# Saving energy through changing light: The impact of illumination on thermal comfort

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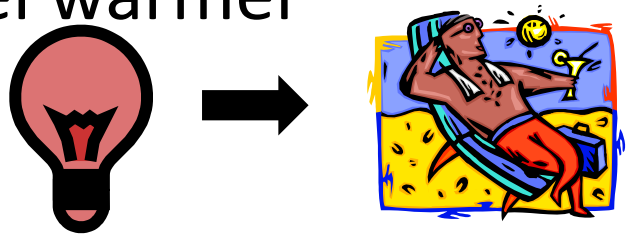
Session 9C

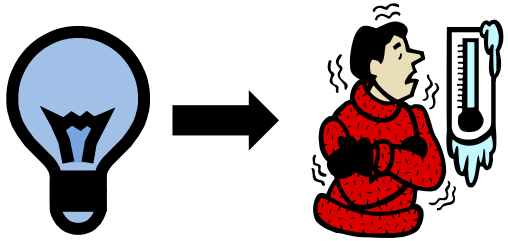
BEHAVE 2014

# The Hue-Heat-Hypothesis – "You feel what you see"

- Light with wavelengths predominantly at the red end of spectrum / of a low colour temperature make people feel warmer



- Light with wavelengths predominantly at the blue end of spectrum / of high colour temperature cooler



# Importance of studying the HHH

- 20 hours per day spent indoors - often under artificial illumination
- Buildings (domestic[1] & non-domestic[2]) responsible for 44% of total $CO_2$ emissions
  - More than half for space heating
  - Increasingly more also for cooling & ventilation

**Can we use light (which is on, anyway) to reduce the need for heating and cooling!?**

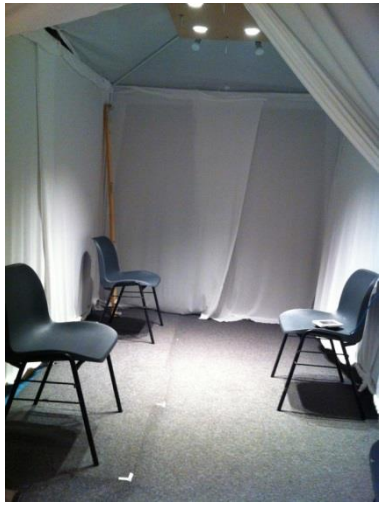
[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/201167/uk_housing_fact_file_2012.pdf
[2]http://www.carbontrust.com/media/77252/ctc765_building_the_future__today.pdf

# Our approach

- Aim: To test the HHH under conditions that allow control of
  - Light
  - Temperature
  - Relative humidity
  - Air velocity
  - Clothing level
  - (Metabolic rate)

- Vary in systematic fashion between conditions

- Keep constant between conditions and subjects



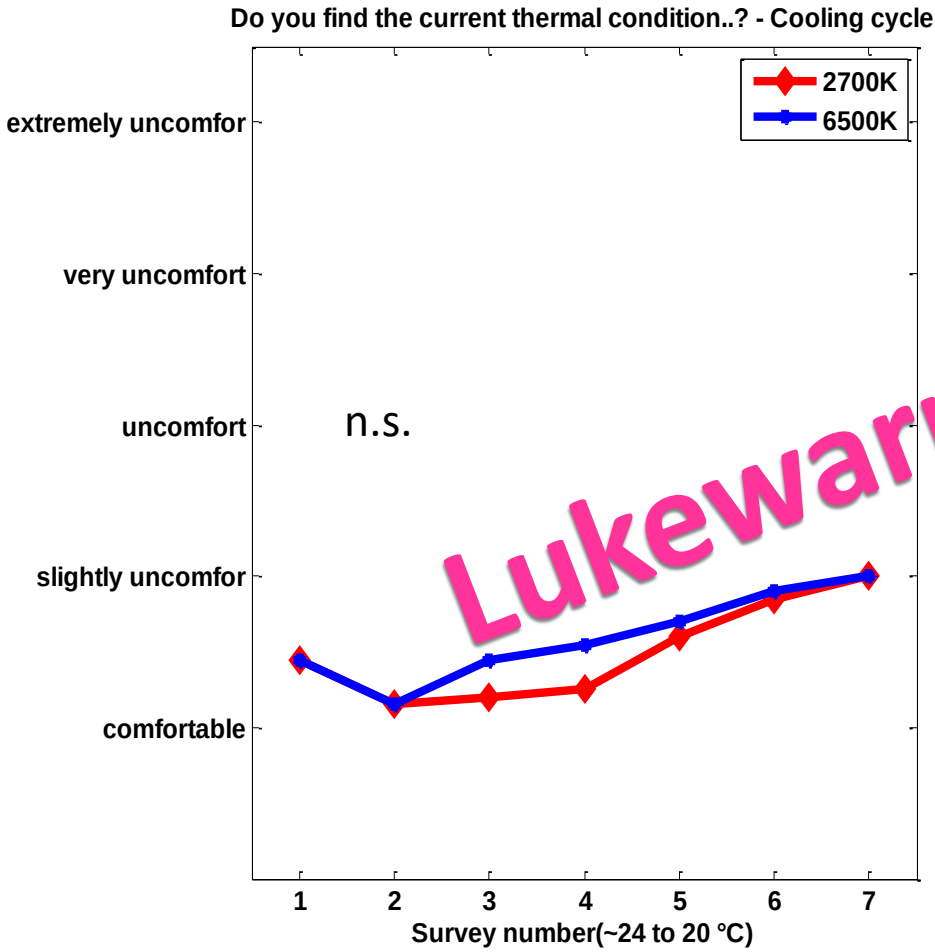
→ Experimental Design

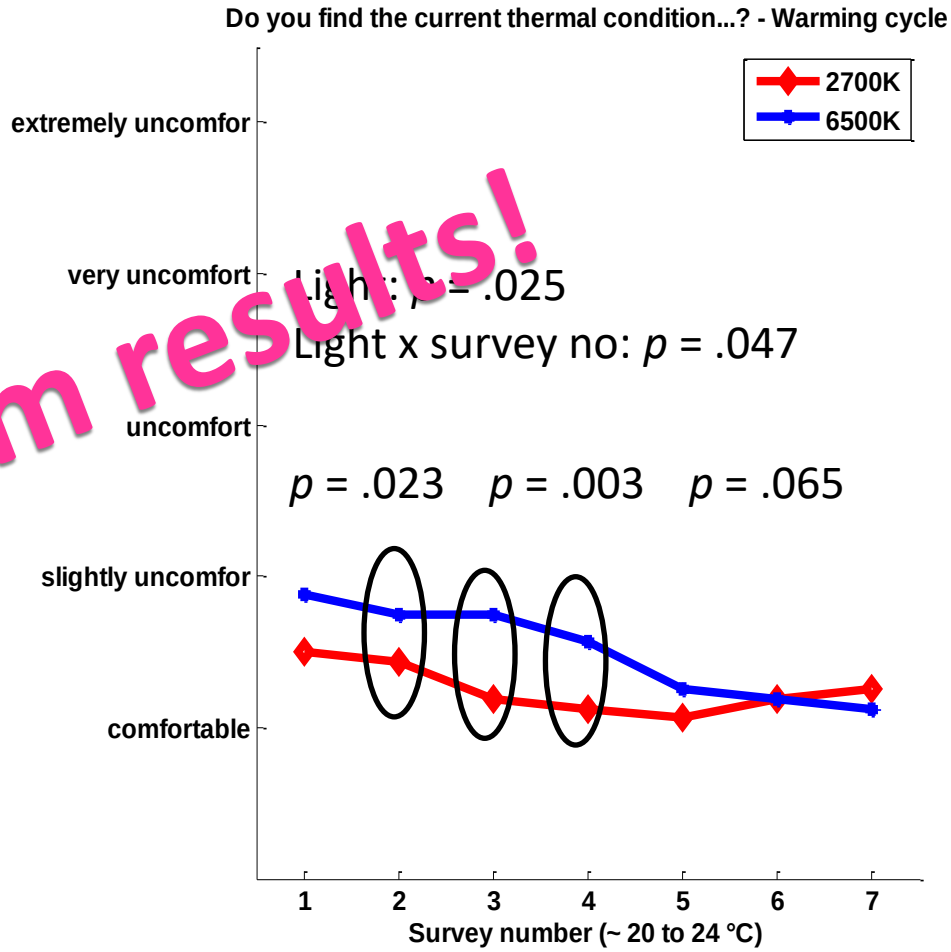
# Study 1

- N = 32 students
- Dependent variable: Self-reported thermal comfort
  - Measured every 10 minutes with standard surveys
- Independent variable(s):
  - Between-subject factor: Light setting of 2700 K ('warm' light) vs. 6500 K ('cold' light)
  - Within-subject factor: Ambient temperature decreasing / increasing between 24 and 20 °C over 60 minutes

Hypothesis:
Comfort **higher** under warm light than cold light (at the lower temperatures).

# Q2




Lukewarm results!

Repeated-measures ANOVA with within-subject factor 'survey number', between-subject factors of 'lighting' and 'gender', 'light' by 'survey number' interaction, Covariates: BMI

# Study 2: Observation

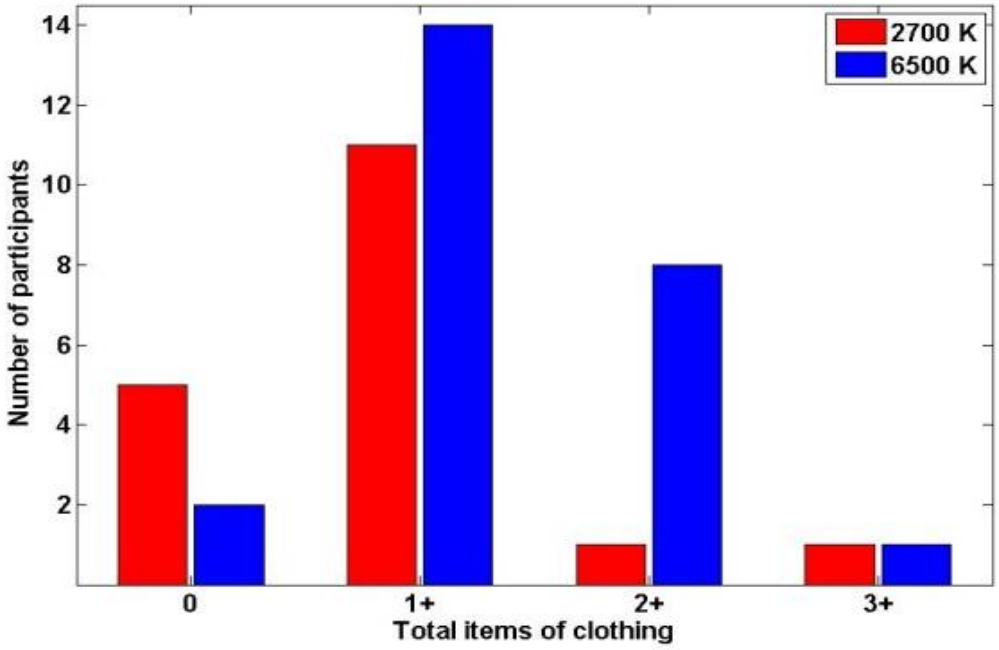
- N = 32 students
- Participants instructed to bring a long-sleeve T-Shirt and a jumper to session, plus blanket provided
- Dependent variable:
  - Change in clothing level
- Independent variable:
  - Between-subject: Light setting of 2700 K ('warm' light) vs. 6500 K ('cold' light)

Hypotheses:

**More** item of clothing put on under cold light than warm light.

Items of clothing put on **earlier** under cold light than warm light.

# Observation: Results




People put significantly more clothing on under cold light than warm light.

No significant temporal difference (only trend).

# Outlook

- Some evidence for effect of light on thermal comfort.
  - Energy saving?
  - Power reduction?
- But: needs more testing
  - In ‘real world’
  - Better operationalization of ‘thermal comfort’
  - Temporal stability?

**Thanks!**

**Questions?**