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VISUAL PERFORMANCE UNDER DIFFERENT ARTIFICIAL ILLUMINATIONS INCLUDING LEDS

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Objectives: The increasing diversity of illumination types requires characterization from both quantitative and qualitative aspects. In most applications today the qualitative parameters of the light sources are prioritized, however with the spreading of LEDs there is more flexibility in color representation and novel products shall emphasize qualitative parameters too. Therefore it is viable to investigate how ambients with similar photometric and colorimetric parameters but with spectrally different light source types like LEDs induce alterations in human visual performance. **Methods:** A lighting booth with four different light source types was used in the experiment with the subject fully merged in the illuminated ambient. Luminance and correlated color temperature (2700K) was adjusted for three (incandescent, fluorescent and LED) of the four illumination types to be equal while the fourth light source (fluorescent) had a significantly different correlated color temperature (6500K). Subjects with normal color vision participated in the tests within two age groups (20-35, n = 20 and 55-70, n = 10). Visual tests of the Cambridge Color Test (CCT) and Contrast Sensitivity Function (CSF) were presented on a computer display by the VSG 2/5 video card of Cambridge Research Systems. The display was placed outside the illuminated ambient in a 5.5° visual angle. Lanthony D15d color ordering test with reflective samples was applied within the illuminated ambient along with tests of reading performance and Ishihara color vision test. **Results:** In the D15d test the lowest error values were found for the incandescent (1.059 ± 0.059) and the 6500K (1.038 ± 0.040) illuminations while the LED and the 2700K fluorescent lamps gave equally high (1.110 ± 0.123 and 1.094 ± 0.069) error rates. The CSF tests did not give statistically significant differences, but the results indicate the most effective performance under the 6500K (ranked best in all conditions) illumination and the least effective with the incandescent lamps (ranked worst in 66% of the conditions). The reading test results have demonstrated better performances under 6500K illumination. The largest statistically significant differences ($p < 0.05$) were found in the CCT tests where the 6500K illumination clearly affected the tritan discrimination (122.8 ± 68.8 vs < 100.0) while the protan and deutan discriminations were more affected by the 2700K lamps with the incandescent having the largest effect. The Ishihara test didn't show any differences under the various illuminations. The tendencies of the differences were generally the same for the two age groups, however the group of 55-70 had smaller differences in all tests. **Conclusions:** The differences in spectral distribution of the ambient illumination affect vision in tasks with reflective samples and also when the stimuli are displayed on a computer monitor. In the latter case the ambient illumination provides the adaptation

background. In general subjects have shown better results under the 6500K illumination for all tests except for the CCT tritan condition. In the comparison of the three 2700K illuminations the LED causes the least confusion on monitor tests and provides the highest score in the reading test. As expected from its color rendering index the incandescent lamp induced better results in the reflective D15d.

Keywords: Visual performance, color vision, illumination, visual adaptation