



# Research into Meares-Irlen syndrome

The 2007 City University/*Optician* prize for best dissertation was awarded to **Joanna Lawrence**. In this extract, she describes the research that has been published in this area

**O**live Meares, a teacher in a New Zealand reading clinic, was the first person to publish a report about the use of tinted overlays to assist with reading difficulties.

Meares questioned several children about the print they were reading and she discovered that when reading black print on white backgrounds, many children perceived the words to move or wobble, or the spaces between words to form streams of white which detracted from the black print and made reading very difficult.

These children preferred small print similar to that produced in adult books, rather than the larger print designed for children, because 'the white doesn't glare at you so much'. One child who used a dirty perspex sheet over his page and another that preferred reading reverse type copy, or white words on a dark grey background, prompted Meares to try tinted perspex overlays to assist with reading.

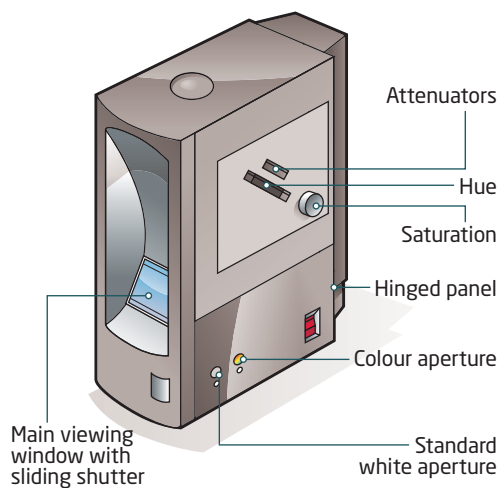
She postulated that the brightness contrast of black-on-white print was a major contributing factor towards reading disabilities.<sup>1</sup>

## Helen Irlen

In 1983, US psychologist Helen Irlen presented a paper to the annual convention of the American Psychological Association, describing how some of her students used coloured acetate sheets to reduce visual distortions when reading.<sup>2</sup>

Irlen coined the term 'scotopic sensitivity syndrome' (SSS) for this perceptual problem and explains in her book, *Reading by the Colors*, first published in 1991, that she developed the theory of SSS over a 10-year period working as co-ordinator of an adult learning disability programme funded by the federal government.

Between 1981-83, Irlen interviewed more than 1,500 adults with reading problems. One subgroup of individuals emerged who had good phonetic skills, adequate decoding skills and sight vocabulary, but still found reading immensely difficult. This group complained that the letters and words ran together or moved,



**Figure 1**  
Schematic diagram of the Intuitive Colorimeter

the white spaces formed rivers down the page and the words became black lines. These distortions got worse with prolonged reading, making comprehension of the words difficult if not impossible. One day, one of the students produced a red overlay that she had used four years earlier in vision training exercises. Another student put the coloured acetate sheet on her page and found that the distortions had stopped.

After trying out many different coloured sheets, Irlen found that 31 out of her 35 students reported that the distortions were much reduced and reading was easier with a coloured overlay. It seemed that the colour necessary to help a student was particular to that student and everyone had different optimal colours.<sup>3</sup>

Irlen then spent the following years developing diagnostic techniques and patenting a set of coloured overlays and coloured lenses or filters. She founded the Irlen Institute for Perceptual and Learning Difficulties in California to offer her patented treatment of Irlen Filters to SSS sufferers. Today there are Irlen Clinics in most US states and across the world, with more than 8,000 certified Irlen screeners working in the educational system in the US, Canada, Australia, England and New Zealand.<sup>3</sup>

## Scepticism about Irlen's claims

Irlen's early claims of discovering a syndrome that could be treated with

her patented Irlen Filters were met with scepticism. The name itself caused controversy. Scotopic vision is mediated by rod photoreceptors and comes into play in dim illumination as rods are 1,000x more sensitive to light levels than cones. Rods are not found in the fovea which is the area of the retina responsible for high acuity visual processing such as reading.

The term 'scotopic sensitivity' implies an increased sensitivity of the rod receptor system. However, since the visual problems reported by SSS sufferers occur when reading, it is the cone photoreceptors and hence photopic vision that is in use and not scotopic vision. The name scotopic sensitivity is, therefore, a misnomer. Irlen defends this name by describing it as a syndrome in which individuals 'perceive the world around them in a distorted way as a result of a sensitivity to certain wavelengths of light'.<sup>3</sup>

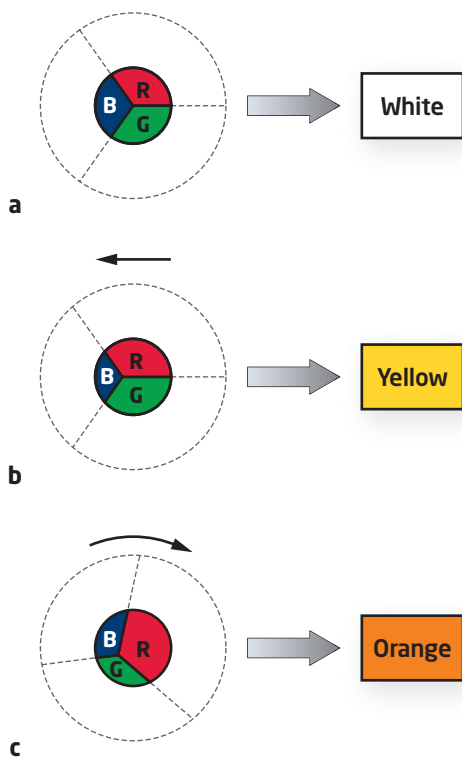
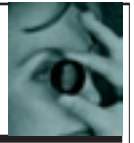
Even more controversial, certainly up to 1990, was the lack of published research data in peer-reviewed scientific journals validating Irlen's claims. Irlen Filters were being widely publicised in the media as a successful treatment for reading disorders, but eye care professionals had no evidence upon which to base any judgements.<sup>4</sup>

Despite this lack of scientific proof, Irlen had patented her filters and was charging sizeable sums of money for the treatment,<sup>5</sup> utilising so-called trained Irlen screeners who were not qualified as eye care professionals.<sup>6</sup> Irlen was claiming that this new syndrome was unrelated to vision anomalies and that the symptoms of SSS remained undetected by standard visual and medical examinations, psychological evaluations or other school-related tests.<sup>7</sup>

Irlen seemed to base this assumption on the fact that all of her clients had received an eye examination within one year of the Irlen testing and hence had no vision problems.

One study, however, that recruited 39 subjects from the general population, for an investigation of Irlen Filters found that despite having had a recent eye examination, 95 per cent of those who met the criteria for having SSS as defined by the Irlen screening protocol, did in fact have significant uncorrected refractive errors, binocular vision problems, accommodative disorders, ocular motor anomalies, or hysterical amblyopia.<sup>8</sup>

The evidence that was available to support Irlen's claims tended to be anecdotal and certainly was not obtained under



**Figure 2** The principle of the Intuitive Colorimeter. A transparent disc (large circle) is divided into three sectors to which are added a coloured filter, red, blue and green. The disc is free to rotate about a central axis and this axis can move horizontally. A circular beam of white light (small circle) passes through the disc and is coloured as a result. The proportion of red, blue and green light is dependent upon the position of the disc with respect to the beam of light. If the beam of light is centred upon the disc the proportions of red, blue and green are equal and white light is produced (a) if the disc is translated horizontally, the proportion of the three primary colours changes and so produces a different coloured light (b) and if the disc is rotated in a lateral position, the saturation of the colour is varied (c)<sup>13</sup>

subjects were aware of the colour of the lenses they were wearing and being existing Irlen clients, they were presumably already convinced of the supposed benefits of those coloured lenses.<sup>11</sup>

**Intuitive Colorimeter**

To overcome the placebo problem, Wilkins designed the Intuitive Colorimeter (Figure 1) to illuminate text with coloured light in order to better study patients who reported benefits from using Irlen Filters.

This instrument allowed the subject to systematically vary the hue, saturation and brightness in order to determine the optimum ‘colour’ for reducing visual distortions.<sup>2,10,12</sup> (Figure 2).

In a revised model of the Colorimeter, a beam of white light passes through a cylindrical filter assembly via a square aperture into a viewing chamber with matt white inner surfaces. The filter assembly is divided into seven sections, each with a different filter so as to transmit light of a different colour. The colours of the filters have hues evenly distributed in a circle around white in the Commission Internationale de l’Eclairage (CIE) 1976 uniform chromaticity scale diagram (Figure 3).

The patient puts his head close to the viewing window and looks at a page of text within the instrument. The entire visual field is coloured with light from the chamber which is initially white. The patient describes any distortions seen and then systematically compares the white light to a coloured light with increasing saturation until all possible colours have been viewed. Any beneficial colours can then be reviewed and the optimal saturation and brightness determined to ascertain the overall optimal colour.<sup>2</sup>

While developing the Intuitive Colorimeter, Wilkins examined several children with reading difficulties. He found that many of them consist-

rigorous scientific conditions. Much of the evidence provided was in the form of questionnaires completed by those wearing the Irlen Filters who reported that the filters helped. However, in such studies there were no control groups, no statistical analyses, and most importantly no consideration of any placebo effect.<sup>9</sup>

The placebo effect is when symptoms are alleviated in some way by an otherwise inert treatment due to the subject believing that the treatment works. Hence, several years after Irlen’s initial claims regarding SSS, the consensus was that underlying vision problems were probably the cause of the symptoms of those individuals who were identified as Irlen Filter candidates and that the therapy itself lacked credibility.

**Arnold Wilkins**

Arnold Wilkins was a scientist working for the Medical Research Council Applied Psychology Unit investigating photosensitive epilepsy in which specific visual stimuli precipitated seizures.

Flickering light had been found to be epileptogenic, as had certain visual patterns, particularly stripes. Such patterns were also found to be ‘uncomfortable to look at’ for non-epileptogenic patients and were reported to cause various visual illusions of colour, shapes or motion. This effect became known as pattern glare. Susceptibility to such illusions seemed to be greater for those who suffered from frequent

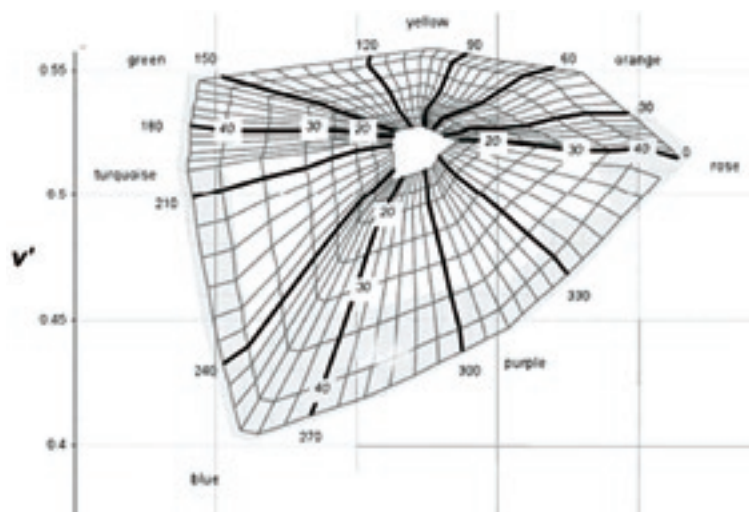
headaches, particular those suffering from migraine.

This research led Wilkins to propose his theory of visual stress in which certain characteristics of visual stimulation can give rise to discomfort and seizures.<sup>10</sup> Wilkins became intrigued about Irlen’s claims that coloured filters could ease symptoms of visual perception dysfunction as the symptoms reported in SSS correlated well with the symptoms reported in visual stress.

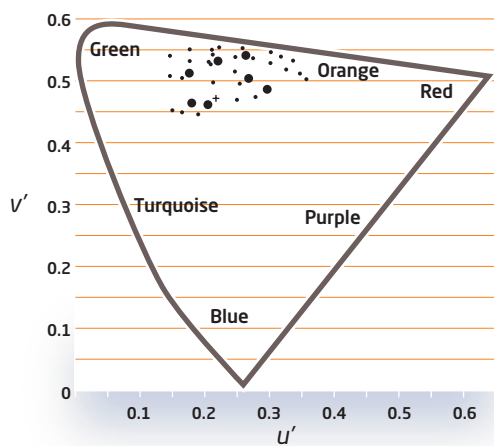
Wilkins examined a selection of individuals who had supposedly benefited from the use of Irlen Filters. Vision was compared using the coloured Irlen lenses, darkened, neutral density lenses that allowed the same amount of light through as the Irlen lenses, and clear lenses.

Overall, the tinted Irlen lenses gave a modest improvement in the speed of visual search, fewer illusions and headaches and for some the lenses also improved acuity and muscle balance.

However, this study again had no control over the placebo effect as the



**Figure 3** The coloured filters of the Intuitive Colorimeter as shown on the CIE 1976 Uniform Chromaticity scale diagram. The concentric curves show the change in chromaticity as the hue control is altered, and the spokes show the change when the saturation control is altered<sup>10</sup>



**Figure 4** The chromaticity co-ordinates of the seven Irlen coloured overlays in the CIE 1976 Uniform Chromaticity Scale Diagram. The large black dots represent the seven overlays and the small dots represent the paired combinations. The cross represents white. Image from Jeanes *et al*, 1997<sup>19</sup>

ently chose very specific settings of the Colorimeter which made the distortions in the text disappear. Wilkins then directly compared the results of his Intuitive Colorimeter with the Irlen method of prescribing tinted filters. In eight out of nine children, the colour appearance of the Irlen trial lenses closely agreed with the colour given by the Colorimeter.<sup>14</sup> This seemed to support the claims of Irlen, and furthermore, indicated that the colour found by the Colorimeter would provide a good indication of a potentially therapeutic colour for tinted lenses.<sup>10</sup> However, further scientific based evidence was still required.

### Therapeutic precision tinting

Irlen used a range of 150 different coloured filters in her treatment protocol.<sup>8</sup>

Wilkins subsequently developed a set of tinted trial lenses using a precise tinting technique that very closely approximated any colour that could be obtained in his Colorimeter. Comments from many children during the developmental process indicated that the colour of any tinted lens needed to exactly match the colour chosen with the Colorimeter or else the beneficial effects were reduced.<sup>2</sup>

Preliminary case studies indicated the benefits of tinted lenses for those with reading difficulties, photosensitive epilepsy and migraine.<sup>15,10</sup> Wilkins therefore conducted an open trial to investigate the long-term use of his tinted lenses. The subjects presented with a variety of problems including reading difficulty, perceptual distortion of text, headaches, eyestrain and photo-

sensitive epilepsy. They were assessed with the Intuitive Colorimeter and chose their preferred colour for reading. Tinted trial lenses were selected and the optimal tinted lenses determined. The lenses incorporated any necessary refractive correction and the subjects were instructed to wear the lenses as they wished.

After approximately one year the subjects reported any benefits of their tinted glasses. Forty-five out of the original 55 subjects were still wearing their tinted glasses of which 44 reported improvement in their presenting symptoms.<sup>15</sup> This trial did not include a full optometric assessment, had no measurement of reduction of symptoms or control over placebo effects and so any reported benefits were impossible to quantify. The results, however, gave Wilkins the impetus to conduct a multi-centre double-blind, placebo-controlled study.

### Coloured overlays

The Irlen Clinics use a set of seven overlays of turquoise, blue, green, yellow, peach, rose and gold<sup>16</sup> which when plotted on a chromaticity diagram (Figure 4) do not appear to sample colours systematically.

Wilkins developed an alternative set of 10 overlays of grey, yellow, lime green, mint green, aqua, blue, purple, pink, rose and orange called The Intuitive Overlays<sup>17</sup> and which systematically and evenly sample the colour space as shown in Figure 5.<sup>18,19</sup>

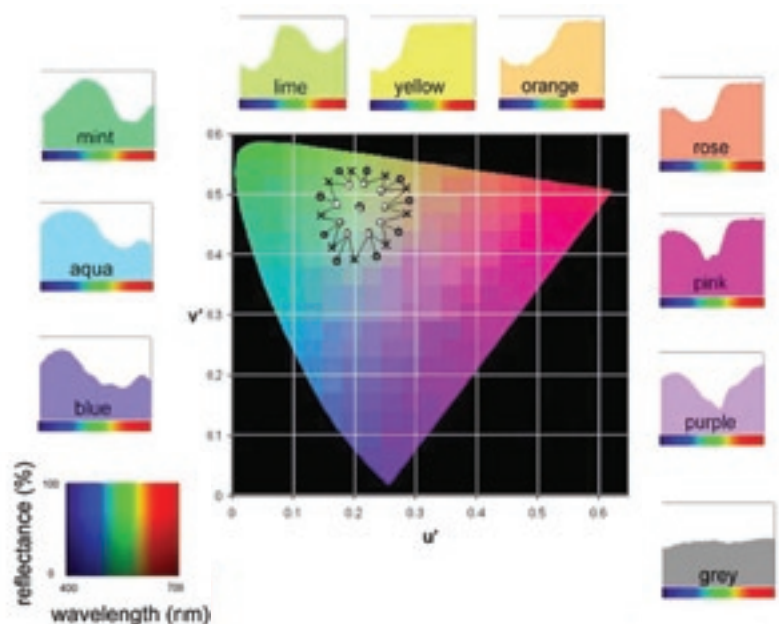
The overlays can be superimposed upon one another, giving a more saturated colour, and in order to sample the colours systematically it is only necessary to combine overlays with another of the same or similar colour as shown in Figure 6. The overlays are glossy on one side and matt on the other to reduce reflections, although when uppermost, the matt surface can reduce clarity.<sup>12</sup>

Several placebo-controlled studies showed that coloured overlays had beneficial effects on reading; one colour gave the best results, whereas other colours gave little or no benefit and the optimal colour was particular to each individual.<sup>19,6,20,17</sup>

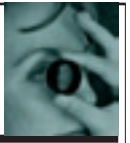
However, the colour of an overlay was not necessarily a good indication of the colour of an optimal tint for glasses.<sup>20</sup> When using an overlay the eyes are adapted to the ambient light, whereas when wearing tinted glasses the entire visual field is coloured accordingly and the eyes adapt to that colour.<sup>19</sup>

This adaptation involves a mechanism known as colour constancy, whereby the brain adjusts for effects of incident lighting and so still recognises the 'correct' colour of objects regardless of the spectral content of the illuminating light. This mechanism underlies the precision of the Intuitive Colorimeter in predicting correct tints for glasses as the entire visual field is illuminated in the chosen colour.

Waldie and Wilkins reportedly investigated whether the optimal colour of an overlay changed with increased



**Figure 5** Chromaticities of the nine-coloured Intuitive Overlays (inner ring of white circles) and the grey overlay (central point) when in contact with a white page. The chromaticities of double overlays of the same colour are shown by the outer ring of circles, and the crosses represent double overlays of neighbouring colours. From Wilkins, 2003<sup>2</sup>



size but found no difference in reading speed using overlays which covered the entire page, overlays which covered the text only and left the margin white or overlays covering the text with a margin in a complementary colour.<sup>22</sup> However, to properly answer this question they should have compared overlays covering the page with much larger overlays covering the entire visual field.

Overlays are used to assess the likelihood of a subject benefiting from tinted glasses without incurring the expense of precision tinted lenses<sup>23</sup> and may even be preferred by some patients when reading rather than constantly wearing a coloured pair of spectacle lenses as some children have reported teasing at school because of their tinted glasses.

### Double-masked, placebo-controlled trial

The gold standard in clinical trial design is the randomised, double-masked, placebo-controlled study.

Subjects are randomly assigned to the therapeutic or control group and are unable to distinguish between the two protocols, hence controlling for any placebo effect, and neither the investigators nor the subjects know which group is which.

Wilkins used a double-masked, placebo-controlled cross-over trial to ascertain whether the reported benefits of tinted lenses were due solely to placebo effects.<sup>23</sup> Schoolchildren selected from those suffering from headaches, asthenopia or reading difficulty were all assessed with coloured overlays to determine which colour best reduced the visual distortions.

Only those children who then used their chosen overlay consistently for at least three weeks were eligible for the study. The Intuitive Colorimeter was used to provide two chromaticities, one of maximal benefit at eliminating visual distortions and another which reduced the distortions but did not eliminate them.

Two pairs of tinted glasses were produced for each subject, an experimental pair with the optimal tint, and a control pair with the sub-optimal tint. The glasses were sent to the children, one pair at a time randomly selected by the tinting laboratory, to be worn for at least one month. Due to the nature of the Colorimeter test procedure, the children were unable to tell which lens colour was their chosen optimal tint and hence the placebo effect was controlled for. The children kept diaries to record episodes of eyestrain and headaches. After both trial periods, 71 per cent of days on which the experimental glasses were worn were recorded as symptom-free as compared

**Figure 6** Part of the Intuitive Overlays Record Sheet showing the different colours of the overlays (inner ring) and the combinations to try when testing (outer ring)



to 66 per cent of symptom-free days with the control glasses; 22 of the 52 children said that they preferred the experimental glasses with 26 preferring the control and four having no preference. The difference between the two tints for each subject was very small, corresponding to approximately six times the just noticeable difference in colour.

The authors postulated that this could explain the fact that both pairs were deemed beneficial and maybe the subjects were unaware of slight differences in symptoms when wearing the different glasses.<sup>23</sup> A greater clinical effect would perhaps have been seen with a greater difference in tints between the experimental and control glasses but this would have weakened the double-masked design of the trial.

In a later study, it was shown that six just noticeable differences from the optimal tint reduced any benefit in reading to less than 5 per cent of the maximum<sup>24</sup> although the reduction in visual symptoms was not quantified.

A similar, double-blind, randomised, controlled trial with cross-over design was used on adult migraineurs to compare the effectiveness of precision tinted lenses in the prevention of visually precipitated headache.<sup>25</sup> Optimal and control tints were selected with the subjects wearing each pair for a period of six weeks. Again the difference in chromaticities of the two tints differed by only six times the just noticeable difference. A marginally significant improvement with the optimal tint was noticed but only 17 subjects completed the trial. A more significant result would likely be achieved with more subjects. Optometric testing on these subjects revealed that the only significantly different factor was the migraineurs' susceptibility to pattern glare which improved with the optimal tinted lenses.<sup>26</sup> This lent weight to the hypothesis that migraine and MIS were related conditions with a common cause of pattern glare.

### Rate of reading test

Wilkins designed a specific reading test in order to accurately compare the speed

of reading in children with and without coloured overlays or tinted lenses.

The test maximises visual stress by using small, closely spaced text, but requires minimal reading ability, hence it is suitable for poor readers. The test comprises a passage of randomly ordered simple words selected from the 110 most frequent words in children's reading books, with the same 15 words rearranged on each of 10 lines. The words have to be seen correctly to be read as they cannot be guessed from context. The text is printed in Times nine-point type and made to resemble stripes by reducing the horizontal spacing between words. The test is scored by noting errors on a score sheet and by measuring the time taken to read the passage with and without a coloured overlay. Different versions are available with the words in different orders.<sup>27</sup>

The test has a high test/re-test reliability and Wilkins also showed that increases in the rate of reading with the coloured overlays is correlated with improvements using overlays on a test requiring silent reading for comprehension and so the rate of reading test can be used as a measure of typical reading tasks.<sup>12</sup>

A study comparing the optimal colours of overlays and lenses measured the reading rate under four conditions of no colour, chosen overlay, lenses matching the chosen overlay and lenses matching the optimal Colorimeter setting.

The results confirmed that both overlays and tinted lenses increased reading speed provided that the colour was optimal for that subject, whereas lenses matching the overlay colour had a much reduced effect showing that the optimal colour of overlays and tints were not identical.

Furthermore, since the subjects were unaware that one set of lenses matched their overlay colour and one matched the Colorimeter setting, it gave credence to the earlier double-masked, placebo-controlled cross-over trial for precision-tinted lenses.<sup>20</sup> These results were corroborated by a randomised controlled trial in 2002<sup>21</sup> when Bouldoukian *et al* concluded that in appropriate patients, individually prescribed coloured overlays can cause an increase in reading performance as well as a reduction in symptoms. ●

### References

A list of references is available from the clinical editor [william.harvey@rbi.co.uk](mailto:william.harvey@rbi.co.uk)

● Joanna Lawrence has just taken her professional qualification exams