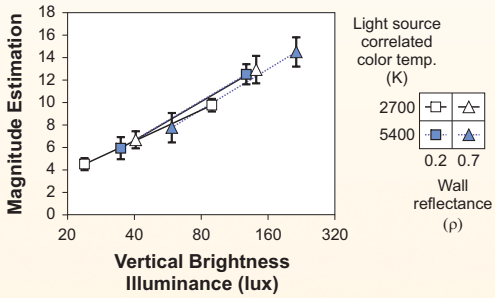
Predicting Apparent Brightness in Indoor Applications

Subjects viewed the above scene illuminated to light levels typical of those found in residences.

Perhaps the most obvious effect of lighting is its ability to make spaces appear bright or dim. Increasing the measured illuminance can obviously make a space appear brighter. It is perhaps counterintuitive that spaces can be made to look brighter at *lower* measured illuminance levels because the apparent brightness of a space is not determined by measured illuminance alone. The spectral composition of the light also affects apparent brightness. Specifically, at the same measured illuminance level, a space illuminated by light sources with relatively more emission at short wavelengths will look brighter than if it is illuminated by sources with relatively more energy at long wavelengths. The LRC recently carried out a study, examining the apparent brightness in a simulated residential space.

People judged the apparent brightness of a simulated living room at different measured illuminance levels, different wall and floor reflectances, and for warm and cool light sources. Two major conclusions emerged from the study. First, it is difficult to predict apparent brightness from measured illuminance levels on the horizontal plane as is normally prescribed for architectural spaces. Illuminance levels measured at the vertical plane near the eye are better correlated to judgements of apparent brightness. Second, the conventional photopic luminous efficiency function, the spectral weighting function inherent in all lighting standards and recommendations, is more poorly correlated with judgements of apparent brightness than a brightness luminous efficiency function that includes short-wavelength cone sensitivity. The results of the study are shown in the following figure where the light sensor was calibrated in terms of the brightness luminous efficiency function and oriented vertically near the plane of the eye.



Mean (±s.e.m.) magnitude estimations of scene brightness as a function of brightness illuminance at the eyes based on the equation below.

$$B(\lambda) = V(\lambda) + gS(\lambda) + 0.5\mathrm{Mel}(\lambda)$$

$B(\lambda)$ is the spectral weighting function for perceived brightness, $V(\lambda)$ is the photopic luminous efficiency function, $S(\lambda)$ is the luminous efficiency function for the short-wavelength (S) cone fundamental, $\mathrm{Mel}(\lambda)$ is the luminous efficiency function of intrinsically-photosensitive retinal ganglion cells (ipRGCs) containing the photopigment melanopsin, and g represents the gain in sensitivity of the S-cone, modelled as a natural logarithmic function of the horizontal illuminance (E), where:

$$g = 0.261 \ln E + 0.719$$

More Information

Rea MS, Mou X, Bullough JD. Scene brightness of illuminated interiors. *Lighting Research and Technology.* Published online before print April 21, 2015, doi: 10.1177/1477153515581412

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