



STRESS in the LEARNING ENVIRONMENT

Influencing stress and wellbeing of university students by
identifying stressors in the physical learning environment

First mentor	Dr.ir. M.H. [Monique] Arkesteijn [TU Delft]
Second mentor	Dr.ir. V. [Vitalija] Danivska [TU Delft]
Third mentor	Ir. S. [Sophie] Schuller, PhD[c], [TU Eindhoven]
Internship supervisor	Ir. S. [Saskia] Knoop [VKZ BV]
BoE delegate	Dr.ir. M.C. [Martijn] Lugten [TU Delft]

***“What is your favourite
place to study (or
work)?”***

Problem statement

SciTechDaily

Biology

Chemistry

Earth

Health

Physics

Science

HEALTH

The Silent Health Crisis: Why Toxic Stress Is the New Smoking

BY LAWSON R. WULSIN, UNIVERSITY OF CINCINNATI – NOVEMBER 23, 2024

NO COMMENTS

7 MINS READ

f Facebook

X Twitter

P Pinterest

Telegram



Research gap

- Students spend a significant amount of time in learning environments¹
- The spaces could mitigate stress and improve wellbeing
- Workplace studies show how design impacts office wellbeing and stress^{2,3}
- But in university context...

Research aim & main question

Research aim

Identifying environmental factors that **influence** stress, and provide insights to help **improve** students' (mental) well-being and their learning experience.

Main question

“What is the relationship between (new) physical learning environments and stress among students at a Dutch University?”

Sub questions

RQ1: “What are the **different types** of stress and stressors relevant to university students in learning environments?”

RQ2: “How can different types of stress in university students be **measured**?”

RQ3: “**What** is a (new) university learning environment?”

RQ4: “What observable **characteristics** of (new) university learning environments **influence** stress among university students?”

RQ5: “How do **newer** university learning environments **differ** from traditional ones in their **influence** on student stress?”

THEORETICAL BACKGROUND

What is stress?

- A psychological and physiological response to internal or external demands^{1,2}
- Balance between demands and resources³
- Adaptive (eustress) or harmful (distress), depending on capability of coping¹

Psychological & physiological

Psychological stress

- Shaped by perception, emotion and context¹
- Impairs focus, memory and decision-making when persistent^{3,4,}

Physiological stress

- Activates the body's automatic systems
- HPA-axis releases cortisol⁵
- SAM-axis triggers adrenaline^{6,7}

Relationship between them is often varied!⁸ Personality traits moderate corespondance^{9,10}

Acute & chronic

Acute stress

- Short-term, sharpen performance if managed well¹
- Triggers fight-or-flight response²

Chronic stress

- Builds over time, wearing down body systems^{3,4}
- Leads to allostatic load (wear and tear without recovery)⁵

Eustress versus distress

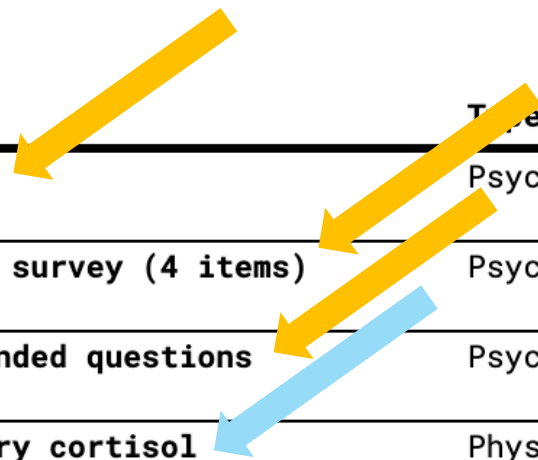
- Eustress: Motivating, enhances focus, energising¹



- Distress: Chronic health risks, affecting cognitive and emotional functioning^{2,3}



How to measure stress

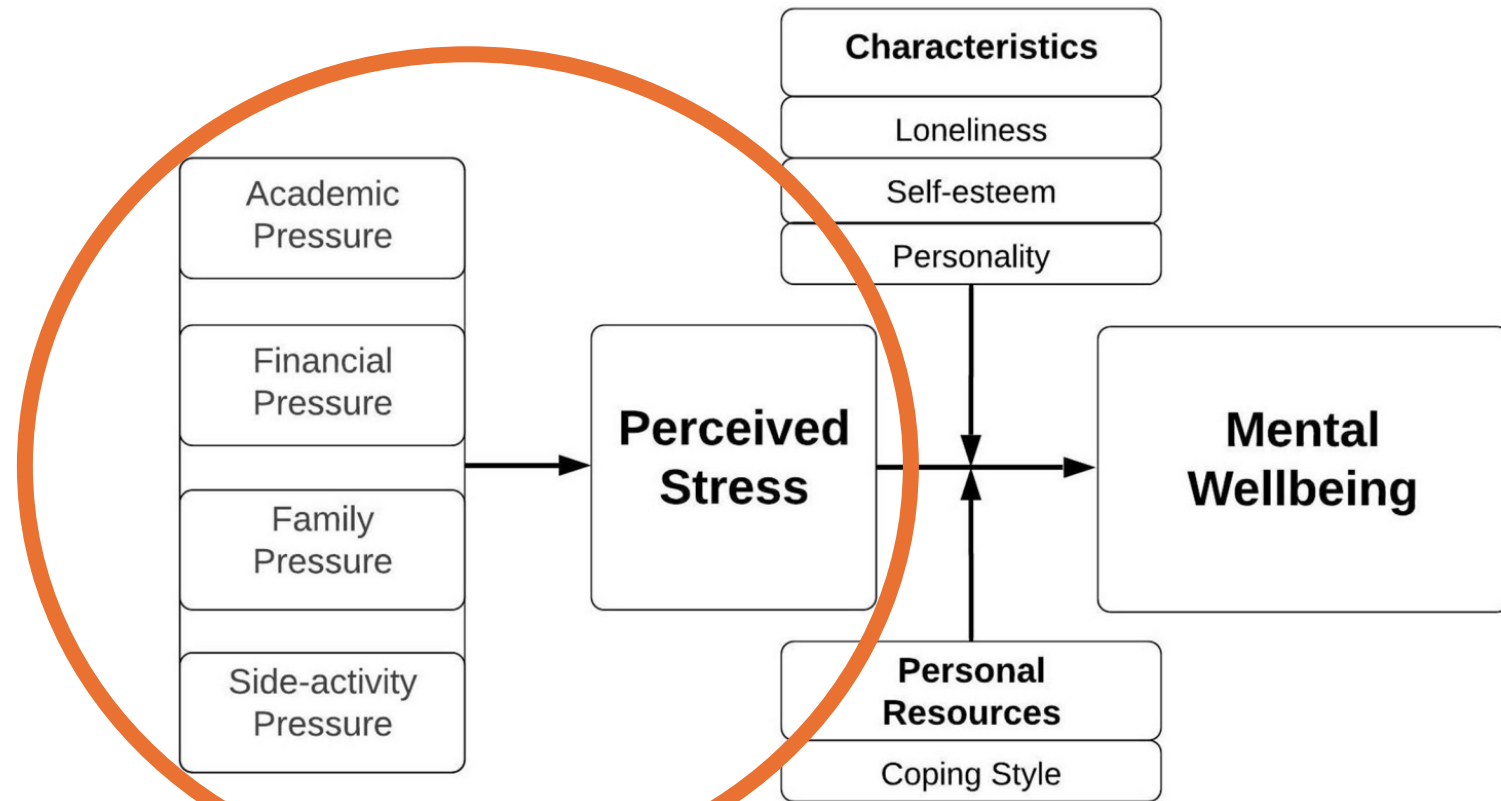


Method	Type	Pros	Cons	Included?
PSS-10	Psychological	Validated, reliable, easy to administer; baseline measure	Retrospective (not momentary), not task-specific	Yes
Custom survey (4 items)	Psychological	Immediate, session-specific feedback; simple and scalable	Limited depth; not standardized	Yes
Open-ended questions	Psychological	Adds nuance and captures personal perceptions	Subjective; requires manual coding	Yes
Salivary cortisol	Physiological	Non-invasive; reflects HPA axis activation	Delayed response curve; requires lab access; individual variation	Yes
Electrodermal Activity (EDA)	Physiological	Real-time response; reflects SAM activation	Devices unavailable; requires calibration and filtering	No
Heart Rate Variability (HRV)	Physiological	High sensitivity to acute stress; rich dataset	Equipment not available; data quality issues without controlled setting	No

Student specific stressors

- Slimmen et al.'s ,model (based on the JD-R² and Student Wellbeing model³), including:

- Academic pressure¹
- Financial pressure¹
- Family pressure¹
- Side-activity pressure¹



Why Learning Environments?

- Students spend approximately 20.000 hours in classrooms!¹
- Improving physical environments could provide preventive measures that improve wellbeing and reduce stress

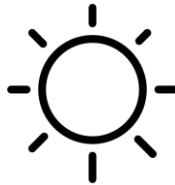
Lessons from work environments

Seven environmental characteristics^{1,2,3}

Noise, acoustics and privacy 1



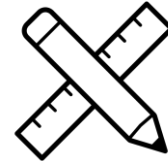
Light and daylight 2



~~Thermal comfort and temperature 3~~



~~4 Indoor air quality and ventilation~~



5 Layout and design

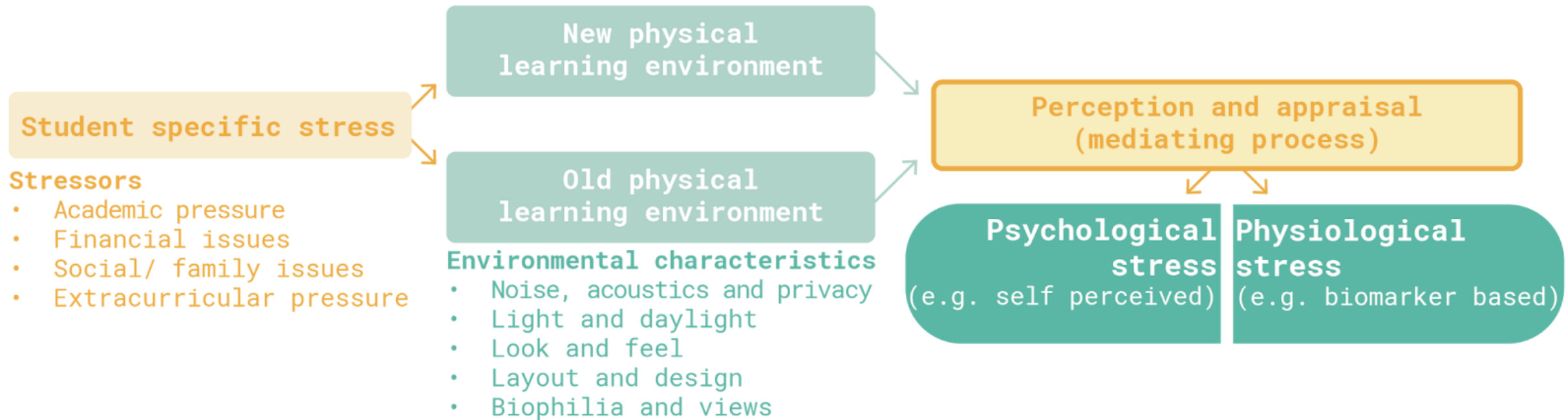


6 Biophilia and views



7 Look and feel

Conceptual framework



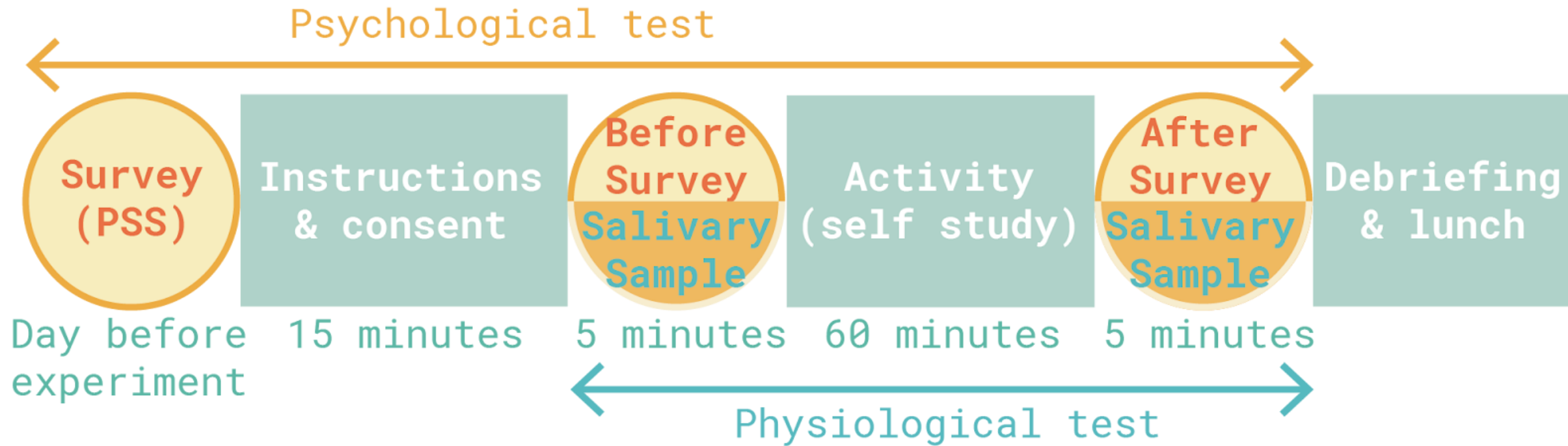
Methodology and hypotheses

An experimental within-subject AB study design^{1,2} using statistical analysis

Hypotheses guiding the experiment:

- H1: *There is a statistically **significant relationship** between **physical learning environment** and students' **perceived stress**, as measured through survey responses.*
- H2: *Students will report **lower** levels of perceived and physiological stress after studying in the **newer** learning environment (Room B), compared to the traditional environment (Room A).*

Experiment procedure



Participants: who, when and how?

- 13 students, of different academical backgrounds, different genders, between ages 21-25
- 10 students for the cortisol experiment
- Week 7 and 8 of Q3

	27-03-25	28-03-25	-	-	31-03-2025	01-04-25	02-04-25	03-04-25	04-04-25
	Thursday	Friday	-	-	Monday	Tuesday	Wednesday	Thursday	Friday
11:00-12:00	Baseline PSS-10	Group 1/ Room A				Group 1/ Room B			
Break	-	-	-	-	-	-	-	-	-
13:00-14:00					Baseline PSS-10	Group 2/ Room B			Group 2/ Room A

Comparing learning environments

Room A (Hall C, BK City)

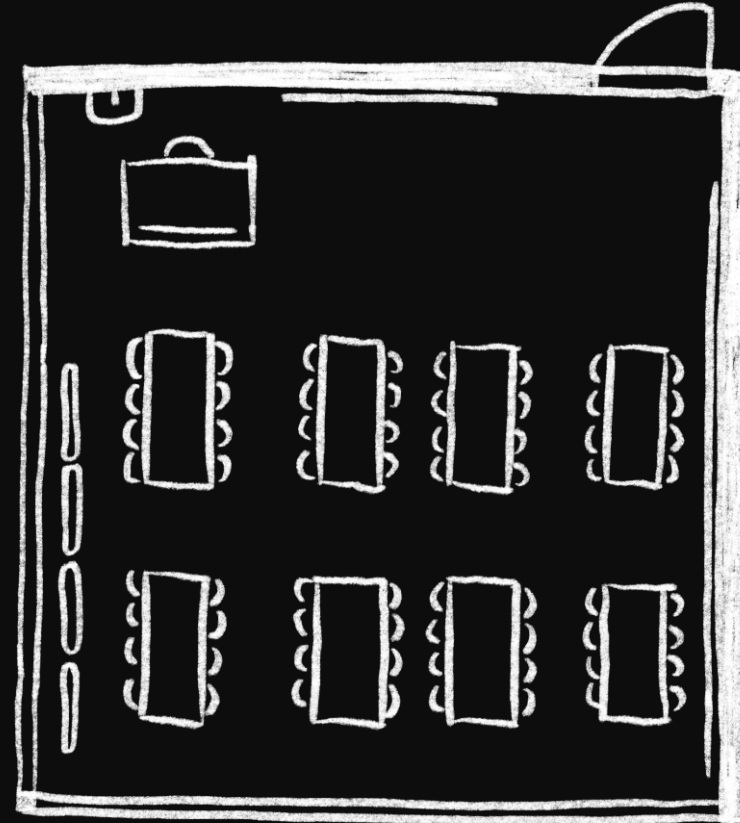
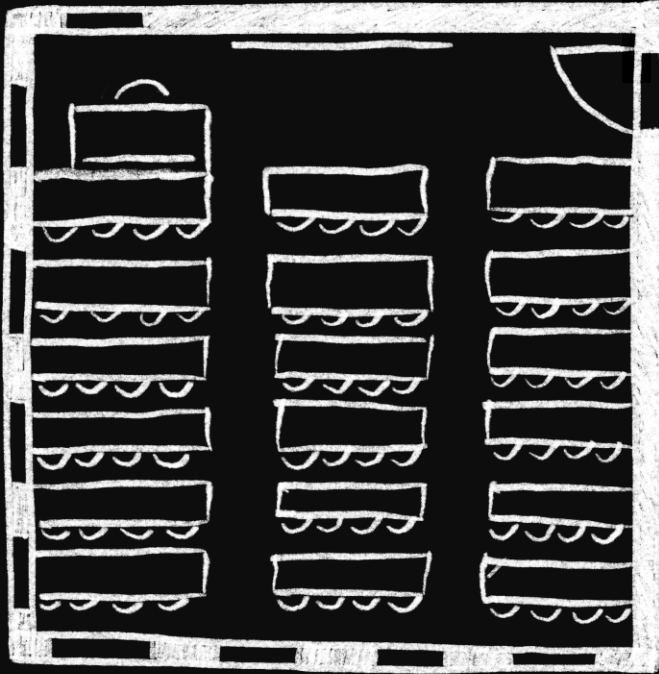
- Constructed in 1923, in use since 2009
- Mixed practice, frontal teaching, movable tables, instruction room¹
- No pictures! Take a look around!

Room B (Hall D, ECHO)

- Constructed and in use since 2022
- Collaborating, flexible tables, project room¹



Layout comparison



Room A (left): 2m^2 per student, Room B (right): $2,95\text{ m}^2$ per student

Comparison of characteristics

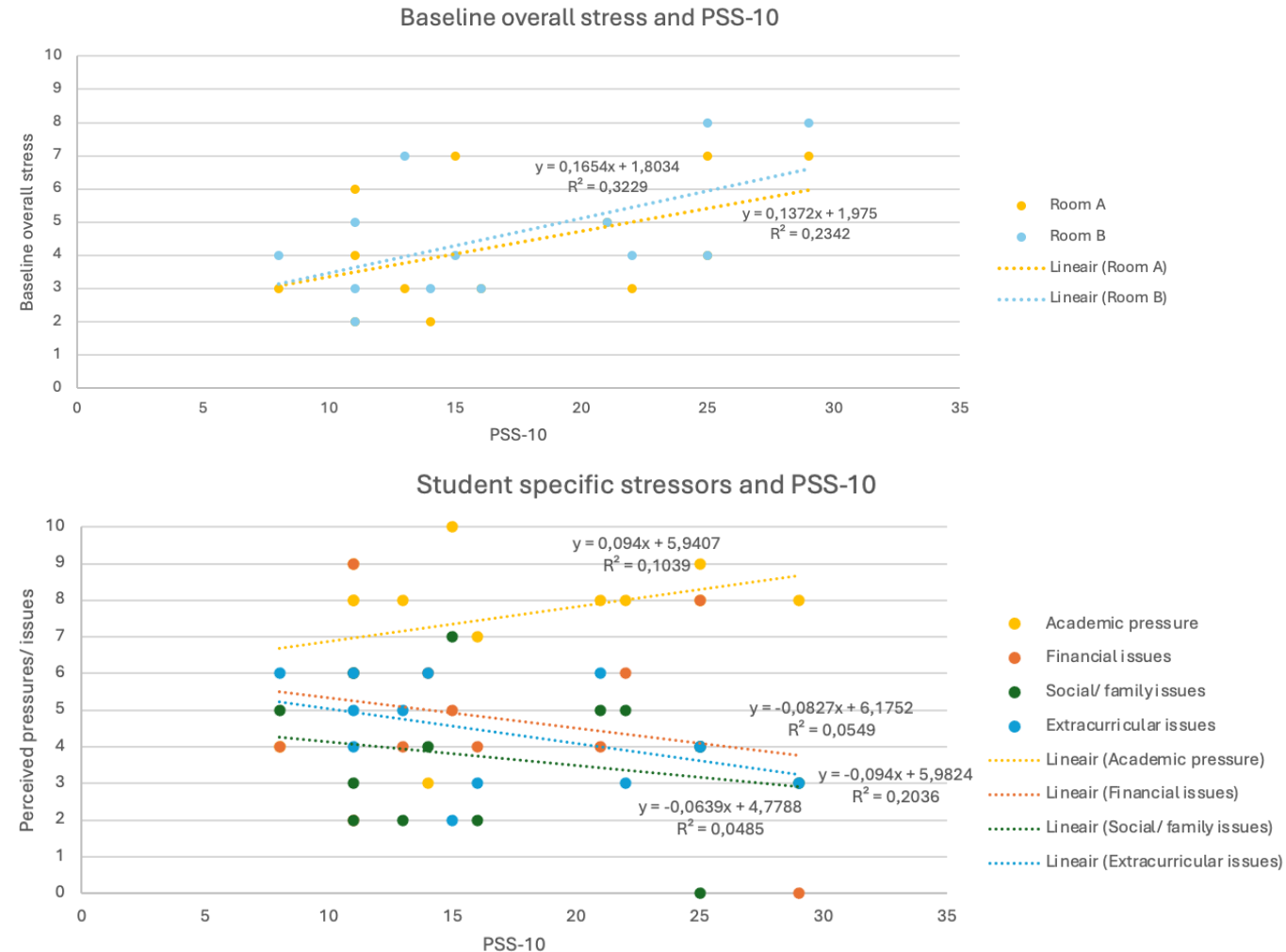
	Characteristic	Room A (Hall C – BK City)	Room B (Hall D – Echo)
	Noise, Acoustics and Privacy	40 dB average; some outside noise due to old windows; limited acoustic insulation	30,3 dB average; excellent insulation with acoustic panels; high auditory privacy
	Light and Daylight	6000 lux (back), 1600–1900 lux (front/middle); high gradient, potential glare	3600 lux (back), 1900–2100 lux (front/middle); more even lighting, less glare
	Layout and Design	Square layout (12×12 m); fixed frontal setup; limited flexibility	Rectangular layout (13.5×14 m); flexible, mobile furniture; supports autonomy
	Biophilia and Views	No indoor plants; views of treetops and park from large windows	Extensive outdoor views; bamboo wall, natural material accents and corridor plants
	Look and Feel	Warm red carpet, white walls, historic-industrial ceiling; cozy but possibly arousing	Cool blue walls, wood tones, black furniture; calm, modern, cognitively focused

RESULTS

(image by Merlin)

Psychological stress

- PSS-10: Correspondence with baseline overall stress and Slimmen's stressors



Psychological stress

Self-reported, four item survey

Overall stress:

Difficulty focussing:

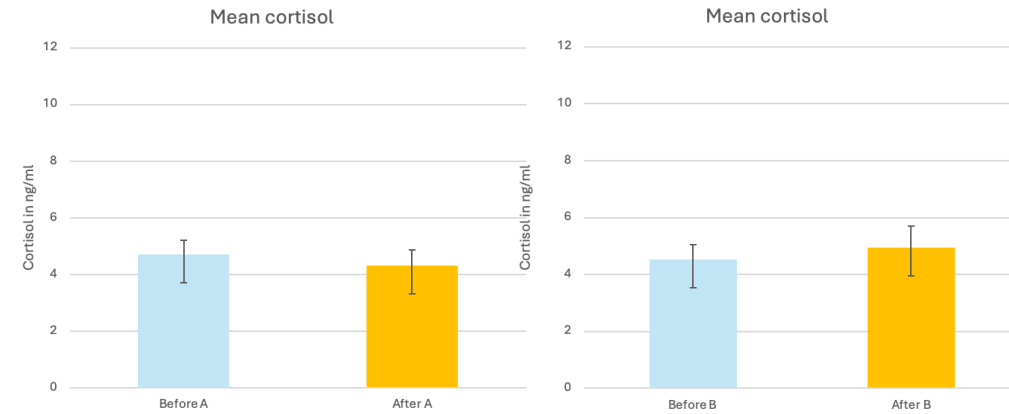
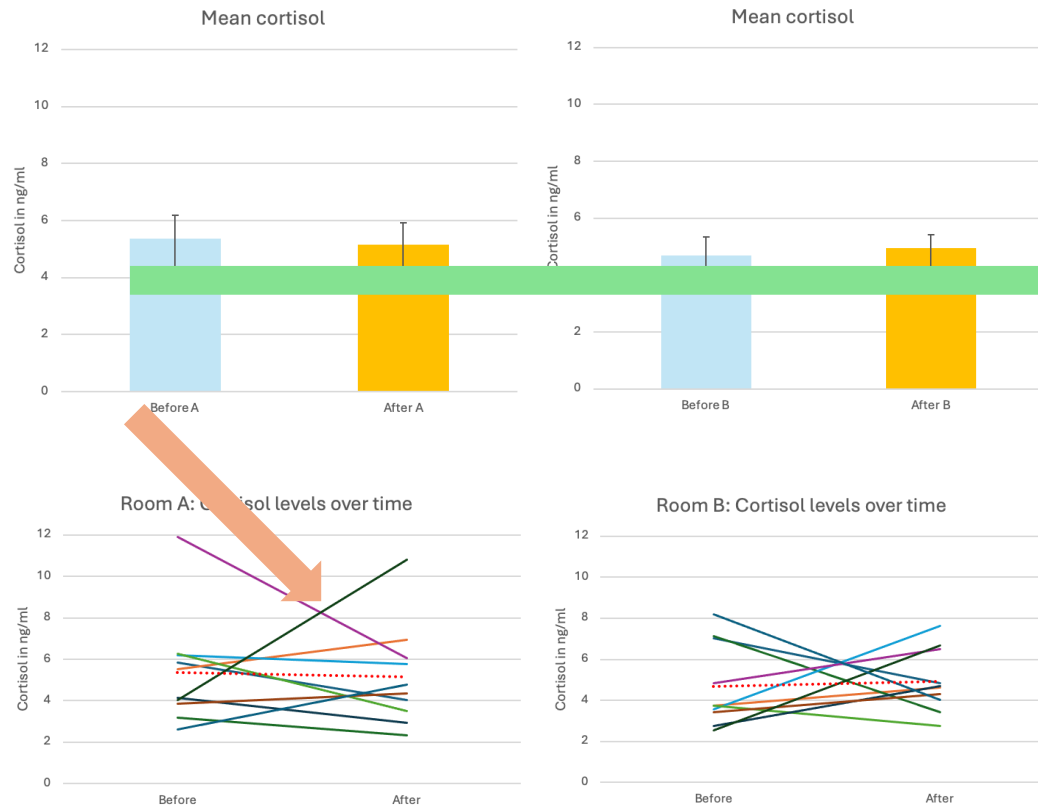
(Self-reported) physiological stress:

Environmental influence:



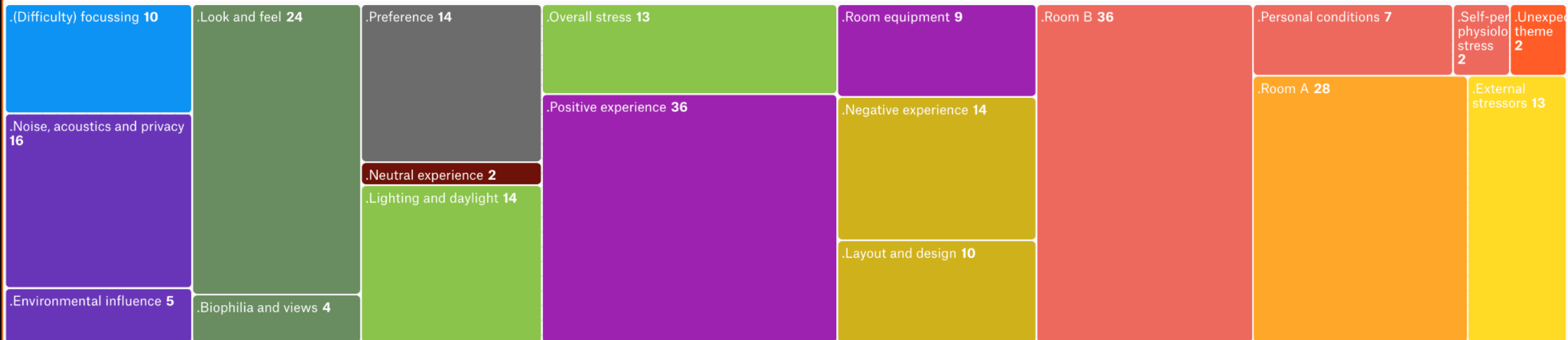
Physiological stress

Salivary cortisol sampling



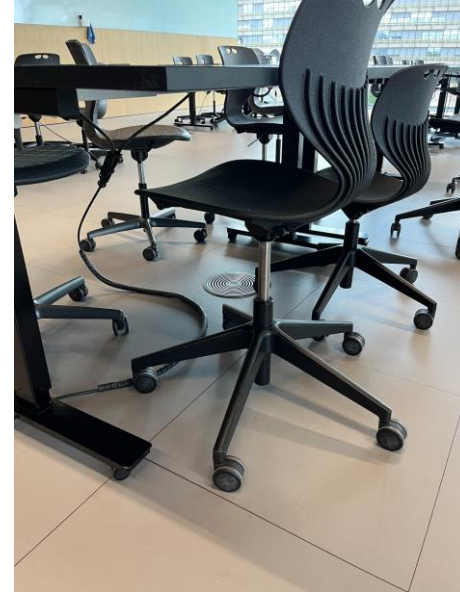
Open-ended questions

- Open-ended question responses were 'coded' with Atlas.ti
- Most quoted 'deductive' code: Look & feel
- Most quoted 'inductive' code: Room equipment

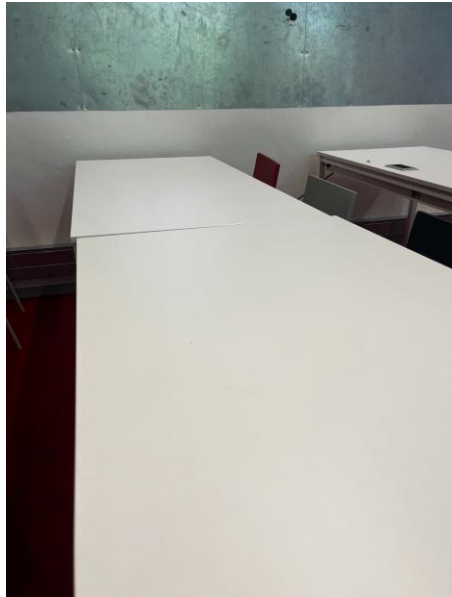


Room equipment

*"I think I prefer this one (Room B) ...
the seats and desks are adjustable"*



"Not all the tables have power outlets (Room A)."



*"The tables at Echo (Room B) were unstable and
the chairs less comfortable."*

Room preference

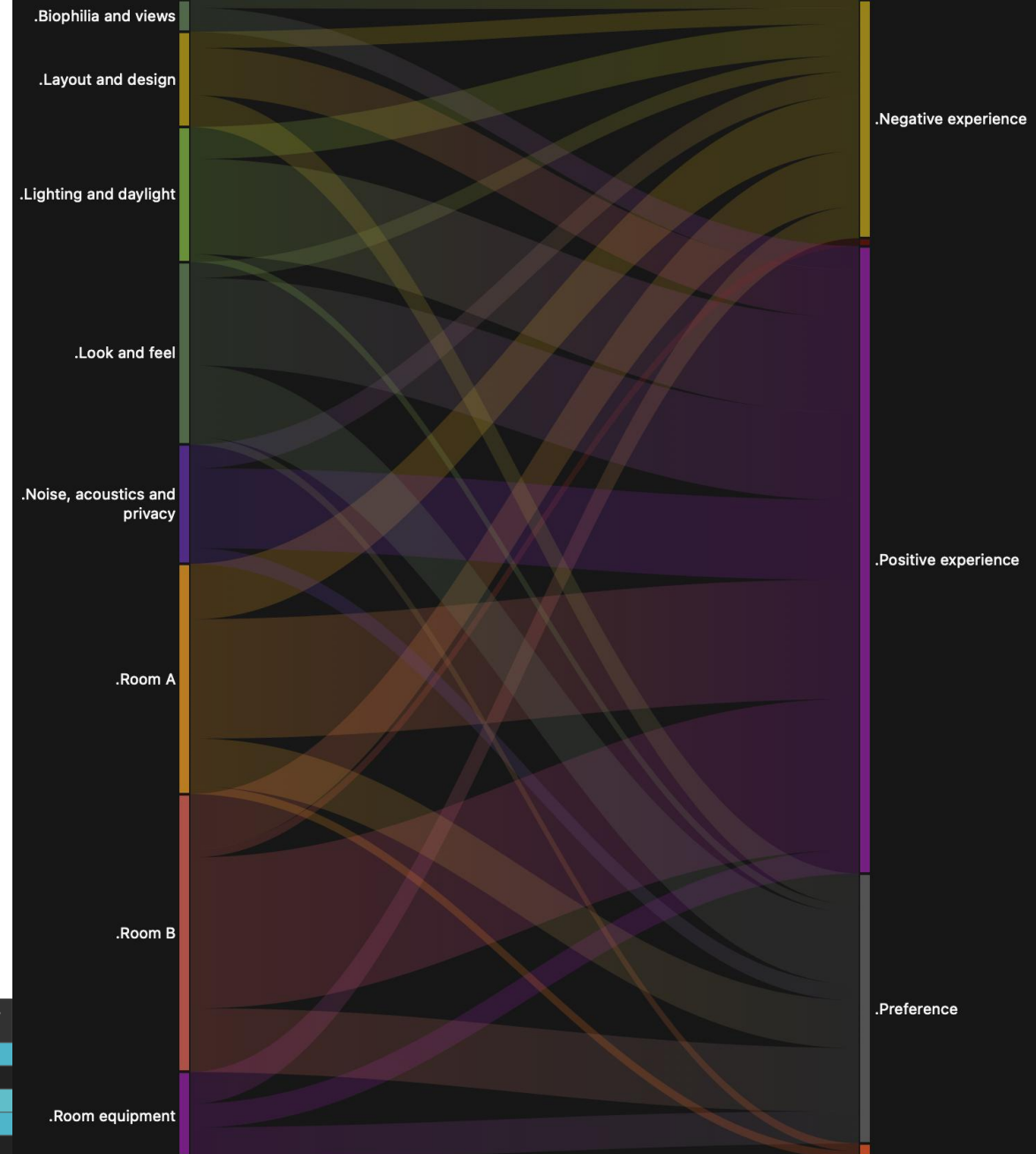
"I think I prefer this room (Room A) to study in because of its cozy feel."

"If I have to concentrate on a deadline, the other room (Room B) is better, I think."

- Both rooms were (mostly) found suitable

"It looks like a strict boarding school... it is also a very large space which has a negative influence on my concentration"

	◆◆ .Biophilia and views Ⓜ 4	◆◆ .Layout and design Ⓜ 10	◆◆ .Lighting and daylight Ⓜ 14	◆◆ .Look and feel Ⓜ 24	◆ .Noise, acoustics and privacy Ⓜ 16	◆◆ .Room A Ⓜ 28	◆◆ .Room B Ⓜ 36	◆◆ .Room equipment Ⓜ 9
◆◆ .Negative experience Ⓜ 14	1	2	4	2	3	7	7	4
◆ .Neutral experience Ⓜ 2	0	0	0	0	0	0	1	0
◆◆ .Positive experience Ⓜ 36	3	6	12	11	10	15	19	3
◆◆ .Preference Ⓜ 14	0	4	1	9	2	6	8	4
◆◆ .Unexpected theme Ⓜ 2	0	0	0	1	0	1	0	0



Key findings

- More improvement in Room B then Room A
 - Moderate improvement in focus (with a decrease in Room A)
 - Significant decrease in (self-reported) physiological stress
- Cortisol didn't match this perception
 - Not aligned with survey results; interesting....
- Room preferences
 - Room B for focus, Room A for comfort
 - Room equipment linked with preference
- Hypotheses partially supported

Discussion: what do the findings really mean?

Cortisol and concentration

Cortisol rose in Room B, but so did focus
→ Not all stress is negative!

→ Cortisol can be supportive

Restoration and room preferences

Room A was cozy, Room B was focused
→ Some spaces soothe, others help you concentrate.

→ No one ideal space, we need both!

Unconscious processing of space

Environmental influence limited, controversial data
→ Architecture influences without awareness

→ Neuroarchitecture, associationism & heuristics explain subtle emotional responses

Combining stress measurement methods

Cortisol said one thing, surveys said another
→ Not a flaw, it's a finding!

→ Combining methods reveals what one would miss

Limitations



Small sample size ($n=13$, $n=10$ for cortisol)



Short sessions (1 hour) may miss cortisol peaks



Real rooms $\neq$ controlled lab



Cortisol is sensitive



Custom survey items



Stress is (very) complex

Conclusions

- Do learning environments influence student stress?
 - Yes; most evident for (self-reported) physiological stress and focus
- Emotional comfort $\neq$ cognitive focus
 - Different spaces support different needs!
- Unconscious design cues matter
 - 'the room didn't affect me', or did it?...?

Recommendations

- For universities
 - Create diverse spaces: some for focus, some for recovery
 - Repurpose underused rooms as study spaces
- For students
 - Match your space to your task
 - Don't ignore how the room makes you feel, it matters!
- For researchers
 - Use larger samples
 - Also include real-time stress tracking (HRV, EDA)
 - Test with more controlled room comparisons

Thank you for listening

Are there any questions?