

'The Effect of Biophilic Glare Control on Occupant Perception'

A MSc thesis project at TUDelft

Eleni Mousteri

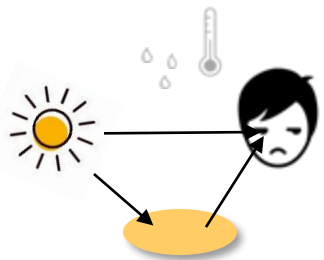
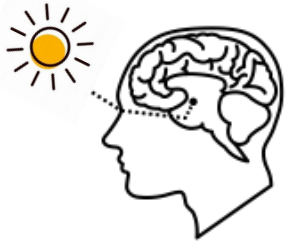
Radiance & HDR Workshop, EPFL

August 2025



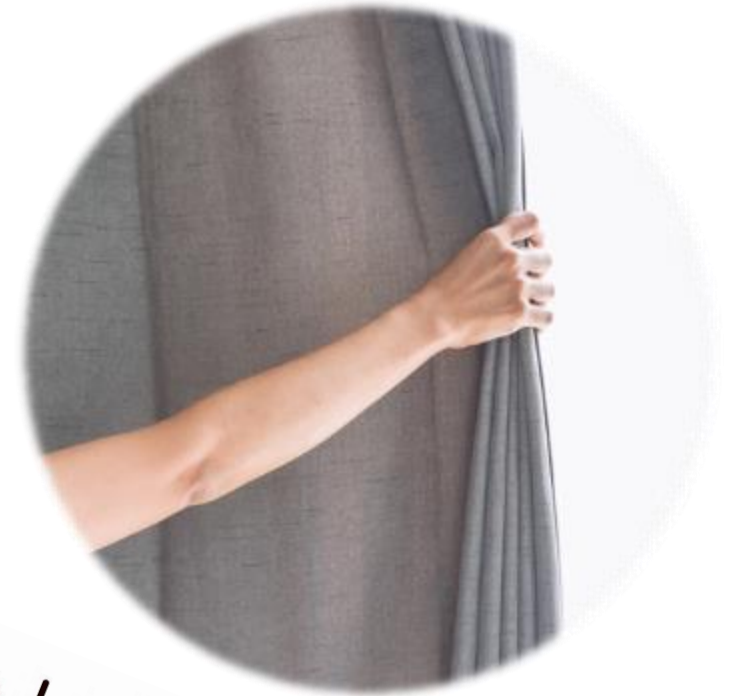
How much time do we spend indoors?

How much time are we exposed to natural light?

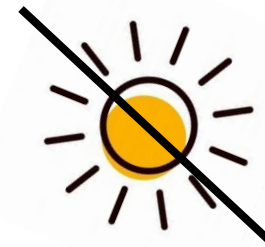


~90%

Additional challenges with shading systems



view out

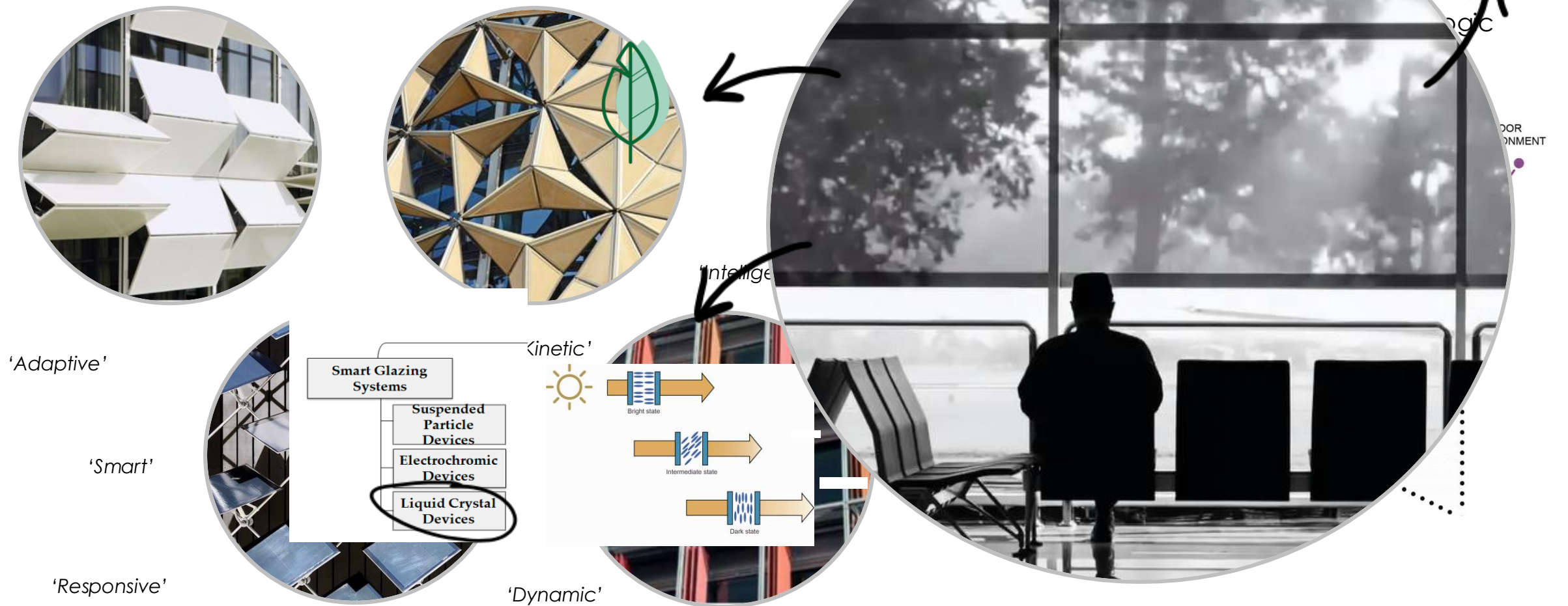


daylight



Adaptive facades & VideowindoW

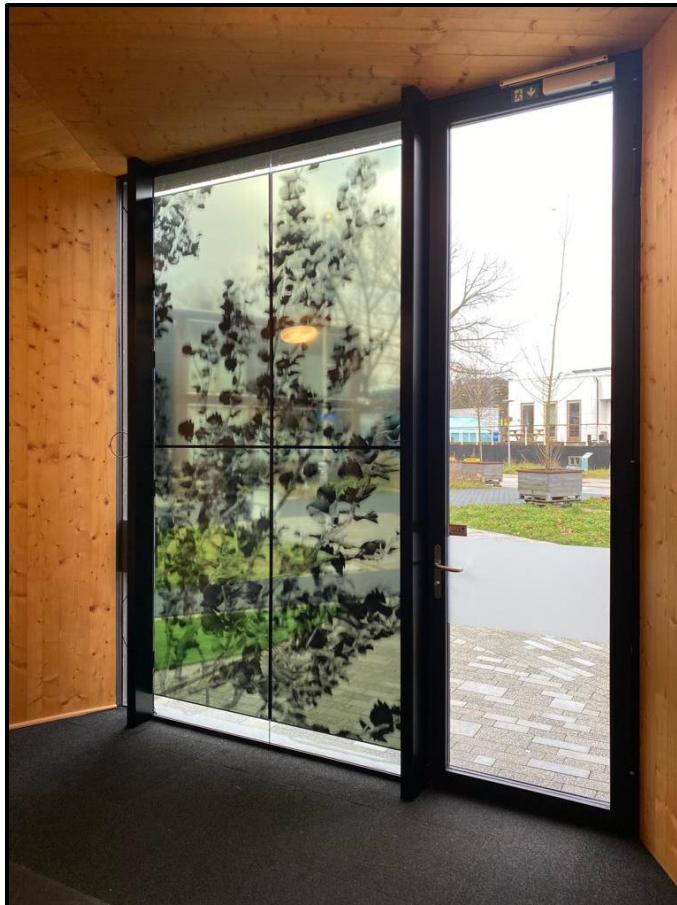
A smart façade system incorporating biophilic patterns.



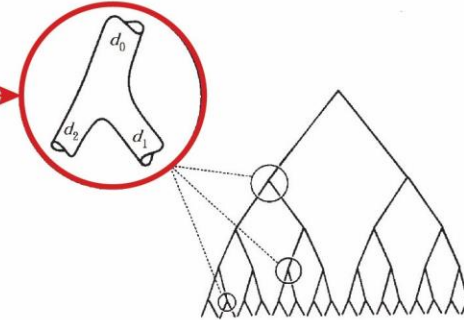
Multi-perspective Biophilic Experience of VideowindoW



Light penetration: Direct



Fractal Geometry: Indirect



Motion: Experience of space & place

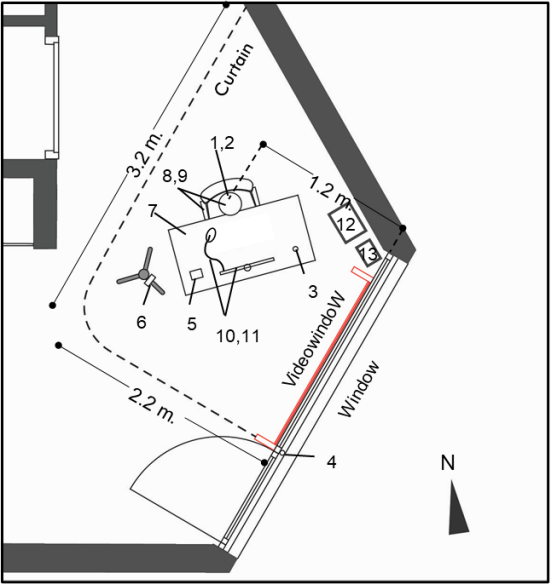
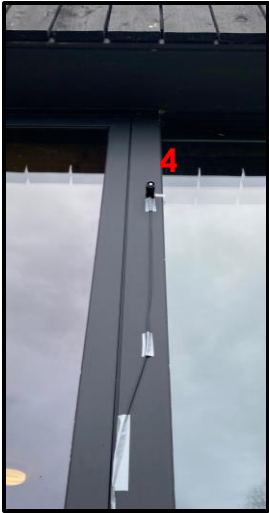
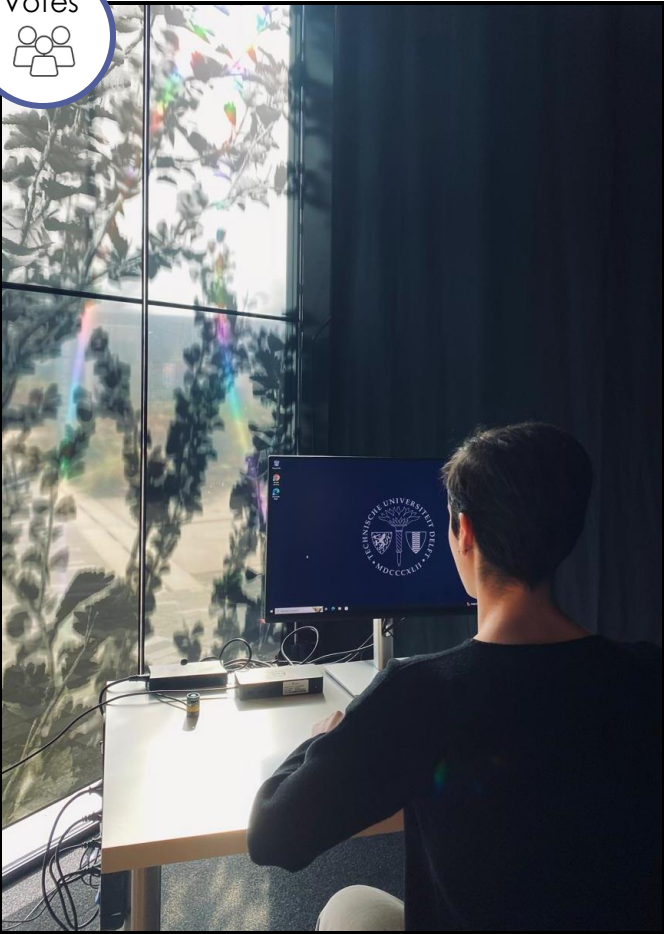


AIM OF THE STUDY

- Design an **experimental setup** to capture occupant perception
- Gather evidence on **occupant perception** regarding:
 - Glare
 - Visual comfort & Daylight
 - View & View obstruction
 - Pattern & Sunlight pattern aesthetics
 - Preferences and connection with nature
- Method: **Physical testing** with human **participants**



Experimental set-up



Equipment legend:

- 1. Canon EOS 70D camera
- 2. Konica Minolta illuminance meter
- 3. Li-cor illuminance meter
- 4. Li-cor illuminance meter
- 5. Hobo
- 6. Hobo
- 7. Workstation
- 8. Desk chair
- 9. Subject's head
- 10. Mouse
- 11. Monitor
- 12. Laptop connected to monitor
- 13. Alpha-log

Patterns tested

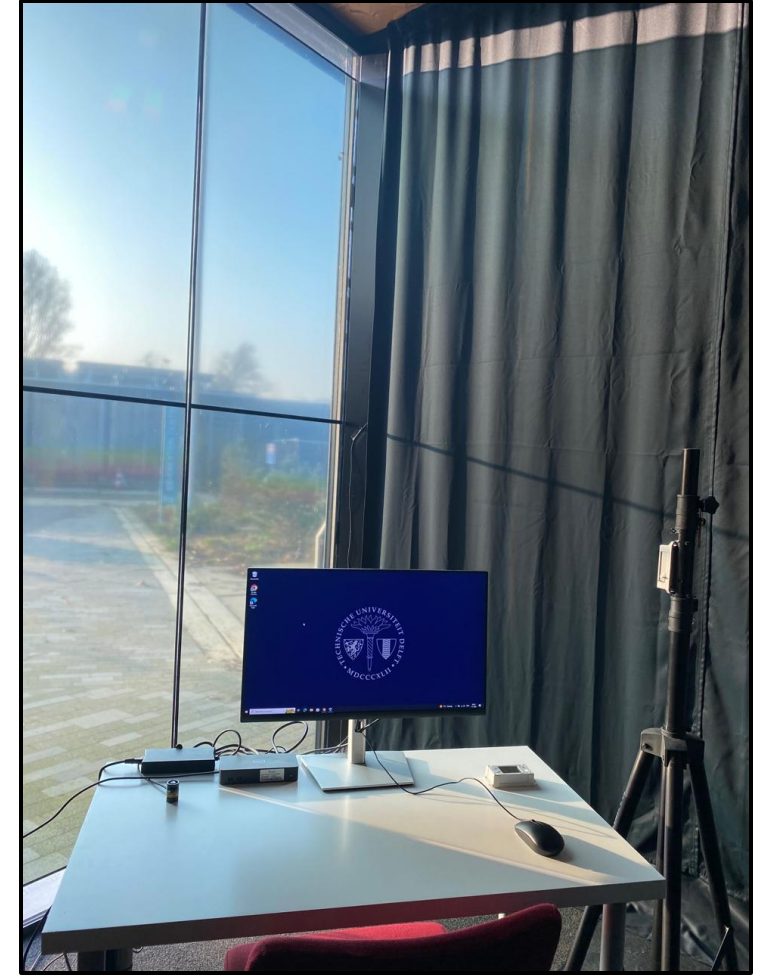
(A) Tree pattern



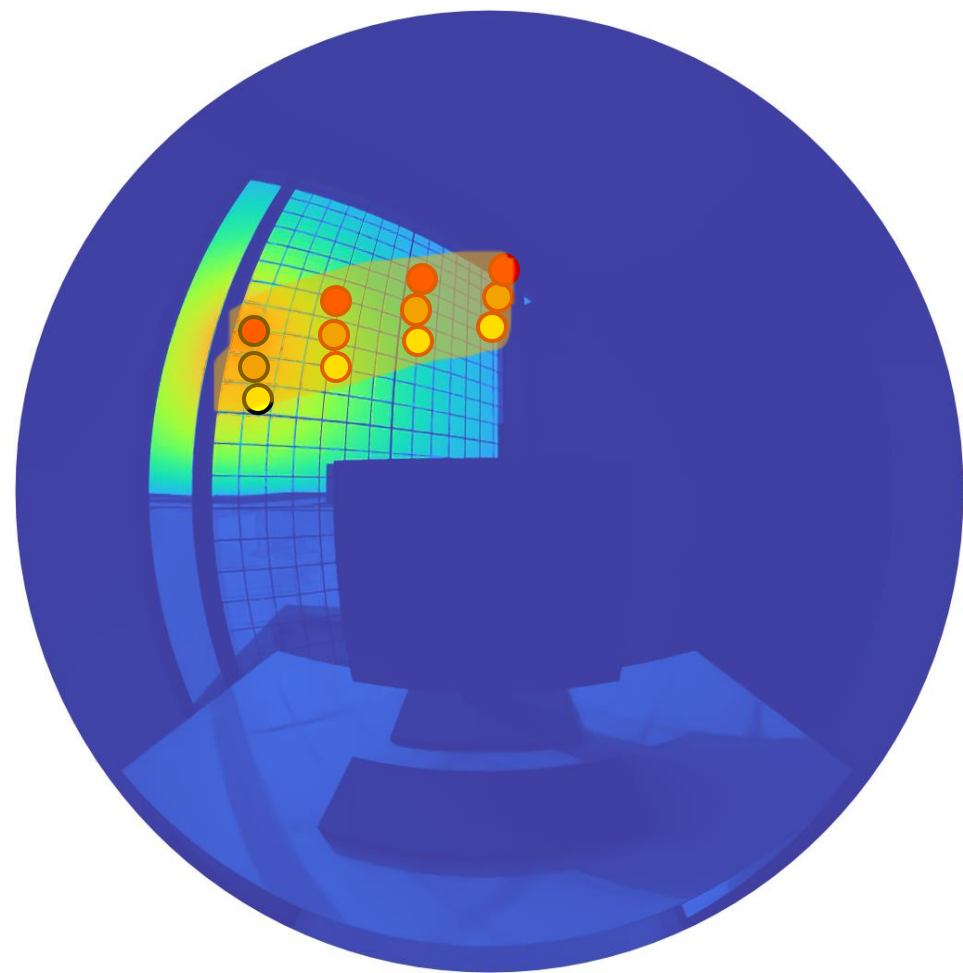
(B) Striped pattern



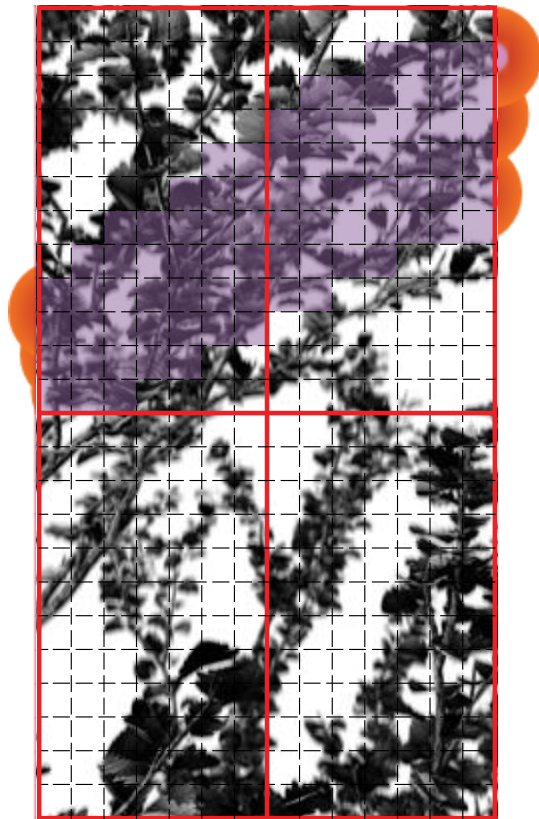
(C) No-pattern



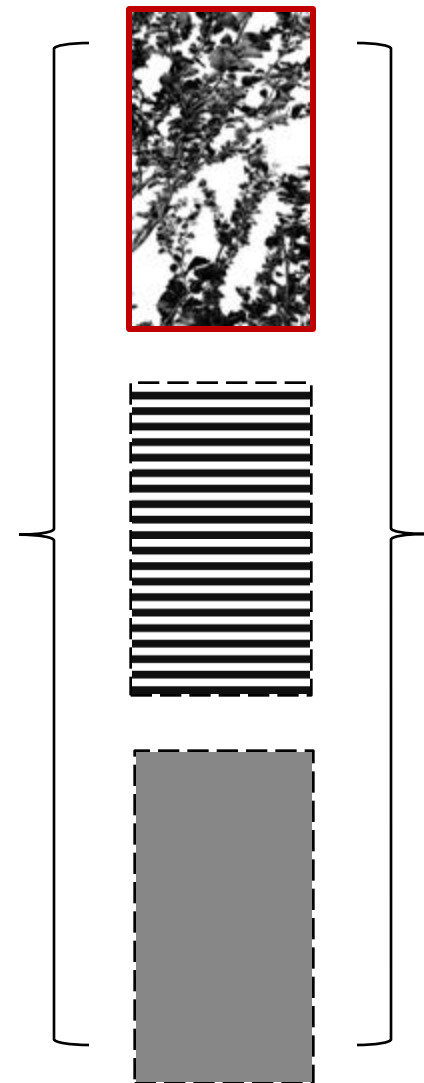
Direct sun & Pattern Selection



- March 1
- March 15
- March 31



53% average transparency



Experimental procedure

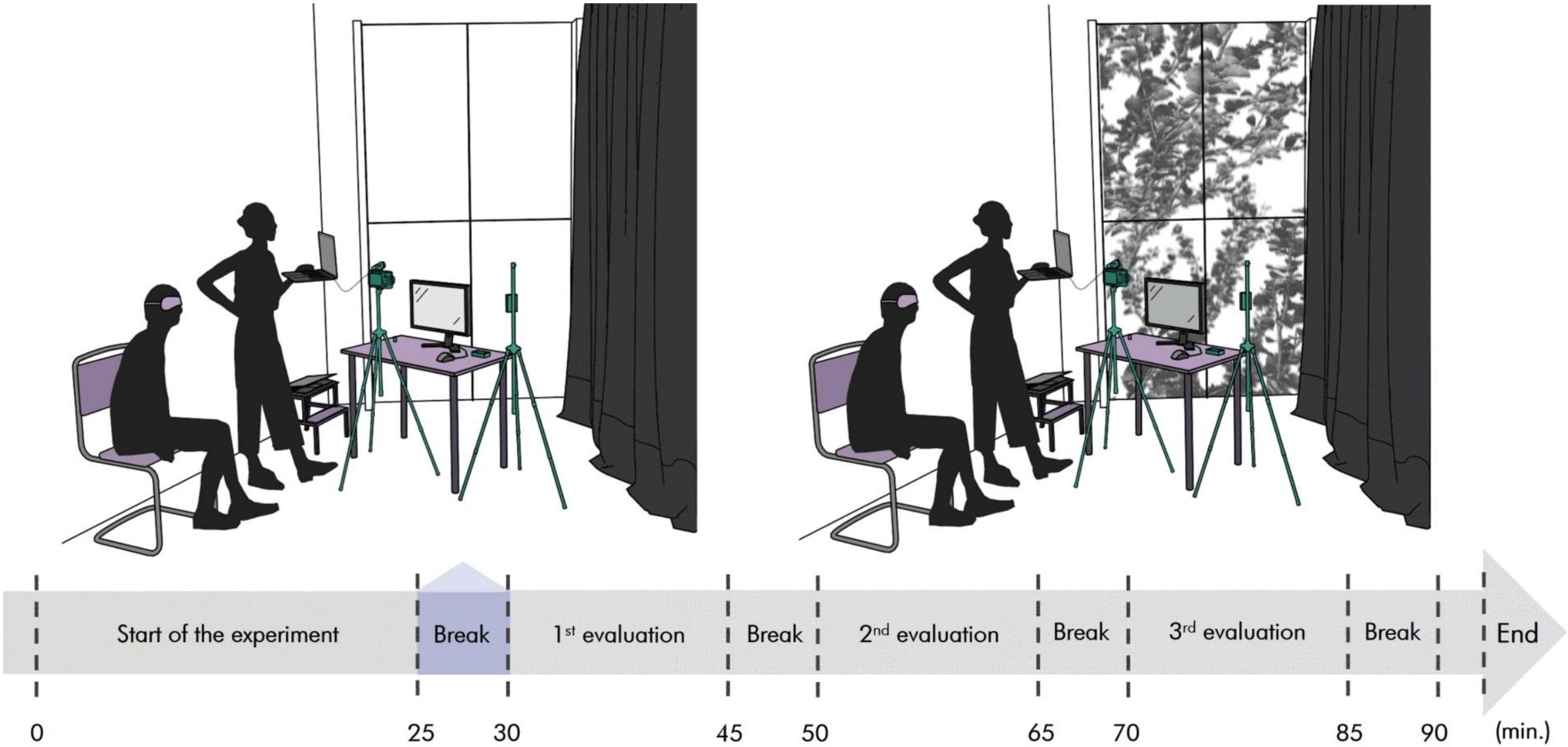
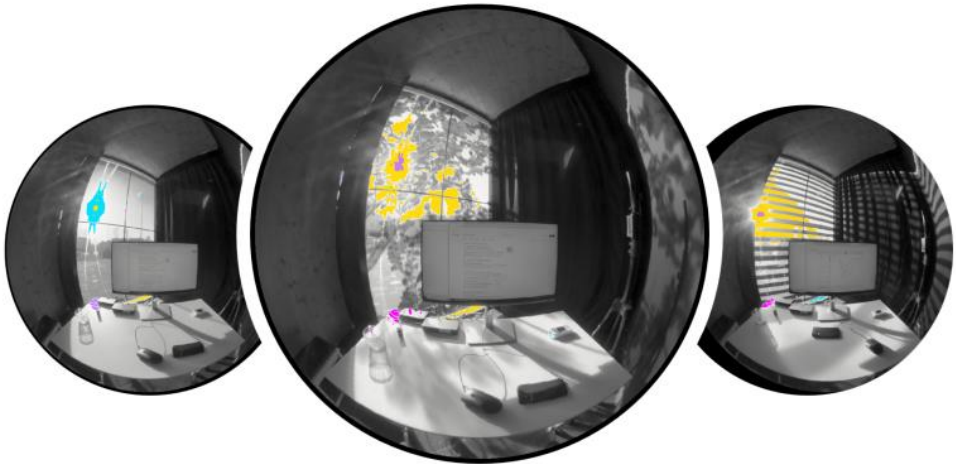
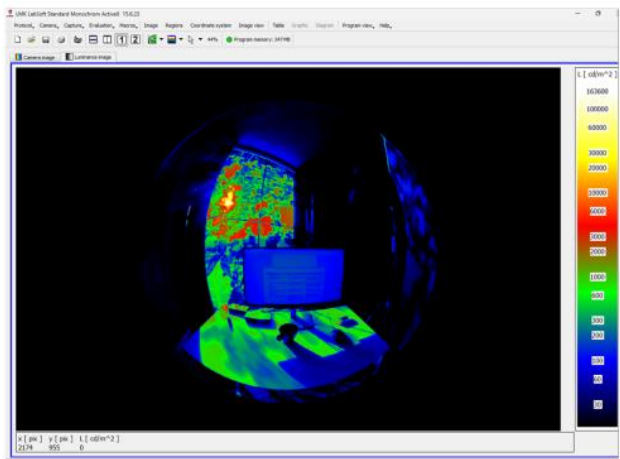
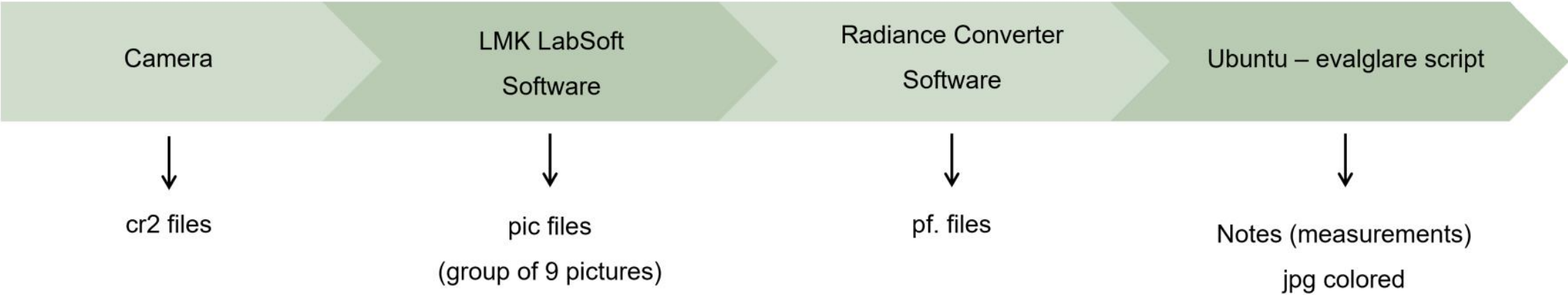


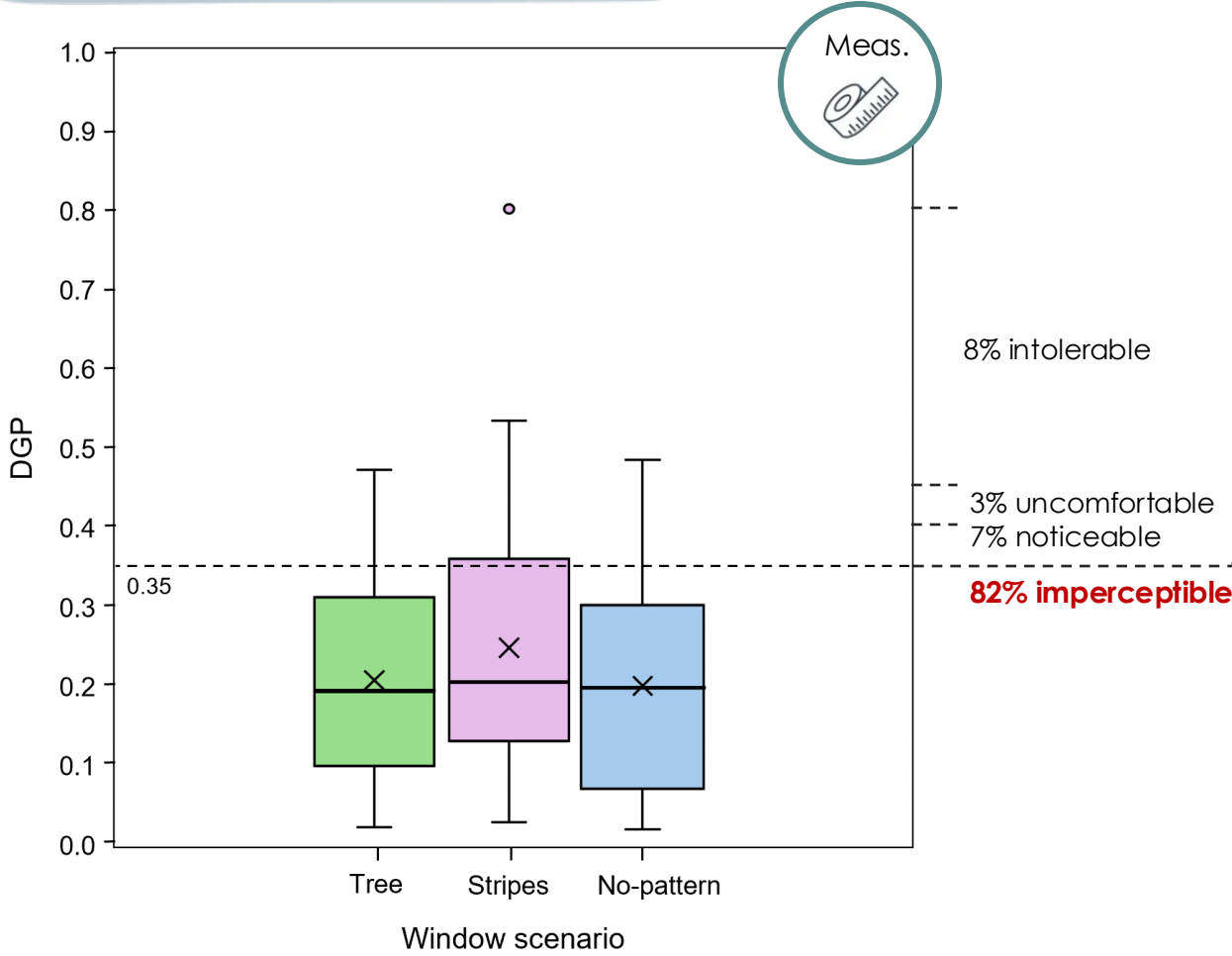
Image Processing



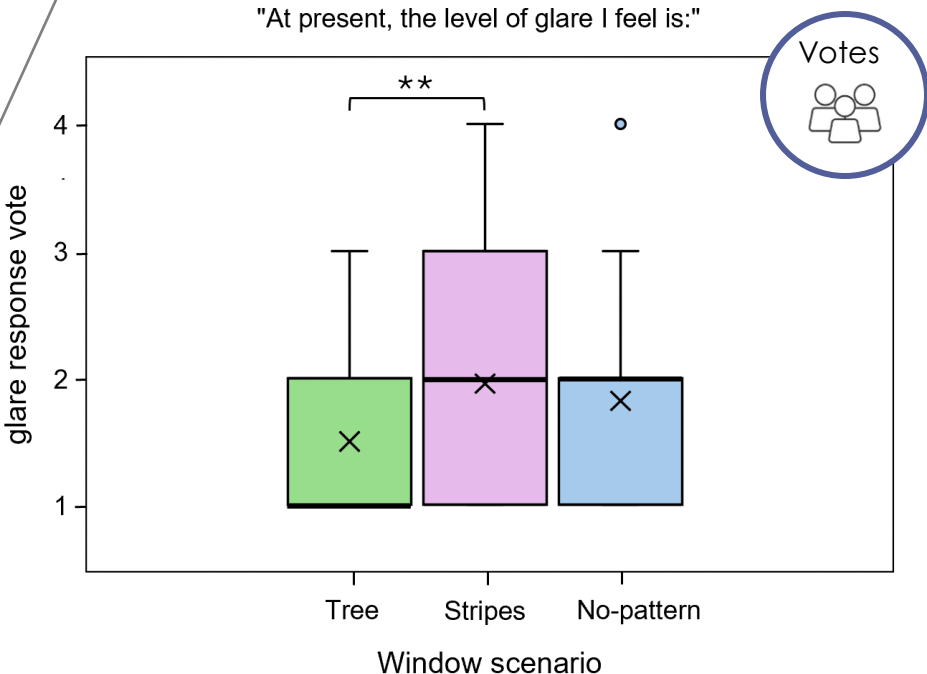
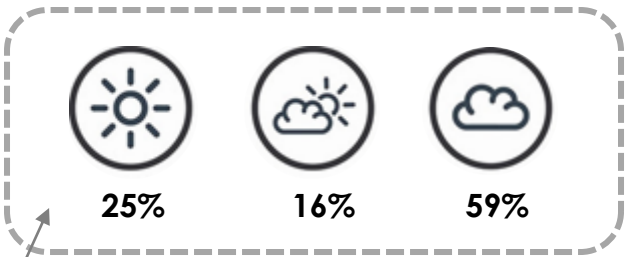
RESULTS



DGP & glare perception



<.35	imperceptible	.40 - .45	uncomfortable
.35 - .40	noticeable	>.45	intolerable



1	imperceptible	3	uncomfortable
2	noticeable	4	intolerable

Significance
p<.05*
p<.01**
p<.001***

Responses from questionnaires

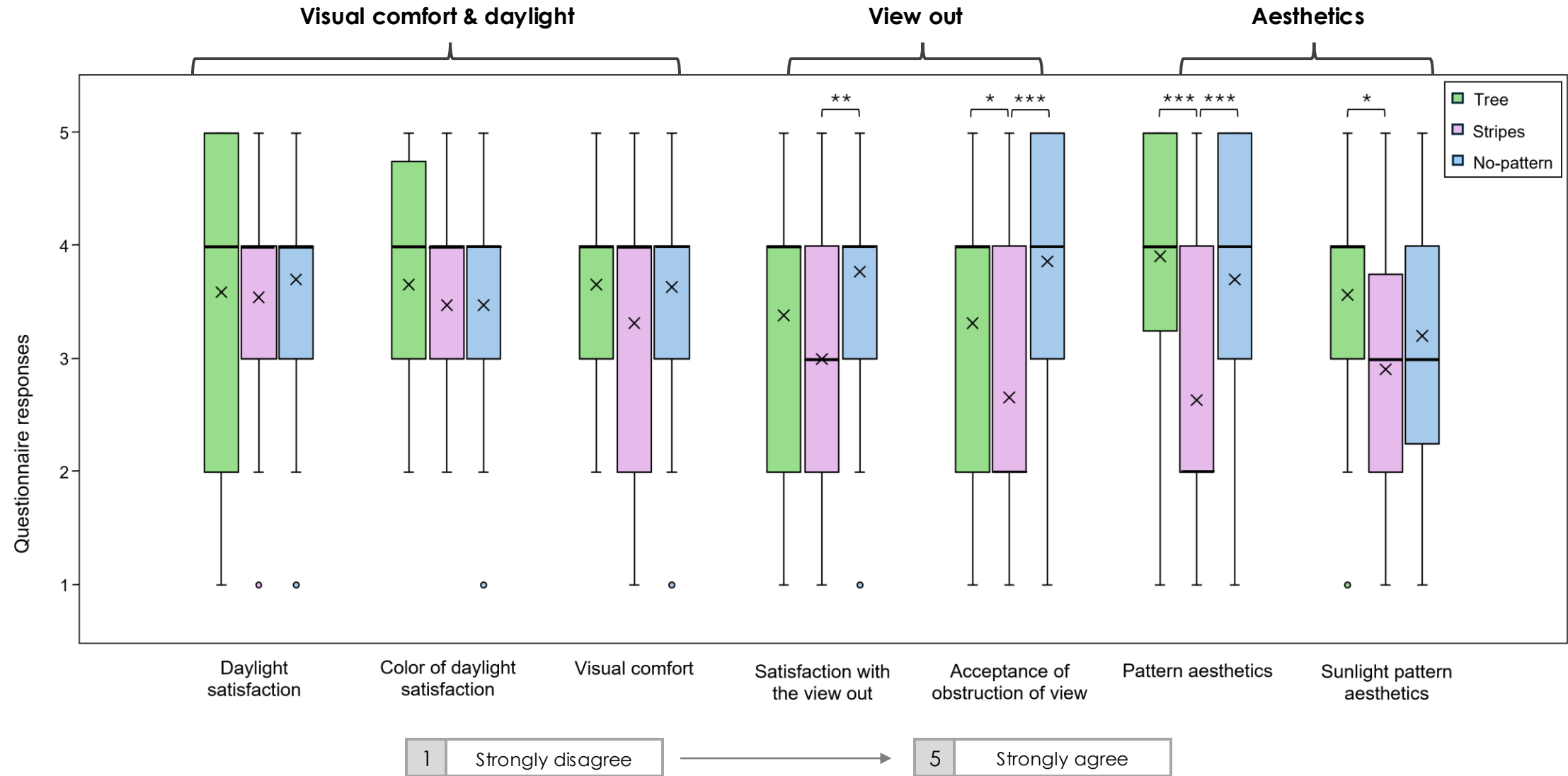


Significance

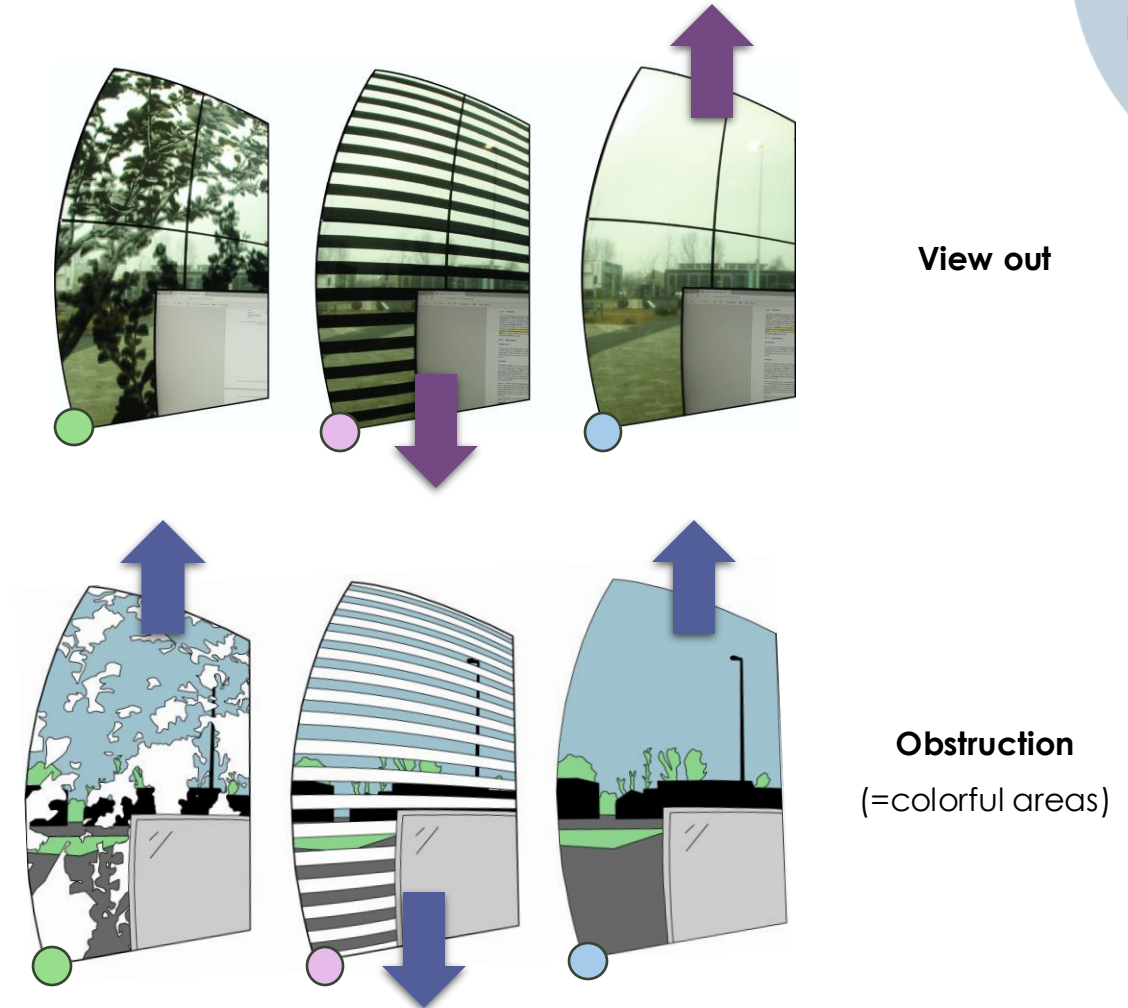
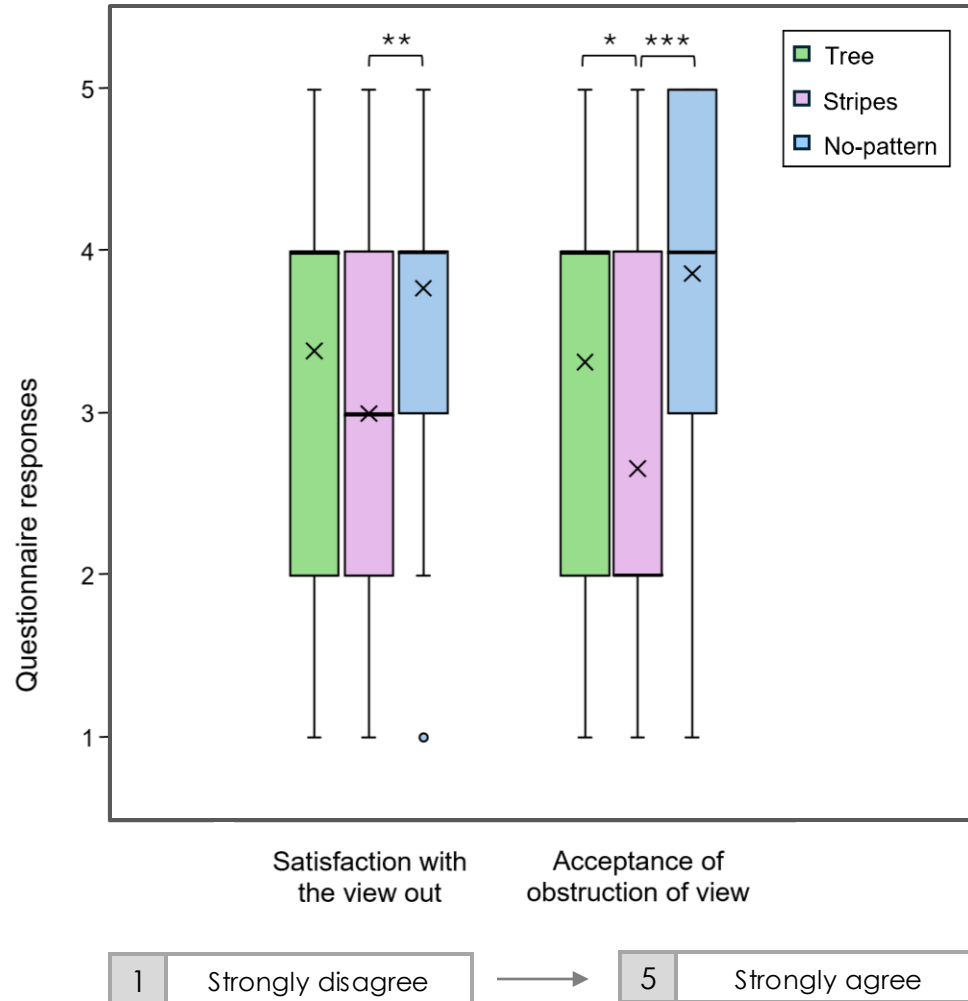
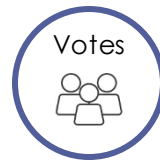
$p < .05^*$

$p < .01^{**}$

$p < .001^{***}$



View satisfaction & obstruction



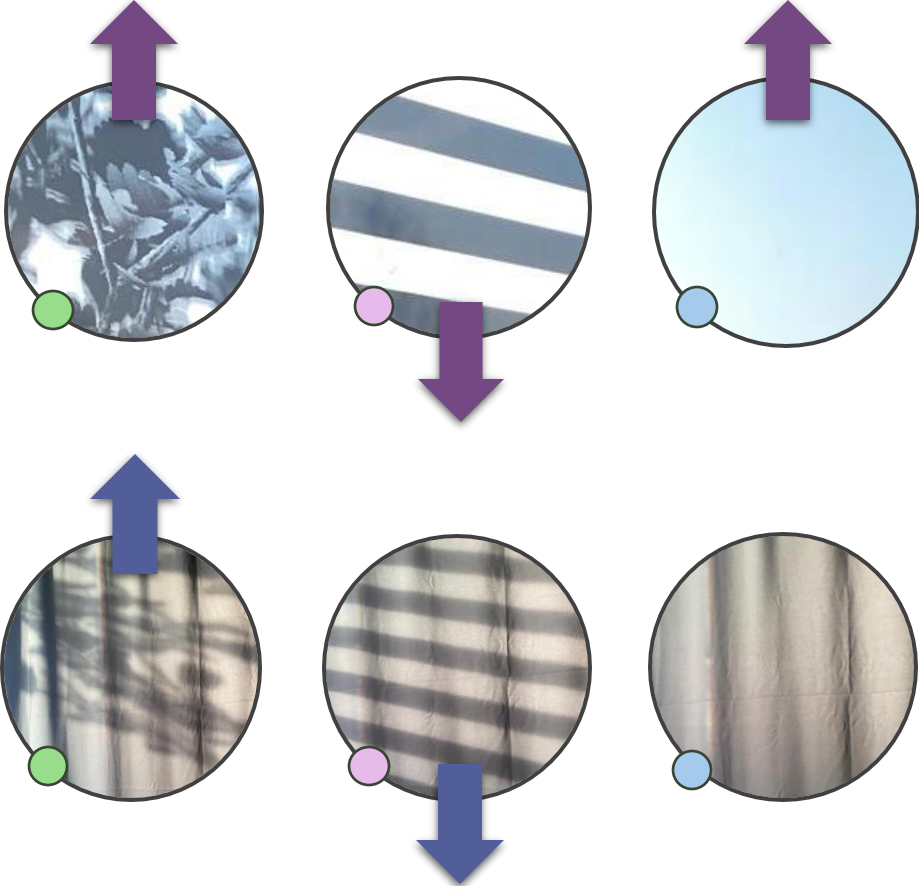
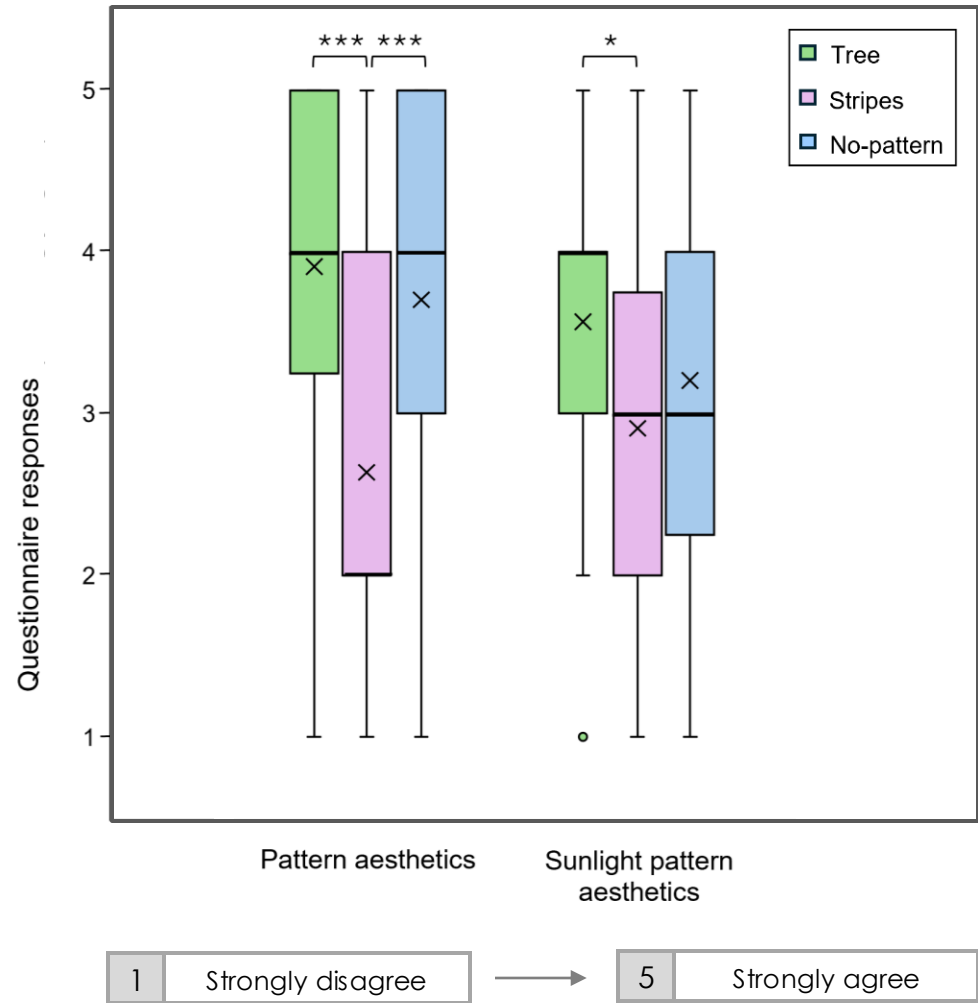
Significance

$p < .05^*$

$p < .01^{**}$

$p < .001^{***}$

Pattern & sunlight pattern aesthetics



Patterns

Sunlight patterns

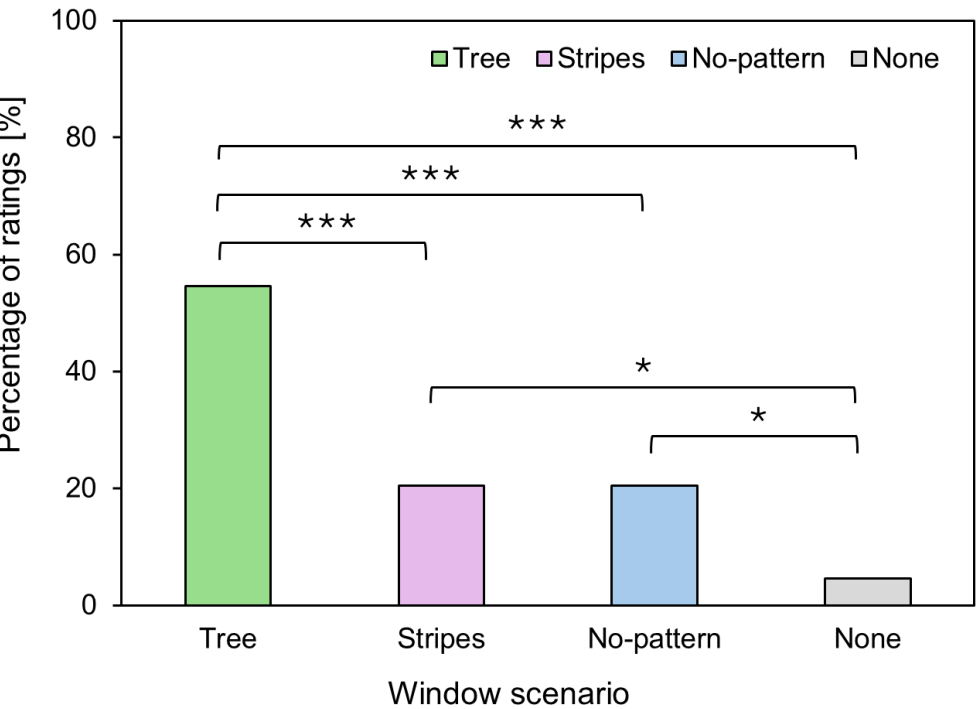
Significance
p<.05*
p<.01**
p<.001***

Pattern preference & connection with nature

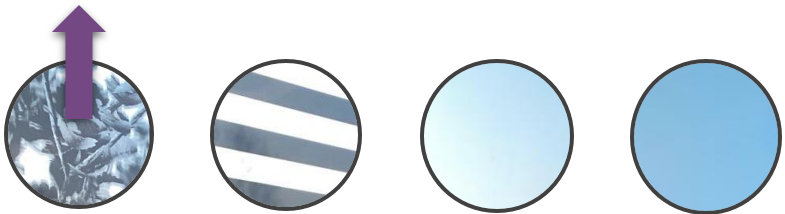
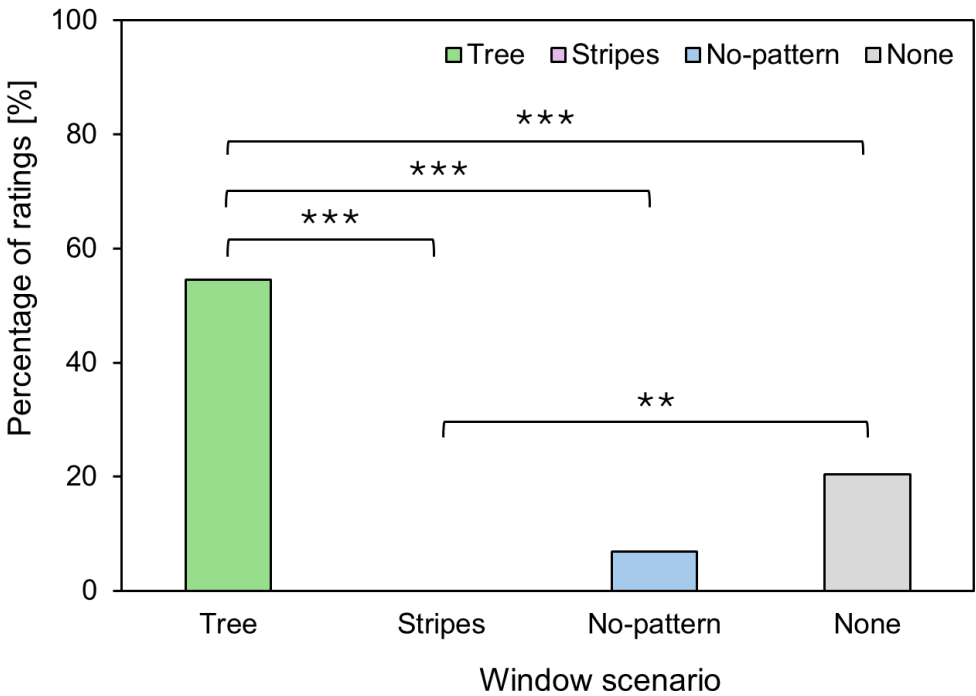


Significance
p<.05*
p<.01**
p<.001***

Among the patterns you have experienced on the glazing, which one is your favorite?



Which of the different scenarios made you feel a connection with nature?



Points to remember

Significant differences among patterns tested



- Glare perception
- View & acceptance of its obstruction
- Pattern & sunlight pattern aesthetics
- Preference & natural connection



- Visual comfort & Daylight

Natural patterns as a potential for accepting:

- automated practice for energy efficiency
- obstructed views or reduced daylight conditions

Limitations

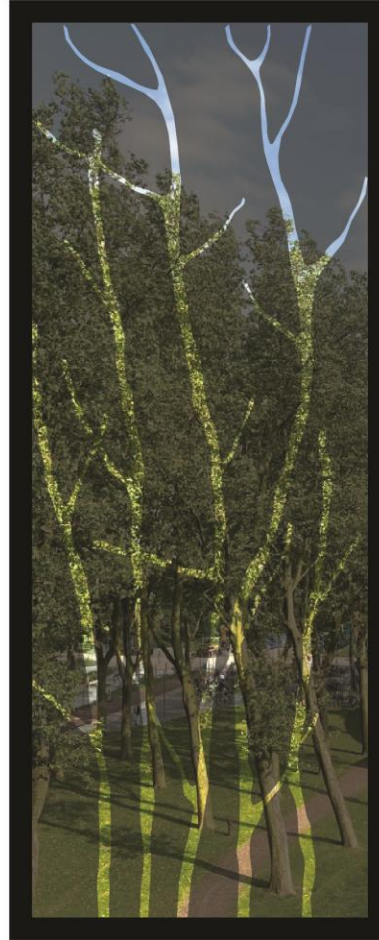
- Short-term exposure
- Lack of glary conditions
- Controlled setup
- Pattern selection
- Type of users



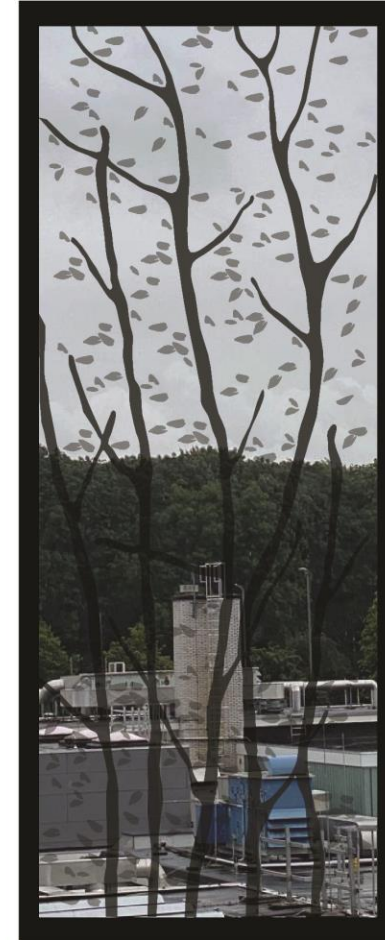
Biophilic design & potential on view



Cover an unwanted view

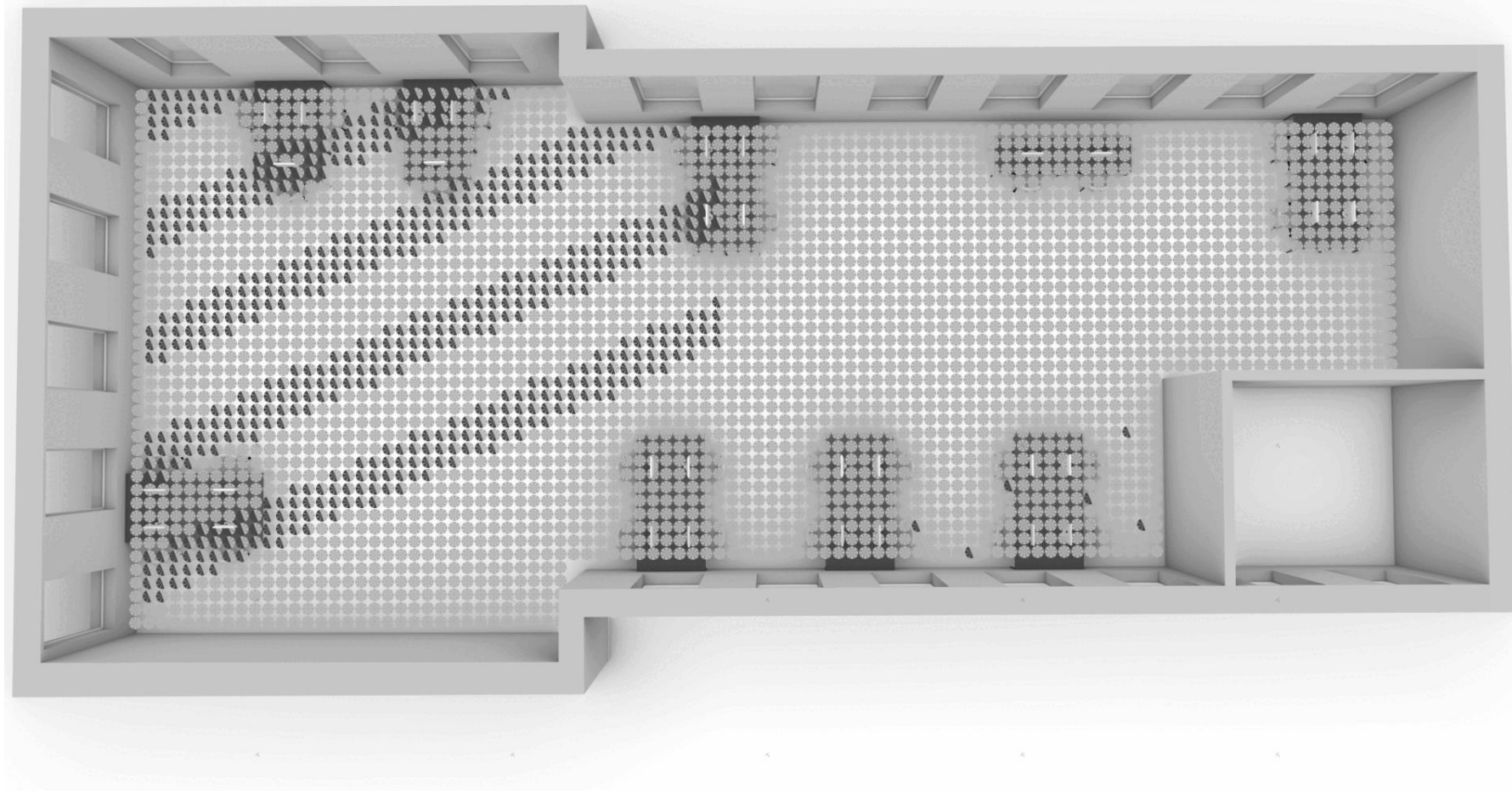


Maintain a natural view



Add biophilic value

Application & challenges

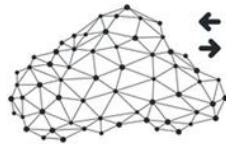


Bridging automation & control

- Automated system



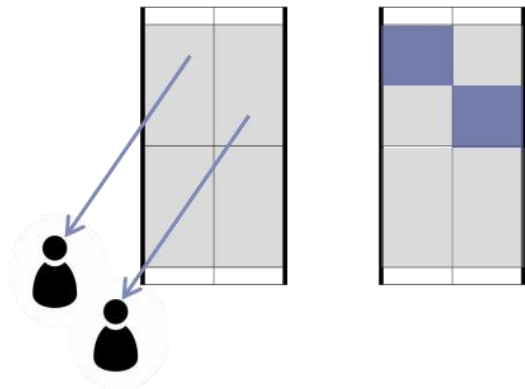
Point cloud system



Occupancy detector



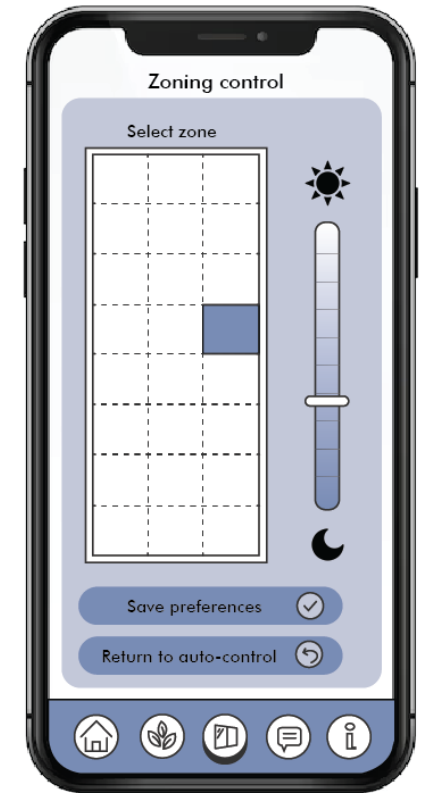
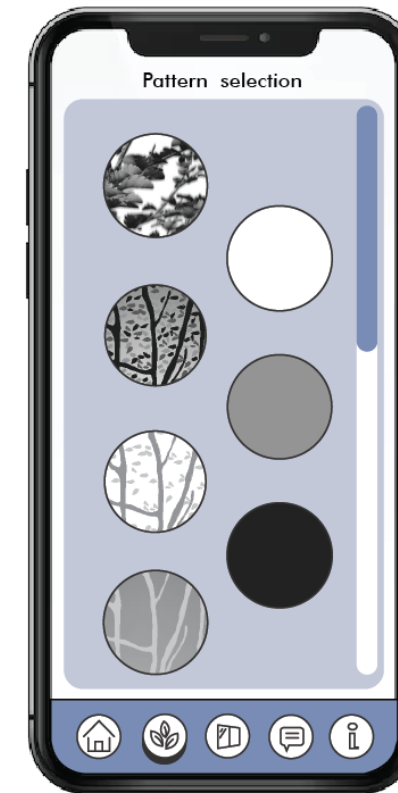
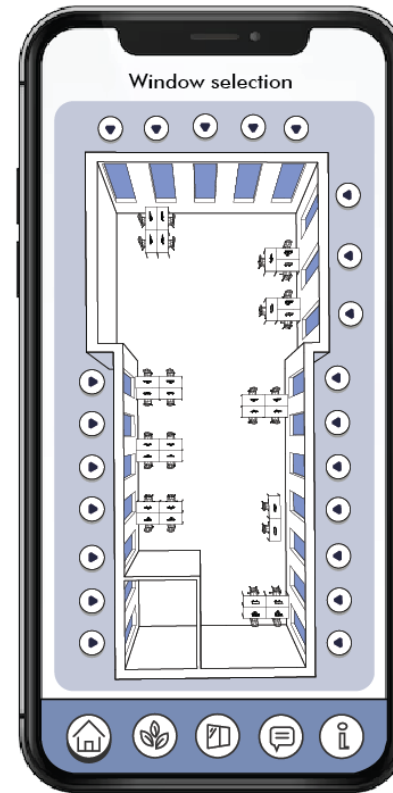
Photosensors for lighting data



Sunray tracing

Zonal control for independent adjustments in the problematic areas

- User-friendly interface for personal control



Points to remember

Significant differences among patterns tested



- Glare perception
- View & acceptance of its obstruction
- Pattern & sunlight pattern aesthetics
- Preference & natural connection



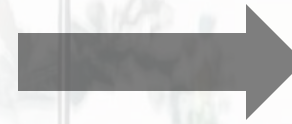
- Visual comfort & Daylight

Natural patterns as a potential for accepting:

- automated practice for energy efficiency
- obstructed views or reduced daylight conditions

Limitations

- **Short-term exposure**
- Lack of glary conditions
- Controlled setup
- Pattern selection
- Type of users



From 'Biophilic Glare Control' to 'Time influence'...

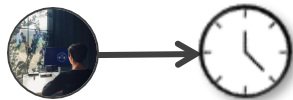


Previous research on
Biophilic Glare Control

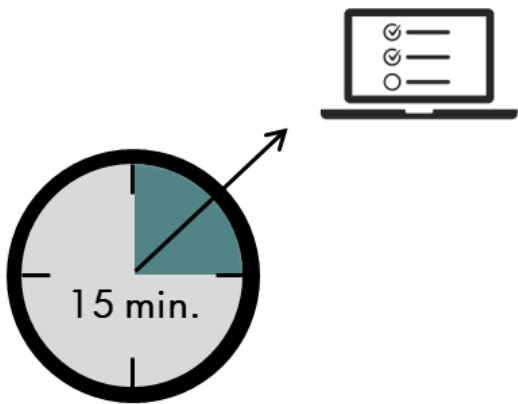


PhD vision on
Time Influence on Glare

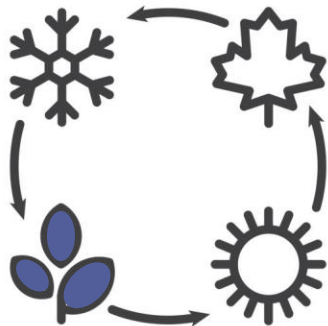
From 'Biophilic Glare Control' to 'Time influence'...



Subjective evaluations
perception recorded



Short-term exposure
15 minutes per pattern



Controlled sun presence
experiments during March



Pre-exposure adaptation period
participants wearing eye mask



Longer exposure durations ?



Seasonal variability ?



Gradual adaptation ?

Individual Adaptation

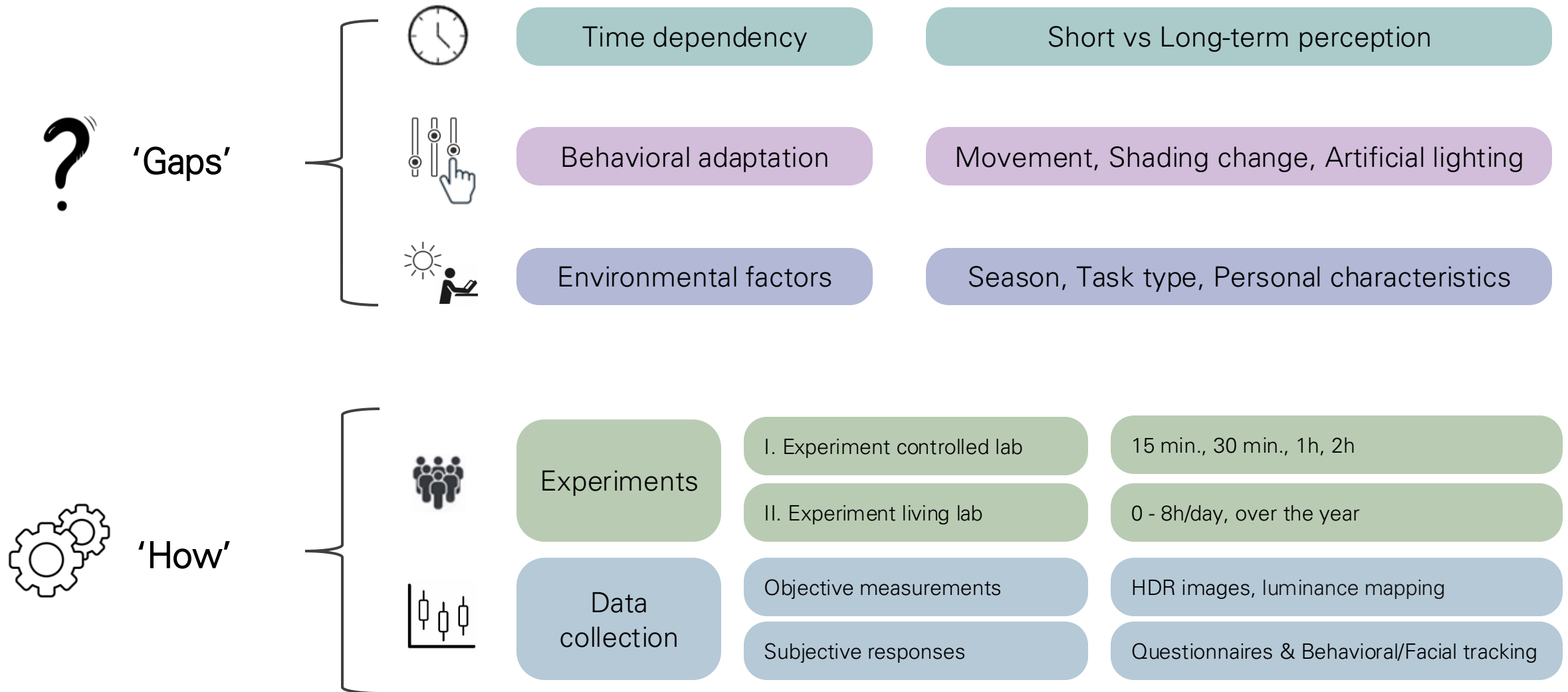
Cognitive Adaptation
past experiences and expectations



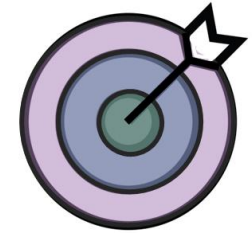
Physiological Adaptation
eye adjusting

Behavioral Adaptation
people response

Focus points and methodology



Goal - Vision



Science

Develop
Time-dependent glare prediction model

+

Include
individual user profiles

Building design

Contribute
Smarter façade & shading strategies improving daylight utilization

Sustainability

Optimize
Daylight-driven building performance

+

Balance
Visual comfort, Energy use and Well-being

A scenic landscape photograph showing a small village with red-roofed houses and a church spire, situated on a hillside overlooking a large blue lake. In the background, there are snow-capped mountains under a sky with scattered white clouds. The foreground features a vineyard and a stone wall.

Thank you!