# Light ceilings don't just seem higher, they look it

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## Introduction

Previous studies from our lab (Oberfeld, Hecht, & Gamer, 2010; Oberfeld & Hecht, 2011) found that the **perceived ceiling height** of interior spaces increases with increasing **ceiling lightness**. These studies used **verbal estimates** of perceived ceiling height in units of centimeters. This direct method of asking for perceived height might give rise to expectation effects. Participants might rate lighter ceilings to be higher because they implicitly or explicitly assume that lighter ceilings should look higher than darker ceilings.

In the present study, we therefore compared the results of a verbal estimation task with those of a **height matching task** (cf. von Castell, Hecht, & Oberfeld, 2014), to answer the question of whether the influence of ceiling lightness on perceived ceiling height represents a direct perceptual effect rather than a cognitive bias or expectation effect.

In the height matching task, participants compared the ceiling height of rectangular interior spaces to the height of a pillar. The point of subjective equality (PSE), which represents a match between the perceived ceiling height and the perceived pillar height, and the difference limen (DL) were estimated from the psychometric functions (PMFs). As participants simply provided an ordinal visual comparison of the perceived ceiling height and the perceived pillar height on each trial, a potential effect of ceiling lightness on the height matches would represent a **direct perceptual effect**.

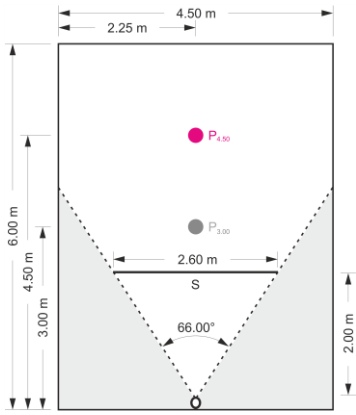
## Method

### Participants

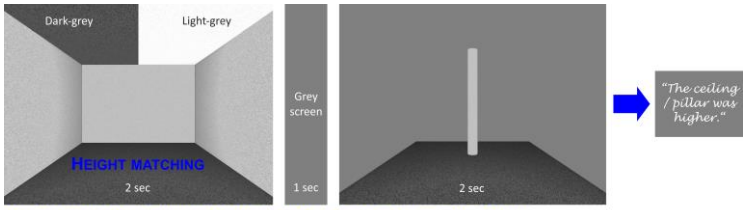
- *N* = 22 (14 women, 8 men), age 20 to 46 (*M* = 24.95 years, *SD* = 5.59 years)

### Stimuli and apparatus

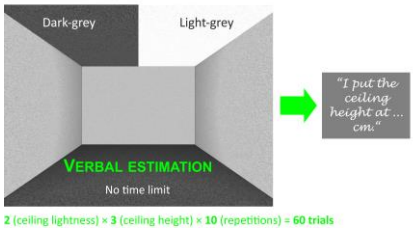
- Large projection screen, stereoscopic viewing
- Eye position horizontally and vertically centered to the projection screen
- Viewing distance: 2.00 m
- Visual angle: 66.00° horizontal, 52.00° vertical
- Virtual eye height: 1.70 m
- Room
  - Constant width and depth
  - Variation of ceiling height (2.90, 3.00, 3.10 m)
  - Variation of ceiling lightness (dark-grey, light-grey)
- Pillar
  - Constant lightness and diameter
  - Variation of pillar height (e.g., 2.75, 2.85, 2.95, 3.00, 3.05, 3.15, 3.25 m, for 3.00 m ceiling height)
  - Variation of pillar position ($P_{3.00}$, $P_{4.50}$)




### Design and procedure




**2** (ceiling lightness) × **3** (ceiling height) × **2** (pillar position) × **7** (pillar height) × **10** (repetitions) = **840 trials**

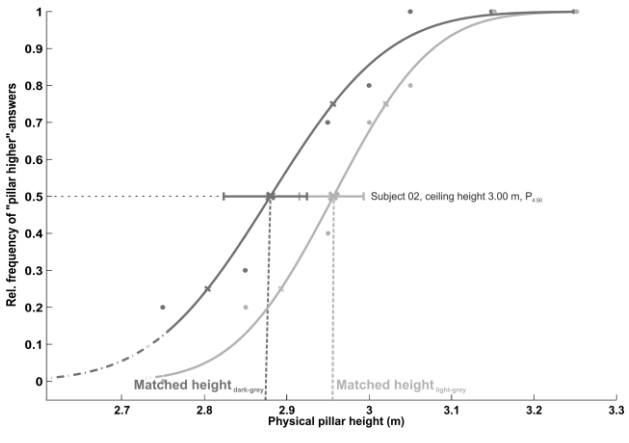



**2** (ceiling lightness) × **3** (ceiling height) × **10** (repetitions) = **60 trials**

### Data analysis

#### Height matching

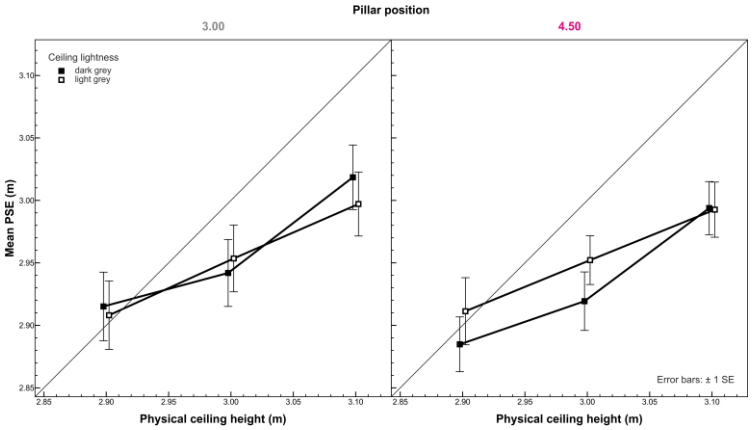
- Fitting of 22 (participants) × 2 (ceiling lightness) × 3 (ceiling height) × 2 (pillar position) = 264 cumulative-normal PMFs, maximum likelihood approach
- PSE = $x_{50}$, DL = ($x_{75} - x_{25}$) / 2
- Goodness-of-fit test (LLR): *p*-values > .10 for 80.70% of the PMFs




## Results and discussion

### Height matching

#### PSE

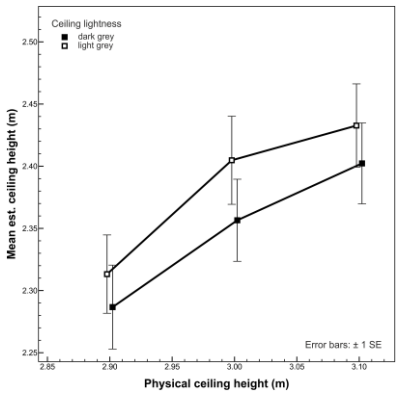



- **Ceiling height***, partial $\eta^2$ = .930
  - → Participants really compared the ceiling height to the pillar height
- **Ceiling lightness × pillar position***, partial $\eta^2$ = .367
  - → Significant effect ($d_z$ = 0.79) of ceiling lightness when pillar in far position
  - → Absence of the effect ($d_z$ = 0.19) in the near position probably due to experimental setup
- **Ceiling lightness × ceiling height***, partial $\eta^2$ = .175
  - → Effect of ceiling lightness smaller for 3.10 m ceiling height
- **Ceiling lightness n.s.**
- All other effects n.s. (*p*-values > .10)

#### DL

- Mean DL 9.37 cm (*SD* = 4.23 cm)
- No significant effects of the experimental parameters (*p*-values > .10)

### Verbal estimation




- **Ceiling height***, partial $\eta^2$ = .632
  - → Mean height estimate increased with increasing ceiling height
- **Ceiling lightness***, partial $\eta^2$ = .211
  - → Considerable increase ($d_z$ = 0.51) in the mean height estimate with increasing ceiling lightness
- All other effects n.s. (*p*-values > .10)

## Conclusion

**In both tasks**, we found **comparable effects of ceiling lightness on perceived ceiling height**. Because the height matching task was based on a direct comparison of two percepts (vertical extent of visual stimuli), our results indicate that the reported positive effect of ceiling lightness on perceived ceiling height is a **direct perceptual effect** rather than a cognitive effect.

## Acknowledgements

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## References

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