would suggest that the average optometrist might see around 10 glaucoma cases each year, and we expend considerable time and effort on the early detection of this disease — and quite rightly so. Do we, however, put as much effort into the early detection of visual problems affecting reading ability, bearing in mind the enormous effect that they may have on a child's life?

The reading task

Let me now turn to the the nature of the reading task. Reading is one of the most complex, and highest level perceptual tasks that we are capable of carrying out. It involves the visual recognition of both single symbols and groups of symbols bound into words, and the conversion of these symbols into meaningful language. The symbols may range from the clear typescript of a printed page, to the spider-like scrawlings of an adolescent schoolboy in haste to get out of the classroom into the playground! These symbols are detected and analysed exceedingly rapidly. As the eyes scan along a line of text, they will typically come to rest some five times along the line, pausing for around 200 milliseconds before jumping on in another saccade to the next fixation point. For the average reader, fixation points are around 2 cm apart, and we take in a span of 10 to 12 letters with each fixation. Thus reading is very definitely not a macular function only.

Fixations also become more frequent the more complicated the text becomes. We also go back (or regress) some 10 to 20 per cent of the time. More information is picked up to the right of the fixation point than to the left, making the right visual half-field the more important in perceptual terms, for most people.

Once a visual image has been detected and 'photographed', the neural image is processed through progressively higher levels of the brain until it is converted into an auditory image, of which we are conscious. The same area of the brain that receives and processes visual language information (the angular gyrus) also sends out messages to initiate and mediate eye movements while reading. In most people, the left angular gyrus is substantially larger than the right, and we know that damage to the left angular gyrus has a very much greater effect on reading than damage to the right angular gyrus. Reading, as with language, is very much more centered in the left hemisphere of the brain.

In order that reading can take place, and that adequate visual memory can be built up and maintained, the brain must receive a clear and coherent image of the text being viewed. Stable binocular vision will lead to clear fused visual images, and allow the build up of visual memory, so vital for good spelling in a language such as English which so often strays from phonetic spelling. If, however, there is poor binocular control then scanning will become erratic, images will not be consistently fused and visual confusion will result.

We rely on our eyes to provide us with a sense of visual direction, enabling us to build

up a mental image of the world around us. If binocular control is erratic, then the information we use to build this mental 'map' will often conflict, leading to poor directional ability and poor visual-spatial co-ordination. The child with binocular control problems will often be the child who is poor at spatial tasks such as ball-catching, and who not only does poorly in his academic work — but is the one to drop the all important catches in a cricket match.

If there is one feature of visual reading difficulties that needs to be emphasised, it is that they are *dynamic*. As optometrists, most of our testing and clinical analysis is done in a static mode, and takes little account of how the eyes actively perform together, both physically and perceptually. The binocular state of a patient may vary widely at different times of the day, and under differing circumstances. A child with a basic convergence weakness may at times demonstrate a degree of esophoria at near, brought about by excessive effort to overcome the underlying problem. Thus we must translate our findings from the 9.30 am patient on Monday morning to what might happen as Fred struggles with his homework at 8.00 pm on Friday night!

Having said that a large percentage of reading problems have a visual origin — what parts of the visual system are involved?

Acuity and refraction

As already stated, the vast majority of learning disabled children have acuities of 6/6 and only small degrees of refractive error, usually hypermetropia of under +1.25 D. Myopia is rare in these children, and one can argue that this is because myopia is a successful adaptation of the eyes to a near-centered environment built on reading! Astigmatism is probably no more common than in the general population. One can begin to see why these children are so often missed on school eye tests.

Binocular vision

Stable co-ordination of the eyes whilst reading is vital if reduced performance is to be avoided. Weaknesses in convergence, and the inability to maintain adequate convergence are probably the most common problems seen and, in turn, these play havoc with tracking ability. In a relatively few children, convergence excess, seen as a variable degree of decompensated esophoria at near is encountered, probably, I believe, as a spasmic response to an underlying divergence excess.

Abnormally low fusional reserves, especially of base-out reserves, are commonly encountered. It is a great pity that fusional reserve measurements are so widely neglected in our routines. Eye tracking ability is perhaps best assessed by means of infra-red eye movement detection devices, though with a little practice one can observe eye movements with a hand mirror whilst a child reads.

Table 1 — Signs and symptoms of visual difficulties

- Print blurs after short periods
- Loses place as reads across page
- Uses finger to mark place
- Omits small words
- Skips lines unknowingly
- Transient diplopia as reads
- Complains of nausea and dizziness
- Frontal headache with near vision
- Screws eyes up and grimaces when reading
- Tilts head over to one side with reading and writing
- Poor concentration span
- Writing untidy and variable
- Misaligns digits when adding rows of numbers
- Confuses left and right
- Reverses letters and words in writing and copying
- Blinking
- Reads very close
- Rubs eyes a lot
- Fatigues easily
- Avoids close work

Accommodation

Accommodative weaknesses are less commonly seen than are convergence problems, but are nonetheless a significant cause of reading difficulty. Not infrequently, reduced amplitude of accommodation is measured in only one eye, and needs to be investigated by cycloplegic refraction, which may well show a latent hypermetropia. Children with accommodative problems often report difficulty in refocussing from near to far and back.

Dominance

The most controversial, and least understood, area of difficulty is related to ocular dominance. It is known that a 'reference' eye is needed to define visual direction when the eye position signals from each eye disagree (as on convergence). This reference eye may alter according to the conditions prevailing, and a forced switch of reference eye can occur due to the receipt of a blurred image in one eye, perhaps as a result of small degrees of anisometropia, or following on from 'successful' squint surgery, which has left a moderate degree of binocularity which is unstable. It also appears that the reference eye when reading is not necessarily the same as the dominant eye in the distance.

Some researchers have linked this far/near switch to the nature of the reading task being so closely linked to language, a left hemisphere function, whereas distance viewing is primarily a movement recognition task (essentially right hemisphere mediated). What is beyond dispute, however, is the larger incidence of undecided reference eye in poor readers compared with the general population.

The signs and symptoms of visual reading disability are many, and affect many areas of life outside reading itself. Some of the more common ones are outlined in Table 1. The presence of only a few signs should alert the optometrist to look for — and expect to find problems.

Examination of children is a time-consuming affair, and is perhaps best conducted with a parent present to help fill in information, and to supply information on school progress. I usually proceed with a fairly conventional refraction, paying especial attention to the aspects of binocular vision already mentioned. In particular, the assessment of convergence is made several times in the examination, checking both near point and the dynamic quality of jump convergence. This is often seen to falter as the child fatigues.

A typical outline of a child examination is given in Table 2. During the examination several extra tests may be introduced, such as simple word reading exercises, giving a measure of the child's reading age, and auditory and visual sequential memory tests. The results of these are useful in determining whether other factors play a significant part in the child's difficulties. Notable in this respect is partial hearing loss, often as a result of persistent catarrhal problems and ear infections in the first four years of life. This often affects auditory discrimination ability, and is detrimental, particularly to spelling.

I investigate reference eye by a battery of techniques, perhaps the simplest method being the relative brightness of the polarised markers on a Mallett fixation disparity unit. This compares favourably with other more complex tests yet it is fast, simple to explain and it is widely available.

Having identified a problem, what options

Table 2 — Outline of the child optometric examination

- Symptoms and history
- Visual acuity measurements
- Convergence analysis
- Ocular motility check
- Phoria/tropia measurements (cover test)
- Retinoscopy (objective refraction)
- Subjective refraction
- Binocular status (distance fixation disparity)
- Accommodation measures
- Near fixation disparity
- Dynamic retinoscopy
- Ophthalmoscopy
- Colour vision analysis
- Assessment and treatment

Additional techniques employed

- In-depth parental questioning
- Assessment of eye movements
- Reading tests (Schonell graded word)
- Visual discrimination tests
- Auditory sequential memory tests
- Sound discrimination tests
- Laterality assessment
- Polarised investigation of reference eye
- Cycloplegic examination

are open to us? Broadly there are six possibilities:

(1) Refractive
(2) Prismatic
(3) Occlusion
(4) Vision training
(5) Tints
(6) Guidance

Spectacles may be used with or without incorporated prism for the correction of refractive error, especially where this is affecting accommodation, or where a forced change of reference eye is occurring because of differences between the two eyes. Prism may be incorporated to reduce convergence fatigue, and can produce astonishing improvements in reading ability immediately. This should, I feel, always be secondary to vision training to modify binocular behaviour, and I regard vision training exercises to be the most important aspect of treatment. In particular the use of physiological diplopia techniques helps build up stable convergence and tracking ability in a manner that requires minimal supervision, and can be done at home.

Short periods of occlusion whilst reading have been used in an attempt to stabilise the reference eye by a number of researchers, notably John Stein and Susan Fowler. At the moment there is some controversy about the success of the method, and it is perhaps wise to avoid this approach until more is known.

If a fashion currently exists in dyslexia, it is for the use of Irlen lenses, the so called 'tinted spectacles'. Several surveys have recently appeared in the optometric press about their use. My own feeling is that any fairly deep tint will give symptomatic relief to many people suffering from binocular dysfunction, a fact that has been well known for many years. I do not feel that tinted lenses can provide a long-term solution for dyslexics, and, indeed, there is beginning to be anecdotal evidence that the effect wears off after some months. I await with great interest a genuinely independent and un-biased assessment of the technique.

Under the heading of guidance come the many snippets of useful information that we can impart to our patient, about posture, working conditions and practices. These are many and come with experience as one sees more and more children, but perhaps the most useful 'advice' that we can give is to make the child aware that his difficulty has a cause, and is not necessarily because he is thick, lazy, stupid — or whatever he may have labelled himself. This can be of enormous psychological importance to a child who may have endured years of nagging from parents and teachers alike, who are frustrated by the child's inexplicable inability to perform as they would expect.

In conclusion, may I say that there is much, much more that we, as optometrists, can do to help these children overcome their visual disabilities. In his day Turville looked ahead to improve the service that optometry could provide to society. In our day we must do the same, by seeking to enable our patients to have the fullest and most complete use of the visual sense, which is perhaps God's second most gracious gift to us — after life itself.

This article is the text of a lecture given by Keith Holland to the Northhamptonshire Optical Society as the 1987 Turville Memorial Lecture.

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