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Coloured Filters - Do They Work?

Arnold J Wilkins, Bruce JW Evans, Peter M Allen

This is the third article in a series of five on Vision and Reading Difficulties. The first article provided a general overview of learning disabilities and specific learning difficulties (SpLD). It outlined the role of the optometrist in helping people with SpLD. The second article covered conventional optometric correlates of reading difficulties (e.g. binocular vision problems). This article and the next will describe the use of coloured filters to treat a condition now known as "visual stress", which is often associated with reading difficulties; the symptoms of visual stress were described in Part 1. The terminology for this condition has changed over the years (e.g. Scotopic Sensitivity syndrome, Meares-Irlen syndrome). Terminology is discussed more in Part 4.

Discovery of the benefit of colour for reading difficulties

Coloured lenses have been used "to ease eyestrain from heavy reading" for more than 200 years (see Figure 1[1] for an example from the British Optical Association Museum). Nevertheless, the first scientific report of the use of colour to assist reading is probably that of MacDonald Critchley in 1964.[2] He described a case of a child with dyslexia, who was unable to read words on white card but could read words printed on coloured card. This isolated report was regarded as a rarity until 1980, when Olive Meares, a school teacher from New Zealand, published a paper in the journal *Visible Language*.[3] This paper described her pupils' reports of visual perceptual difficulties, and how these difficulties could be reduced by covering the page with sheets of plastic such as x-ray film, or Perspex. Three years later, Helen Irlen, a psychologist from California, read a paper to the American Psychological Association[4] describing how her students reported fewer visual distortions when aided by *coloured filters. In her book Reading by the Colours*[5] she reports 37 individuals with visual perception problems; 31 were helped by a coloured sheet. For each individual helped, certain colours could make things better but other colours could make things worse. However, for each person helped, there was one colour that worked best.

Dr Irlen went on to investigate whether the benefit of coloured sheets could be replicated by the use of coloured lenses. The advent of plastic lenses had made it possible to create coloured lenses cheaply and easily. Previously it had been necessary to create a batch of glass tinted to a particular colour, an expensive process that was justifiable only if a large number of lenses were to be made in that particular colour. With resin lenses it was possible to colour a spectacle lens simply by dipping it into hot dye for a few minutes. Dr Irlen made a set of trial lenses that could be combined to provide a greater range of colours, and discovered that she could often obtain a tint that was beneficial for patients. She set up Irlen Institutes in which she licensed the treatment with coloured filters that she devised. Irlen claimed, controversially, that the coloured filters needed to be prescribed using her methods. Despite the anecdotal evidence of their success, her commercial activities aroused scepticism and ultimately the

Figure 1
Early tinted lenses dating from the beginning of the 19th Century. Courtesy of the British Optical Association Museum and the College of Optometrists (photograph kindly provided by Neil Handley, Curator)

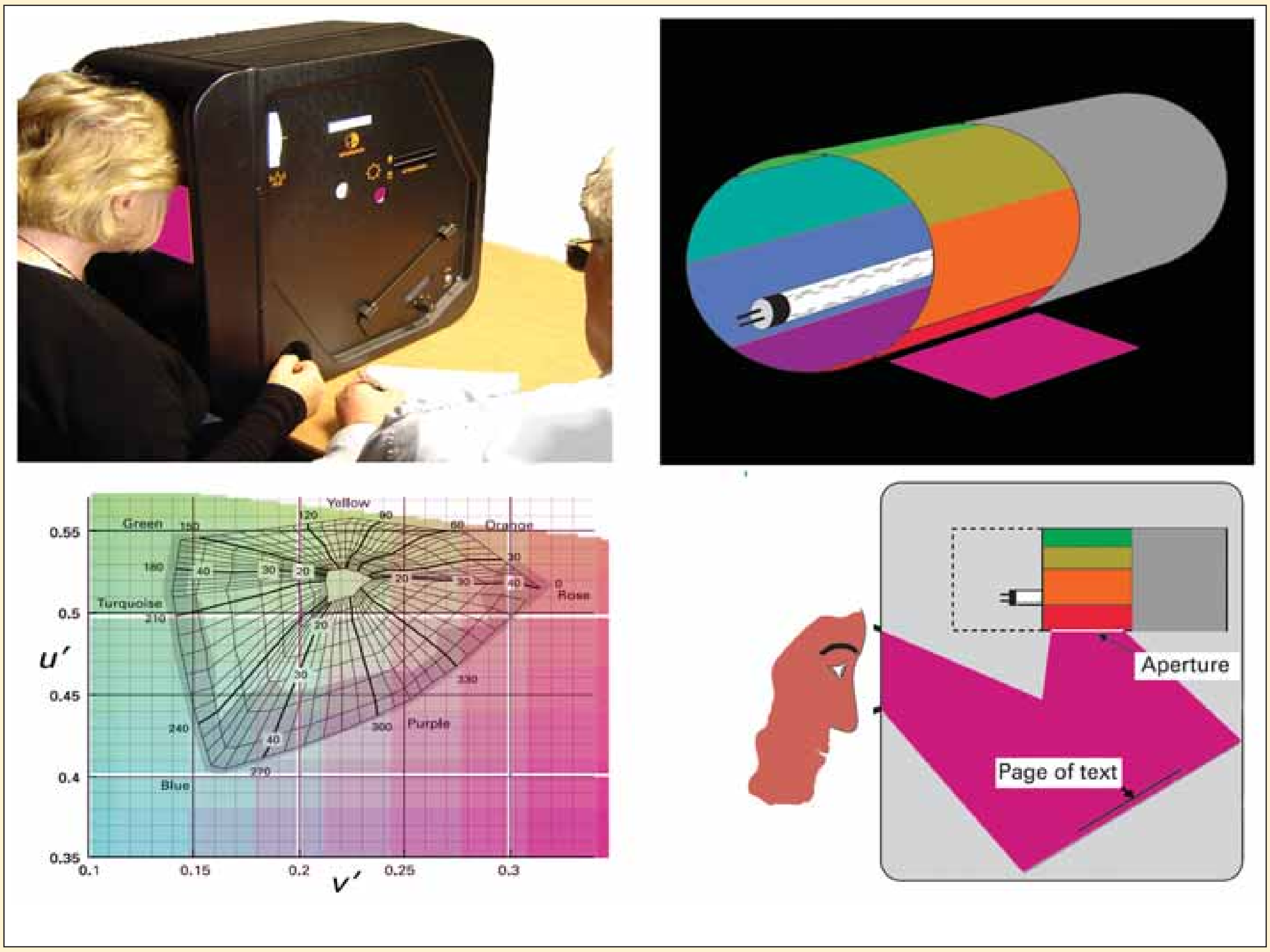

Figure 2

The Intuitive Colorimeter Mark 2. The upper left panel shows the Colorimeter in use, and the panel below, the chromaticities available in the instrument. The concentric contours are the loci of chromaticities obtained by rotating the hue control, and the radial lines the loci obtained by changing the saturation control. The upper right panel shows the light source and filter arrangement. The filters can rotate about the axle of the cylinder changing hue and the cylinder can slide along its axle, changing saturation. The light enters the viewing chamber (lower right) through a square aperture.Filters over this aperture alter brightness in discrete steps

opposition of established practitioners of ophthalmic care. Without her initiative and drive however, the discovery would have been submerged in a swamp of scepticism and might have sunk without trace. That being said, in order for a new treatment to make progress there needs to be scientific evidence that the treatment works and ideally some idea as to why.

The Intuitive Colorimeter system

In his book *Visual Stress*[6] Wilkins described an exploration of the physiological mechanisms whereby visual stimuli can provoke seizures in patients with photosensitive epilepsy. Using the electroencephalograph (EEG) he showed that photosensitive patients were often sensitive not only to flickering light but also to geometric visual patterns with very specific characteristics. The patterns evoked curious visual phenomena in normal observers, illusions of colour, shape, and motion, to which individuals with migraine were unusually sensitive. He discovered links between the illusions people reported and the headaches they had. For example, people who reported frequent headaches tended to report more illusions; the illusions were more pronounced in the 24 hours before the start of a headache and if the pain was on one side of the head the illusions tended to occur on one side of the pattern when you looked at its centre.

Further experimentation revealed that if the characteristics of the patterns were changed, so too was the likelihood of illusions. It changed in almost exactly the same way as the likelihood of seizures in photosensitive patients! Particular patterns of stripes were the worst, the sort that the op-artists such as Bridget Riley employ to produce exciting visual effects. The illusions people reported in text were in fact remarkably similar to those reported in striped lines. When the "stripes" produced by lines of text above and below those being read were covered by a mask (typoscope), the clarity of text improved, particularly for people who were susceptible to illusions in patterns of stripes.

There were early reports of coloured glasses, usually blue, being effective in reducing photosensitive seizures, so when Irlen's discoveries were publicised in the British press, Wilkins thought there might be a connection. He constructed an instrument that illuminated text with coloured light so as to study the patients who reported benefit from the Irlen filters. At first, he mixed the light from three lamps (red, green, and blue) but patients found difficulty adjusting the mixture to produce the colour that they found to be most helpful. He invented an alternative instrument that permitted the separate manipulation of the intuitive dimensions of colour: hue, saturation and brightness. The instrument subsequently became known as the Intuitive Colorimeter (see Figure 2).

The Intuitive Colorimeter has several advantages for assessing the subjective effects of coloured light: (1) hue, saturation, and brightness (more strictly it is luminance, not brightness) can be varied separately and in an obvious way (2) the variation is continuous rather than discrete (3) the perceptual effects of colour can be studied while the patient's eyes are colour-adapted (4) the assessment is quick and efficient, and (5) all surfaces are white and illuminated with coloured light; there are no coloured surfaces that might affect the judgment.

In the Mark 2 Intuitive Colorimeter, a beam of white light from a set of fluorescent lamps (CIE Type F3) passes through a cylindrical filter assembly (shown in three-quarter view in Figure 2 upper right, and as a diagram in cross section in Figure 2 lower right). The filtered light passes via a square aperture into a viewing chamber with matt white inner surfaces where it is mixed by multiple reflection. The filter assembly is divided into seven sectors with different colour filters. Patients' eyes are close to the viewing aperture so that their entire visual field is coloured with light from the chamber. They look at a page of text mounted on an inner surface. When the filter cylinder is in its start position (shown by the dotted lines in Figure 2 lower right) the light passes through the neutral filter and is white. When the filter cylinder is slid along its axle (without rotation), the saturation of the colour in the viewing chamber increases, and chromaticity varies along the radial lines in the CIE UCS diagram (Figure 2 lower left). By rotating the filter cylinder, combinations of neighbouring filters result in a continuously variable range of hues (concentric rings in the CIE UCS diagram, Figure 2 lower left). Because the spectral transmissions of the filters resemble those of their neighbours, the spectral properties of the light entering the eyes closely resemble those when the tinted lenses are worn under conventional fluorescent lighting, even though additive colour mixture is used in the colorimeter and subtractive mixture is used for the lenses. The similarity of distribution means that individuals who have a colour deficiency can use the instrument. The recently launched Mark 3 Intuitive Colorimeter uses the same technique of colour mixture, but with a more up-to-date multi-phosphor fluorescent lamp.

The early version of the Intuitive

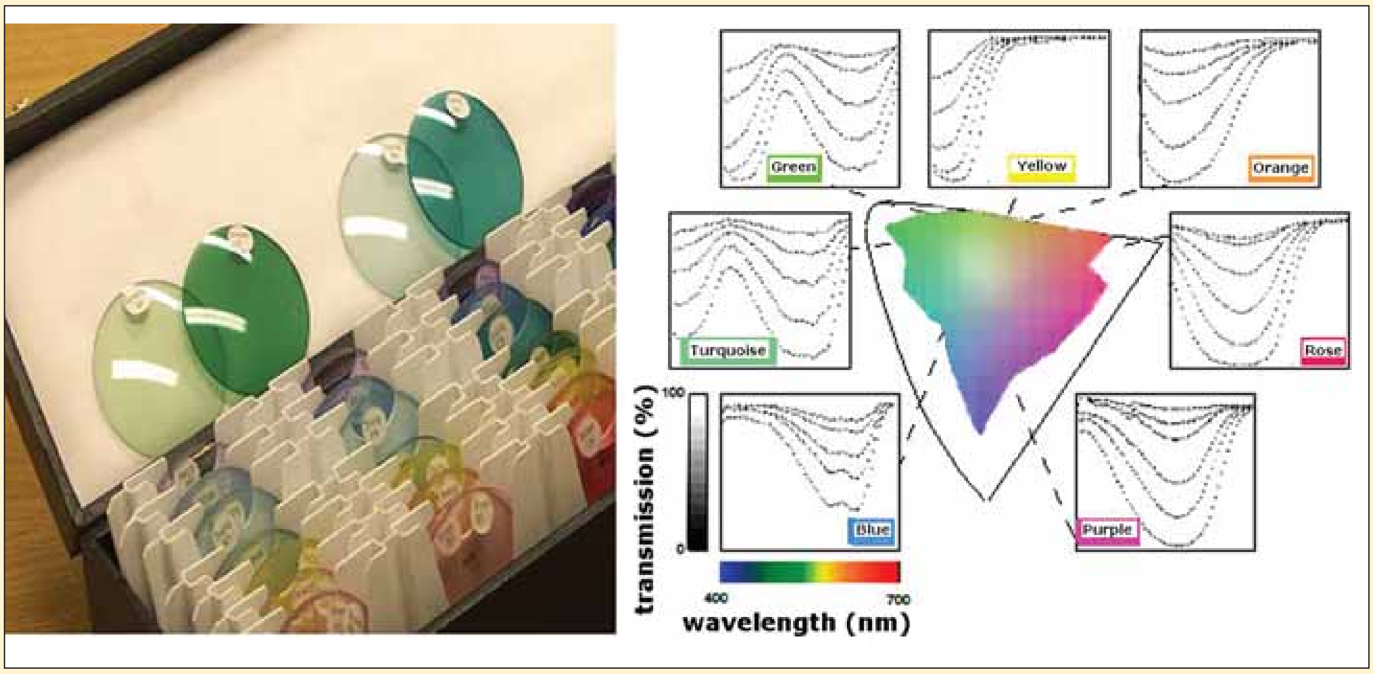

Figure 3

Left: Cerium tinted trial lenses. Right: Graphs of the spectral transmission (periphery) and the gamut of colours (centre) the Cerium lenses provide

Colorimeter (Mark 1) made it obvious just how specific a colour was required in order to best reduce the distortions of text, because it was only with the specific colour selected using the colorimeter that patients reported maximum benefit. If the efficacy of coloured filters was to be examined experimentally, a tinting system that could provide any colour with sufficient precision was required. Such a tinting system was designed with the help of Tim Noakes, a director of Cerium Visual Technologies (Figure 3).

Only two dyes are necessary to obtain any shade (Figure 3). For example, a yellow-green is produced with a combination of yellow and green trial lenses, and a red is produced with a combination of rose and orange lenses. The lenses are arranged in pairs, one for each eye. For each colour five pairs provide a series of increasing saturation. The deposition of dye doubles from one pair to the next in the series. This means that the saturation of colour can be increased in very small increments by an efficient combination of the lenses. The five pairs of lenses provide 2^5 = 32 possible combinations and 32 levels of saturation. The 32 levels of saturation of one dye can be combined with the 32 levels of lenses from dyes of neighbouring colours, giving more than 7,000 possible combinations of trial lenses, all with slightly different shades of colour, providing close approximations to any possible Colorimeter setting, together with many colours that are more saturated than those in the Colorimeter.

The lenses were designed with the following minimal assumptions: (1) it was necessary to approximate any chromaticity to within one just-noticeable difference; (2) because there are many different spectral transmissions that will provide a given chromaticity, dyes were selected from those available so that the transmission was as high as possible and varied with wavelength as smoothly as possible, so as to minimise the different colours that result under different types of artificial lighting.

Precision tinted contact lenses can also be prescribed using the Cerium system, as they can for the Irlen and ChromaGen systems.

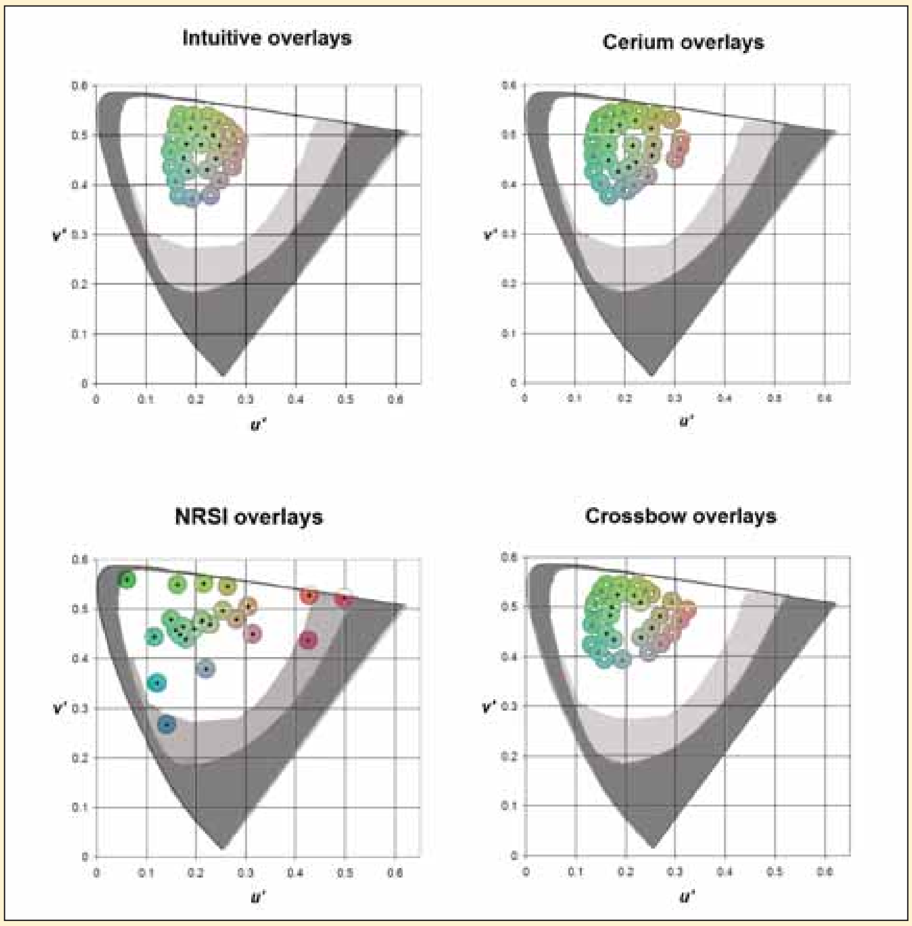

Figure 4

Four commercially available systems of overlays. The position of each point indicates the chromaticity of the overlay in the CIE UCS diagram. The black points represent the single overlays. The white points represent the chromaticities of two identical overlays one upon another, and the grey points represent two superimposed overlays of neighbouring chromaticity. The points are surrounded by circles having the colour of the overlay. Uncoloured areas lying outside the circles represent colours for which there is a colour difference (ΔE*) greater than 25 to the nearest overlay. The light and dark grey shaded areas indicate chromaticities that are available only with filters that provide a reflectance less than 20% and 10% respectively. Note that the chromaticities shown are those under the equal energy illuminant

Evidence for the efficacy of tinted lenses

Evidence for the efficacy of precision tinted trial lenses has accumulated over the 15 years since their launch. It began in a small way with an open trial involving patients who responded to reports in the media.

Open trial

In the open trial, patients selected a chromaticity that reduced perceptual distortion of text viewed in the Intuitive Colorimeter. Coloured lenses that provided the chosen chromaticity under conventional lighting were then offered to patients, and a year later at the end of the trial, more than 80% were still wearing their lenses and reporting benefit.[7] The trial was indicative but not conclusive because of the role that placebo effects can play in studies of this kind. A double-masked trial that controlled for placebo effects was needed, whereby neither patients nor clinicians were aware of whether the patients were wearing a genuine treatment tint or not. Such a trial was difficult to undertake because patients already knew the colour of the lens they had selected as being beneficial.

Double-masked trial

Patients can adapt to the coloured light when viewing text in the Colorimeter, so the lenses appear more strongly coloured than expected; the colour appearance of the most beneficial lenses therefore cannot easily be recognised. This enabled a double-masked study to be conducted, whereby patients were offered two pairs of spectacles, only one of which provided the chosen chromaticity; patients and clinicians were not aware of which pair was which.[8]

The children who took part in the study selected their optimal colour in the Colorimeter. The hue was gradually changed until the child reported the distortions starting to reappear, and this setting provided a suboptimal placebo control. Spectacle lenses were made to match each setting, and one pair, active or control, selected at random by an independent collaborator, was glazed into frames and sent to the child. Of course, we could not be sure the control lenses were actually inert, but it was fairly certain that the active lenses should be more effective than the control. The children and their parents were asked to keep diaries in which they noted any symptoms of headache.

At the end of the investigation, the diaries revealed statistically significantly fewer symptoms in children that had been prescribed the active tint. Because the active and placebo tints were closely similar in colour (they differed by six just-noticeable-differences) the trial demonstrated not only that the active tint was more beneficial than the control, but also that the tint needed to be selected with precision for optimal effect.

Australian study

Another randomised placebo-controlled trial was conducted by Robinson and Foreman using Irlen lenses.[9,10] Patients were able to see their lenses at the time of selection, so the trial was not strictly double-masked. Nevertheless, using conventional measures of reading ability, the study found similar results; coloured filters help people with visual stress and need to be individually and precisely prescribed. The study also compared the individual filters to a pair of blue lenses. The blue lenses were found to be less effective than the individually prescribed pair.

ChromaGen study

Harris used tinted contact lenses for people with colour vision defects, arguing that when worn monocularly these improved colour perception (perhaps by providing rivalrous cues). He then extended this approach to individuals with dyslexia, initially monocularly and then binocularly. Using clear contact lenses (with only a handling tint) as a control he showed that tinted contact lenses improved reading speed on the Rate of Reading test to a greater extent than the control.[11] Although the study claimed to be a double-masked placebo-controlled trial, it is not certain whether the trial was masked because patients may well have been able to appreciate the difference between a clear lens and one that was tinted.

Systems of overlays

Irlen had used sheets of coloured plastic placed over the text (overlays) and this was found to be a simple and quick method of screening for the possible use of colour to treat visual stress. The early findings with the Intuitive Colorimeter, however, suggested that each patient required their own individual colour. If patients were to obtain a chromaticity close to their individual requirement it was therefore necessary to create a set of overlays that sampled chromaticities both systematically and as comprehensively as possible. An examination of the Irlen overlays showed that they did not sample chromaticity systematically.[12] An alternative set of overlays, the Intuitive Overlays, was therefore designed. The logic underlying the design was simply to offer a sufficient choice of different colours within the constraints imposed by the use of filters (strong colours, those with high saturation, are not possible with overlays unless they are very dark).

Figure 4 shows the chromaticities of the overlays of four systems on the market in May 2008. (The Irlen overlays are not included because in the UK they are available only to Irlen licencees). In chronological order of their introduction these are: (1) the Intuitive Overlays (ioo Sales Ltd, London, UK) 10 coloured overlays, including grey; (2) the Cerium Overlays (Cerium Visual Technologies Ltd, Tenterden, UK) 12 coloured overlays including grey; (3) Overlays from the National Reading Styles Institute (Syosset, NY, USA) 24 coloured overlays including two shades of grey; (4) Crossbow Overlays and Reading Rulers (Crossbow Education Ltd., Stafford, UK): each now with 10 coloured overlays, excluding grey.

The number of colours available with each system depends on how the overlays are used. They can be used singly, or in combinations, one overlay on top of another, to increase the number of available shades. The overlay systems differ as regards the recommended test procedure. The Intuitive Overlays, Cerium Overlays and Crossbow Overlays provide instructions as to permissible combinations of overlays, so as to avoid unnecessary testing of pairs that provide the same or similar colour. Only pair-wise combinations of overlays having the same or neighbouring chromaticity are combined to provide stronger colours where needed. As can be seen, the overlays provide most chromaticities possible with filters that are not dark. The National Reading Styles Overlays are not designed to be used in combination; the instructions simply specify the testing of each in turn. Note that despite the large number of overlays available, the possible chromaticities are limited, and there are large areas of colour that are not available, represented by the white areas of the CIE diagram.

Do overlays help?

The development of the Intuitive Overlays enabled patients to obtain a chromaticity close to that which is optimal for text clarity. It eventually became clear that an appropriately chosen colour could not only improve perceptual clarity and reduce perceptual distortions, but also could reduce visual fatigue and increase the speed of reading and of visual search.

A study of unselected children in mainstream education found that when offered a choice of overlays, 20% routinely used an overlay of their chosen colour for reading. They did so without prompting for months on end, claiming improved clarity and reduced perceptual distortion.[13] One method of determining whether a patient will benefit from overlays is therefore simply to provide the overlay, and see whether it is used.

At first it proved difficult to measure the benefit the patients claimed, because although the overlays seemed to prevent fatigue, a benefit in reading speed could be obtained only after 10 minutes of reading conventional prose, when the patient started to tire.[14] A simple brief clinical assessment of any benefit from an overlay was needed.

In 1996 Wilkins developed the Rate of Reading Test.[15] This simple test differed from conventional reading tests in several important respects. The patient was asked to read a paragraph consisting of randomly ordered common words. Each line had the same 15 high frequency words in a different order. Children who were poor at reading could succeed at the task because the words were simple. Children would often make errors of transposition of words or omission of a line, but they were usually unaware of their errors because the text was meaningless, so a sense of failure was avoided. The words could not be guessed from context (they had to be seen to be read), and so visual errors were easy to measure. The text was printed in a small font and the resultant fatigue meant that it was possible to show an increase in reading speed with overlays within two minutes. It was simply necessary to ask a patient to read aloud for one minute with the overlay and then for a further minute without the overlay, and compare the speed.

Many studies have been conducted with overlays in schools using the Rate of Reading test.[13 16 17] It was possible to show that 5% of children in mainstream schools read at least 25% more quickly with an overlay of their chosen colour. Overlays chosen at random and grey overlays had little effect, as did placebos such as clear overlays, UV-blocking overlays (described as 'Research Model')[18] or grey overlays (described as "new, from the United States and combining all the colours"). The further the colour from the optimal one, the slower the reading speed.[13]

Children who were consistent in their choice of overlay colour on re-test were more likely to show faster reading with the overlay.[13] A beneficial effect of overlays was later found in adult students.[19]

In the above studies the optimal overlays were selected by placing each overlay in turn over of a passage of text beside another placed over a similar passage. The patient chose the clearest and most comfortable. If, instead, the text was replaced by plain paper and patients were asked to use a similar technique to choose their favourite overlay, the favourite colour had little effect on reading speed.[20]

The improvement in perceptual efficiency using coloured filters has now been demonstrated using visual search tests[21, 22] including the Developmental Eye Movement test,[23, 24] and the circles search test[25] as well as in conventional reading performance[14] and in the speed of sentence comprehension.[16]

How big should the overlay be?

Waldie and Wilkins[26] compared the increase in reading speed using three types of overlay. All types were of the same chosen colour, but one was of a size just sufficient to cover the text being read, but not the white margins that surrounded it, one covered the entire page including the text margins, and one covered the text whilst the surround was covered by an overlay of complementary colour. All three conditions were associated with an equivalent increase in reading speed, suggesting that the overlay needs only to be of a size sufficient to cover the text being read. Overlays smaller than

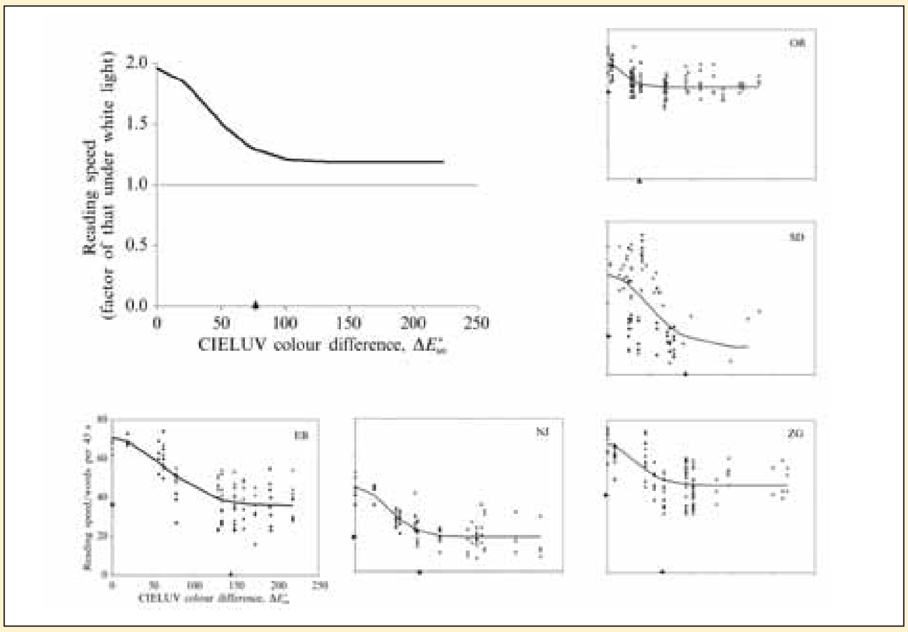

Figure 5
The small panels show for five patients the reading speed under light of various chromaticities plotted as a function of the difference in colour between the chromaticity used for reading and that selected as optimal for visual clarity. The large panel shows the data averaged for the group

this are available as "reading rulers" from Crossbow Education. Originally these overlays were available in only five colours, although the number has now increased to ten.

How many overlay colours are necessary?

The five Crossbow reading rulers were shown to have no effect in increasing reading speed by Smith and Wilkins.[27] Intuitive overlays cut to similar size and used as reading rulers did increase reading speed, however. The difference between the overlays was attributed to the limited range of colours available with the original five Crossbow reading rulers, an inference supported by further recent work.

Should overlay and spectacle lens colour be the same?

When spectacle lenses are worn, the entire visual field is coloured. The eyes adapt to the colour in a manner similar, but not identical, to the adaptation that occurs when the light source is itself coloured. The conditions of adaptation are different in the case of an overlay, which provides one surface colour among many when illuminated with white light. The difference in the conditions of adaptation may be one possible reason why the association between the overlay colour and lens colour is weak; so weak that the colour of the optimal overlay cannot be used to predict the colour of the optimal lens. Lightstone et al.[28] asked patients to read with the optimal overlay, with lenses that matched the overlay in colour and with lenses that matched the colour chosen in the colorimeter. The lenses that matched the overlay in colour did not increase reading speed, whereas the optimally coloured overlay and lenses that matched the colorimeter setting both did, despite their different colours.

Is there one colour for life?

Clinical experience would suggest that sometimes patients wear their tints for a period and then cease to wear them because the symptoms remit. More frequently, however, symptoms return after a period of about a year even with continued use of the spectacles, and a revised tint is usually successful in giving a further period of remission. The necessary change in tint can be substantial, but more frequently it is relatively slight. A change in tint is more common in the young; adults usually continue to find their tint useful for many years, sometimes decades. In two open trials, 80% of patients were still wearing their tints when followed up one year after first provision.[7, 29] It is possible that the benefit from filters effects a relatively permanent improvement in symptoms. Newman Wright et al.,[25] in a study of patients with multiple sclerosis, divided patients into two groups at random, giving one group overlays of the selected colours, and the other group grey overlays. After two weeks' experience of overlay use, the group that had received coloured overlays had improved their reading speed not only with the overlay but also without. No such improvement was seen in the group that received grey overlays. This group was then given their coloured overlay, and after experience of its use, they too showed an improvement in reading speed, both with and without the overlay.

Does the tint need to be precise?

The Rate of Reading test[15] was used to examine the precision of colour necessary to improve reading speed. Five patients who routinely wore coloured lenses were asked to read in the Intuitive Colorimeter (without their lenses).[30] The colour of light illuminating the text was selected at random from one trial to the next and a large number of trials conducted in two sessions per patient at least two weeks apart. The sessions showed closely comparable results. Patients read most quickly under the colour they chose as clearest and most comfortable. As the colour of the light departed from this optimal chromaticity, the reading speed declined. It declined in a similar way for all patients (Figure 5). The greater the colour difference (CIE delta E*) between the optimal colour and the colour under which the patient read, the slower the reading rate, no matter whether the change in colour was one of saturation or hue. When the colour difference exceeded about 80, the reading speed was similar to that under white light.

Although it may be difficult to explain these findings theoretically, they are of practical significance for at least two reasons. First, they help to explain why patients can choose a specific colour for their lenses under one lighting condition, and the lenses are nevertheless useful under different lighting. If the optimal chromaticity is chosen under white (halophosphate) fluorescent lighting, the reading speed under other lights can be calculated using the average function shown in Figure 5. It turns out that most tints selected under white fluorescent light (CIE type F3, used in the Intuitive Colorimeter), should continue to offer an increased reading speed under incandescent lighting (Illuminant A) and daylight (Illuminant D65). The exceptions are those tints with purple hue, which exaggerate the differences between light sources by selectively transmitting light at each end of the visible spectrum.

The function in Figure 5 also permits an estimate of the number of lenses that are necessary in any tinting system, if that system is to have a given percent efficacy compared to a theoretical system that offers an infinite number of tints and could in principle obtain the optimal chromaticity under any given light. A simplifying assumption is made that each individual requires their own optimal chromaticity and that the optimum may lie anywhere in the gamut of colours available in tinted lenses with a transmission greater than 5%.[31]

Although it may turn out that some chromaticities are not generally necessary, there is little indication of this to date. The gamut of required chromaticities can be obtained with a few imprecise tints (see Figure 6 upper left), or many precise tints (see Figure 6 upper right), and the average reduction in reading speed calculated when the imprecise tint departs from optimum, as it must for some chromaticities. Considerations of this kind lead to the function shown in Figure 6 (bottom), which suggests that for a 95% efficacy a tinting system must have about 6,000 tints, which is the case with the Intuitive Colorimeter. This may seem a large number, but it can be provided by different combinations of relatively few tinted trial lenses. By contrast, the ChromaGen system offers eight whilst there are no available figures for the Irlen system.

Although it is possible to examine patients without the Intuitive Colorimeter, using a wide variety of tinted trial lenses, it is necessary to combine these to provide the requisite variety of tints. Any test procedure based entirely on the comparison of a succession of tinted trial lenses is therefore likely to be lengthy and tiring. Both the randomised controlled trials of precision tinted lenses[8-10] indicate that to treat visual stress, the required colour needs to be precise. From a clinical perspective, this means that coloured lenses for people with visual stress should not be prescribed casually using a small number of tints. If a practitioner were to only prescribe refractive corrections for myopia in integer steps (e.g. -1.00D, -2.00D, or -3.00D only) this would be considered bad practice, and a similar consideration is likely to apply to the use of coloured filters for visual stress.

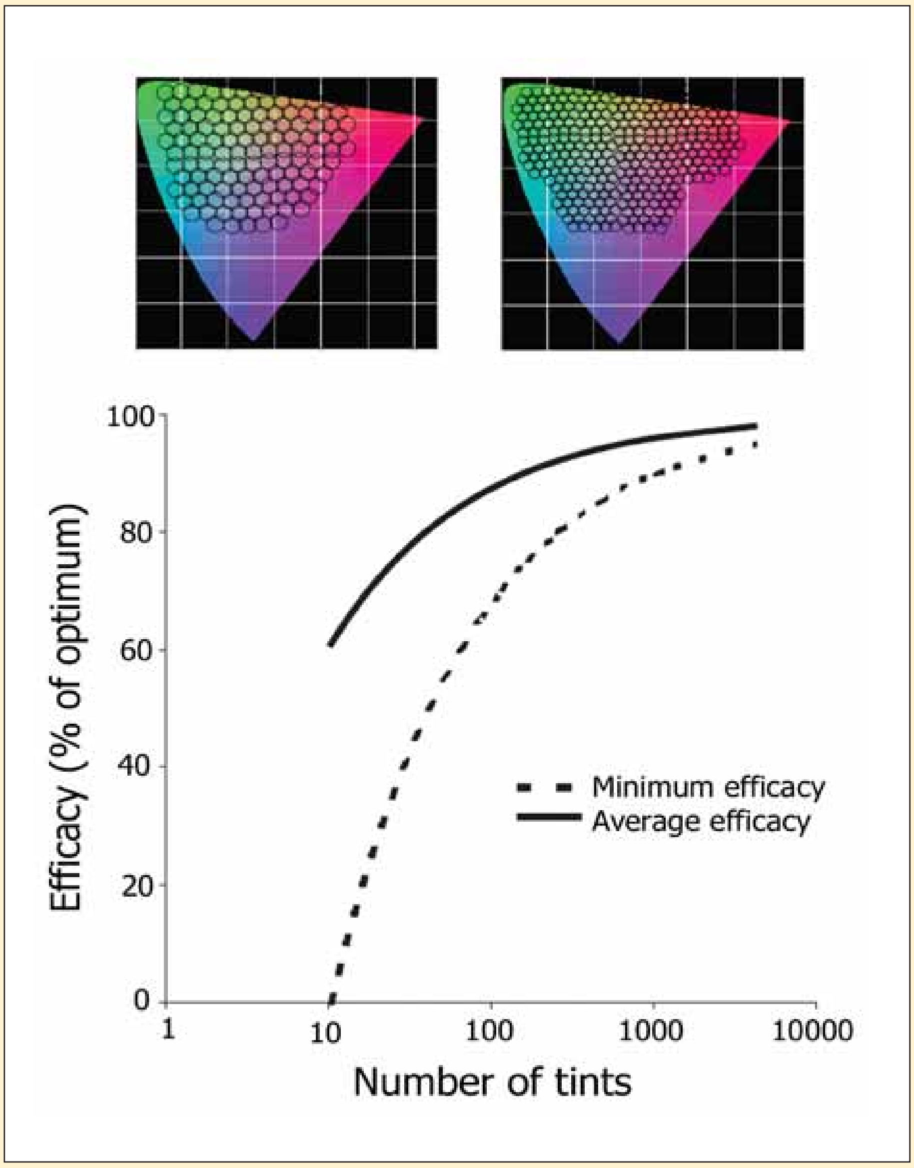

Figure 6
A few tints can sample chromaticity sparsely (upper left panel), but by increasing their number (upper right panel) chromaticity can be sampled with greater precision. Note that the chromaticites are evenly disposed to cover those regions of the chromaticity diagram where the tints offer adequate transmission. The graph shows the efficacy of the tinting system as a function of the number of tints[31]

Conclusion

There is evidence the coloured filters improve reading speed and comprehension, and that these benefits cannot be explained entirely in terms of placebo effects. There is evidence that the colour optimal for therapy is individual and needs to be selected with precision. In the next article the possible physiological mechanisms for these effects will be explored.

About the authors

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 where for many years he studied photosensitive epilepsy, a study that later generalised to an investigation of visual stress.

Mr Evans is Director of Research at the Institute of Optometry and Visiting Professor to City University. He spends most of his working week in an independent optometric practice in Essex. Bruce first started researching visual factors in dyslexia in 1988 and he is author of the book *Dyslexia and Vision.*

Peter Allen is a Principal Lecturer and Director of Clinics at Anglia Ruskin University. Mr Allen is an examiner and assessor for the College of Optometrists. He is an active member of the Myopia and Visual Function research group including research in recent years on visual stress, reading, and accommodative facility.

References

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1) Which of the following statements about the use of tinted lenses is TRUE?
a. The Intuitive Colorimeter was invented in America in 1983
b. The Intuitive Colorimeter was invented in New Zealand in 1980
c. Coloured lenses have been used to ease visual stress for over 200 years
d. Coloured lenses have been used to ease visual stress for 20 years

2) Which of the following statements about the use of tinted lenses is TRUE?
a. The Irlen system is routinely used by eye care practitioners
b. Modern precision tinted lenses are made from glass
c. The Mark 2 Intuitive Colorimeter uses 24 filters
d. The Mark 2 Intuitive Colorimeter uses 7 filters

3) Which of the following is FALSE. The first double-masked randomised-controlled trial of precision tinted lenses:
a. Was conducted in the UK using the Intuitive Colorimeter
b. Used contact lenses and some patients had a different lens for each eye
c. Used diaries that revealed statistically significantly fewer symptoms with the active tint than the control
d. Was a trial in which neither the patients nor researchers knew which tint was supposed to help

4) Which of the following statements about the Australian study is TRUE?
a. It was a randomised placebo-controlled trial
b. The trial was not strictly double-masked
c. Coloured filters were found to help people with visual stress and need to be individually and precisely prescribed
d. All of the above

5) Which of the following statements about Intuitive Overlays is TRUE?
a. They were designed to offer a very limited choice of different colours
b. Pair-wise combinations having the same or neighbouring chromaticity are combined to provide stronger colours where needed
c. Any combination of overlays can be used to provide additional colours
d. Strong colours (high saturation) are not possible with overlays unless they are very light

6) Which of the following statements about coloured filters is FALSE?
a. There is only a weak association between overlay colour and spectacle lens colour
b. An overlay needs only to cover the text being read to be effective
c. Revised tints are not successful in providing further periods of remission
d. The ChromaGen system offers 8 different tints

7) Which of the following statements about the Intuitive Colorimeter Mark 2 is TRUE?
a. It allows hue, saturation, and brightness to be varied continuously
b. It allows hue, saturation, but not brightness to be varied continuously
c. It allows hue, brightness, but not saturation, to be varied independently
d. It creates different colours by mixing the light from three different lamps

8) According to a model of reading rate as a function of chromaticity, how many tints are required for 95% efficacy in every suitable patient?
a. 10
b. 60
c. 100
d. 6000

9) Which of the following is FALSE. The Rate of Reading Test permits an assessment of:
a. Reading speed
b. Reading age
c. Tracking errors
d. The effects of coloured overlays

10) Precision tints should be used under white fluorescent lighting. The majority can be used under incandescent lighting and daylight. Which tint colour is unlikely to be effective under all lighting conditions?
a. Yellow
b. Green
c. Blue
d. Purple

11) How can you determine whether an overlay helps prevent visual stress?
a. Offer the overlay for use for a trial period
b. Measure how much it increases reading speed
c. Assess the effect on symptoms
d. All of the above

12) In two open trials of precision tints what proportion of patients were still using their tints after one year?
a. 50%
b. 60%
c. 70%
d. 80%

Please complete online by midnight on April 22 2009 - You will be unable to submit exams after this date – answers to the module will be published on www.optometry.co.uk