Applying Non-Invasive Circadian Phase Measurement Strategies to Assess Wellbeing in Daylit Environments

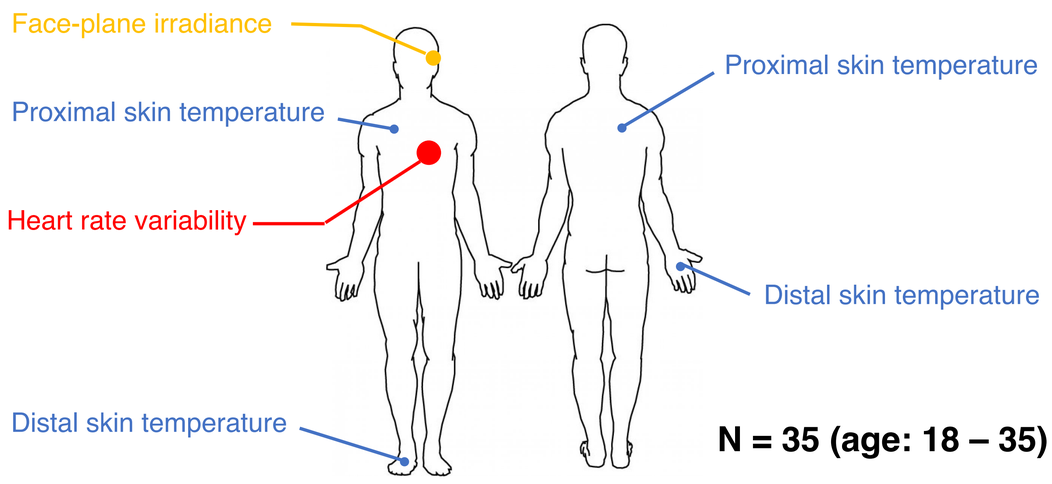
Forrest Webler[1]*, Victoria Eugenia Soto Magan[1], and Marilyne Andersen[1]
[1]Laboratory of Integrated Performance in Design (LIPID), EPFL, Switzerland

Abstract

What is the effect of spectrum and illuminance on acute and circadian effects in a real space? We examine the following hypotheses in a field study using two identical lecture halls on the EPFL campus.

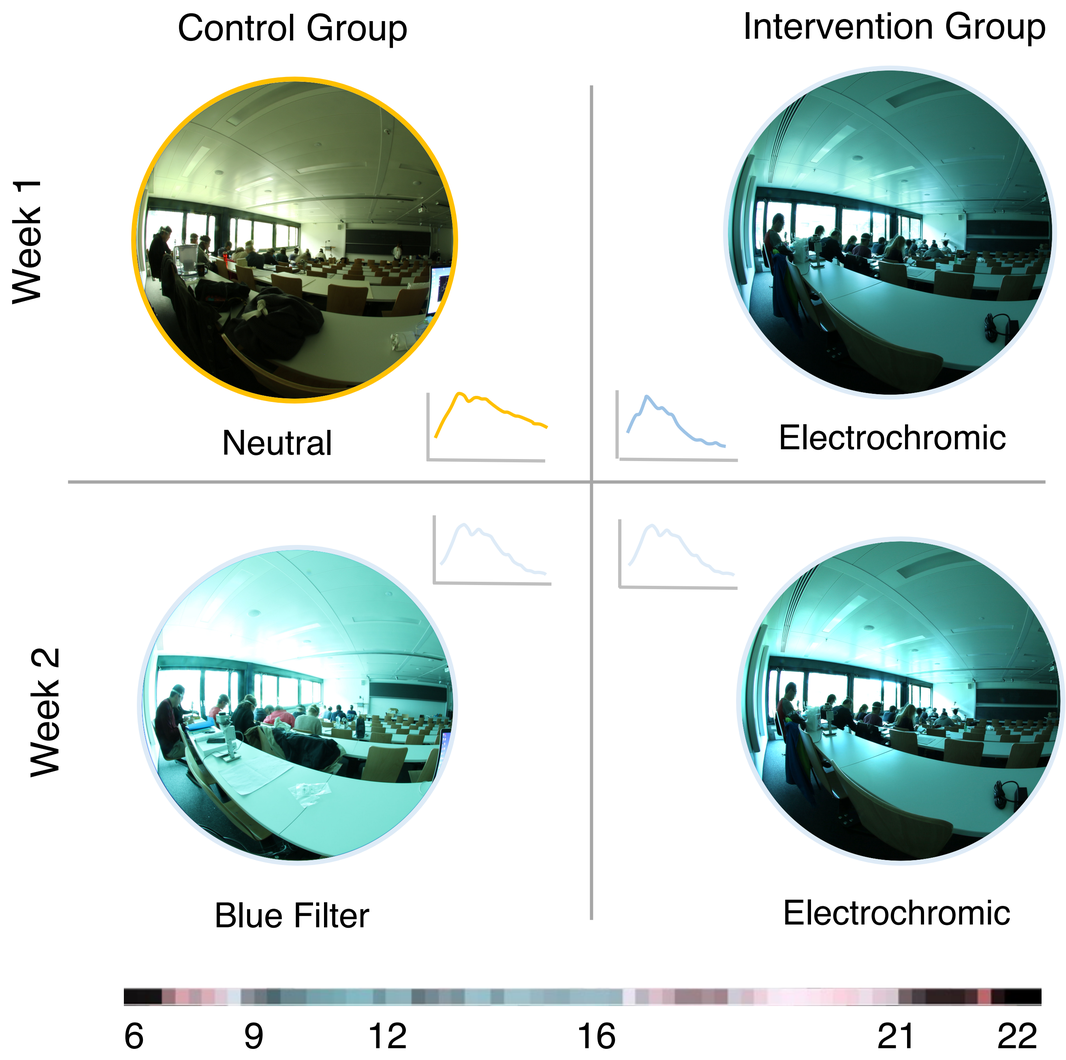
H
Hypotheses

1. **Brighter** and **red-impoverished** daylight will increase **alertness** and cognitive function, while also reducing fatigue.
2. ***Bluer*** daylight in the morning will aid circadian resetting, helping to reduce phase advances and delays due to desynchronization of the circadian clock.

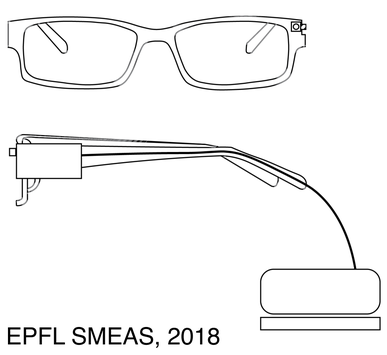


N = 35 (age: 18 – 35)

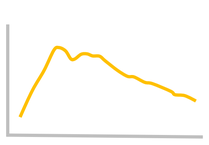
Experimental Design



I. Wearables



EPFL SMEAS, 2018

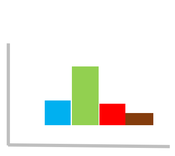


- Full vis. spectrum
- Weather resistant
- 18 hours of continuous recording at 6' sampling
- Low cost (< 300 EUR)
- Worn on head

LightWatcher, 2014

- UV,R,G,B,IR channels
- Photopic lux
- 7 days of continuous sampling at 10ms
- Motion/acceleration
- Temperature
- Worn on head

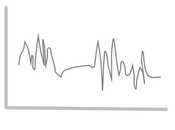
LYS, 2017



- R,G,B, IR channels
- Lux from R,G,B only
- 7 days continuous sampling at 10s
- Motion/acceleration
- Worn on chest
- Directional
- Attractive
- Low cost (80 EUR)

FirstBeat, 2017

iButton, 2010

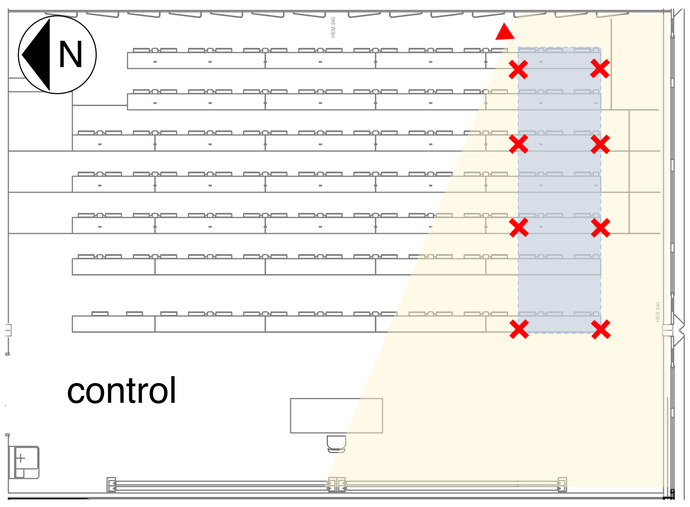


- HRV for alertness
- Worn from wake to sleep

- iButtons for proximal and distal temperature
- Worn 24/7

II. Space Monitoring

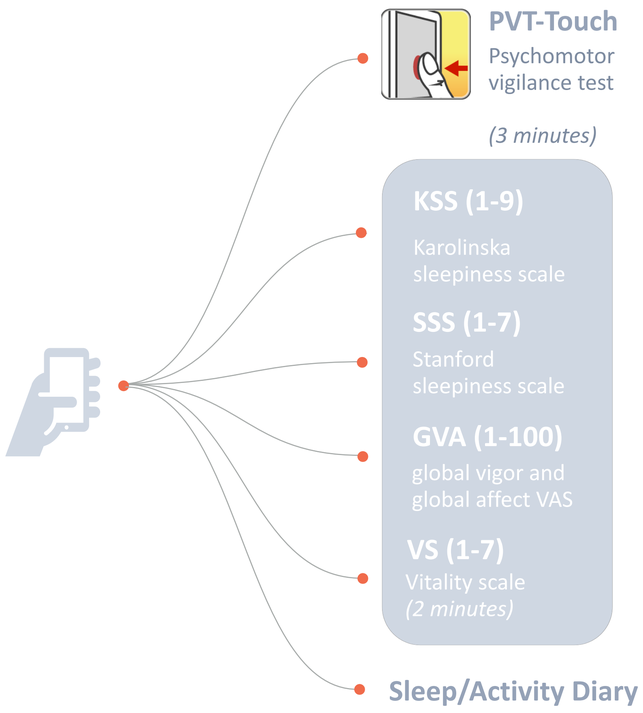
Data loggers with attached luxmeters were placed strategically in the two classrooms our goal was to create a detailed map of the lighting conditions within the space while also recording other environmental conditions like temperature.



HDR images were taken to assess glare in the room as well as document changes in sky conditions.

III. Questionnaires

App-based sampling was used for fast and reliable data collection.



PVT Touch is a validated measure of alertness. Together with the four subjective scales, we can quantify acute effects.

Conclusion

Our new device makes measuring face-plane irradiance possible. Adding irradiance data to existing models can help increase reliability of phase shift models using other physiological markers like skin temperature and heart rate. We hope our methods will help advance understanding of the importance of daylight on circadian resetting and acute effects.

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Forrest Webler is a current PhD candidate in LIPID. His work is concerned with the impact of light on wellbeing. Specifically how behavior influences exposure to light and the consequences of circadian desynchronization. He holds a masters in Biomedical Engineering from Brown University.

*forrest.webler@epfl.ch

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