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A model for the simultaneous analysis of reflectance spectra and basis factors of Munsell color samples under D65 illumination in three-dimensional Euclidean space

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In this paper we present the results of an analysis of the physically measured surface reflectance spectra of 360 matt Munsell chromatic color chips plus 10 flat achromatic vectors corresponding to Munsell Valve levels 10 (white) to 1 (near black) for a total sample size of 370. Each of the 370 spectra were multiplied by the spectral radiant power distribution of D65 light so that the final results represent the spectra of reflected light from Munsell color chips under D65 illumination. We simultaneously model the structure of the color chips and the spectra in a common three-dimensional Euclidean space, oriented to yield the most interpretable structure with respect of the Munsell color structure. In this orientation axis 1 roughly corresponds to the mean power of the spectral reflectance (approximate Munsell Value), axis 2 goes from Munsell Red to Blue-Green, and axis 3 goes from Munsell Green-Yellow to Purple. Basiss factors for the spectra are also plotted against wavelength and Munsell Hue. These plots have implications for theories of opponent processes. By plotting the chips and spectra in the same space we obtain virtually exact correspondences between the various Munsell hues and spectral values in nm for comparison to those obtained by previous researchers. Mathemical derivations are provided to validate the common Euclidcan model.