Optometric Characteristics of Children with Reading Difficulties who Report a Benefit from Coloured Filters

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10.7.1 INTRODUCTION

In 1983 Irlen described 'scotopic sensitivity syndrome', a condition that she said is characterised by the presence of certain symptoms which are alleviated by tinted lenses. The symptoms, which principally occur when reading, can be described as eyestrain, headache, and anomalous visual effects and the benefit from tinted lenses is claimed to be idiosyncratic and very specific (Irlen, 1991). A review of the literature noted that the putative condition and associated therapy lacked both a sound theoretical basis and rigorous placebo-controlled trials (Evans and Drasdo, 1991). The condition, in fact, was first described in detail by Meares (1980) and the term 'Meares-Irlen Syndrome' may be most appropriate.

Recently, Wilkins *et al.* (1994) have carried out the first double-masked placebo-controlled trial of a tinted lens therapy for children who report these symptoms. The results of this study will be briefly summarised. New research will also be presented in which some of the subjects in the original trial are compared with a control group to investigate the optometric correlates of the syndrome. The aim of this research is to further understanding of the aetiology of Meares-Irlen Syndrome.

10.7.2 RESUMÉ OF DOUBLE-MASKED TRIAL

The aims of the previous study were to determine whether the 'tinted lens treatment' represents anything more than a placebo. To concentrate our sample, we studied children aged 9–14 years who had eyestrain or headaches, and who had been voluntarily using and claiming to benefit from a coloured overlay for at least three weeks. The children were all well-adapted to any necessary refractive corrections (which were worn for all testing at the relevant viewing distance) and subjects with binocular vision anomalies that required treatment (according to conventional criteria; Pickwell, 1991) were excluded.

A new instrument, the Intuitive Colorimeter (Wilkins *et al.*, 1992), was used to find an optimal chromaticity for each subject, which was reported to improve their perception of printed text. The colorimeter was then used to identify a second chromaticity, of very similar colour to the first, which was described by the subject as having a less beneficial effect on the text. Two pairs of tinted CR39 spectacles were made for each subject; one of which matched the optimal chromaticity ('experimental tint'): the other matched the sub-optimal chromaticity ('control tint'). There was no systematic variation in the saturation or transmission of the experimental and control lenses and the mean chromaticity difference between them was equivalent to six just-noticeable-differences (Wilkins *et al.*, 1994).

The subjects wore each pair of tinted spectacles, in random order, for a period of four weeks, with an interval of at least four weeks between each pair. Because of colour adaptation, children were unaware of the precise colour of their colorimetry settings. Several other measures were taken to ensure that the study was double-masked (Wilkins *et al.*, 1994) and when the subjects were questioned at the end of the study it was confirmed that they were unaware of which pair of tints matched their preferred colorimeter setting. Throughout the study the children completed daily symptom diaries, detailing occurrences of eyestrain and headache. Sixty-seven children entered the study and 36 completed the symptom diaries.

The experimental tint reduced symptoms of eyestrain and headache significantly more than the control tint. Thus, the study showed that coloured filters can help to reduce eyestrain and headaches for reasons that cannot be solely attributed to a placebo effect. The prevalence of colour vision defects in the study population, as detected by Ishihara and 100-hue testing, was similar to that expected in a normal population (Wilkins *et al.*, 1994).

10.7.3 MATCHED CONTROL GROUP STUDY

To discover more about why some children are helped by tinted lenses, we decided to compare the optometric characteristics of a sample of the children from the tinted lens trial with a matched control group.

10.7.3.1 Subject selection and matching

Sixteen of the children in the original trial came from Upbury Manor School in Kent and these were defined as the tinted lens group for the matched group study. We screened a further 92 children from the same school to select controls. Forty-five children were excluded because they had symptoms and/or demonstrated a positive response to testing with coloured overlays and four because they gave unreliable results during testing with coloured overlays. A further 12 children were excluded because they had been prescribed glasses but were not wearing them, and two were excluded for medical reasons. The remaining 29 were tested with a group IQ test and with the Suffolk reading test. Twenty-five of these were selected on the basis of these test results so as to match the tinted lens group in chronological age, IQ (Raven *et al.*, 1988a,b), and reading performance (Suffolk Reading Test).

10.7.3.2 Methods

The children were investigated (without using any coloured filters) with the following optometric tests: near visual acuity with a logMAR chart, objective refraction by distance fixation retinoscopy (Evans *et al.*, 1994a); distance and near cover test, near dissociated heterophoria, near associated heterophoria, stereo-acuity (Randot Test, contoured circles), AC/A ratio, near vergence reserves, near point of convergence, and amplitude of accommodation (Evans *et al.*, 1994b). The spatial contrast sensitivity of the tinted lens group was assessed with the Vistech near contrast sensitivity charts (taking the median result for each spatial frequency from all three charts) and the temporal contrast sensitivity (at 10 Hz) of both groups was assessed by varying the modulation contrast of a sinusoidally flickering low spatial frequency target (Evans *et al.*, 1995).

Some people experience eyestrain, headaches, and anomalous visual effects when viewing certain types of striped patterns and this 'pattern glare' has been extensively studied by Wilkins *et al.* (1984). Wilkins and Neary (1991) suggested that pattern glare might account for a benefit from tinted lenses in Meares-Irlen Syndrome. We tested for pattern glare using two high contrast square wave gratings, one with spatial properties that should cause pattern glare (pattern glare grating) and the other of low spatial frequency, which should not cause pattern glare (control grating). Subjects were asked scripted questions to detect if they perceived any of the following perceptual distortions when they viewed the gratings: colours, bending, blurring, flicker, shimmering, disappearing and re-appearing. The total number of distortions that a subject reported with a given grating was taken as their pattern glare score for that grating. This procedure is the usual method of quantifying pattern glare and has been described in more detail by Evans *et al.* (1995, 1996).

10.7.3.3 Results

No extra-ocular muscle palsies or strabismus were detected in either group. The groups did not significantly differ in terms of visual acuity, refractive error, cover test results, near dissociated or associated heterophoria, or AC/A ratio. The median near point of convergence was slightly ($p = 0.085$) more remote in the tinted lens group (5.25 cm) than in the control group (4.5 cm) and the mean amplitude of accommodation was lower in the tinted lens group (14 D cf 17 D; $p = 0.014$). The convergent and divergent vergence reserves were reduced in the tinted lens group (see Figure 10.7.1), who also had significantly worse near stereo-acuity (medians: tinted lens group, 35"; control group, 20"; Mann-Whitney U Test, $p = 0.0022$). The tinted lens group reported significantly more pattern glare than the control group in the grating that was designed to cause pattern glare (medians: tinted lens group, 4; control group, 2; Mann-Whitney U Test, $p = 0.025$), but not in the control grating (medians: tinted lens group, 0; control group, 0; Mann-Whitney U Test, $p = 0.90$).

The temporal contrast sensitivity (at 20 Hz) was not significantly different in the two groups. The spatial contrast sensitivity data were compared with the results obtained in a previous study of dyslexic and control children. We compared data from 50 of the children in the tinted lens trial (not just those from Upbury Manor School) with the data from 37 dyslexic and 42 control children (Evans *et al.*, 1995). The tinted lens ('Meares-Irlen

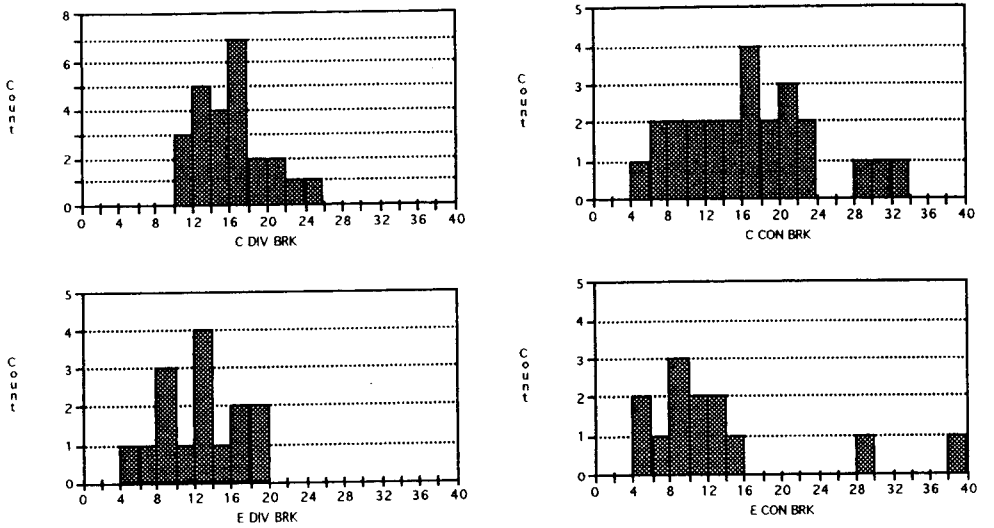

Figure 10.7.1. Graphs of the divergent and convergent vergence reserves ('DIV BRK' and 'CON BRK', respectively) in the control ('C') and tinted lens ('E') groups. The units for the abscissa are prism diopters.

Syndrome') group did not differ significantly from the controls at any of the spatial frequencies tested (1, 2, 4, 8, 12 cpd).

10.7.4 DISCUSSION

The present study investigated the optometric correlates of Meares-Irlen Syndrome, which is claimed to occur more commonly in dyslexic (50 per cent) than in good readers (10 per cent) (Irlen, 1991). A previous study used similar methods to investigate the optometric correlates of dyslexia (Evans *et al.*, 1994a,b), and it is interesting to compare the results of these two studies (see Table 10.7.1). Dyslexic children are believed, on average, to show reduced spatial contrast sensitivity to low spatial frequencies and impaired temporal contrast sensitivity (Lovegrove *et al.*, 1986). These anomalies have been described as a deficit of the transient visual system. Dyslexic children also frequently show signs of binocular instability (Evans *et al.*, 1994b), which has been characterised as reduced vergence amplitude and stability (Giles, 1960). Evans *et al.* (1993) linked the dyslexic's binocular instability, a motor deficit, with the impaired flicker perception, a sensory deficit. The present study suggests that children with Meares-Irlen Syndrome share the motor visual correlates of dyslexia, but do not demonstrate the sensory visual correlates. More research is needed to study these sensory factors using larger groups and more sensitive psychophysical techniques.

The symptoms of Meares-Irlen Syndrome are non-specific and the increased prevalence of subtle ocular motor anomalies in the tinted lens group raises the question of whether ocular motor factors might somehow be the mechanism for a benefit from coloured filters. This hypothesis is related to claims that children with the symptoms of Meares-Irlen Syndrome can be treated as effectively with optometric vision therapy as with coloured filters (Blaskey *et al.*, 1990). However, we think that this hypothesis is unlikely for the following reasons (Evans *et al.*, 1996). In the matched group research we questioned the children and their parents about whether the subjects had been observed to cover one eye

Table 10.7.1. Comparing the optometric correlates of Meares-Irlen Syndrome with the optometric correlates of dyslexia

Variable	Meares-Irlen Syndrome	Dyslexia
refractive error	normal	normal
heterophobia	normal	normal
vergence amplitude	reduced	reduced
accommodation	reduced	reduced
stereo-acuity	reduced	normal
spatial CSF	normal	reduced at low SFs
temporal CSF (20 Hz)	normal	reduced

when reading. Clinically, this symptom is taken to be a sign of binocular anomalies (Pickwell, 1991, p. 31), yet we found it to be no more common in the tinted lens than in the control group. Further, although the vergence reserves, amplitude of accommodation, and stereo-acuity were statistically significantly worse in the tinted lens group, the differences between the groups were slight and unlikely to be clinically significant. These observations suggest that our selection criteria to exclude subjects with clinically significant ocular motor anomalies were sufficiently rigorous to allow the conclusion that the benefit from colour in our tinted lens group was not the result of ocular motor anomalies.

Nevertheless, we investigated the possibility that there was a tendency for our subjects to prefer a chromaticity that would modify their accommodation in such a way as to reduce any heterophoria. Analyses showed that there was not a statistically significant effect of this type. Finally it should be noted that the double-masked placebo-controlled trial supports Irlen's claim that the chromaticity of the optimal coloured glasses can be highly specific. We know of no other ocular motor mechanism which shows this high chromatic specificity.

10.7.5 CONCLUSIONS

The double-masked placebo-controlled trial suggests that people who experience eyestrain, headaches, and anomalous visual effects whilst reading sometimes report a reduction in their symptoms when they use individually and precisely prescribed coloured filters. This benefit is not solely attributable to a placebo effect (Wilkins *et al.*, 1994), although a placebo effect is doubtless a factor in at least some cases. One method of reducing the number of 'placebo cases' when prescribing precision tinted lenses is to screen initially with coloured overlays and to only carry out intuitive colorimetry once a person has shown a sustained benefit from an overlay. This method is used routinely with children (Irlen, 1991; Wilkins, 1994), although it should be noted that our study confirmed theoretical predictions that the colour of a person's optimal tinted spectacles cannot be predicted from the colour of their preferred overlay.

Our group of subjects who, on average, showed a benefit from coloured filters were compared with an asymptomatic control group who did not report a benefit from colour but who were matched for age, IQ, and reading performance. Optometric testing showed that the tinted lens group did not differ significantly from the control group in their visual acuity, refractive error, and heterophoria. However, the tinted lens group had a reduced vergence and accommodative amplitude and poorer stereo-acuity than the control group. This suggests that the tinted lens group demonstrated the motor optometric correlates of dyslexia (Evans *et al.*, 1994b). Our finding that they did not manifest the sensory optometric

correlates of dyslexia (Evans *et al.*, 1994a) requires replication with more sensitive psychophysical tests than the clinical nature of our study permitted. The tinted lens group did demonstrate more pattern glare than the controls, and we feel that this is likely to be an important part of the explanation for the efficacy of coloured filters.

Our results suggest that the benefit from coloured filters is not simply derived from a correction of ocular motor anomalies. However, since we excluded subjects with clinically significant orthoptic problems and still found an increased prevalence of subtle ocular motor anomalies in our tinted lens group it seems likely that there is an increased risk of people with Meares-Irlen Syndrome suffering from ocular motor anomalies that might require treatment. This is in agreement with the literature (Blaskey *et al.*, 1990) and, therefore, we think it important that before trying coloured filters people should have a thorough optometric examination and any clinically significant conventional visual anomalies should be corrected.

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