Australian Orthoptic Journal 1991; 27: 1-11

The Patricia Lance Lecture, Melbourne 1990

FIVE YEARS OF TINTED LENSES FOR READING DISABILITY

ANNE FITZGERALD, DipAppSc(Cumb), DOBA, MPH(Syd).
University of Sydney, Dept Clinical Ophthalmology Save Sight and Eye Health Institute

The Patricia Lance Lecture is fitting recognition for all the work Miss Lance has done for Orthoptics both in Australia and overseas.

Miss Lance instilled in all her students the importance of the need for clinical research, and I hope that this presentation will live up to the standards she encouraged in us.

I am very honoured to be the first of Miss Lance's students to be asked by the Council of the OAA to present the Patricia Lance Lecture and I am going to discuss my research into the use of tinted lenses in the treatment of reading disability.

Tinted lenses were introduced to Australia in 1985 by Helen Irlen, a psychologist from the USA.

As there was no scientific backing for the therapy and no clinical evidence supporting Irlen's claims of a cure for reading disability, many thought that the treatment may die a natural death like so many of the other miracle cures for reading disability that have appeared over the years.

It would appear however that the reverse has happened. Irlen clinics have been established, under a franchise arrangement, in every capital city in Australia as well as in a number of country areas. Irlen clinics have also been established in centres throughout the world, (including New Zealand, UK, USA, Hong Kong, Canada and the Netherlands) once again, under a franchise arrangement.

Although testing of Irlen lenses has revealed that they are Solar CR39 lenses tinted with commercially available dyes there is an inordinate expense involved in their prescription. According to a report from the Australian Institute of Health in February, 1990[1] the charges being levied by the Irlen franchises for consultation and lenses are as follows:
First hour — $65 to $75
Second hour — $65 to $75.

During the first hour the patients are screened to assess their eligibility for tinted lenses. If they are eligible they return for a second one hour visit to have the tint colour and strength established. To have the tinted lenses made up it costs $60 for plano lenses or $105 for prescription lenses.

According to Irlen, to be eligible to be helped by Irlen lenses the patients must have 'scotopic sensitivity syndrome' which is a specific visual dysfunction associated with sensitivity of white light and a preference for certain wavelength bands. Irlen states that this sensitivity and thus reading ability depends on an interaction between rods and cones.[2]

The terminology is misleading as the scotopic system is not used when reading. Also, as we read in photopic conditions the rod receptors are relatively inactive, thus no interaction between rods

Address for correspondence: Anne Fitzgerald, Department of Clinical Ophthalmology, Sydney Eye Hospital, Sir John Young Crescent, Woolloomooloo, 2011, Australia.

and cones is necessary for reading. Irlen's explanation of a rod cone interaction is meaningless.

Irlen claims that her lenses filter out the narrow band of light which causes the visual symptoms commonly associated with reading disability. Analysis of the lenses revealed that, as expected, they did not entirely filter out any wavelength of light.[3]

Irlen also claimed that "...by filtering out the offending wavelength the lenses improve contrast and make the print clearer and bigger".[4] Results of my research, which will be discussed later in this paper, do not support Irlen's claim that tinted lenses improve the clarity.

The claim that tinted lenses make the print bigger has only been substantiated in cases where a plus correction has been added to the lenses.

Since 1985 I have been involved in a number of studies aimed at assessing the effect of tinted lenses on vision and contrast sensitivity in normal and reading disabled children.

In the first study conducted in Adelaide as part of the Speld South Australia tinted lens study group I tested a group of reading disabled children with and without tinted lenses.[5] These children also had their reading assessed by the remedial teacher at the Flinders Medical Centre. The results of this study demonstrated that reading did not improve in any of these children after three or six months of tinted lens wear.[6,7]

At the same time a number of other studies reported on the effect of tinted lenses on reading ability. Some authors reported that tinted lenses did not alter reading ability[6-10] while others reported that they did.[2,11-17] One paper reported mixed results.[18] The papers with the positive results usually attempted to give a reason for their findings. Two papers reported that the tinted lenses had improved the patients' ability to see. This intrigued me as neither of these papers formerly assessed visual acuity. All the reports were based on subjective comments from the patients.[12,16]

Our study was the only one to assess vision. I found that visual acuity and contrast sensitivity were not altered by the use of tinted lenses. Thus there was no quantitative change in vision.[19]

In a subsequent study I conducted in Sydney, vision and contrast sensitivity were assessed on 325 primary school children with and without various colours and strengths of tinted lenses.[6,20]

The results of this study demonstrated once again that vision and contrast sensitivity were not altered in normals with the use of tinted lenses irrespective of the tint colour or the strength of the tint used.

In both the Sydney and Adelaide studies the Vistech Vision Contrast Test System (VCTS) 6000 at 1/3m and 6500 at 3m were used thus contrast sensitivity was assessed at 1.5, 3, 6, 12 and 18 cycles per degree (cpd). The high spatial frequency (narrow stripes), 12 and 18 cpd represent vision needed for reading. The wider bands are commonly associated with more gross visual tasks such as face and object recognition.

The results of my first two studies provided no visual evidence that would explain why tinted lenses should improve the ability to see print on a page. As a result I began to strongly suspect that the lenses may have been causing a placebo effect or that there was a 'visual preference' effect at work.[6,21]

The placebo effect of the tinted lenses was that wearing tinted lenses gave the children a REASON or excuse for their inability to read and the tinted lenses acted as an attention factor. This, in turn, boosted their self esteem and gave them a reason to try to learn to read. Some of the literature both for and against tinted lenses also commented on the possible placebo effect.[12,16,18,22]

Visual preference could also be a factor. Almost everybody has a preference for looking at the world through one or other colour and strength of tint. The tinted lenses alter the appearance of objects and it is possible that this alteration could be MISINTERPRETED as an improvement in vision. Wilsher and Taylor[22] suggested that dyslexics should differentiate visual preference and other psychological factors affecting the way they see the page from actual improvement in visual performance.

Despite my feelings about the placebo and visual preference effects of the tinted lenses I was still curious because discussions with so many of

the tinted lens wearers and their parents revealed that they were convinced that tinted lenses improved things (without necessarily affecting their reading ability in many cases). I was not certain if a placebo effect could be so widespread. As a result I decided to look at the question of why we traditionally used tinted lenses or sunglasses, what their benefits were, and if they really affected our ability to see.

The use of sunglasses to reduce glare is not new. In the 15th century an Ophthalmologist called Turberville prescribed silk veils which were worn by his patients to reduce post operative photophobia.[23] This technique was the predecessor of sunglasses.

Sunglasses are now extremely popular as demonstrated by the 1974 statistics from the USA. In that year there were over 100 million new pairs of sunglasses purchased in the USA giving the manufacturers over $300 million in profits.[24] Sunglasses are big business and people like wearing them.

The wearing of sunglasses affects the light entering the eyes in the following manner. They affect

1. the intensity of the light
2. the spectral distribution
3. the environmental factors which operate on light by altering the background illumination.

However there is debate in the literature as to whether sunglasses alter vision.

Results of testing yellow tinted sunglasses for example showed, in one study of 98 subjects,[25] that despite cutting down the intensity of light and altering the spectral distribution, the sunglasses had no effect on vision or contrast sensitivity. One interesting point reported in this paper was that although the lenses did not improve the ability to see, over 50% of the patients reported a subjective improvement in vision and contrast while wearing the yellow tint. This was thought to be secondary to improvement in visual comfort. These findings were supported by a number of other publications using other coloured sunglasses.[26,27]

Although these studies did not statistically demonstrate that sunglasses altered visual acuity and contrast sensitivity in normal indoor laboratory lighting such lenses may alter visual performance under specific lighting conditions or in the outdoors.[28-30] These outdoor conditions include bright sunlight, glare from the ocean, glare from roads, and glare from fog and snow. (Glare is the result of light, the intensity of which is greater than that of the background to which the observer is adapted).

BRIGHT SUNNY DAY

Although the human eye only sees light from about 380 nm to 760 nm, short wavelength ultraviolet light also enters the eyes. High levels of short wavelength spectral light together with longer wavelength ultraviolet light cause the visual annoyance associated with glare. When looking at a scene on a sunny day, firstly with sunglasses consisting of an ultraviolet filter and a coloured filter, and then without, it is apparent that sunglasses minimally alter the appearance of the scene. This occurs because the sunglasses reduce the amount of short wavelength light hitting the eye. Also, visual comfort is enhanced as it is not necessary to 'screw up' the eyes to look at the scene.

Thus sunglasses can alter the appearance of the world and enhance visual comfort without necessarily altering visual acuity in bright sunlight.

SNOW and FOG

The effect of glare is very noticeable when there is more ultraviolet light such as at altitude or where light is preferentially reflected into the eyes for example from the snow or in conditions of fog.

Fog is made up of droplets of water and it is the size of these droplets which determine the manner in which the light is scattered and thus the intensity of the glare. Normally short wavelength blue and violet light is scattered more than red and green wavelengths. As a result, yellow lenses which absorb short wavelength light, will minimize the effect of the scatter of the light in fog and improve visibility. Thus sunglasses have a physiological effect on our ability to see in fog.[31]

In other low contrast conditions where there are high levels of ultraviolet light, such as in blizzards and snow, yellow and yellow green tinted sunglasses or goggles will enhance visual ability by absorbing more short wavelength light.

Some studies claim that Polaroid lenses will give most improvement in visual ability in these low contrast conditions.[30] They also work just as well on reflected glare such as the glare from water.

Polaroid sunglasses are very effective for reflected glare from flat surfaces. This is because the light is preferentially reflected off surfaces and is generally reflected in a horizontal plane. Polaroid lenses oriented vertically absorb most of these reflected light rays and work no matter what the ambient light levels.

Much of the literature concluded that sunglasses only altered vision due to an increase in apparent contrast and brightness to mid spatial frequencies especially in extreme environmental glare conditions.[30, 32] Thus, in out-door conditions sunglasses enhance visual comfort and alter the appearance of the world and can sometimes alter the ability to see at mid spatial frequencies (not at high spatial frequencies).

There are a number of ocular conditions in which sunglasses do alter the ability to see in normal viewing conditions and in mildly increased glare. Two such conditions are colour vision anomaly and rod monochromatism.

(i) ABNORMAL COLOUR VISION: Tinted lens filters alter the purity of a colour so we perceive the colour slightly differently. This effect is extremely mild in patients with normal colour vision but it can have marked effects on patients with poor colour vision. Farnsworth[33] tested patients with a variety of colour vision defects. He found, for example, that yellow lenses affected colour appreciation markedly in patients with moderate to moderately severe colour defects and red tinted lenses markedly reduce vision in patients with severe colour vision loss. He concluded that patients with colour vision loss should only be prescribed mildly tinted lenses.

Tinted lenses can also be used to enhance the appearance of objects to enable colour defective patients to pass tests like the Ishihara. Red lenses brighten the reds compared to the other colours enabling the patient to distinguish between the number on the plate and the background.

(ii) ROD MONOCHROMATISM: This is a condition in which the cones do not function normally rendering the child partially sighted and colour deficient. These children are extremely photophobic and virtually blinded by very bright light.

Recent work has demonstrated that dark red tinted lenses (especially contact lenses) which absorb long wavelength light will reduce the reflected glare from the background. This improves the contrast between the background and the image for rod monochromats.[34]

As there are some conditions in which sunglasses actually alter vision I decided to investigate if Irlen's hypothesis that reading disabled patients were more affected by glare than normals[4] was correct and, if so, did tinted lenses improve their ability to see, as they do for rod monochromats.

I investigated the effect of tinted lenses on vision and contrast sensitivity in conditions of increased glare in reading disabled children and children who read normally.

This study was conducted in the Division of Orthoptics at the Lincoln School of Health Sciences, La Trobe University.

Two groups of patients were studied

Group 1. 22 reading disabled patients aged 8-19 years who had been prescribed tinted lenses at the Irlen tinted Lens clinic in Melbourne. (Nineteen children were 16 years or under).

Group 2. 129 school children aged 12 to 16 years.

To be included in the study the patients had to have monocular visual acuity of 6/6 or better (Snellen's) and N5. Stereopsis had to be normal using the Lang Stereotest and strabismus was excluded.

All the children were tested with and without tinted lenses using the Vistech Multivision

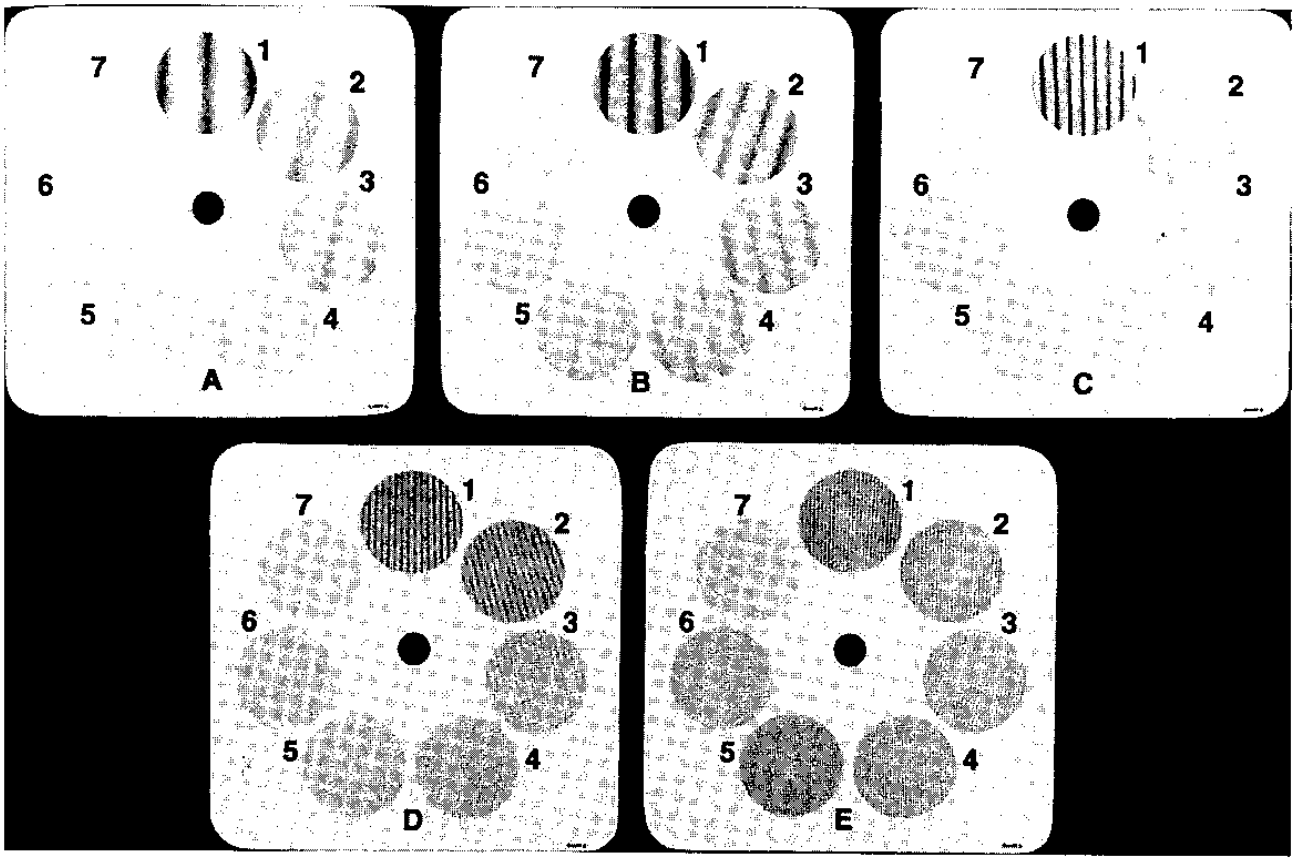

Figure 1a: MCTS Contrast Sensitivity Targets.

Contrast Test System (MCTS) test. Contrast sensitivity was assessed under normal photopic lighting conditions both with and without additional peripheral glare. Testing was done at 1/3m.

The gratings used are the same as those used in the VCTS tests, namely circular gratings of 1.5, 3, 6, 12 and 18 cycles per degree. The children were asked to look at each circular target in turn and inform the examiner of the orientation of the stripes (see figures la and lb). The minimum contrast at which the stripes could be detected was recorded for each spatial frequency (strip width).

Each of the normals (group l) had contrast sensitivity assessed binocularly at 1/3m with one randomly selected colour and strength of tinted lens. Tint colours used included green, yellow, blue, pink, amber, grey and clear with strengths of 25%, 35% and 50%.

Patients in group 2 were tested with and without the lenses prescribed by the Irlen lens clinic using the Irlen technique.

The test was firstly performed under normal photopic lighting conditions with and without tinted lenses and then with the peripheral glare lights turned on with and without tinted lenses. The results were recorded and later averaged for the whole group and transposed onto the evaluation form supplied with the test (see figure 2). The horizontal axis gave the stripe width or spatial frequency and the vertical axis gave the contrast sensitivity.

RESULTS

In this study only 22 tinted lens wearers from the Irlen Lens clinic were examined so, at best it can be described as a pilot study giving preliminary results only. (The full statistical analysis of the results is the subject of another publication).[35]

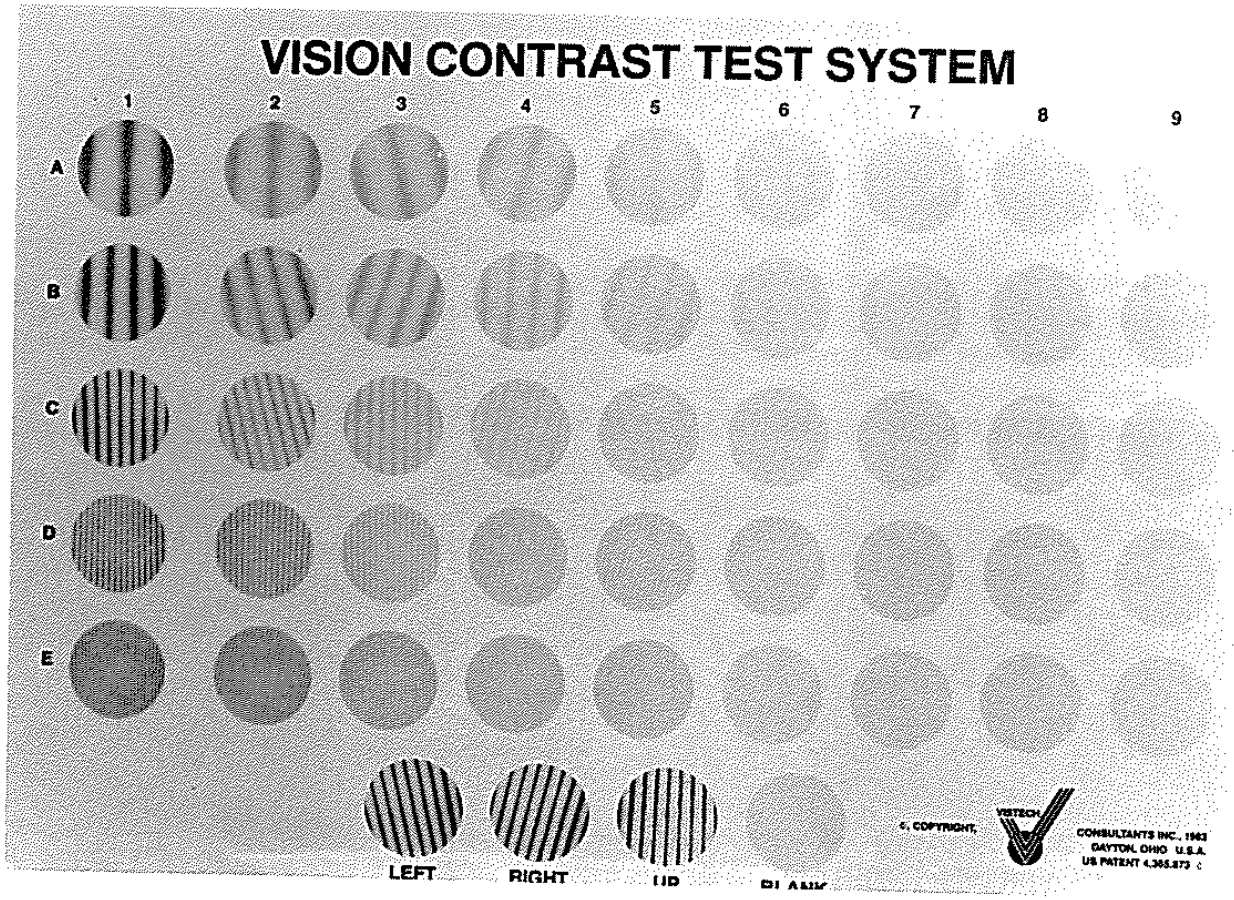

Figure 1b: VCTS Contrast Sensitivity Targets.

Effect of tinted lenses:
Analysis of variance (ANOVA), at the $p<0.05$ significance level, showed that the score was a statistically significant alteration with the use of tinted lenses in Rows A, D and E in the normals.[35] In Row A the score minimally increased with tinted lenses and in Rows D and E the score minimally decreased when tinted lenses were worn (see figure 2a). The same findings occurred using a Wilcoxon matched pairs signed-ranks test and using a Friedman two-way ANOVA.[35] These results differed from my results gained when using the Vistech VCTS 6000 and it conflicted with other reports in the literature on the effect of tinted lenses on contrast sensitivity.[5,19,20,25,27,30] (The pattern of the alteration of score with tinted lenses was confusing as there was a tendency for scores to decrease in Row A and increase in Rows D and E).

In the Irlen clinic reading disabled group, tinted lens wear did not have a statistically significant effect on contrast sensitivity (Wilcoxon test; see figure 2b). This result was in keeping with the other reading disabled patients I have assessed.

Effect of glare (without tinted lenses):
Using an ANOVA, a Wilcoxon test and a Friedman analysis in the normals peripheral glare produced no statistically significant effect on contrast sensitivity in Rows A, D and E however in Row B and C the response to the contrast sensitivity test improved (see figure 3a). This improvement was statistically significant.

In the Irlen clinic reading disabled group, contrast sensitivity improved using peripheral glare without tinted lenses in Rows A, D and E (see figure 3b). This improvement was NOT

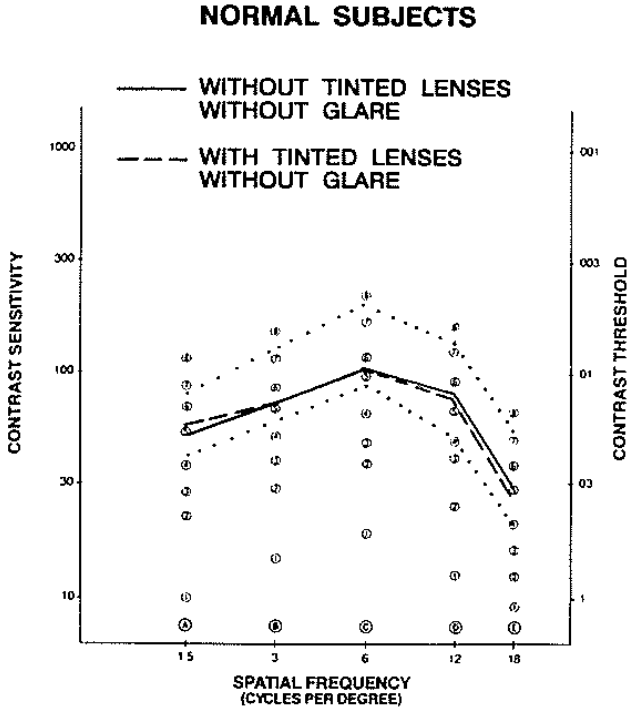

Figure 2a: The Effect of Tinted Lenses on Contrast Sensitivity (NO Glare); Normal Subjects.

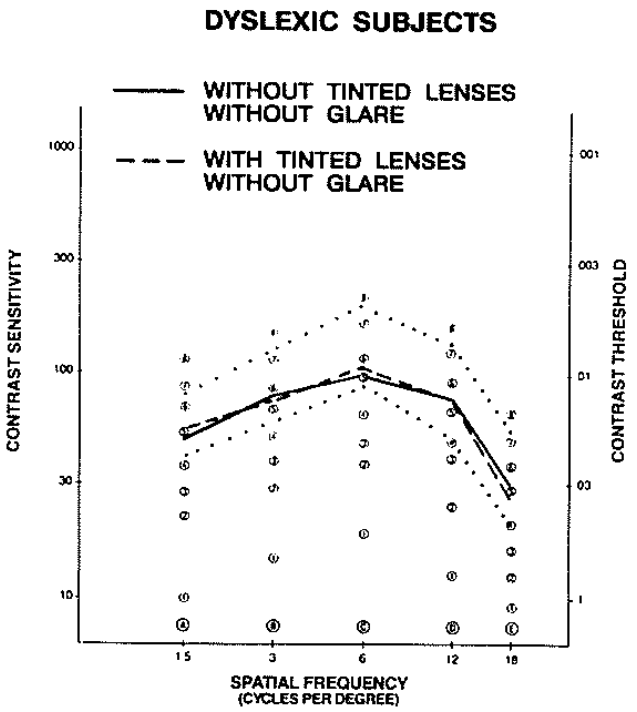

Figure 2b: The Effect of Tinted Lenses on Contrast Sensitivity (NO Glare); Irlen Lens Clinic Patients.

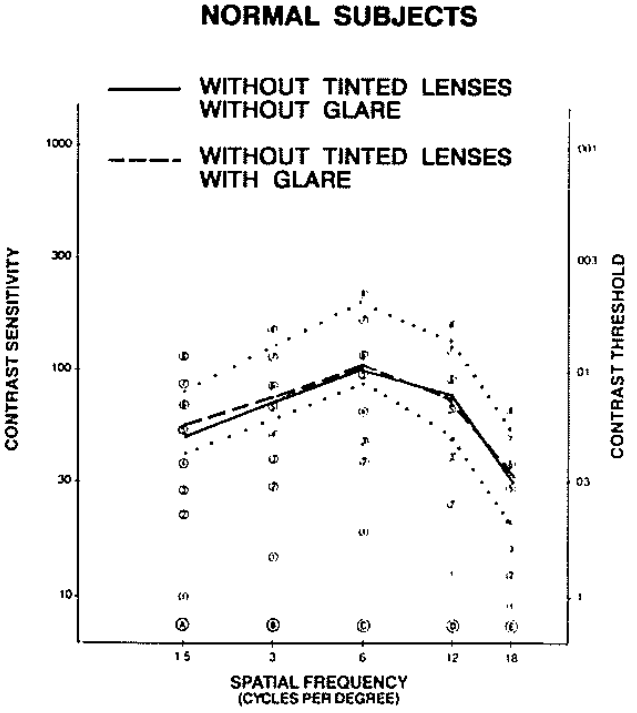

Figure 3a: The Effect of Glare on Contrast Sensitivity (NO Tinted Lenses); Normal Subjects.

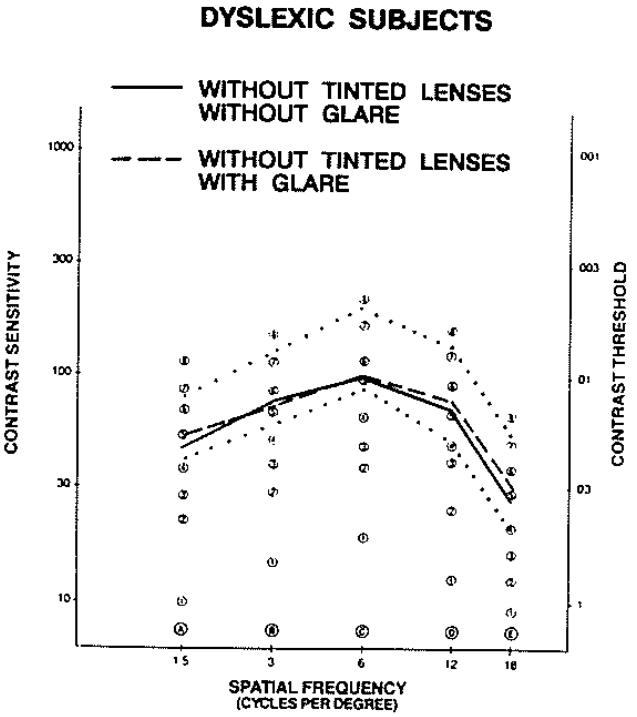

Figure 3b: The Effect of Glare on Contrast Sensitivity (NO Tinted Lenses); Irlen Lens Clinic Patients.