The Colorimetric Cross Method for Maximising Melanopsin Ratios

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The aim of this work is to explore a novel method for spectral light source design, for use in vision science experiments studying the function of melanopsin, using a chromaticity based approach to find the optimal peak wavelengths of narrowband LEDs from which to compose a metameric pair of light 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 source with specific characteristics.

A metameric pair can have drastically differing melanopsin contributions whilst appearing identical (i.e. generating identical LMS photoreceptor responses). Thus, they can be used to study the possible influence of melanopsin in the retinal ipRGCs, 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 contribution 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 lights 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.

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