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## Vision & Reading Difficulties Part 1: Specific Learning Difficulties and Vision



Dr Peter Allen, Prof Bruce Evans, Prof Arnold Wilkins

This article is the first in a series of five about vision and reading difficulties, and provides an introduction and an overview of learning disabilities and specific learning difficulties. It outlines the role of the optometrist in helping people with such problems; it describes the symptoms that optometrists should look for and it provides an overview of the evidence-based approach. The second article in this series will cover the optometric and orthoptic correlates of reading difficulties. Articles three and four will describe the use of coloured filters, including background, techniques, evidence, and mechanism. The final article will draw together the themes in the series of

articles and discuss the clinical protocol and the role of the eye-care practitioner in managing visual factors associated with reading difficulties.

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### Overview of specific learning difficulties

Despite an average or above-average level of intelligence, some individuals have particular difficulties with tasks such as reading, writing and spelling. People with these problems are described as having specific learning difficulties (SpLD). Unfortunately, since most learning is mediated by the written word, those with reading and spelling problems will struggle, even if they are highly intelligent and articulate (Figure 1). SpLD persists throughout life and can have deleterious consequences for careers.<sup>1</sup>

A distinction needs to be drawn between profound learning disabilities (intellectual impairment) and SpLD. In SpLD, performance in specific areas is much worse than one would expect from the overall level of intelligence. People with profound learning disabilities are likely to have difficulties in a wide range of skills and have impaired intelligence, for example as measured with an IQ test. Profound learning disabilities are often associated with a variety of visual problems,<sup>2</sup> but



➔ **Figure 1**

There are many different types of SpLD including reading difficulties

the present series of articles will concentrate on the visual anomalies that can be associated with SpLD.

There are many different types of SpLD. Some of the main ones are summarised below.

- Reading and spelling difficulties – often known as *dyslexia*. Dyslexia refers to a cluster of symptoms, which result in people having difficulties with specific language skills, particularly

reading and spelling. People with dyslexia commonly experience some difficulties not only with reading and spelling but also with other language skills such as writing, and pronouncing words.

- Difficulties with written language – often referred to as *dysgraphia*. Dysgraphia can manifest itself as difficulties with spelling, poor handwriting and trouble putting thoughts on paper.

- Lack of numerical skill – often called *dyscalculia*. Dyscalculia refers to a wide range of life-long learning difficulties involving mathematics. There is no single form of maths disability, and difficulties vary from person to person and affect people differently in school and throughout life. Dyscalculia is sometimes associated with dyslexia.

- Difficulty with co-ordination – *dyspraxia*. This condition is closely related to two other labels, developmental co-ordination disorder and clumsy child syndrome.

The skills involved in writing, reading, listening, speaking, and reasoning overlap and so it is not

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surprising that people can be diagnosed with more than one SpLD. Attention Deficit Disorder (ADD) is a condition that becomes apparent in some children in the preschool and early school years. It is hard for these children to control their behaviour and/or pay attention. ADD is a common condition that is often associated with SpLD. ADD is sometimes associated with hyperactivity (ADHD) but it is important to realise that the condition can occur without the hyperactivity element, when the main features are inattention and impulsivity. The eye-care practitioner should be aware that results from certain tests (e.g., ocular motility and cover test) may not be reliable if the patient's attention has wandered.

## Dyslexia

According to the British Dyslexia Association (BDA), dyslexia is a *'combination of abilities and difficulties that affect the learning process in one or more of reading, spelling and writing. Accompanying weaknesses may be identified in areas of speed of processing, short term memory, organisation, sequencing, spoken language and motor skills. There may be difficulties with auditory and/or visual perception. Dyslexia can occur despite normal intellectual ability and education opportunity. It is constitutional in origin, part of one's make-up and independent of socio-economic status.'* (from the BDA website: <http://www.bdadyslexia.org.uk/whatisdyslexia.html>)

Dyslexia affects 5% to 10% of the school age population<sup>3</sup> and it can have a profound effect on schooling. The term "dyslexia" is sometimes used indiscriminately for people with specific or even non-specific learning difficulties. The cause of dyslexia is not known although it is generally agreed that a core feature in most cases of dyslexia is a deficit in phonological abilities.<sup>4</sup> This describes a problem in understanding the speech sound structure of words. Although visual factors are not usually the main cause of dyslexia, certain visual problems are particularly prevalent

and these can be a contributory factor in a child's reading difficulties. In other words, in dyslexia, the problem with reading and spelling can be multifactorial, requiring a multidisciplinary approach to treatment. The optometrist is an important member of this multidisciplinary team and the purpose of this series of articles is to outline the optometrist's role.

There have been many attempts over the years to classify dyslexia into various subtypes. Typically, these classifications include three groups: an auditory or phonological subtype (dysphonetic), a visual-spatial or performance group (dyseidetic), and a mixed group (dysphonetic/dyseidetic). There is controversy over this, since some studies suggest that dyslexia is so heterogeneous that it defies classification. It should be stressed that

the word 'visual' covers a very wide range of skills and the visual-spatial subgroup have difficulties with high level visual functions, not with the low level visual functions that optometrists assess. In fact, such classifications are not useful as indicators of which cases of dyslexia should be seen by an optometrist.<sup>5</sup>

In essence, the role of the optometrist is to ascertain to what degree, if any, visual dysfunction is contributing to a case of SpLD and to alleviate any visual factors that may be contributing to the person's overall difficulties. An accurate diagnosis of dyslexia is not the role of an eye-care practitioner but is typically conducted by an educational psychologist or teacher qualified in special educational needs. The diagnosis of dyslexia is usually one of exclusion, following specific educational tests, after other factors



➔ **Figure 2**

Coloured overlays used to diagnose visual stress



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such as intellectual disability and gross dysfunctions of hearing or vision have been eliminated. It is the optometrist's role to provide appropriate investigation and management of any visual factor(s) that may be a significant cause of the difficulty or may contribute to the overall problems in performance.<sup>6</sup> A person does not need to have been diagnosed as having dyslexia before seeking help from an optometrist. Indeed, it would seem sensible for any children whose teachers or parents suspect underachievement at school to have a detailed investigation with an optometrist who has specialised in vision and learning.

## An overview of the visual correlates of reading difficulties

Future articles in this series will describe the visual correlates of specific learning difficulties in detail, but these correlates will be briefly summarised now, in order to set the scene. Some of the research that implicates these correlates has studied dyslexia, whereas other studies have investigated populations that are more heterogeneous, described, for example, as having reading difficulties, specific and otherwise. There is some evidence supporting the common sense notion that the visual correlates of both of these conditions are similar. In any event, the exact psychological diagnosis may not be available, since it is to be hoped that children who underachieve will come to the optometrist at an early stage, before they have seen an educational psychologist. The present authors believe that all children who underachieve ought to have a detailed eye examination to detect the conditions outlined in these articles.

### Visual Stress

The inability to see comfortably without distortion and discomfort has been referred to as "visual stress".<sup>7</sup> The condition appears to be particularly prevalent in individuals who suffer from dyslexia,<sup>8,9</sup> migraine,<sup>10</sup> and photosensitive epilepsy.<sup>11,12</sup>

When aspects of the visual scene are of high contrast and in a striped

configuration, visual stress is likely to be evoked in those who are susceptible.<sup>13</sup> Consequently, reading material (which forms stripes from horizontal lines and from vertical letter strokes) has the potential to elicit visual stress. The occurrence of visual stress specifically associated with reading has been described by Meares,<sup>14</sup> Irlen,<sup>15</sup> and Wilkins.<sup>16</sup> The susceptibility of some individuals to reading-related visual stress has been variously termed scotopic sensitivity syndrome,<sup>15</sup> Irlen syndrome,<sup>17</sup> Meares-Irlen syndrome (MIS),<sup>17</sup> pattern-related visual stress,<sup>19</sup> and Meares-Irlen syndrome/visual stress (MISVis).<sup>20,21</sup> Wilkins has proposed that the underlying anomaly in visual stress is hyper-excitability of the visual cortex, possibly as a result of impaired gain control mechanisms, and that the effects of this can be alleviated in a variety of ways, including modifying the design and layout of printed text and through the use of colour (Figure 2) (see also Parts 3 to 5 of this series).

The prevalence of visual stress varies depending on the diagnostic criteria used but significant degrees of visual stress affects about 12% of unselected samples of the population<sup>22-24</sup> and about 30% of children with dyslexia.<sup>8</sup>

The detection, diagnosis, management, and aetiology of visual stress in people with reading difficulties will be described in more detail in Parts 3 and 4 of this series.

### Binocular instability

Binocular instability is characterised by an unstable heterophoria and low fusional reserves.<sup>25</sup> A controlled study found that the main sign of binocular instability (low fusional reserves) is present in about 5% of good readers and in 15% of poor readers.<sup>25</sup> This does not mean that 15% of poor readers need eye exercises; the binocular instability may in some cases be subtle and may not require treatment because it is not causing any problems. The fact that 5% of good readers have one of the signs of binocular instability shows that there is not a simple causal relationship; low fusional reserves will not necessarily make a person a poor reader. The detection of low fusional reserves using

a prism bar (Figure 3), and the diagnosis and management of binocular instability are discussed in detail in the second and fifth part of this series.

### Accommodative anomalies

There is some evidence that, on average, children with dyslexia have a slightly lower amplitude of accommodation than age-matched children without dyslexia.<sup>25</sup> These differences are only slight, but indicate that people with dyslexia may be predisposed to suffer from accommodative anomalies that can compound reading difficulties. It is unlikely that a very high proportion of people with reading difficulties require treatment for accommodative anomalies, but it would nonetheless be sensible for people with academic underachievement to have a detailed assessment of their accommodative functions. This is discussed in detail in the second and fifth part of this series.

### Other visual factors and reading difficulties

The three most common optometric correlates of reading difficulties have been mentioned above. Other optometric anomalies, such as refractive errors ocular convergence insufficiency, are not especially likely to be present in people with reading problems, but can of course be present in any individual. This is another reason why people with reading difficulties should have a full eye examination. The overall protocol for the optometric management of people with reading difficulties is discussed in the final (fifth) part of this series.

Another visual correlate of dyslexia should be mentioned at this stage, because it is often raised in the scientific literature. Many studies have found that a subtle deficit of visual processing is often associated with dyslexia; a deficit of the magnocellular system. Such a deficit may or may not be of clinical significance, but a brief overview will be given in the second article of this series. The second article will also summarise the controversial use of vision therapy to 'train' saccadic or pursuit eye movements as a putative treatment for reading difficulties.



Symptom or history	Rationale
Is the SpLD mainly with reading, spelling, writing, or mathematics?	If a visual problem is present, then one would expect reading to be a problem. Sometimes reading may be adequate, but nonetheless capable of improvement.
History of spectacle wear	Evans et al. <sup>25</sup> found that children with SpLD were more likely to have been prescribed spectacles, but were often not using them. This may indicate zealotry for practitioners to try borderline refractive errors.
History of eye exercises or patching	Some children may have received eye exercises for binocular vision anomalies, or vision therapy by a behavioural optometrist. Patching might indicate amblyopia.
History of use of coloured filters	Sometimes the required treatment colour changes. Discontinued use of coloured filters in the past does not necessarily mean that filters are no longer required
History of epilepsy, 'fits, faints or funny turns'	Some people with photosensitive epilepsy can be helped by using coloured filters. <sup>13</sup>
Headaches: frequency, type, severity, location, associated factors, triggers	Headaches when reading or from lights or patterns can be a sign of visual stress, particularly if the headaches have the characteristics of migraine. Headaches can also be triggered by binocular vision anomalies or uncorrected refractive errors.
Is reading usually clear: does it ever go blurred?	Blurring can be a sign of refractive, accommodative, or orthoptic anomalies. It can also be a sign of visual stress. For some children, text is initially clear and then blurs; so the questioning needs to ask specifically whether text ever blurs.
Do letters or words stay still or do they move?	Moving text is a common symptom of visual stress, but can also be a sign of binocular instability. Again, the movement may only happen after reading for a while, so the question should reflect this.
Do letters or words change size or fade or disappear?	These symptoms can indicate anomalies of binocular co-ordination or accommodation (possibly in latent hypermetropia), or alternatively visual stress.
Do you have trouble changing your focus from seeing the board to a book?	This could be a sign of accommodative dysfunction or binocular inco-ordination. Alternatively, there may be no visual cause since people with dyslexia often have poor short-term memory and copying from the board requires the person to hold information in short-term memory.
Do you ever experience double vision?	A classic sign of a binocular vision anomaly, but can also be a sign of visual stress. Diplopia can be demonstrated (e.g., with a vertical prism) so that the child knows what is meant.
Do you ever experience sore or tired eyes (e.g., when reading)?	May be a sign of refractive, binocular, accommodative and anterior segment anomalies, visual stress, or just normal tiredness. If associated specifically with reading (e.g., 'Reading hurts my eyes and I have to stop') rather than, for example drawing, then may be suggestive of visual stress.
Do you hold reading material unusually close or far away?	May be a sign of refractive, binocular, or accommodative anomalies, visual stress, or just a habit.
Do you ever close or cover one eye?	This symptom is strongly suggestive of a binocular anomaly. Occasionally, can be a sign of visual stress.
Do you tend to skip or omit words or lines?	Can be a sign of visual stress, a binocular anomaly, or just late reading development. Much more rarely, it might be a sign of an eye movement anomaly.
Does the page seem too bright?	Can be a sign of visual stress (e.g., 'the page is so bright that it stops me seeing the words properly').
Are you particularly sensitive to light?	Can be a sign of visual stress or a binocular vision anomaly. Photophobia and frequent headaches seems to be a strong indicator that precision tinted lenses may help. <sup>13</sup>
Family history of learning problems	SpLD tends to run in families.
Family history of orthoptic problems	Orthoptic problems tend to run in families.
Family history of migraine	Migraine headaches tend to run in families and can sometimes be helped with precision tinted lenses.

**➔ Table 1**

Examples of some symptoms than can be useful in assessing people with SpLD. N.B., this list is not exhaustive



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## Symptoms to look for

There are a large number of symptoms that can lead a practitioner to suspect that their patient may be susceptible to one of the three main correlates of SpLD outlined above. Some of the most common symptoms include those listed in Table 1. It should be stressed that this list is not an exhaustive list; even practitioners who have been examining children with SpLD for many years can be surprised to hear a patient provide a new description of a symptom, which can be imaginative, instructive, and revealing.

It would be helpful if practitioners could predict what type of visual problem a person has from their symptoms. Unfortunately, most of the symptoms that are likely to occur in people with SpLD can have several causes. Nonetheless, some symptoms do suggest the possibility of the conditions indicated in Table 1.

It is not uncommon for a child to fail to describe any symptoms for a visual condition that would, in an adult, cause acute complaints such as blurring, eyestrain, or headaches. Yet, once the condition has been corrected the child

may then describe the initial symptom that has now been alleviated. This needs to be stressed to teachers - it is not safe for them to conclude that if a child does not report visual symptoms then they do not need an eye examination. The term visual perceptual distortion is sometimes used to generically describe several symptoms that can occur when viewing a page of text or writing on a white board (e.g., blurring, doubling, movement, patterns, fading, colours).

Even when children do report visual symptoms, their reports are often difficult to interpret. Whilst many adults can clearly differentiate between blurring, doubling, and words moving, many children cannot. Even if they can, these symptoms are non-specific. In other words, different visual problems can cause similar symptoms. For example, the symptom of words moving on the page is suggestive of visual stress, but could also be caused by binocular instability. Conversely, the symptom of diplopia is suggestive of binocular vision anomalies, but could also be caused by visual stress.

Many of the visual symptoms in

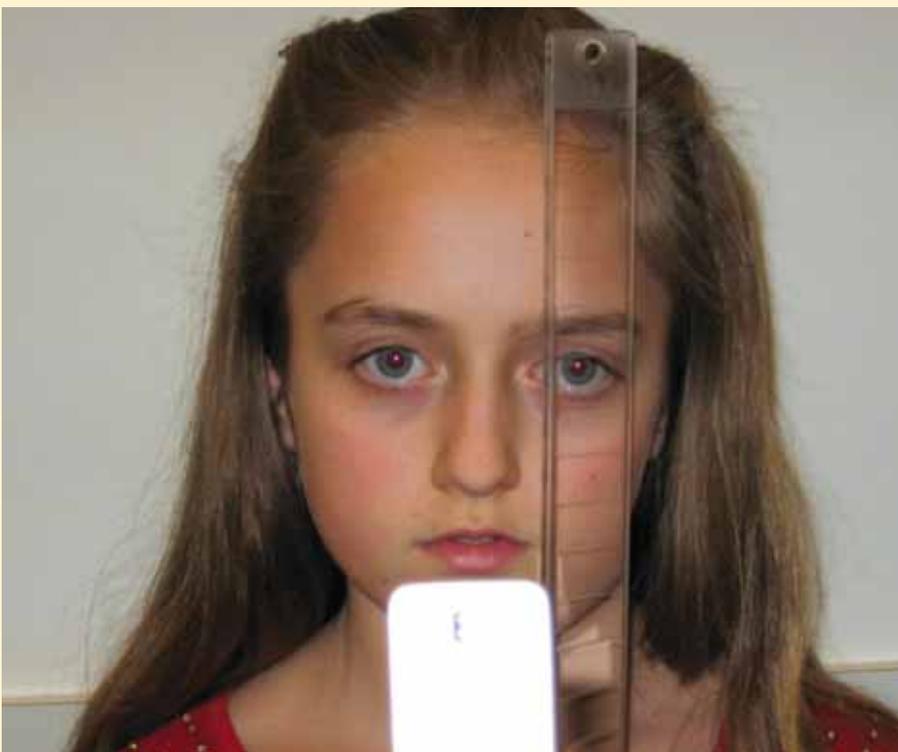
Table 1 do not occur immediately, but rather after the child has been reading for a while and the questioning of the patient needs to detect this. For example, many of those children who would say "no" to the question "Are words in a book normally blurred?" are likely to say "yes" to the question "Do words in a book ever go blurred?"

Although the absence of symptoms does not necessarily imply that a child does not require optometric attention, the presence of visual symptoms certainly does indicate the need for an eye examination. It is important for the practitioner to fully investigate potential causes of symptoms. Nonetheless, the presence of symptoms does not necessarily mean that a visual problem is present. Just asking about a symptom will be enough to convince some children that they suffer the symptom, even when they don't!

It is recommended in these articles that optometrists specialising in this field should carry out a detailed investigation of visual function in people with SpLD. It is useful to send out a questionnaire in advance of these appointments and this might include, as a starting point, the questions listed in Table 1. An example of such a questionnaire is available at [www.cmt-optometrists.co.uk/spldq.doc](http://www.cmt-optometrists.co.uk/spldq.doc) and practitioners are welcome to download this and modify it for their own use (this questionnaire is based on an early prototype used in research by the second and third author many years ago, and has been updated several times by the second author, benefiting from the input of many colleagues).

## The evidence-based approach

It is extremely important when investigating healthcare related issues to ensure that any information you have gathered is founded on good science. With the advent of the internet there are numerous 'miracle cures' for a very wide range of conditions. An internet search for the keywords 'reading difficulties', 'vision', and 'treatment' provides over 300,000 different websites, many of which advocate a variety of visual treatments for reading



➔ **Figure 3**

Fusional reserves used to diagnose binocular instability



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problems. Some of these treatments will be valid but inevitably some will be a complete waste of time and money. It is important for us as professional eye-care practitioners to be able to provide impartial and objective advice on such products/treatments and to help our patients make an informed judgment whether to proceed with them. In order to overcome this problem, healthcare professions have adopted the principal of evidence-based healthcare.

Evidence-based healthcare is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based healthcare requires the integration of individual clinical expertise with the best available external clinical evidence from systematic research. Individual clinical expertise is the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice.<sup>26</sup> External clinical evidence is gathered from peer-reviewed inter-disciplinary journals (like those detailed in *Optometric Quarterly Reviews*). The peer review process involves the journal editor sending manuscripts out to two or more experts who critically review the work to ensure it conforms to adequate standards. The reviewers almost invariably require improvements before the work is published. It is especially important for work on reading difficulties and vision to be published in inter-disciplinary journals, because this is an inter-disciplinary field and there is a need to ensure that the paper is not just selected by a 'clique' of believers in a particular theory. Indeed, many academic journals publish a list of experts who have acted as referees for the journal and the multi-disciplinary background is self-evident.

It is worth being cautious about the results from research that has not been published following a peer-review process. If the reader is knowledgeable about research methodology then they may themselves be able to review an unpublished manuscript describing a research study. But most readers do not

have this expertise and will need the reassurance that an article has been through the peer-review process.

External research evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision.<sup>26</sup> Equally, the reliance on clinical experience in the face of conflicting research evidence runs counter to the principles of evidence-based practice.

All professions wish to develop, but the appropriate development requires that both new and existing techniques and protocols are properly validated. Without such validation, practice may be to the detriment of patients. The evidence-based approach will ensure that our patients receive the best clinical care possible.

The authors have applied an evidence-based approach throughout this series of articles, concentrating on studies that have been published in peer-reviewed journals and that use a control group matched to the reading disabled group in terms of age, reading age and preferably IQ. Using these criteria, the literature reveals visual stress, binocular instability, and possibly accommodative insufficiency to be visual correlates of reading difficulties. These conditions are briefly summarised above and are described in more detail in the rest of the series.

A correlate is very different from a cause. In North American cities, there is said to be a correlation between the number of storks, and the number of births. Sadly, this does not necessarily mean that storks deliver babies! It is relatively easy for researchers to show that optometric factors are correlated with reading difficulties, but this does not mean that they are causes.<sup>25</sup> Similarly, if an optometrist treats a visual anomaly in a person with reading difficulties, they should never claim that it will definitely cure the reading difficulty. If a visual problem is a likely cause of a patient's symptoms however, then it is reasonable to conclude that treatment will help these

symptoms.

When discussing visual interventions (corrections, treatments, or therapies) there is really only one research design that is universally accepted as providing the best evidence - the double-masked randomised controlled trial. In this research design the putative treatment is compared with a control treatment and neither the patient, parent, teacher, or researcher is aware of which intervention is 'real' and which is the control. It is important that the control treatment mimics the experimental treatment in terms of the time, attention, and in other relevant factors that could influence the patient or others. For example, when researching vision therapy it would not be adequate for a control group to have a less intensive or less 'hi-tech' treatment than the experimental group.

Although the series of articles will concentrate on evidence-based approaches, some other techniques and interventions will be briefly mentioned if the community optometrist is likely to encounter them or be asked about them by parents or patients. The lack of evidence or limitations of these approaches will be noted though.

### **About the authors**

Peter Allen is a Principal Lecturer and Director of Clinics at Anglia Ruskin University, and an examiner for the College of Optometrists. His research in recent years has focussed on visual stress, reading, and accommodative facility.

Bruce Evans is Director of Research at the Institute of Optometry and Visiting Professor to City University. He works in independent optometric practice in Essex. Bruce first started researching visual factors in dyslexia in 1988.

Arnold Wilkins is Professor of Psychology at the University of Essex and Director of the Visual Perception Unit. His career has been spent mainly in research at the Medical Research Council Applied Psychology Unit in Cambridge, in the area of photosensitive epilepsy, a study that later generalised to an investigation of visual stress.

### **References**

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## Module questions

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- 1) Which of the following is MOST accurate about Specific Learning Difficulties?
  - a. They only occur in intelligent people
  - b. They only occur in people of below average intelligence
  - c. They result in children performing well in school
  - d. They persist throughout life
- 2) Which of the following is NOT a type of Specific Learning Difficulty?
  - a. Dyslexia
  - b. Dysarthria
  - c. Dysgraphia
  - d. Dyscalculia
- 3) Which of the following is TRUE about Specific Learning Difficulties?
  - a. Dysgraphia can manifest itself as difficulty with spelling
  - b. A lack of numerical skill is often called dyscalculia
  - c. Dyspraxia is related to developmental coordination disorder and clumsy child syndrome
  - d. All of the above
- 4) Which of the following is MOST accurate about Attention Deficit Disorder?
  - a. It is often associated with hyperactivity
  - b. It is attributable to poor parental discipline
  - c. It is invariably associated with dyslexia
  - d. It is unlikely to influence the results of optometric tests
- 5) Which of the following is FALSE about dyslexia?
  - a. Dyslexia affects 5% to 10% of the school age population
  - b. A core feature in most cases of dyslexia is a deficit in phonological abilities
  - c. Visual problems are irrelevant in dyslexia
  - d. People with dyslexia have little problem understanding the spoken word
- 6) Which of the following is FALSE regarding visual stress? Visual stress:
  - a. Is the ability to see comfortably without distortion and discomfort
  - b. Is not associated with any other conditions
  - c. Has previously been named photopic sensitivity syndrome
  - d. All of the above
- 7) Which of the following is FALSE about visual stress?
  - a. It may be due to hypo-excitability of the visual cortex
  - b. Reading material has the potential to elicit visual stress
  - c. It is more prevalent in children with dyslexia
  - d. It is prevalent in those with dyslexia, migraine and photosensitive epilepsy.
- 8) Which of the following is TRUE about binocular instability?
  - a. A stable heterophoria and high fusional reserves are present
  - b. A stable heterophoria and low fusional reserves are present
  - c. An unstable heterophoria and high fusional reserves are present
  - d. An unstable heterophoria and low fusional reserves are present
- 9) Which of the following is TRUE about the symptoms of Specific Learning Difficulties (SpLD)?
  - a. Visual factors that contribute to SpLD will always cause symptoms
  - b. All children with SpLD will report visual symptoms
  - c. Children don't always report symptoms because they assume they are 'normal'
  - d. Symptoms are reliable for diagnosing visual factors affecting SpLD
- 10) Which of the following symptoms is NOT likely in binocular instability?
  - a. Double vision
  - b. Eyestrain and headaches on waking
  - c. Eyestrain and headaches after reading
  - d. Blurred vision
- 11) Which of the following BEST describes 'evidence-based healthcare'?
  - a. Always using latest techniques in place of conventional approaches
  - b. Trying new approaches on a few patients and adopting them if they work
  - c. Relying on evidence from rigorous systematic research only
  - d. Integrating clinical expertise with evidence from rigorous systematic research
- 12) Which of the following is the BEST research design for validating treatments?
  - a. Matched control group study
  - b. Double-placebo controlled matched trial
  - c. Double-masked randomised controlled trial
  - d. Open trial

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