Color appearance of aged observers

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Introduction

The human visual system (HVS) seems rather stable over much of the life span, though it is well known that it ages constantly with the advance of life[1]. Besides the contribution of neural factors, the optical density rise of the crystalline lens and therefore the decreased illuminance of the retina seem to be the major answer for the age-related weaknesses e.g. in color discrimination or the intensity of color perception. The transmittance of the lens decreases and its spectral characteristics also change[2]. There is some evidence that the HVS adapts to these changing circumstances and re-compensates itself across the life span, and therefore a kind of long-term color constancy holds [3]. To see this more in detail, our research concentrated on typical HVS functionalities that are expected to exhibit losses or shifts in color vision if aging is considered as a factor, namely, color balance (white point), chroma perception, unique hues, and preferred hues. In the present work, these changes related to aging were investigated in terms of CIECAM02 measures, by using a computer-controlled CRT display based experimental set-up in a dark laboratory room. We conducted experiments by employing five elderly (average age: 66.6) and five young observers (average age: 25.8) and the following types of observations were carried out.

White point experiment

Observers were presented three different tasks: 1. a full-screen high luminance nearly achromatic field with a picture in the centre of it; 2. a full-screen high luminance nearly achromatic field with a full-screen picture appearing after 10 seconds; and 3. a full-screen high luminance nearly achromatic field without any picture. The observer's task was to set the chromaticity of the white background by the aid of two sliders on the user interface of the experimental program which enabled changing the CIECAM02 a_c and b_c parameters of white (near the D65 and the Planckian curves) until a "preferred white" (perceived achromatic) was found. For the tasks containing an image, the image was transformed simultaneously with the observers' adjustments so that the 'white balance' of the image always matched the adjusted white background. We found that, for all tasks, elderly observers preferred warmer whites than young observers. The preference of elderly observers was 7535 K and the preference of young observers was 7835 K in the 1st (small picture) condition. Similar results were found also in the 2nd and 3rd conditions. This contradicts the hypothesis of the preference of bluish tones to counterbalance the short wavelength absorption of the eye lens.

Unique hue and preferred hue experiments

The aim of this experiment was to point out unique hue and preferred hue differences between young and elderly observers. Observers were shown a homogenous color patch on a mid-grey background. The hue of the patch was

adjustable. The CIECAM02 lightness (*J*) and chroma (*C*) of the patch were constant. The task of the subject was to change the hue of the patch by adjusting a track bar until the hue perception of the patch matched one of the requested unique hues (unique red, unique green, unique yellow and unique blue). Observers were carefully instructed about the concept of unique hue. In another task, they had to reproduce their most preferred color corresponding to the following color names: red, green, yellow, and blue, with a similar experimental set-up. Observations were performed at different lightness and chroma levels.

Results showed that the most remarkable differences occurred at low lightness levels, and generally, elderly observers' unique hues were slightly shifted toward shorter wavelengths.

Chroma perception

The observer's task was the adjustment of the chroma of color disks of different hues displayed on the monitor until all disks exhibited equal amount of perceived chroma to a reference color of given chroma. The hue angles of the adjustable disks differed 45° each in the CIECAM02 a_C-b_C plane. 8 hues were investigated at different lightness levels (*J*) and for different values of chroma (*C*) of the reference colors.

The equal amount of chroma found by the observers depended both on hue angle and on the *J* and *C* parameters. For the same hue angle, elderly observers required more chroma than young observers, see Figure 1.

The white preference and the chroma perception differences between young and elderly observers seemed to be of larger importance than the unique hue and preferred hue differences.

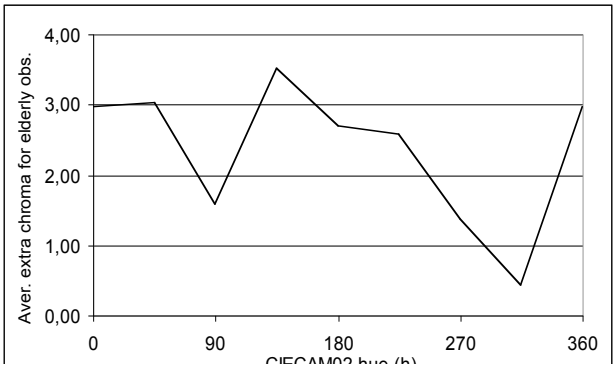

Figure 1. Average chroma difference (ΔC CIECAM02) as the function of hue, between the elderly and the young

References

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