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41st European Conference on Visual Perception (ECVP) 2018 Trieste

Welcome Address

The 41st European Conference on Visual Perception (ECVP) took place in Trieste (Italy), from August 26 to 30, 2018. This edition was dedicated to the memory of our esteemed colleague and friend Tom Troscianko, with an emotional Memorial lecture in his honour held by Peter Thompson during the opening ceremony.

The conference saw the participation of over 900 fellow vision scientists coming from all around the world; the vast majority of them actively participated, allowing us to offer an outstanding scientific program. In particular, we hosted almost 300 oral presentations in 21 symposia and 21 talk sessions, and more than 500 posters during the innovative 'Poster day'. Among symposia, there were two special ones: the European Symposium on Perception and Action in Sport (ESPAS), gathering the most influential researchers in the field, and Perceptual Structures – A Festschrift for Michael Kubovy, celebrating his retirement. As concerns keynotes, the Perception lecture was held by Dejan Todorović, while the Rank Prize lecture was held by Branka Spehar; moreover, in the program we also included the Kanizsa lecture, held by Walter Gerbino. Finally, we respected the tradition of the Illusion night, this year entitled "Un mare di illusioni" as it took place by the sea.

To conclude, we sincerely thank all the volunteers, whose contribution was fundamental for the success of the conference.

The ECVP 2018 organising committee

Tiziano Agostini, Paolo Bernardis, Carlo Fantoni, Alessandra Galmonte, Mauro Murgia and Fabrizio Sors

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Luminance and Chromatic Contrast Sensitivity at High Light Levels

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Contrast sensitivity functions (CSF) are commonly used to characterise the sensitivity of the human visual system at different spatial scales, but little is known about CSF at light levels reflecting everyday outdoor vision. The purpose of our study was to measure chromatic CSF at medium and high luminance levels (100, 1,000 and 7,000 cd/m^2). Stimuli were displayed on a high dynamic range display allowing background luminance levels of up to 15,000 cd/m^2. Also, 0.5° Gabor patches were generated; stimulus placement and threshold estimation were controlled using a four-alternative forced choice procedure (Quest; PsychToolBox). CSF were measured in three directions in colour space, reflecting early post-receptoral processing stages: an achromatic (L + M) direction, a 'red–green' (L/(L − M)) direction, and a 'lime-violet' direction (S/(L + M)). Our preliminary results suggest that the shape of the chromatic CSF is changing when the background luminance is increased from 100 and 7,000 cd/m^2. Local and global adaptation models will be discussed.

The Program Simulating Dichromacy as a Possible Tool for Detecting Color Deficiencies

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A normal human color vision is based on three types of cones with L, M, and S photopigments. The absence of one of them results in dichromacy: protanopia (−L), deuteranopia (−M), and rare tritanopia (−S). There were many applications developed to make a normal trichromate understand how the dichromates perceive colors, generating a single picture for each form of dichromacy. However, there are an infinite number of images indistinguishable from the original one. My program converts the input picture by direct and inverse transformations between monitor pixel values (R, G, and B) and relative cone excitations (L, M, and S), depicting it in various "palettes." All three images (original, "deuteranopic," and "protanopic") are presented simultaneously. The subject under test must choose one picture differing in color from the other two. Normal trichromates select the original picture as the most different one, protanopes select "deuteranopic" image, and deuteranopes select "protanopic" image.

Tablet-Based App for Screening for Colour Vision Deficiencies in Young Children

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There is currently no widely available and accurate test for diagnosing colour vision deficiency (CVD) in pre-literate children, yet young children with CVD may be particularly disadvantaged by widespread use of colour in early learning environments. We present a new tablet-based app that is aimed as a tool for screening for CVD in children aged 2 to 6 years. The app measures chromatic thresholds along protan, deutan and tritan confusion lines using an adaptive staircase procedure. Targets are coloured discs presented on a grey surround, with both luminance and tritan noise included to increase sensitivity. The test is embedded in a child-friendly interface 'game' where children reveal characters by correctly selecting the coloured targets. We are able to achieve accurate colour calibration on Apple iPads, with errors along the MacLeod-Boynton L/(L + M) axis under 0.5% and maximum tritan errors of 3% (which are masked by the tritan noise). We present preliminary results from a population of 4- to 7-year-old children.

Effects of Reflecting and Sub-Surface Scattering Lights on Facial Skin Appearance

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The light enters the skin is reflected, propagated, absorbed and diffused in each layer. We examined the effects of reflecting and sub-surface scattering lights on facial skin appearance and how we evaluate the skin quality. We measured the reflecting and the scattering components of nine women's faces by applying Nayer's method and generated artificial average faces which had different ratios of the reflecting and the scattering components. Participants evaluated healthiness, preference, skin transparency, luster and whiteness of each face. The results show that the optimal ratios of both components for skin transparency depend on individuals. We found that skin transparency can be explained by a function of three variables: luster, whiteness

The program simulating dichromacy as a possible tool for detecting colour deficiencies

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Introduction

The normal human color vision is based on three types of cones in the retina: with long-wave (*L*), medium-wave (*M*) and showt-wave (*S*) photopigments. The absence of one of them results in dichromacy: protanopia (-*L*), deuteranopia (-*M*) and rarely encountered tritanopia (-*S*).

There are many places on the Internet illustrating for a normal trichromat how the dichromats perceive colours. Some examples of simulated colour images "seen through the eyes of dichromats" are probably based on verbal descriptions of the perceived colours by people with colour deficiencies, others seem to use accurate, but often unpublished algorithms.

Two different examples of simulation of colour blindness

A – an illustration from https://4tololo.ru/content/14043. The first image is for normal trichromats, the second is for deuteranopia and the third is for protanopia.

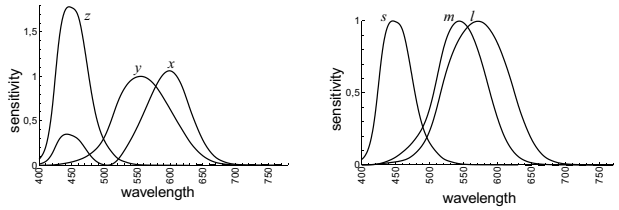
B – the same original image and its simulations for deuteranopia and protanopia created by the online colour blindness simulator at http://www.etre.com/tools/colourblindsimulator/.

It can be seen from the figure A that all objects are still distinguishable by their hue on the image made for deuteranopes (this image looks like a simulation of an anomalous trichromacy, not a dichromacy). Simulated images from the figure B look more plausible for colour vision scientists but cause questions among ordinary people: "Why do the images seen by deuteranope and protanope look so similar? Why are they both yellow?" The present work was done to answer these questions by creating another, our own colour blindness simulator.

Methods

The work of the simulator is based on direct and inverse transformations between monitor pixel values (R, G, and B) and relative cone excitations (L, M, and S).

Relative spectral sensitivities of human cones were deduced from the CIE XYZ colorimetric system basing on the set of three copunctal points: protanopic ($x_p = 0.75$; $y_p = 0.25$; $z_p = 0.0$), deuteranopic ($x_d = -1.7$; $y_d = 0.7$; $z_d = 0.0$) and tritanopic ($x_t = 0.17$; $y_t = 0.0$; $z_t = 0.83$) (Nyberg, Yustova, 1957).



Spectral distribution curves for C.I.E. XYZ standard colorimetric system and human cone spectral sensitivities

Conversions from the monitor RGB values to LMS cone excitations and vice versa were made with the assumption that the monitor was set up to the colour temperature of 6500 K ($x_w = 0.3127$; $y_w = 0.3291$) and had the gamma value of 2. For the simplicity of calculations the LMS values were scaled so that the brightest monitor white colour (255, 255, 255) corresponded to the LMS values (1, 1, 1). The final transformation matrices were the following:

$$\begin{pmatrix} L \\ M \\ S \end{pmatrix} = \begin{pmatrix} 0.2900 & 0.6466 & 0.0634 \\ 0.1133 & 0.7745 & 0.1121 \\ 0.0191 & 0.1161 & 0.8648 \end{pmatrix} \cdot \begin{pmatrix} R_{lin} \\ G_{lin} \\ B_{lin} \end{pmatrix} \qquad \begin{pmatrix} R_{lin} \\ G_{lin} \\ B_{lin} \end{pmatrix} = \begin{pmatrix} 5.1171 & -4.2992 & 0.1822 \\ -0.7470 & 1.9443 & -0.1974 \\ -0.0130 & -0.1659 & 1.1788 \end{pmatrix} \cdot \begin{pmatrix} L \\ M \\ S \end{pmatrix}$$

where R_{lin}, G_{lin} and B_{lin} are the linearized monitor colour values: $R_{lin} = \left(\frac{R}{255}\right)^{\gamma}$; $G_{lin} = \left(\frac{G}{255}\right)^{\gamma}$; $B_{lin} = \left(\frac{B}{255}\right)^{\gamma}$

The algorithm

1. The original image is loaded into the memory.

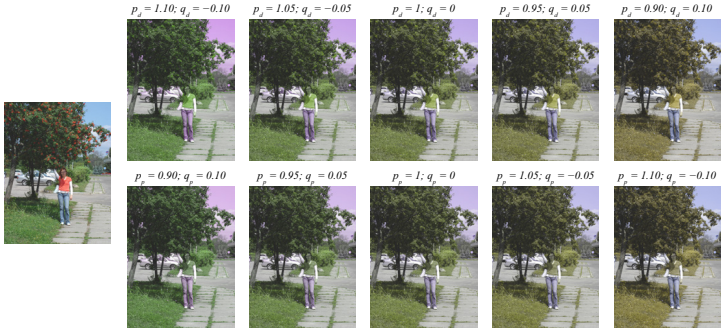
--- preparation ---

2. For each pixel of the original image the following steps are performed:
   1) linearized monitor colour coordinates R_{lin}, G_{lin} and B_{lin} are calculated and the maximum values of them are recorded (these values will be needed for the further scaling of the color range of the original image);
   2) these values are converted to the L, M and S values for the normal trichromate;
   3) these L, M and S colour coordinates are converted to those for deuteranopes and protanopes (with special considerations on the values for the omitted types of cones – see Details section);
   4) the L, M and S values calculated for dichromats are converted back to (R_{lin}, G_{lin}, B_{lin}) colour space; at this step it is highly probable that some of the values will exceed the range [0...1], which indicates that the colour range of the simulated image exceeds the monitor gamut and the image can not be correctly displayed; for these cases the maximum values of R_{lin}, G_{lin} and B_{lin} are recorded and the offset value (in (R_{lin}, G_{lin}, B_{lin}) colour space) for the original image is calculated.

--- conversion ---

3. For each pixel of the original image the following steps are performed:
   1) linearized monitor colour coordinates R_{lin}, G_{lin} and B_{lin} are calculated and scaled according to the data obtained at the preparation phase of the algorithm; this results in decrease in brightness and/or saturation of the converted trichromatic image;
   2) these values are converted to the L, M and S values for the normal trichromate;
   3) these L, M and S colour coordinates are converted to those for deuteranopes and protanopes;
   4) the L, M and S values calculated for dichromats are converted to (R_{lin}, G_{lin}, B_{lin}) and then to RGB.
4. All three images (modified trichromatic image and two simulated ones for dichromats) are displayed.

Results



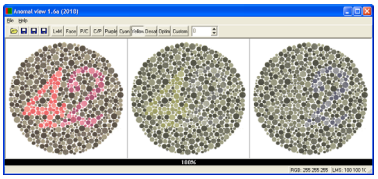
The original colour image (left) and five simulated images for each of two types of dichromacy

Upper row: images simulated for deuteranopia; lower row: images simulated for protanopia.

At first sight the images in the upper and lower rows are very similar for a normal trichromat. However you could find the berries on the rowan-tree in any image from the upper row and (probably) could not find them in the lower row.

The interface of the program with an Ishihara test image →

The first image is the original image, the second image is simulated for deuteranopia and the third – for protanopia.



Details

The programs for simulating of dichromacy, as a rule, generate a single image for each form of dichromacy. It is usually argued that the simulated image looks like it appears for a subject with a given form of dichromacy (Brettel et al., 1997). However, there is no single way to simulate an image as it appears for protanope, deuteranope or tritanope, because there is an infinite number of images indistinguishable from the original image for the dichromat. These images differ from the original trichromatic image only in the signal of the omitted colour channel (*L* for protanopia, *M* for deuteranopia, *S* for tritanopia). Here we consider only simulation of protanopia and deuteranopia.

There are several obvious ways to calculate the signal in the omitted colour channel. Suppose we have calculated the L, M and S values for a given pixel of an image for the normal trichromate.

1. The value of the omitted colour channel can be set the same as the value of the neighbouring channel. This means that for protanopia simulation we assign $L_p = M$, $M_p = M$ and $S_p = S$, and for deuteranopia simulation we assign $L_d = L$, $M_d = L$ and $S_d = S$. The extension of this approach to simulation of anomalous trichromacy was discussed by M. Lucassen and J. Alferdinck (Lucassen, Alferdinck, 2006).
2. The colours in the images simulated for dichromats can be painted in the yellow-blue monitor "palette". This approach is very similar to the first one but there is a very small difference. According to our scheme of conversion the pure yellow monitor colour (255, 255, 0) corresponds to the following *L*, *M* and *S* values: $L = 0.937$, $M = 0.888$, $S = 0.135$ (note that *L* and *M* values are not equal to each other). To preserve this yellow colour in the simulated images we should assign $L_p = (1.065 \cdot M - 0.065 \cdot S)$ for protanopia simulation and $M_d = (0.939 \cdot L + 0.061 \cdot S)$ for deuteranopia simulation.
3. In the general case the signal in the omitted colour channel can be calculated as a linear combination of signals in existing channels: $L_p = p \cdot M + q \cdot S$ for protanopia and $M_d = p \cdot L + q \cdot S$ for deuteranopia, where *p* and *q* are some coefficients. To preserve white colours on the simulated images the sum $(p+q)$ should be equal to 1.
4. As far as the dichromat has only two spectral types of cones, the simulated image (indistingushable from the original trichromatic image for the dichromat) can be drawn by the use of two monitor channels. For deuteranopia and protanopia simulations red and blue or green and blue pair can be used, resulting in magenta or cyan "palettes". In these cases, of course, white colours can not be preserved.

The proposed approach does not allow to simulate anomalous trichromacy.

Conclusion

1. The proposed program simulator allows the person with normal trichromatic vision to understand how the dichromats perceive colour images, and which images they can not distinguish.
2. The program can be used for rough detection of dichromacy. The subject under test must choose one picture differing in color from the other two. Normal trichromats select the original picture as the most different one, protanopes select the image simulated for deuteranopia, and deuteranopes select the image simulated for protanopia.
3. Looking at the Ishihara and Rabkin test plates through the simulator helps to understand what figures (and where on the image) the dichromats could see.

References

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