Surface color influences interior rooms' perceived spatial layout

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Previous studies & motivation

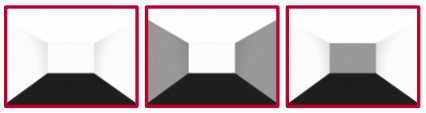
Ceiling and wall luminance influence the perceived spatial layout of greyscale three-dimensional room simulations: Lighter surfaces are judged more distant than darker surfaces

Perceived height

- **Perceived height increases with increasing ceiling luminance**
  (e.g., von Castell, Hecht, & Oberfeld, 2016; Oberfeld, Hecht, & Gamer, 2010)

Perceived width and depth

- **Perceived width increases with increasing side-wall luminance**
- **Perceived depth increases with increasing rear-wall luminance**
  (von Castell, Hecht, & Oberfeld, in preparation)



Can the luminance effect be transferred to chromatic surface colors?
Do the saturation and hue of surface colors also influence the perceived layout of interior spaces?

Method

Subjects

- N = 22 (10 women, 12 men)
- Age 19 to 34 years (M_{age} = 23.95, SD_{age} = 3.57)

Apparatus

Oculus Rift DK2

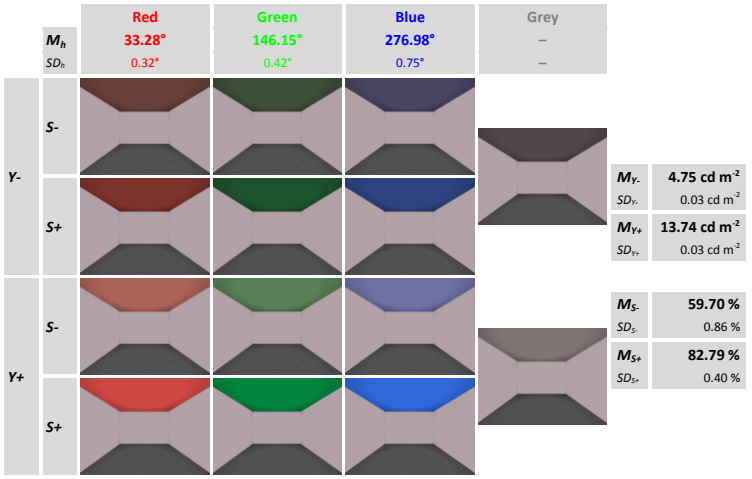
- FOV: horizontal ≈ vertical ≈ 100°
- Virtual eye height: 1.30 m

Stimuli

3D room simulations

- Independent variation of ceiling luminance, saturation, and hue
- Constant luminance of rear and side walls (M_Y = 25.46 cd m^{-2})
- Variation of ceiling height
- Constant room width (4.50 m) and depth (5.80 m)

*Measured with a **spectroradiometer***
*Colorimetric values calculated from **CIE L*a*b* color space, D65 white point, 10° standard observer***



Design and Procedure

Independent variables (IVs)

- Luminance *Y* (*Y-*, *Y+*)
- Saturation *S* (*S-*, *S+*)
- Hue *h* (Red, Green, Blue)
- Luminance-matched achromatic ceilings (Grey)
- Ceiling height (2.90, 3.00, 3.10 m)

Dependent variable (DV)

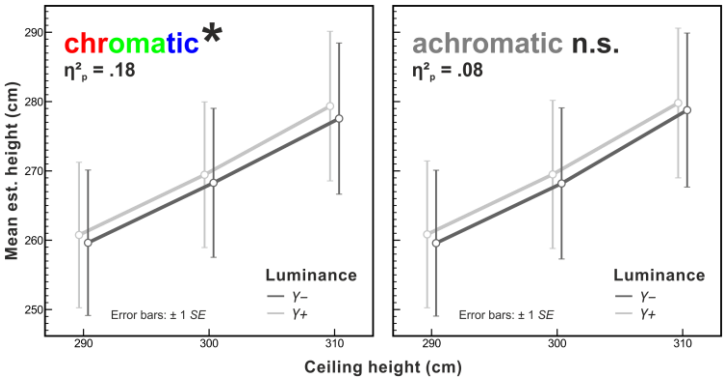
- Centimeter ratings of **perceived height**

⇒ *[**2**(Y) × **2**(S) × 3(h) + **2**(Y achromatic)] × **3**(Ceiling height) × **10**(trials per combination of IVs) = **420 trials** per subject*

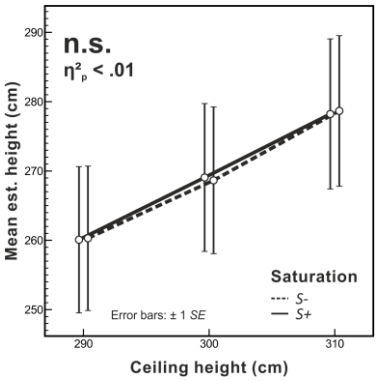
Results

Y* × *S* × *h* × Ceiling height rmANOVA for *chromatic* ceiling colors
Y* × Ceiling height rmANOVA for *achromatic* ceiling colors

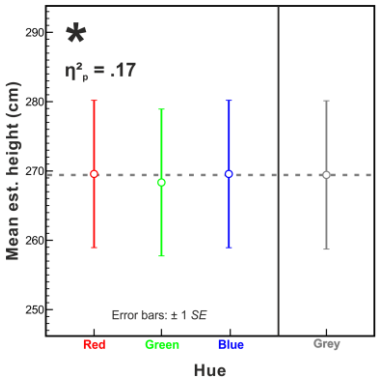
Luminance



Saturation



Hue



Ceiling height*

- Perceived height increased with increasing ceiling height, both for chromatic (η^2_p = .81) and achromatic (η^2_p = .76) ceiling colors

Luminance × Hue × Ceiling height* (η^2_p = .13)

- Maximum effect of hue on perceived height for medium-high (3.00 m) high-luminance (*Y+*) ceilings (not illustrated)

Note: All other effects n.s.

Conclusion

- The previously reported achromatic luminance effect can be generalized to chromatic ceiling colors: subjects judged lighter ceilings higher than darker ceilings, independent of saturation and hue
- Absence of luminance effect in the achromatic condition probably due to a smaller luminance difference than in previous studies (e.g., Δ_Y = 16.46 cd m^{-2} in von Castell et al., 2016)
- First indications that ceiling hue influences the perceived height of interior spaces: subjects judged green ceilings slightly lower than red, blue, and grey ceilings
- Virtually no effect of saturation
- No evidence for an "oppressive" effect of colorful ceilings on perceived height

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