Screening for Meares-Irlen Sensitivity in Adults: Can assessment methods predict changes in reading speed?

Short title: Screening for Meares-Irlen sensitivity

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Abstract

Two methods of assessing candidates for coloured overlays were compared with the aim of determining which method had the most practical utility. 58 adults were assessed as potential candidates for coloured overlays, using two methods; a questionnaire which identified self reported previous symptoms, and a measure of perceptual distortions immediately prior to testing. Participants were classified as normal, Meares-Irlen sensitive, and borderline sensitive. Reading speed was measured with and without coloured overlays, using the Wilkins Rate of Reading Test and the change in speed was calculated. Participants classified as normal did not show any significant benefit from reading with an overlay. In contrast, a significant reading advantage was found for the borderline and Meares-Irlen participants. Current symptom rating was found to be a significant predictor of the change in reading speed, however the previous symptom rating was not found to be a reliable predictor. These data indicate that the assessment of perceptual distortions immediately prior to measuring colour preference and reading speed is the most meaningful method of assessing pattern glare and determining the utility of coloured overlays.

Introduction

Meares-Irlen Syndrome is a condition that was first characterised by Meares (1980) and Irlen (1983) and documented in the United Kingdom by Wilkins (1995). People with Meares-Irlen Syndrome experience perceptual distortions and discomfort that have been commonly termed pattern glare or visual stress. Pattern glare can interfere with reading, causing symptoms such as blurring and movement of lines. Consequently, Meares-Irlen Syndrome is often associated with reading impairments such as dyslexia. The syndrome is not however simply dyslexia under a different label, as many adults without specific reading impairment can be sensitive to patterns and experience distortion and visual stress (Evans and Joseph, 2002). People who suffer migraine have also been shown to be sensitive to pattern glare (Drummond, 1986; Drummond, 1997; Harle and Evans, 2004). For consistency this paper will use the term “Meares-Irlen” to refer to the type of individuals who are sensitive to pattern glare and who are found to have some form of symptoms or measurable change in performance evoked by visual stress.

There is a wide range of evidence that pattern sensitivity can be reduced or eliminated using coloured overlays and tints. Products such as the Intuitive Overlays (I.O.O. Marketing Ltd, London, UK) have been shown to benefit reading (Jeanes *et al.*, 1997; Wilkins *et al.*, 2001; Evans and Joseph 2002; Wilkins, 2002). This benefit is not considered a placebo (Wilkins *et al.*, 1999; Bouldoukian *et al.*, 2002; Wilkins and Lewis, 1999) nor is the preference of the

coloured overlay related to familiarity, memory (Wilkins *et al.*, 2005) or a reduction in contrast (Jeanes *et al.*, 1997).

Dyslexic readers show up to a 25% advantage in reading speed when they read a text with a coloured overlay of their choice (Tyrrell *et al.*, 1995; Wilkins *et al.*, 1996; Evans *et al.*, 1999; Wilkins, 2002). Evidence also indicates that coloured overlays and tints can significantly improve the performance of other tasks; for example, overlays have been shown to benefit sentence comprehension and reading accuracy (Williams *et al.*, 1992; Robinson and Foreman 1999; Robinson and Conway 2000). Coloured overlays and tints have also been shown to significantly reduce the symptoms of migraine. It is worthy of note that in the case of migraine, colour therapy reduces symptoms without effecting reading impairment/reading speed (Harle and Evans, 2004).

Whilst there has been much research into the use of colour to aid reading performance, the aetiology of the Meares-Irlen Syndrome and the actual locus of the interference in the visual system remain under-specified. A number of possible causes of Meares-Irlen Syndrome exist however the cortical hypersensitivity explanation proposed by Wilkins (2003) has received UK support. Wilkins postulates a neurological theory and suggests that Meares-Irlen Syndrome must be linked to a strong physiological response in the perceptual system and that the cortical hyper-activity is linked to symptoms such as eye strain and migraine. Evidence from EEG and neuro-imaging supports the physiological basis of the syndrome (Wilkins, 1995; Wilkins *et al.*,

1999; Huang *et al.*, 2003), whilst evidence from psychophysical measurement is more variable (Blaskey *et al.*, 1990; Solan, 1990; Menacker *et al.*, 1993; Simmers and Bex, 2001; Simmers *et al.*, 2001a; Simmers *et al.*, 2001b).

In spite of the growing evidence for the use of colour therapy, some eye care professionals remain sceptical about their efficacy. Whilst some studies find that coloured overlays do indeed improve symptoms or performance (Wilkins *et al.*, 1994; Robinson and Foreman, 1999; Wilkins *et al.*, 2001; Evans and Joseph, 2002) others have failed to find such effects (Blaskey *et al.*, 1990; Solan, 1990; Menacker *et al.*, 1993).

The way in which an individual is diagnosed as having a sensitivity to pattern glare has, to date, only been addressed indirectly. There is currently no standardised mode of assessing Meares-Irlen sensitivity, although a number of different options exist. Previous research has identified Meares-Irlen candidates with self reports of previous symptoms using questionnaires and interviews (Irlen, 1983) asking people about their experience of discomfort and pattern glare generally (Evans and Joseph, 2002) or asking them to report perceptual distortions when they view a pattern known to evoke distortions in those with sensitivity (Wilkins, 2003). This is the basis of the pattern glare test as described by Wilkins (1995, 2003).

The aim of this paper is to determine which of these methods of assessing and identifying individuals with Meares-Irlen sensitivity is the most reliable, and to determine whether there is a direct correspondence between a persons score on these measures and the change in reading speed found when coloured overlays are used. Such a relationship would provide strong evidence that Meares-Irlen sensitivity can be adequately explained in terms of pattern glare and may also indicate which method of screening is the most reliable.

Methods

Participants

Informed consent was obtained from every participant after a verbal and a written explanation of the procedures was given. The tenets of the Declaration of Helsinki were followed. 58 (31 females, 27 males) adult participants were randomly selected for testing. The ages ranged from 18-65 years (mean age of 35, SD 13.2 years). None of the participants had previously used coloured overlays or taken an assessment of this nature. None of the participants classified themselves as dyslexic or having reading disability. All had corrected to normal or normal vision, and could read N5 at 40cm, and had a distance VA of at least 6/5. None of the participants had ever been treated for binocular vision anomalies, or were known to be migraine sufferers. Other optometric data were not obtained as previous studies have suggested that subtle binocular and accommodative anomalies are not major aetiological factors in

Meares-Irlen Syndrome (Evans *et al.*, 1995; Evans *et al.*, 1996; Evans, 2001; Scott *et al.*, 2002).

Procedure

Two screening measures of Meares-Irlen sensitivity were taken from each participant. A detailed questionnaire of general symptoms was given together with a more direct measure of pattern glare at the time of testing. In both cases each 'yes' answer added one to the score. The first measure (termed *previous symptoms*) identified the kinds of symptoms that participants had noticed prior to the testing session. These symptoms were identified using the self assessment questions based around those used by the Irlen Institute (Irlen, 1983). The questionnaire required a yes/no response to questions for example "Do any of the following bother your eyes, or make you feel uneasy in any way?....headlights from oncoming traffic?" (See Appendix 1 for the full list of questions). This gave a score out of 20 for each person, with scores of 4 or more taken to indicate that a person may be sensitive to pattern glare. A more direct measure of pattern sensitivity and glare (termed *pattern glare*) was also taken. This was based on the test for pattern glare described in Wilkins (1995, 2003). Participants were shown an interference grid, and then given a series of questions regarding the perceptual distortions that they experienced. (For example, "Looking at the pattern do you see: blurring, bending of the lines, shadowy shapes amongst the lines, etc. - See Appendix 2). The interference grid was a square wave luminance profile, that, when viewed at a distance of 40 cm, had a radius of 14 degrees, a Michelson contrast greater than 0.8, a

duty cycle of 50% and a spatial frequency of 3 cycles per degree. The interference grid is illustrated in Wilkins (1995). In accordance with the procedures outlined in previous research a threshold for sensitivity was selected. In this instance individuals with scores of 4 or more were taken to indicate that a person may have sensitivity to striped patterns and experience glare and/or Meares-Irlen like symptoms. We selected a cut off threshold that was 1 unit higher than that used by previous authors (Irlen, 1983; Wilkins, 1995). In order to classify a person as being pattern sensitive and likely to experience Meares-Irlen type symptoms, a score above threshold in both screening measures was required. The participants classified as pattern sensitive should theoretically show an advantage when reading with a coloured overlay.

All participants were initially given the previous symptoms questionnaire and then asked to view the interference pattern and answer the pattern sensitivity questions. Each participant was asked to select their preferred coloured overlay using the procedure outlined in the test pack instructions. For the participants in the control group, who did not have a colour preference, a random colour was chosen. The Wilkins Rate of Reading test was then administered, using the counterbalanced presentation given in the test instructions. The Wilkins Rate of Reading test (small type version) was used together with the Intuitive Overlays Test Pack (I.O.O. Marketing Ltd, London, UK). The overlays sample colours systematically having chromaticities of even distribution around the circumference of a circle in the CIE (1976) diagram (see Wilkins *et al.*, 1999 and Bouldoukian *et al.*, 2002 for more detail). All overlays were used singly. The overlays provided nine colours and

a grey (reflectance approx. 47%) when used singly. For the clear (control) presentation, no overlay was used. Timing was carried out using a stopwatch.

Results

The participants were selected and then categorised as follows: Those with no colour preference and who scored below threshold (a score of 3 or less) on the pre-assessment were classed as normal. Participants with low scores (or at threshold or higher on only the previous symptoms assessment) but who were found to have a preferred colour were classed as borderline. Participants who scored at threshold or higher (a score of 4 or more) on both pre-assessment measures and had a preferred colour were classed as Meares-Iren sensitive. This resulted in 18 participants being classified as borderline, 20 participants classified as normal and 20 participants as having Meares-Irlen pattern sensitivity.

Two different analyses were carried out. The first analysis considered mean reading speed, and an additional analysis considered the changes in speed when reading with and without an overlay. The mean reading speeds are shown in Table 1. Participants with Meares-Irlen sensitivity were found to have a significant reading speed advantage when a coloured overlay was used. When the reading speed of the participants was analysed using ANOVA, there was a main effect of participant $F_{2,57} = 5.62$, $p = 0.0058$, a significant main effect of overlay $F_{2,57} = 9.57$, $p = 0.0031$, and a significant participant by overlay interaction $F_{2,57} = 13.97$, $p = 0.00001$.

[TABLE 1 ABOUT HERE]

Additional analysis was carried out by calculating the change in speed by taking the difference between each participant's speed in the clear and overlay conditions. ANOVA revealed that these changes were also highly significant $F_{2,57} = 13.97$, $p = 0.0001$. Post hoc comparisons of the means were made using Tukey's HSD. The change in speed for normals was significantly different to that found with the Meares-Irlen group (diff = 23.37, $p < 0.05$) and the borderline group (diff = 14.3, $p < 0.05$) but the Meares-Irlen group did not differ significantly to the Borderline group (diff = 9.06, $p > 0.05$).

[FIGURE 1 ABOUT HERE]

Regression analysis of change of speed

[FIGURE 2 ABOUT HERE]

The mean change in speed had a range from no advantage (shown by those classed as normal) up to a maximum of 64 words/min advantage shown by certain individuals classified as Meares-Irlen/pattern sensitive. Pattern sensitivity ratings ranged from a minimum of 0 to a maximum of 9 (out of a possible 12) and the previous symptoms ranged from a minimum of 0 to a maximum of 20 (out of a possible 20).

The change in speed data were entered into a stepwise multiple regression model to determine whether it was possible to predict the benefit that the colour filter would have (in terms of the change in reading speed) given the participant's score on the pattern glare and previous symptoms questionnaires. Stepwise multiple regression indicated that the pattern glare questions were a reliable predictor of changes in reading speed. In contrast, the previous symptom questions did not reliably predict changes in reading speed. ($F_{1,57}$ = 10.31, p = 0.002, R^2 = 0.273; Current symptoms $F_{1,57}$ = 6.35, p = 0.014; Previous symptoms $F_{1,57}$ = 0.35, p = 0.42). This indicated that the Wilkins style assessment of pattern glare was the most useful and that scores on this assessment would serve as a useful predictor of the change in reading speed that would occur if coloured overlays were used.

Discussion

The analysis of reading speed indicated that the coloured overlays produced no benefit for people classified as normal (colour: 161 words/min, clear: 167 words/min diff = -6 words/min). In contrast the people classified as borderline and Meares-Irlen sensitive did show a positive change in reading speed when their chosen coloured overlay was used (borderline colour, 122 words/min, clear 114 words/min diff = +8 words/min; Meares-Irlen sensitive colour: 151 words/min, clear 135 words/min, diff = +16 words/min). As people who suffer from migraine often show a preference for a particular coloured overlay, but do not show an increase in reading speed with their chosen overlay (Harle and Evans, 2004), it is important not to include them in the reading speed data analysis. None of the participants in the current study suffered from migraines.

Differences in reading speed for the normal and Meares-Irlen participants were robust in the two separate analyses of reading speed. When change in speed was calculated there was a difference between the normals and the borderline and Meares-Irlen sensitive groups and the presence of a significant participant by overlay interaction indicated that these differences were significant. Post hoc comparisons found that normals were significantly different to the Meares-Irlen group (diff = 23.37, $p < 0.05$) and the borderline group (diff = 14.3, $p < 0.05$) but the Meares-Irlen group did not differ significantly to the Borderline group (diff = 9.06, $p > 0.05$). These findings suggested that at least one of the assessment criteria used to identify Meares-Irlen type candidates was a reliable measure. The utility of each measure was addressed with the regression analysis.

The regression analysis indicated that 27% of the variance of the reading speed data could be explained by the manipulation of the predictor variables; the previous symptom and pattern glare ratings. This regression was highly significant indicating that the relationship between the symptom ratings and reading speed was robust. Whilst the pattern glare rating was found to be a significant predictor of the change in reading speed, the previous symptom rating was not found to be reliable in predicting changes in reading speed that occur with the coloured overlays. It is interesting to note that the direct rating of pattern glare was found to be a reliable predictor in spite of the fact that the effective range of possible scores was smaller. This is advantageous to practitioners as it not only reduces assessment time, but also produces more reliable results.

The data reported indicate that results from different assessment measures can vary considerably. This has important implications for research and for optometric practice. In optometric practice, it is desirable to be able to identify potential candidates for colour therapy quickly and accurately. In terms of research, it is extremely important to be able to select the research sample accurately, as inadequate selection criteria may elicit null findings and weaken any potential effects. This may be one explanation to account for the variation found in psychophysical measurements generally (Blaskey *et al.*, 1990; Solan, 1990; Menacker *et al.*, 1993; Simmers and Bex, 2001; Simmers *et al.*, 2001a; Simmers *et al.*, 2001b). It may also account for why some studies have found that coloured overlays improve performance (Wilkins *et al.*, 1994; Robinson and Foreman, 1999; Wilkins *et al.*, 2001; Evans and Joseph, 2002) whilst others fail to find such effects (Blaskey *et al.*, 1990; Solan, 1990; Menacker *et al.*, 1993).

One possible reason why the previous symptoms are not as predictive as the direct assessment of pattern glare is that the recall of symptoms is prone to bias; memory processes have been shown to be biased by mood, emotion and many other factors. The mood congruence effect is one such effect, and it has been shown that when a person experiences a particular mood state, the material recalled is congruent with that particular mood (Bower, 1981; Matt *et al.*, 1992). Furthermore, memory recall is also prone to primacy and recency effects (Conrad, 1965; Lewandowsky and Murdock, 1989). Therefore, recall of previous symptoms may vary and may depend on factors such as the mood at testing. Those who have recently or frequently experienced discomfort may be more likely to score on this assessment than those with more intermittent symptoms. More intermittent problems might be specific to certain environmental factors such as lighting or a particular task. The pattern glare test may be more robust as it should capture a more general sensitivity to glare or pattern sensitivity related to visual processing that is not so easily labelled or identified with general questioning.

Whilst the analyses reported here do not find that previous symptoms can reliably predict changes in reading speed, this does not preclude that these questions may be useful in identifying migraine sufferers whose symptoms may be reduced with the use of coloured tints. Indeed, coloured overlays and tints have been shown to significantly reduce the symptoms of migraine (Harle and Evans, 2004). For this specific purpose, history and symptoms may indeed prove to be a useful predictor as those who suffer migraine are often found to be sensitive to glare (Drummond, 1986; Drummond, 1997). The research by

Northway (2003) has also considered the reporting of symptoms, and suggested that these are useful in predicting the continued use of coloured overlays in children with reading impairment. The experience of symptoms and the utility of this knowledge for predicting success of coloured therapy for migraine sufferers and other patient groups is perhaps a topic for future research.

This paper indicates that the assessment of pattern glare and perceptual distortion immediately prior to measuring colour preference and reading speed is the most meaningful method of determining whether the use of a coloured overlay would be beneficial for those who experience glare and discomfort when reading. Whilst the reporting of previous symptoms may provide a useful indication that an individual may warrant further investigation we did not find these questions useful in predicting the potential benefit that a coloured overlay may have for a particular individual in terms of their performance on a visual task such as reading.

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Appendix 1:

Questionnaire about (previous) symptoms

Please answer each question with either YES/NO

Do any of the following bother your eyes, or make you uneasy in any way:

Reading textbooks for long periods?

Working on a computer for long periods?

Working/reading under fluorescent lights?

Reading dark print on glossy/white paper?

Doing visually-intensive tasks such as sewing or crossword puzzles?

Bright light?

Glare from the sunlight?

Headlights from oncoming traffic/cars?

Patterns or stripes?

Fluorescent lights?

Bright/ neon colours?

Do you:

Prefer lenses with tints or sunglasses?

Become tired/drowsy under bright or fluorescent lighting?

Seem to get a headache from fluorescent lighting?

Feel your performance deteriorates in bright/fluorescent light?

Feel like there is too much light when reading?

Feel like there is not enough light when reading?

Prefer to read in dim lighting?

Feel like you need less light to read or work?

Feel that your eyes tire quickly when reading?

Appendix 2

Looking into the centre of the grid that is in front of you…..Do you see any of the following? Please answer each question with either YES/NO.

Pain/Discomfort

Shadowy shapes amongst the lines

Shimmering of the lines

Flickering

Red

Blue

Green

Yellow

Blur

Bending of any lines

Nausea/Dizziness

Unease

Table 1: The mean reading speed (words per minute) and standard deviations for participants reading with and without their chosen overlay.

	Normal	Borderline	Meares-Irlen
Colour	161 (23.3)	122 (32.0)	151 (32.1)
Clear	167 (27.2)	114 (30.8)	135 (29.9)

Figure 1: Change in speed of reading when participants use coloured overlays, shown with 95% confidence interval.

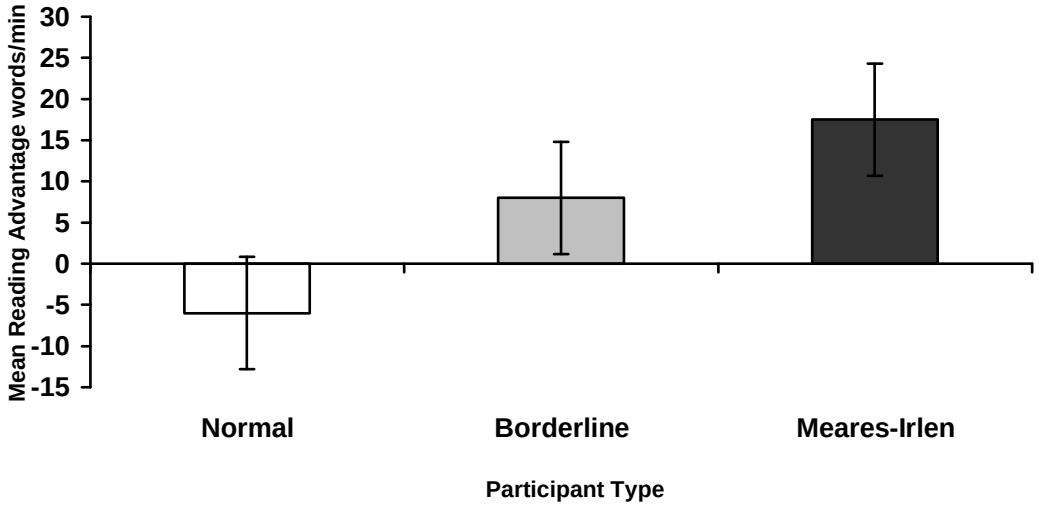

Figure 2: Change in reading speed as a function of pattern sensitivity and previous symptoms