An exploration of areas of colour space expanded for ‘colour blind’ observers.

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Introduction

- There are three types of cone in the normal eye: the S, M, and L cones (Figure 1).
- Colour anomalous observers (6% of males) have hybrid forms of the normal M and L cones, and thus have a different colour space.
- Remarkably, they can discriminate some colours that are indiscriminable to normal trichromats (Bosten, Robinson, Jordan, & Mollon, 2005).
- Our aim was to find specific colours that are metameric for normal, but distinct for anomalous observers.

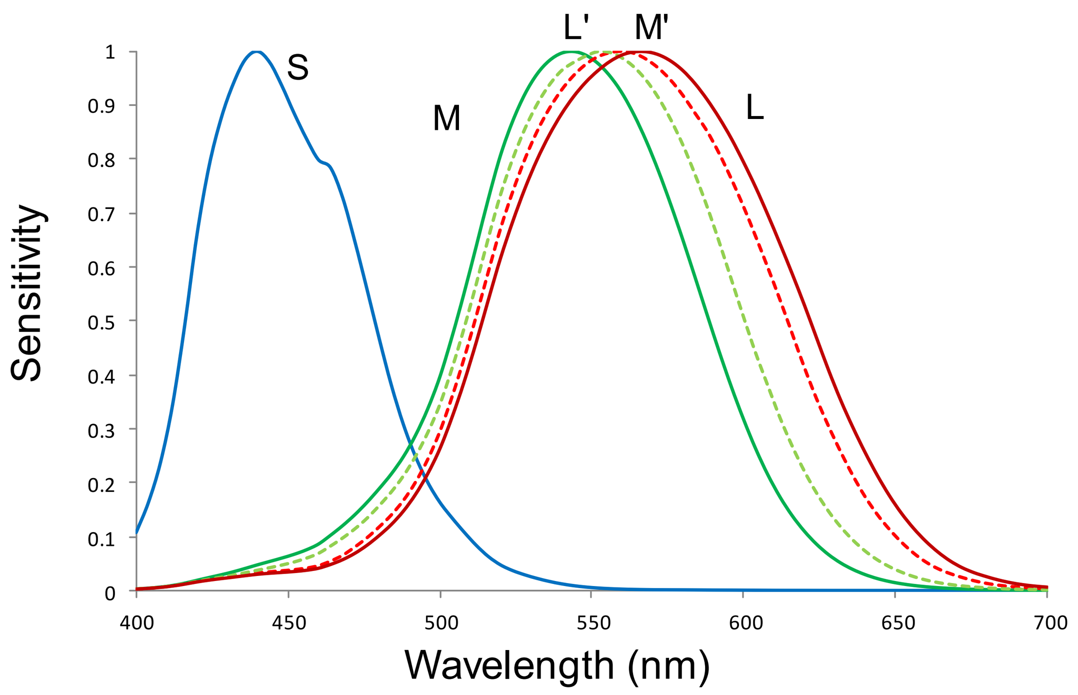

Figure 1. - DeMarco, Smith, & Pokorny (1992) Cone Fundamentals.

Trial Phase

- Almost 400 paint samples were created from mixing 15 single-pigment paints in three different proportions.
- We used acrylic paints because they share characteristics with surfaces found in the natural world, unlike monochromatic lights or those emitted from computer monitors.
- We sought metameric pairs differing in the spectral range between 550-700nm but with otherwise similar reflectance spectra.
- The reflectance spectra were measured under standard illuminant C.
- To calculate the signals to the physiological colour channels, we multiplied the reflectance spectra by the cone fundamentals and summed the output to give the activation of each type of cone. The signals to each type of observer’s two colour channels were calculated from these and plotted in MacLeod-Boynton colour spaces respective of observer type.
- To find metameric samples for normal observers we sorted the paint mixtures into perceptual colour categories and identified violet + yellow mixtures as potential metamers and proceeded to the development phase.

Development Phase

Procedure

- Violet + yellow mixtures were created in five consecutive proportions and measured as described in the trial phase.
- Two mixture pairs were identified that were near metamers for normal observers but slightly different for anomalous observers.
- These paint pairs were mixed again in even finer proportions, and were calibrated and converted into the colour spaces of each type of observer as described in the trial phase (see Figures 2, 3, and 4). Additionally, to suppress S-cone activation, these mixture samples were measured under a yellow-filtered illuminant.

Results

- Disappointingly, the expected separation in signals for anomalous observers was not found, and the samples were distinct for normal observers as well.

Conclusions

- Our chosen violet + yellow mixtures are not suitable for investigating the expansion of colour space of anomalous trichromats.

Placeholder for paint samples

Discussion

- Identifying colours to demonstrate the expanded areas of anomalous colour space is important and has many implications.
- People with anomalous trichromacy are usually labelled ‘colour blind’, and as a result are often unable to pursue certain career options. But, given the variation in colour vision in general, any disadvantage an anomalous observer has may not even be noticeable. And, the advantage anomalous trichromacy conveys could be harnessed in professions where the use of certain colour cues is particularly salient.
- It is therefore important that blanket labelling of ‘colour blind’ individuals is reconsidered and discrimination arising from that labelling is avoided.
- A further exploration of different colour combinations is still necessary.

References:

Bosten, J.M., Robinson, J.D., Jordan, G., & Mollon, J.D. (2005). *Current Biology, 15*(23).

DeMarco, P., Smith, V.C., & Pokorny, J. (1992). *JOSA A, 9*(9).

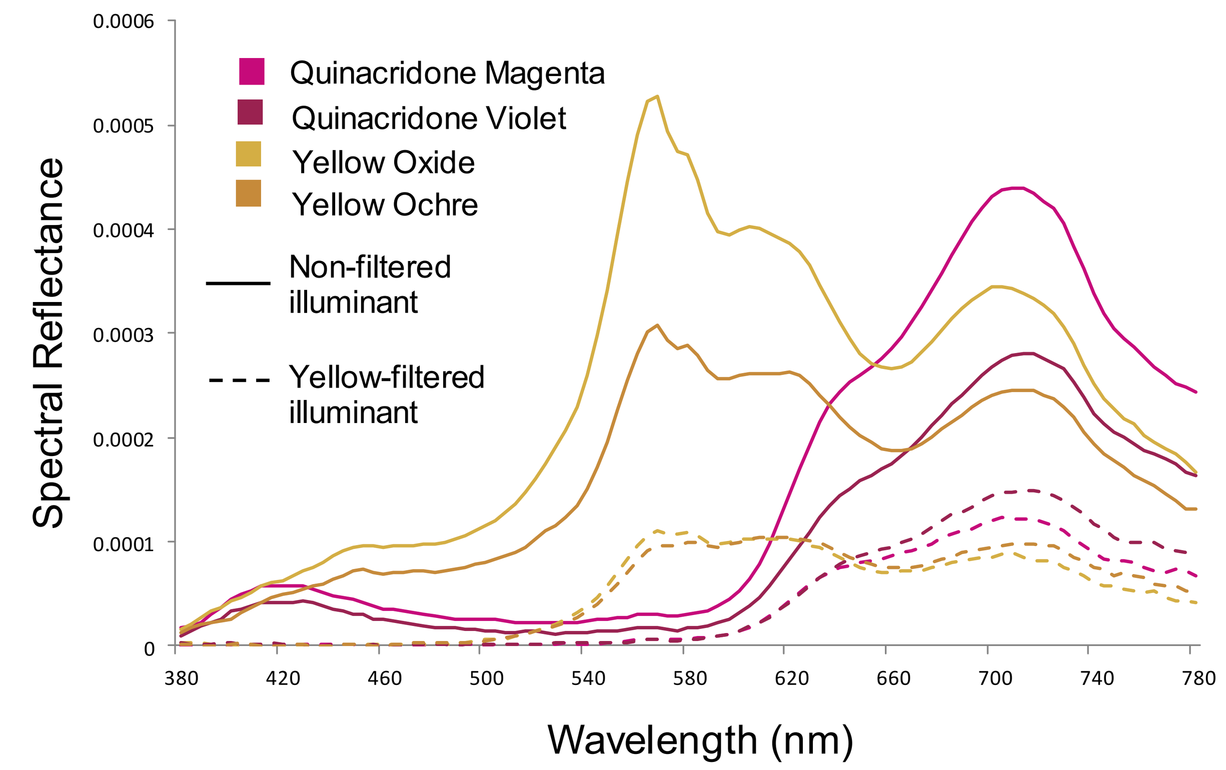

Figure 2. - Reflectance spectra for violet and yellow paints.

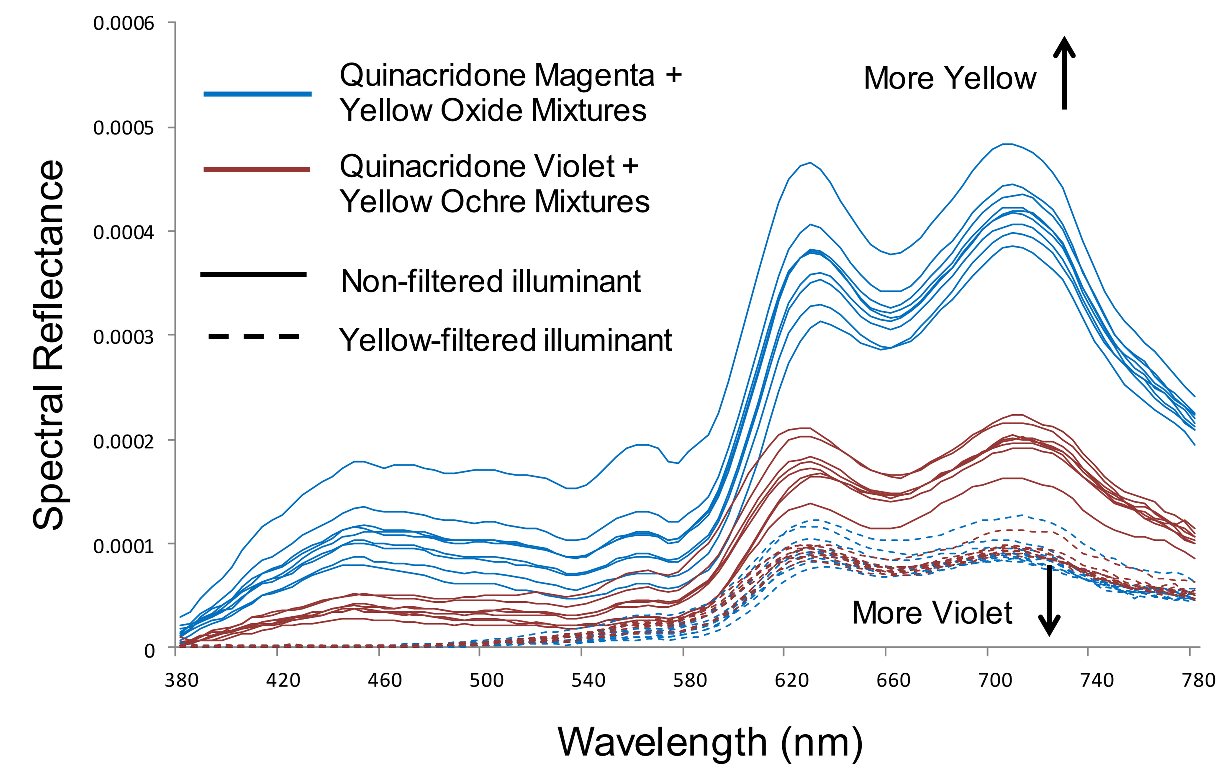

Figure 3. - Reflectance spectra for violet + yellow mixtures.

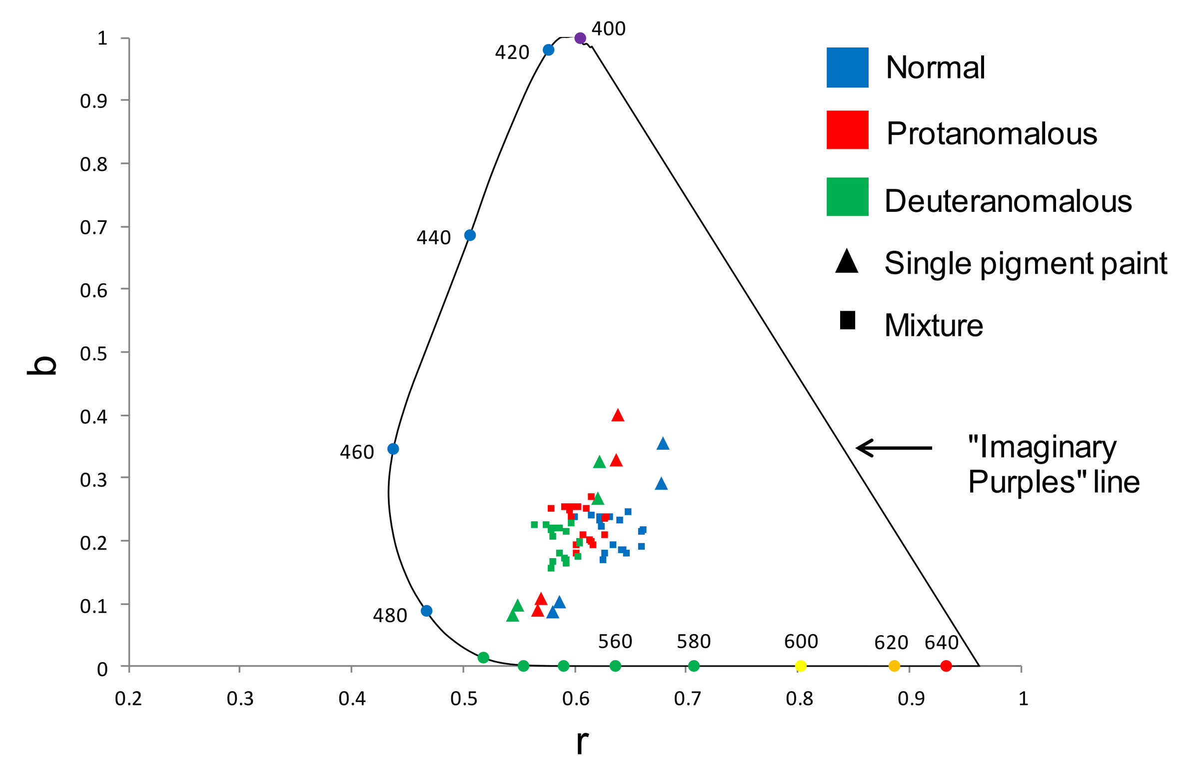

Figure 4. - Violet + yellow mixtures plotted in a MacLeod-Boynton Diagram.