Origins and history of the Standard Observers

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Historical background and aims

The investigation of colour-mixture data began in the XIX° century. Once Young (1802) had stated the trichromatic hypothesis, several approaches were explored. Maxwell (1852) designed an apparatus to study colour matches and verified the trivariance of vision. Grassmann (1853) generalized the properties of colour matching. Helmholtz (1860) synthesised the experimental and the physiological approaches. Later, König and Abney produced high standard data.

The need for standardization of colour measurement emerged with the advancement of industry. Specifically, the need for a standard observer for colorimetry was expressed soon after "Average Normal Visibility Values" (the CIE standard photometric observer) were published in 1924. By that time, several scientists had already elaborated rules for establishing a conventional colorimetric system.

The standard observers

In the late twenties, colorimetric measurements were performed in two different laboratories (Wright, 1928-29; Guild, 1931). The close agreement between the two sets of experimental measurements is quite impressive. This is due to the accuracy of the measurements as to the reproducility of the observers colour matches. The data were presented in terms of "trichromatic coefficients of the spectral colours" (spectral chromaticity co-ordinates). It was stated that "the spectral distribution curves" (colour-matching functions), when weighted by the luminosity factors of the primaries, summate exactly to the standard 'normal' visibility curve" (quoted from Wright, 1981),. The curves incorporate the standard visibility function.

The choice of reference primaries **X**, **Y**, **Z** was made for the sake of simplicity. First, it would produce an all-positive system and facilitate colorimetric computations. Second, the luminance information would be given by the *Y* tristimulus value, an advantage that we still enjoy. This work resulted in the adoption of the "CIE 1931 standard colorimetric observer".

Later, the V(lambda) curve has proved to be in error at the violet end of the spectrum. For sure, such an error has been harmful to the standard colorimetric observer. Nevertheless, as the colour-mixture data were free of error, any corrected visibility curve would improve the derivation of colour-matching functions. Such an improvement *V'*(lambda) was proposed by Judd in 1951, but not adopted by the CIE at that time.

The "CIE 1964 supplementary standard colorimetric observer" meets the needs for large-field colorimetry. Rules for establishing the data basis were the same as in 1931 but a different experimental protocol was designed (Stiles & Burch, 1959). Tristimulus values were directly derived from 10 degrees colour-matches, without input from any

external photometric data basis. The result is acknowledged by the industrial community and by the scientific community as a safe data basis.

Perspectives

Nowadays, colorimetry is spread among many industrial fields. Eminent scientists have written excellent study books (Wyszecki & Stiles, 1982). Colour-matching functions form the basis for modelling colour vision.