Professional prescribing of tints and coloured filters

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The art of prescribing tints and coloured filters is an essential part of any optical professional's repertoire. They should be able to assess which tints are acceptable for the patient and, perhaps more importantly, which are not. They should know when and how to prescribe, and also when tints are inappropriate. Optical professionals should be able to specify a clinical tint and expect it to be modified accurately when lighting determines that it is necessary. They should be aware of colour, brightness and the effects of lighting, reflectance and remittance. They are obliged to be aware of the physiological effects of the filter prescribed – both good and bad. In short, the public rightly expect the optical professions to be experts in tint and filter prescribing. But is this reality?

Current methods of prescribing tints by optical professionals vary from "does the tint match the frame?" to empirical prescribing to eliminate harmful wavelengths. With some notable exceptions, most professionals will work on a "trial and error" basis for the vast majority of prescribed tinted lenses. The question is "Is this acceptable?" If tints have little or no effect, the answer is yes, but if they have significant effects then it is clear that this paradigm must change.

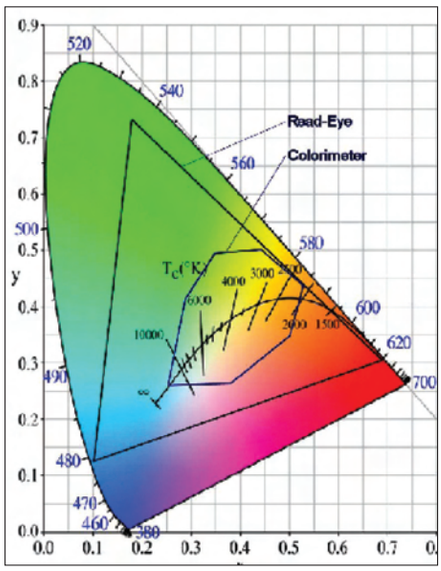

Figure 1
Comparing the colour gamut of the Intuitive Colorimeter with the Read Eye (CIE 1931 colour space diagram)

There are numerous factors to be taken into account when prescribing tints or filters. These include the patient, task, environment, ambient lighting and transmission of the lens. Each must be understood when prescribing any tint and should be considered by the professional. This is particularly important if the optometrist endorses the tint prescription – "tint clinically necessary". If the optometrist does not endorse its prescription with precise instructions such as the CIE coordinates, which can be modified depending on task, then it is traditionally the decision of the dispensing optician to determine the optimum filter. In this case they must understand how to prescribe a clinical tint adequately for a given patient.

From a prescribing perspective, it is not appropriate to name a proprietary filter on the prescription unless the dispensing has been accurately determined. As such, the only practical method of prescribing a clinically necessary filter is to denote colour space coordinates - and the dispensing optician should know how to determine the filter for the task from this information, taking into account metamerism (colour changes due to lighting) and factors such as McAdams eclipses (essentially colour tolerances).

The patient – recognising need

The reason for wearing a tint or filter is usually determined by patient need. They may be photophobic with reflex tearing, have asthenopia and spend their time with significant discomfort, they may work in a job that requires eye protection, or they may have a wide range of physical responses that could be provoked by the ambient light. Therefore recognition of need is crucial but may not be obvious, even to a professional. It is therefore essential that optical professionals recognise symptoms that may indicate the need for professionally prescribed tints.

Symptoms that may indicate a need for a tint/coloured filter are numerous, often co-morbid and may have a number of different aetiologies. Therefore it is important that a professional can differentiate those conditions in which filters are appropriate from those which do not have a visual cause. This can be extremely complex, in particular when determining whether a tint is necessary and, if so, which filter is the most appropriate. In cases of a non-verbal / non-cooperative patient it is still important, perhaps even more important, to prescribe filters appropriately in cases of clinical necessity. Trial and error methods are often inadequate / impossible and empirical methods inappropriate, but with knowledge, and the right instrumentation, it can be done. The author suggests prescribing tints and filters correctly can make as much difference as a refractive error correction – in many cases it can be even more important. However, some optometrists / dispensing opticians believe that tints "have no effect" and would dispute this assertion. This position is becoming increasingly untenable, and the author believes unsustainable.[1]

Types of tints

There are four major types of tints: (a) *Broad spectrum* – these are designed to have limited saturation and therefore

cannot be used either to assess or treat problems at the edge of colour space. They do not change colour perception significantly. They are the most common optometric filters. (b) *Band filter* – these are often much more saturated and therefore can be used to assess and manage problems at the edge of colour space. These include lenses such as blue light blockers and the V-Dex range of lenses. They may be much more complex to prescribe and it is critical that the optical professional is aware of prescribing techniques and potential problems before prescribing. They are often extremely powerful lenses in effect (positive and negative) and proper use can make massive differences to outcomes. They are used relatively rarely except by knowledgeable professionals. They are often an extremely effective optometric intervention. They will be lighter than a broad-spectrum filter when colour space positions coincide. (c) *Notch* – these are rarely used in optometric practice but they can be of great use in specialised cases. They are expensive to design and prescribe but they may become more common in the future as a "booster" in prescribing. (d) *Variable (photochromic)* - these are generally broad-spectrum brightness filters although other types are available.

Methods of tint prescribing

There are six principal methods of tint prescribing, and it will become clear in this article that optical professionals should not use some of these. Each of these methods is discussed in more detail in the following sections.

Does it match the frame?

This is prescribing a tint as a purely cosmetic addition to a lens. Whilst in many cases this is acceptable, it depends on the effect of the tint being either neutral or beneficial. The optical professional should satisfy himself or herself that:

1. The tint is suitable for purpose
2. The effect of the tint is not harmful
3. The patient does not need a clinical tint

This requirement of making sure that the tint prescribed is fit for purpose means that the optical professional should check whether the tint has an effect on the patient, especially any negative effects. Prescribing using this technique has significant risks – and therefore it should be used with caution.

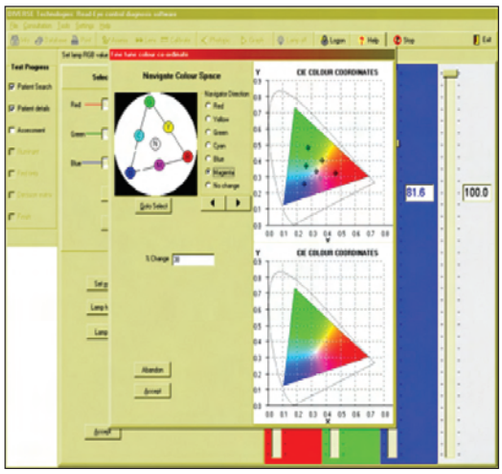

Figure 2
Using a forced choice method in colour space – similar to a crossed cyl method in colour space

Trial and error

This is prescribing a tint for clinical need by using of a range of trial lenses.[2] This can be acceptable providing there is a sufficient range within colour space (not just the number of lenses available) and that task and ambient lighting can be replicated. It is very difficult, perhaps impossible, to achieve optimal colour using this technique, but it may be possible to get a good result in many cases. However, this approach does have a number of drawbacks:

- It is extremely difficult to be systematic as the colour vision / perception of the assessor may well interfere with filter choice
- It can be virtually impossible to predict the effect of ambient lighting change
- The number of trial lenses will have to be very large for clinical use
- The assessment will inevitably be very time consuming
- It is difficult / impossible to take into account patient tolerances

This method is unlikely to be good practice in cases of clinical need or that in which very accurate prescribing is necessary.

Prescribing from overlays

Many children have been prescribed overlays as an aid to reading and it is common for parents to ask their optician to supply tinted spectacles to match. There are many pitfalls in taking this action. For example, the overlays are double pass filters assessed in unknown lighting conditions, the effect of peripheral lighting is often different using spectacles, and the limited range of overlays makes it very unlikely that the optimum tint has been chosen initially. Matching a spectacle tint by eye in this case is virtually impossible (even though it would at first glance appear simple). The best advice here is never to prescribe a tint from an overlay without re-assessing it yourself. And trying to match the overlay with a tint is almost always poor prescribing.

Empirical prescribing

Empirical prescribing may be divided into two parts – task and protection. *Task prescribing* may be used when a specific cut-off may be beneficial e.g. to promote contrast within sports such as shooting or tennis. Flicker modulation reduction may be possible depending on light emission and the lens transmission curves. In some cases the task will determine whether a broad spectrum or band filter is more appropriate as target remittance may be a factor in filter performance. But there can be a dilemma – the best filter for the task may be illegal for the task for which the lens is prescribed. For example, optimised filters may improve visual acuity, visual fields and peripheral image detection, but are illegal for night driving. So, do you prescribe for optimum vision or to comply with the law? The law is paramount but you could prescribe the same lens for other tasks such as walking around.

Protection prescribing is a different matter entirely. The most obvious protection need is from ultraviolet (UV) light, with infrared (IR) and blue light protection also possible.[3] In cases where safety is involved, the optician should understand the risks and must prescribe lenses that filter the potentially harmful radiations. Often a band filter or notch filter is necessary, as standard broad-spectrum optometric filters may be inadequate. All optical professionals should be able to prescribe filters for safety and task, but in addition they should be aware of how these lenses affect the patient in other ways – and prescribe the best type of filter from

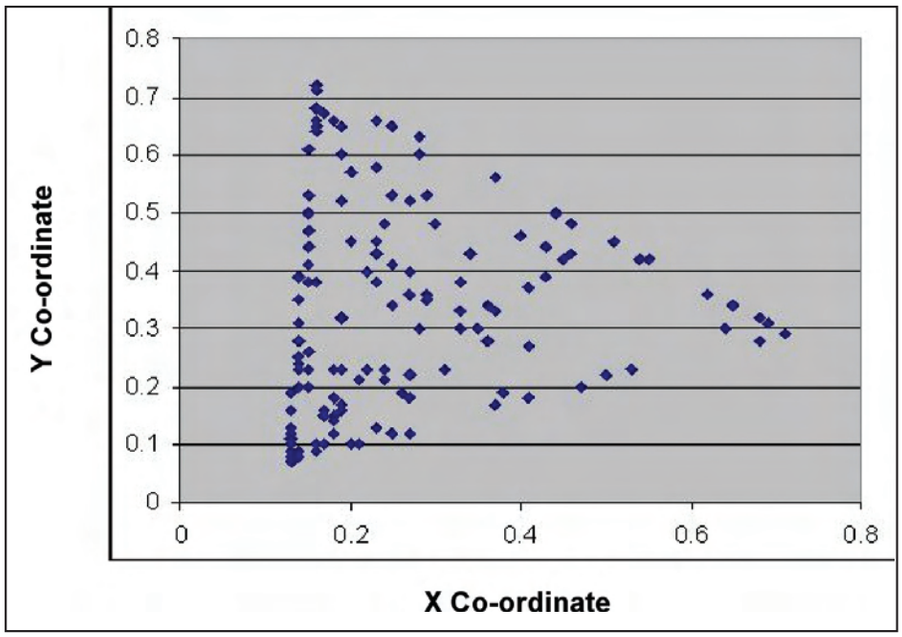

Figure 3
Optimum positions (x and y co-ordinates) in colour space of 180 consecutive patients found using the Read Eye in clinical conditions – note how they are found at edge of colour space range and mainly outside range of any other assessment method

the range that is available – even when prescribing a protective lens.

Colour instrumentation

Subtractive Colour

The most obvious method of an instrument that uses subtractive colour assessment and prescribing is the Intuitive Colorimeter (Cerium Visual Technologies, Kent, UK). It is essentially a fluorescent light source with a number of coloured filters placed in various ratios between the light source and the viewing panel. It was developed by Arnold Wilkins and funded by the Medical Research Council. Assessments are mainly confined to reading-related problems, although there have been some notable successes in other areas such as finding lenses in migraine relief. It prescribes broad-spectrum filters only (its limited range prevents it being able to find more complex filters) and has been trialled with some measure of success. It has been described in detail in Optometry Today in previous issues.

The method of prescribing usually followed is one where the optometrist will alter the hue, saturation and brightness within colour space until an optimum position is found. They will then have a basis for determining the filter to be prescribed and by utilising a bank of trial lenses they can find the optimum lens from within their range. In addition, they have an online programme to modify the tint for use under differing lighting conditions.

Additive colour

The only system on the market at this time that uses an additive approach is the Orthoscopics Read Eye. It is based on the principals of univariance i.e. it approximates a separation of the cone cell responses (based on a route mean square – RMS – analysis of retinal function) and allows the professional great flexibility when determining filters. It was part funded by the UK government as a significant improvement on previous technology.

It has a large colour space triangle (over double that of the next best instrument), is extremely accurate in comparison with previous techniques and works to CIE (the international colour body) coordinates – to three figures (see Figure 1). Comparing the colour gamut of the Read Eye to that of the Intuitive Colorimeter shows that the range of the colorimeter is completely encapsulated within the range of the Read Eye.

There are a number of assessment techniques available at both distance and near, from iso-luminance rotation in colour space (similar to the Colorimeter), through effective near separation of the cone cell pathways (and an approximation of opponency pathways), to forced choice methods (similar to cross-cyl. in colour space – see Figure 2) and it is even possible to use objective methods in assessment of optimum colour response. Comparisons are possible either as adapted methodology (similar to the Intuitive Colorimeter) or usually much more satisfactorily immediate comparisons. It is even possible to assess colour vision problems using this instrument and develop colour contour mapping.

A colour envelope in which optimum visual performance can be achieved is found (this allows tolerance determination – Figure 3) and ambient lighting options and combinations of lighting are used to show filter options. These can be emulated with any lighting conditions using the illuminant system and immediate comparisons may be made; either different variations of filter (e.g. broad spectrum versus band filter) or the transmission range of an individual filter that may be appropriate within the colour envelope.

It is vitally important that the professional can determine the accuracy of filter that is supplied by the manufacturer and the Read Eye also has incorporated within it a lens assessment system and how accurate it will be in varying lighting conditions. But is it too complex and accurate? If tints have little effect then the answer must be yes – but if they have significant effects then accuracy and range is critical, and the answer must be no.

Conditions that may benefit from clinically prescribed filters

There are a number of areas that may benefit from visual stimulus control, some of which may be new to optometrists. Some effects can be measured using conventional methods whilst others are more problematic. Research is at present limited and some of it cannot be published due to patent law restrictions but we are aware of over a hundred effects of visual stimulus control i.e. using tints can be very successful in a variety of areas and in many cases they are

much more effective than standard optometric interventions. These effects may be placed into a number of areas:

- Primary optometric results
- Orthoptics
- Medical conditions
- Cognitive difficulties
- Synesthetic effects

There is also an obvious question that must be asked – if prescribing the correct tint can alleviate difficulties then can prescribing the wrong one (even one that looks identical) induce unwanted effects? A good example of this would be the change from Crookes alpha / A2 tints to their visually matched equivalents in CR39. Most optical practices in the country had significant problems with non-tolerance with this change, even though the lenses looked identical!

Optometric and Orthoptic areas that may respond to tints

Several aspects of visual function may respond, either positively or negatively, from the prescription of tints. These include:

- Visual Acuity – including amblyopia
- Prescription changes due to lighting e.g. night myopia (a major cause of non-tolerance?)
- Eye movement (saccades and pursuit)
- Strabismus
- Fusion
- Nystagmus
- Convergence insufficiency
- Accommodation problems
- Visual fields and attentional fields – including restoration of field loss[4]
- Fixation and tracking
- Visual stability
- Temporal processing – the Pulfrich effect, sensory integration effects, mid line effects, hand-eye coordination

The science and assessment techniques are straightforward and well accepted but are beyond the scope of this article. Perhaps the most important of the above is temporal processing changes – the effects are often massive for the patient in terms of quality of life, yet optical professions rarely, if ever, address these.

Other effects

The medical effects of filters are principally found in a range of neurological conditions, although the science is not yet understood or well researched at present. It is a potentially exciting area for optometrists in the future. The author has conducted some exciting research in this area and is looking forward to being able to publish the outcomes soon. Cognitive effects of filters are diverse and common, and frequently not recognised. They are particularly numerous in patients with special needs, such as Autism, Aspergers syndrome, Cerebral Palsy, Dyslexia and Dyspraxia. It is important that optical professionals either assess these themselves or refer to a practice that will take appropriate action. Lighting effects in special needs such as metamorphopsia, dysmorphia and prosopagnosia should be routinely assessed and managed.

Synesthetic effects i.e. visual stimulus is perceived by another sensory system, are likely to be much more common than is realised, although they may be extremely difficult to recognise, particularly when there is a temporal and spatial mapping discrepancy. They are common in autism.[5,6]

Prescribing the right lens

It is clear from what has been written that most tinted lenses are prescribed by either trial and error or empirically. A relatively small number are prescribed by the Intuitive Colorimeter and the Orthoscopics Read Eye. Empirical prescribing may be very useful, and trial and error can be acceptable, but the optical professional has to be aware of the potential pitfalls of these techniques. If a clinically necessary lens is required it is essential that the professional can find the most appropriate lens for the problem and demonstrate how they came to that decision.

Conclusion

It is worth remembering that a tint / filter effect is determined by the lighting, the lens transmission curve, the object viewed and the response of the patient. The latter is of paramount importance and it is this that should be determined by the optical professional. Tint specification on the spectacle prescription should preferably follow an internationally recognised format such as CIE coordinates, not a commercial lens type, as this may change depending on task. The dispenser should then work out the optimum lens depending on task and environment. However, this complexity presents the challenge that faces optometry – how can clinically prescribed tints be specified on the prescription in a simple and easy to understand manner? Future research currently underway might help to answer this question.

About the Author

Ian Jordan is a dispensing optician in specialist practice with his optometrist wife Beatrice in Ayr, Scotland. He is also a director of Orthoscopics and has designed lenses (and tints) for well known optical companies. He is a well-known international lecturer for a wide number of professions. He has written six books and often writes for a number of professional magazines. He is involved in much innovative research – with universities and other bodies – although most has to remain confidential for commercial / patent reasons. He has won a number of awards for R&D.

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