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Possible influences of motion and attention to contribution of retinal adaptation effect in color constancy

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論 文 内 容 の 要 旨

Color constancy is the common phenomenon where the perceptual color of a surface does not change significantly by an illuminant changes. The adaptation of the photoreceptors at the retina and early part of neural pathways and cognitive mechanism occurring at a higher level are considered as two main factors contributing to the color constancy. The retinal adaptation effect is that since cones and early neural pathways are adapted by the color illumination, the matching in the color constancy will reflect the reduction of cone and/or neural responses. The illumination estimation effect is that the observer will estimate the color of the illumination and shows the color constancy in considering the reflectance of the colored surface (shown in the standard pattern in this study). It is not clear, however, how the utilization of these color constancy mechanisms depends on target motion and attention. This study aims to investigate about the possible influences of target motion and attention defined by a gaze-state to the color constancy. The color constancy was examined under three conditions in a haploscopic view on a monitor: target-static and target-motion and target-rotation conditions. In the motion conditions, color targets in both patterns moved from top to bottom with the speed of the 3 deg. /sec, or color targets rotated 10 times in one min. For attention modulation, we additionally used two observation conditions; the observers were asked to fixate their eye on the test target as an eye-fix condition or to explore the entire stimulus as an eye-free condition.

Since the color constancy would be analyzed not only in terms of cone excitations but also in terms of color-opponency, the illuminations in this study was set by chromatic shifts on red-green and blue-yellow color-opponent axes. The colors of red and green illuminants were shifted equally by the color difference of 53 ΔE^*uv along (L-M) axis. The colors of blue and yellow illuminants were shifted by 45 ΔE^*uv along [S-(L+M)] axis. The 5 deg.-square standard pattern illuminated by D65 (white) illumination (in simulation) and 5 deg.-square test pattern illuminated by one of color illuminations were presented side by side in the haploscopic view; both patterns consisted of a 1.2 deg.-square central color target having one of 12 colors as a surface property

surrounded by background ellipses painted by other 8 colors. Six color-normal observers from 22 to 28 years old were asked to complete the task by making a simultaneous paper match on the color targets between the standard and test patterns under the D65 and color illuminations, respectively.

The results of this asymmetric color matching experiment indicated that the motion of the target could not improve the color constancy; rather the motion averagely decreased the color constancy. In the gaze-state, the free eye movement increased the color constancy. Each result could be explained by different situations of retinal adaptation effect and illumination estimation effect. In the motion and eye-fixation condition, foveal part of the retina was rather adapted to the mean chromaticity of the surround, so the retinal adaptation was stronger in this condition. The motion, however, made less attention to the color of the background; it could cause weaker effect of the illumination estimation. Conversely, in the static (no motion) condition, the attention to the background colors caused the illumination estimation effect stronger and the color constancy was improved. The result of this study is different with that of previous literature measured by achromatic adjustment experiment, in which the color constancy was influenced more by the cone adaptation and less by the illumination estimation. On the contrary, in this study, the result of the asymmetric color matching could be influenced by both illumination estimation and cone adaptation when the illumination estimation effect is stronger than the cone adaptation effect.