The Colorimetric Cross Method for Maximising Melanopic Ratios

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The aim of this work is to explore a novel method for metameric light source design for use in vision science experiments studying the function of the photopigment melanopsin in the retinal intrinsically photosensitive retinal ganglion cells (ipRGCs). A chromaticity based approach is used to find the optimal peak wavelengths of narrowband LEDs from which to compose a metameric pair of sources. This method is an alternative to methods utilising the theory of metameric blacks, which are well suited to experimental design where there is pre-existing multi-channel lighting hardware. This method instead starts with a 'blank slate', and considers the optimum wavelengths with which to create a light source with specific characteristics.

A metameric pair can have drastically differing melanopic contributions whilst appearing identical (i.e. generating identical LMS photoreceptor responses). Thus, they can be used to study the effect of melanopsin activation, by substituting one of the pair with the other and noting any difference in effect (known as the 'silent substitution' method). It is desirable that the differentiation in melanopsin activation be maximised.

A simple metameric pair can be created using four spectrally distinct narrowband LEDs where two contribute exclusively to each light source of the metameric pair. The minimum requirement for metamerism in this case is that; when considered in a chromaticity space, the line connecting the chromaticities of the two LEDs contributing to the first light source must cross the line connecting the chromaticities of the two contributing to the second. The position at which these two lines cross should be the chromaticity of the metameric pair, which can be achieved by adjustment of the intensities of the LEDs in each pair.

A tool was developed in Matlab to predict the melanopsin contributions of realisable metameric pairs. One such metameric pair, using close-to-optimal wavelengths, was fabricated with four groups of LEDs as a proof of concept and for use in further experiments.

Keywords: colorimetry, melanopsin, metameric pair, stimulus design, LED
Category: 08. Color & Light / 09. Colour Science & Technology
Presentation Preference: Either talk or poster