New scientific results

1. The wavelength discrimination function is related to the spectral distribution of the brightness compensated neural opponent signals according to the following equation:

$$w(\lambda) = c_1 \log\left(\frac{c_5}{c_2 \frac{dc_{rg}(\lambda)}{d\lambda} + c_6}\right) + c_7 \Bigg|_{\frac{dc_{rg}(\lambda)}{d\lambda} > \frac{dc_{by}(\lambda)}{d\lambda}}$$

$$w(\lambda) = c_1 \log\left(\frac{c_5}{c_3 \frac{dc_{by}(\lambda)}{d\lambda} + c_4}\right) + c_7 \Bigg|_{\frac{dc_{rg}(\lambda)}{d\lambda} < \frac{dc_{by}(\lambda)}{d\lambda}}$$

where $w(\lambda)$ is the wavelength discrimination function, c_{rg} and c_{by} are the red-green and blue-yellow brightness compensated opponent signals and c_1-c_7 are constants. The $w(\lambda)$ function's values are determined by the c_{rg} signal above 540 nm and by the c_{by} signal below 540 nm.

2.a Monochromatic wavelength values can be defined for the color identification of color normals that determine the spectral boundaries between the main color identification categories. The limiting 'λ' values are the following:

Color category boundaries	**λ, nm**
Purple-Blue	435,6
Blue-Turquoise	487,7
Turquoise-Green	511,5
Green-Yellow	554,8
Yellow-Orange	582,2
Orange-Red	616,4

2.b The monochromatic color identification of color normals can be characterized with the '$D_{0,5;c}$' spectral values that give the dominant wavelength range for each color category where the specific color name is used more than 50%. The size of the ranges for the specific color categories are the following:

Color category	$D_{0,5}$, nm
Purple	48
Blue	62
Turquoise	16
Green	54
Yellow	19
Orange	28
Red	168

3. The monochromatic color identification wavelength (λ_{C}), that is based on the numerical transformations' density function of monochromatic color identification tests is suitable for the differentiation between color normals and different types and severities of anomalous trichromats. Therefore with a monochromatic color identification test carried out in the visible wavelength range in at least 10 nm steps, the different types and severities of protanomaly and deuteranomaly can be diagnosed.

4.a Based on the modeling of broadband spectra stimuli on the color perception of color normals and anomalous trichromats in the OCS color system a two-dimensional value can be defined that characterizes the type and severity of the color deficiency for 'n' different color identification categories. The value is given with the following equation:

$$ID\#\left(c_{rg};c_{by}\right)=\left(\frac{1}{n}\sum_{i=1}^{n}\left|\overline{c_{rg}}_{\,i}\right|;\frac{1}{n}\sum_{i=1}^{n}\left|\overline{c_{by}}_{\,i}\right|\right)$$

where c_{rg} and c_{by} are the color coordinates in the OCS color system for the different spectral stimuli.

4.b The identification values is suitable for the color vision correction modeling of anomalous trichromats in the OCS color system in the following formula:

$$ID\#\left(c_{rg}^{\ korr};c_{by}^{\ korr}\right)=\left(\frac{1}{n}\sum_{i=1}^{n}\left|\overline{c_{rg}^{\ korr}}_{\,i}\right|;\frac{1}{n}\sum_{i=1}^{n}\left|\overline{c_{by}^{\ korr}}_{\,i}\right|\right)$$

where c_{rg} and c_{by} are the color coordinates in the OCS color system with the contribution of the color vision correction filters.

5. The spectral approximation error of photopic color vision test instruments providing spectrally matched light distribution for broadband spectral distributions in the λ_1 - λ_2 wavelength range can be given with the following equation:

$$\Delta = \frac{\int_{\lambda_1}^{\lambda_2} \frac{V(\lambda)((O(\lambda) - I(\lambda))^2}{I(\lambda)} d\lambda}{\int_{\lambda_1}^{\lambda_2} V(\lambda) I(\lambda) d\lambda}$$

where Δ is the integrated spectral approximation error for a given spectral distribution, $V(\lambda)$ is the human relative photopic spectral sensitivity function, $O(\lambda)$ is the output and $I(\lambda)$ is the input spectral distribution respectively.