



InnoRenew CoE

Livade 6, 6310 Izola/Isola, Slovenia, T: +386 40 282 944, E: coe@innorenew.eu, www.innorenew.eu

Wood and Restoration

Can wood provide restoration in buildings?

Michael Burnard

Deputy Director, InnoRenew CoE

Assistant Professor, University of Primorska

mike.burnard@innorenew.eu

+386 (0) 31 427 672

Wood & Health
28 November 2018
Oslo, Norway



Restoration

- Recover a depleted resource
 - Ability to focus attention
- Physical recovery?
- Stress is a useful indicator and serious health problem.





What is restoration?

- The relationship between restoration and nature is theoretically grounded in environmental psychology
- The concept of restoration is important... restoration is:

a process of renewal that replenishes a depleted social, psychological, or physical resource (Hartig, 2004)



Restoration

Two key restoration theories:

1. Attention restoration theory (Kaplan & Kaplan, 1989)
 2. Psychophysiological restoration theory (Ulrich et al., 1991)
-



Restoration

- Biophilia hypothesis (Wilson, 1984)
humans have an innate connection to life and life-like processes
 - The human connection to nature
The human connection to nature can trigger restorative processes...
(Kaplan, 1995; Herzog et al., 1997)
-



Stress & Restoration

- Stress is a public health concern
- Physiological responses to stressors can have long-term damaging health effects
- Work stress is a key contributor to chronic stress

McEwan, 1998



Stress & Restoration

- People are known to recover from stress more quickly in nature

Tyrväinen et al., 2014



- But... people spend 80-90 % of their time indoors, separated from nature.

USGBC, 2010





Finding a solution

- Connect people with nature where they are most





Is this enough?





Restorative by design?

- Biophilic design & Restorative Environmental Design are building design paradigms that seek to bring nature, and its restorative effects indoors.

(Kellert et al., 2008; Derr & Kellert, 2013)





Current Understanding

- Previous research found different physiological responses to indoor environments with wood and without
 - Some of those physiological responses are common stress indicators
-



Previous research

- Most previous research linking interior wood use and stress had shortcomings in experimental design
 - To few subjects
 - Unrealistic settings/circumstances
 - Test exhaustion
 - Did not account for strong individual differences in stress responses
-



An exception

Fell (2010): wood use in offices seems to improve stress response, and very likely recovery...



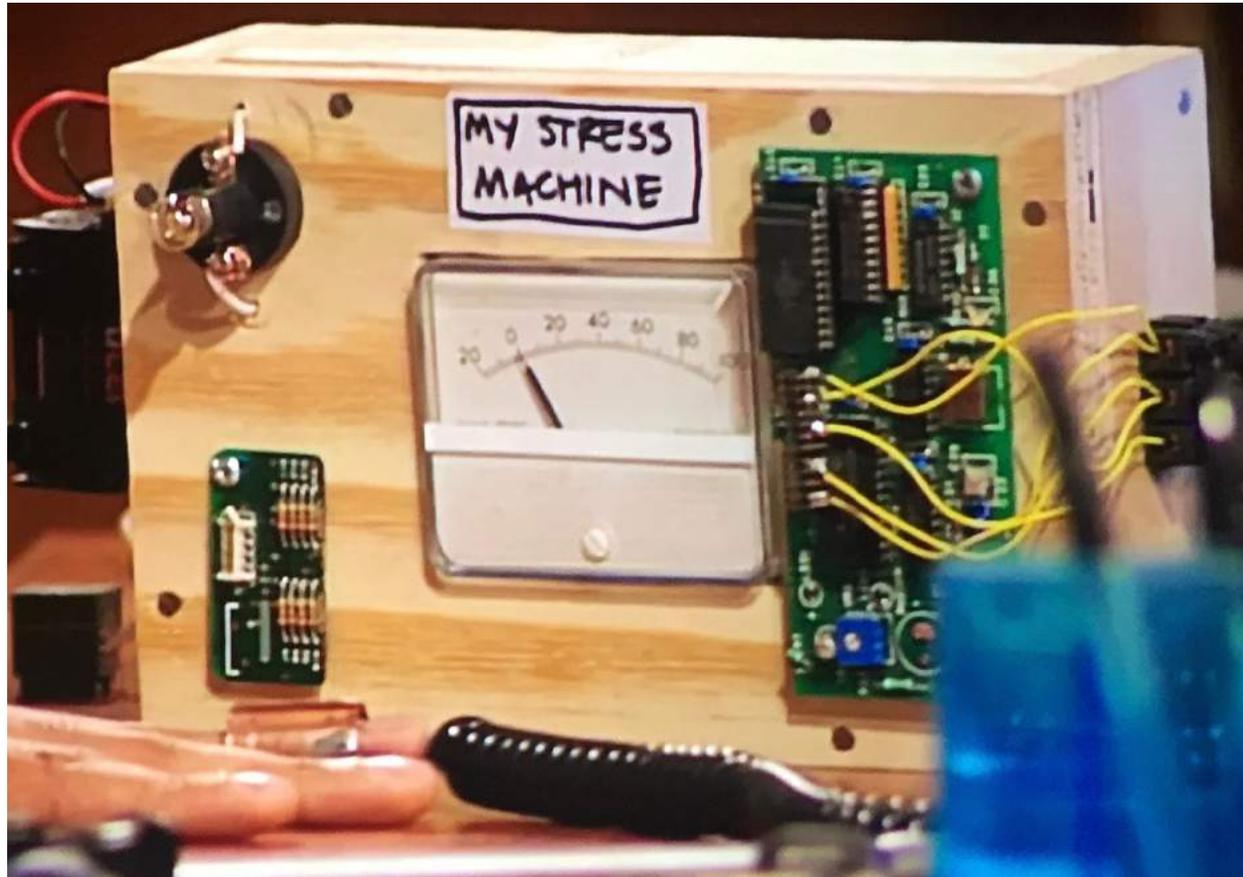


An experiment to study restoration...

Human stress in offices

- Compare stress responses and recovery between an office with wood furniture and an office without wood furniture.
- Compare two wood types
- Use objective indicator of stress and strong experimental design

Human stress in offices



Objective measure of stress?

Salivary free cortisol

Other stress-focused research suggests cortisol is a useful indicator of stress and stress recovery in experimental settings.



Cortisol

- Cortisol is a steroid in the glucocorticoid class of hormones
- Considered a reliable measure of adaptations to stress from the hypothalamus-pituitary-adrenal axis (Hellhammer et al, 2009)



Cortisol

- ... is a steroid in the glucocorticoid class of hormones
- ... is a reliable measure of adaptations to stress from the hypothalamus-pituitary-adrenal axis (Hellhammer et al, 2009)
- Assessed from saliva, which is painless and easy to sample
- Well defined process for assessment, with commercially available sampling devices and kits (ELISA).
- Saliva is stable, easy to store and transport



Challenges with cortisol

- Cortisol levels vary following a circadian rhythm (Van Cauter et al, 2016)
- Sources of variation:
 - Technician to Technician variance
 - Plate to Plate variation
 - Person to Person variation
- Disassociation with perceived stress (Hellhammer et al, 2009)
- Human research concerns: research ethics approval, informed consent, commitment, health & behaviour screening, etc.



Experiment: stress measurement and experimental design

- Salivary cortisol concentration was the primary indicator of stress
 - Stress response verified with heart rate monitor
- Within subjects experimental design
 - Subjects tested twice: once in a wood furniture room, once in a control room.
 - Differences between tests for each subject are compared.



Experiment: test settings

- Simulated offices
 - 2 rooms
 - Each room was divided in two parts (control, wood)
 - Each part was 2.5 m x 2.5 m
 - Each had identical furniture, apart from material





Experiment: within subjects

- Within subjects design
 - Each subject was tested in one room
 - Each subject was tested once in each section of the room (control, wood)
 - Order randomised
 - Wood-type (room) was randomised





Experiment: Sampling

Recruiting subjects:

- Newspaper ad
- Email blast at University
- Snowball

Restrictions:

Over 18 years of age

Non-smoker

Not pregnant

Healthy: no heart or stress related illness

Screened for: hormone treatments and birth control



Experiment: test procedures

Test procedure:

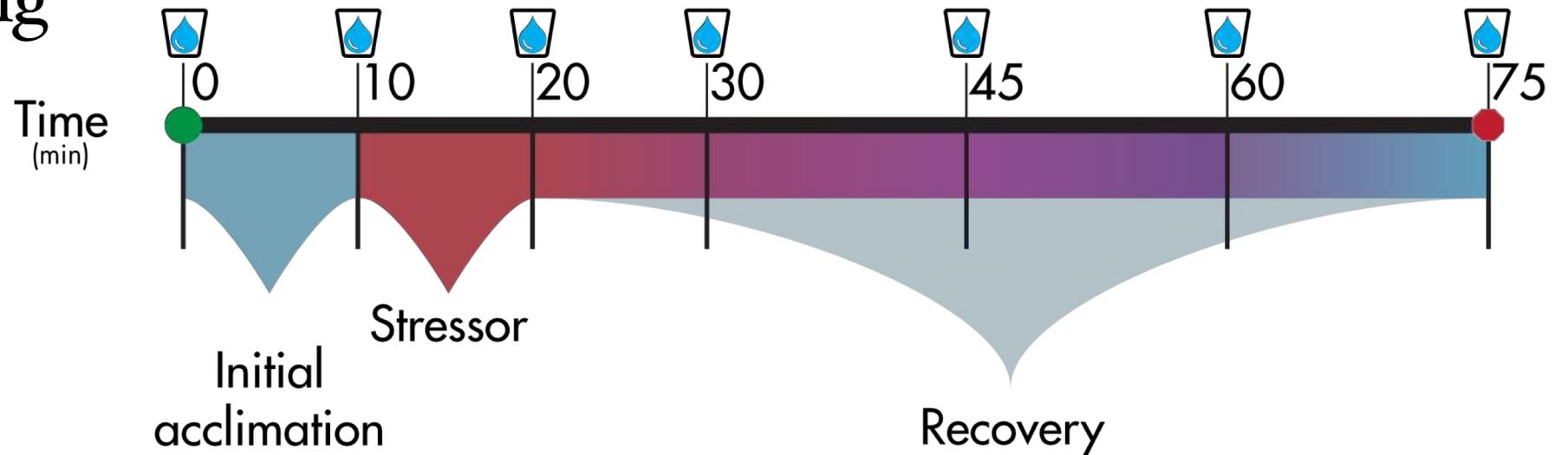
- Pre-test: informed consent, wear heart rate monitor, WHO-5
- Saliva samples collected with Salivette devices



Experiment: test procedure

Test procedure:

- 75 minutes
- During test: 7 saliva samples, stressor, recovery, proofreading





Experiment: test procedure

Test procedure:

- Stress inducer was an emotional induction procedure
 - Random assignment of one of two movie segments
 - Action films showing physical violence
 - Displayed, with sound, on a laptop screen or iPad
 - Each subject watched each film once.

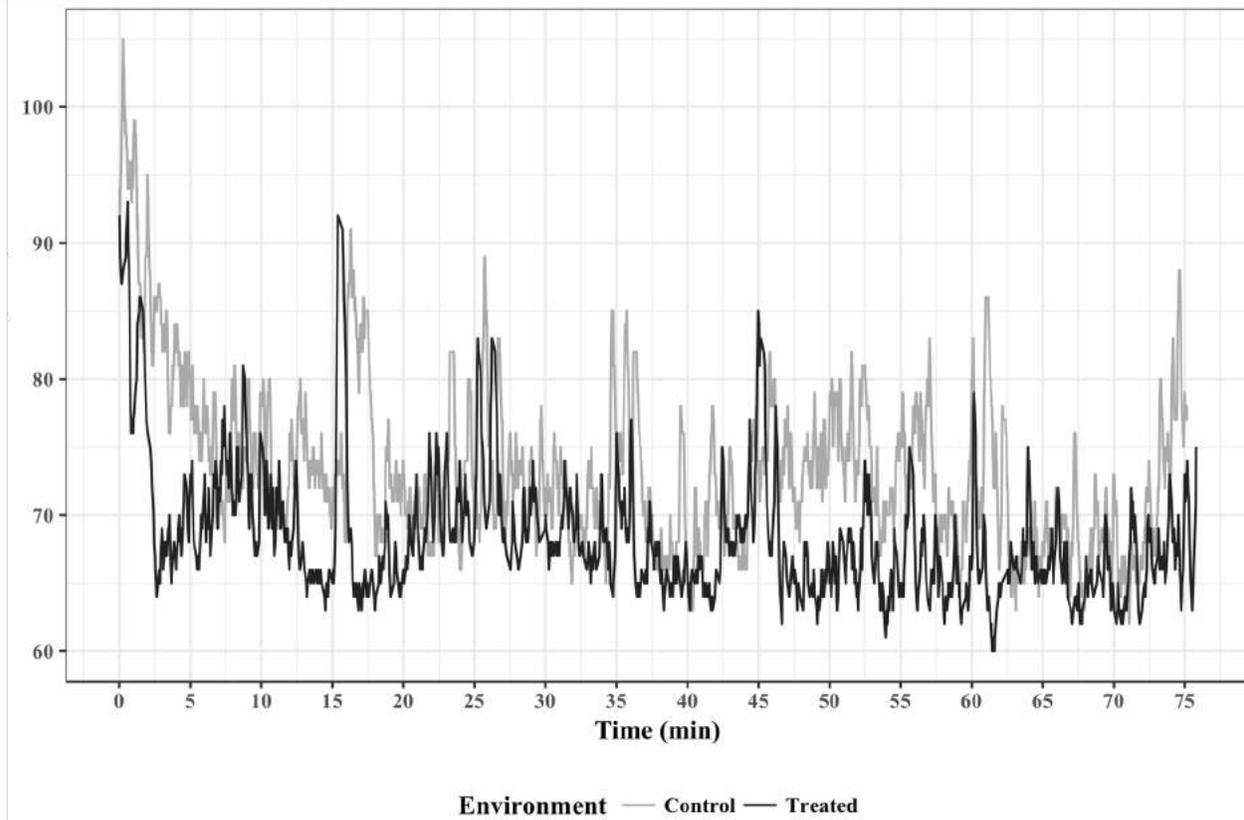
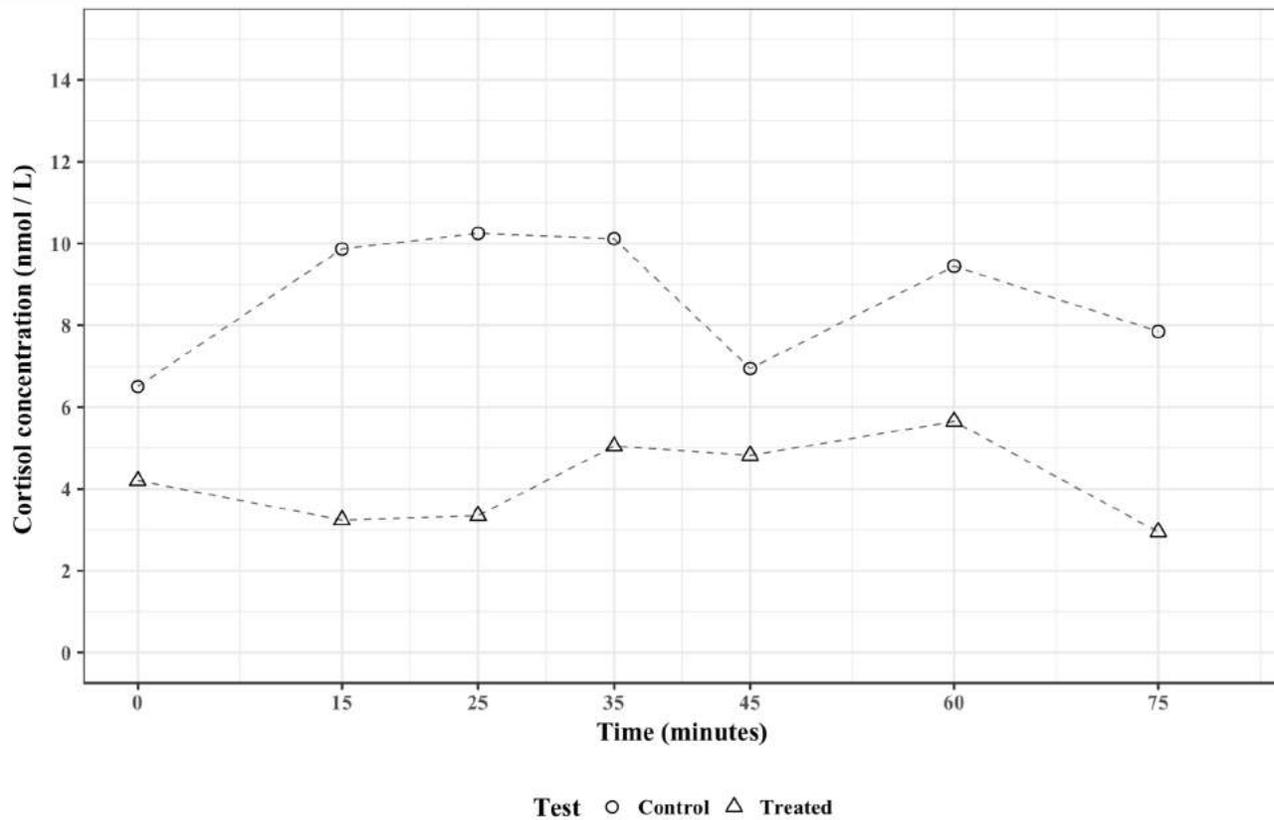


Results: subjects

- 61 healthy adults
- Slovenia, Italy, and long-term visitors
- Ages between 18 and 52 (mean: 27.7 ± 9.3 years)
- 41 female, 14 male
- 33 undergraduate students
- 28 PhD students or professionals

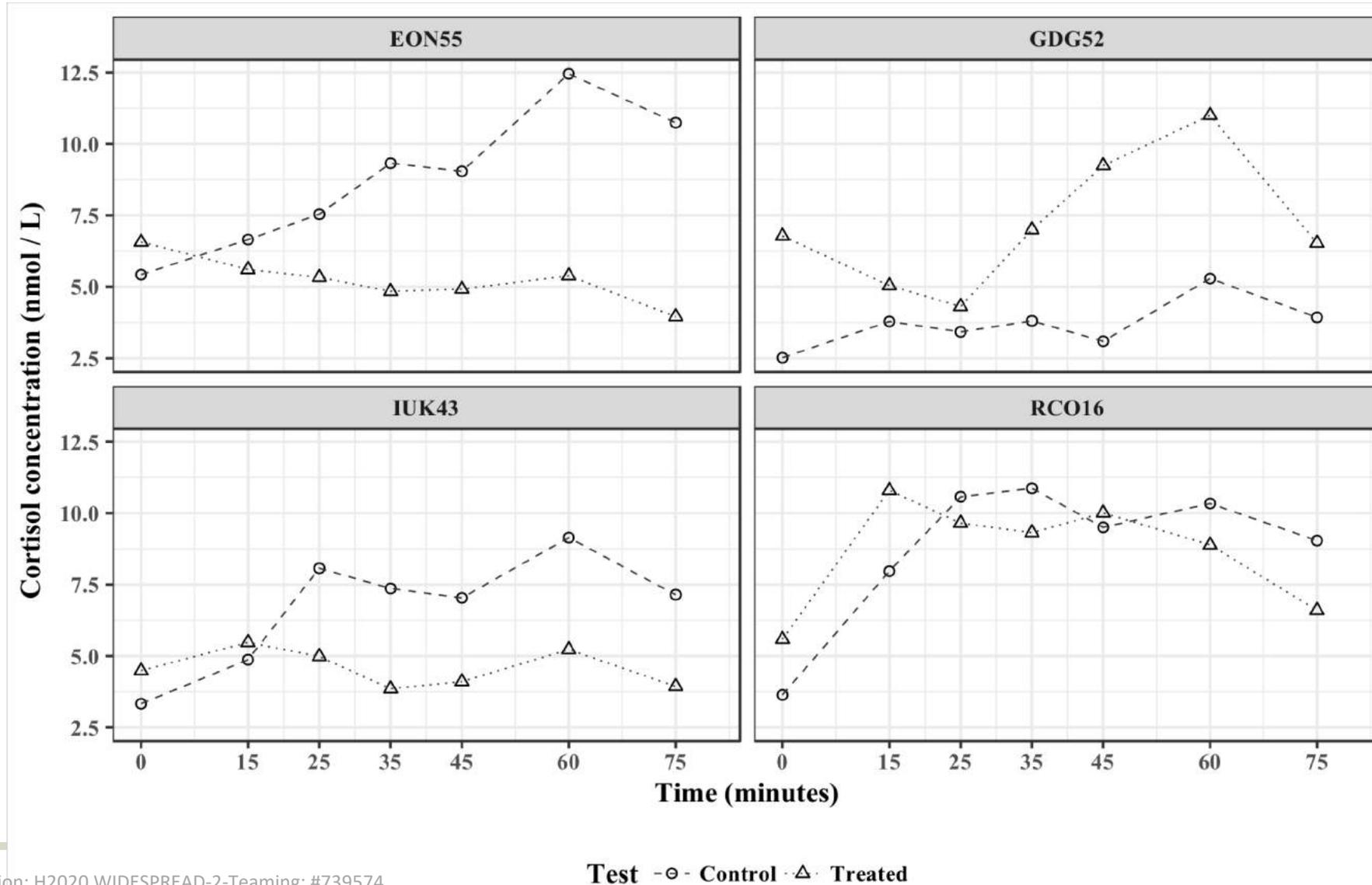


Results: stress response



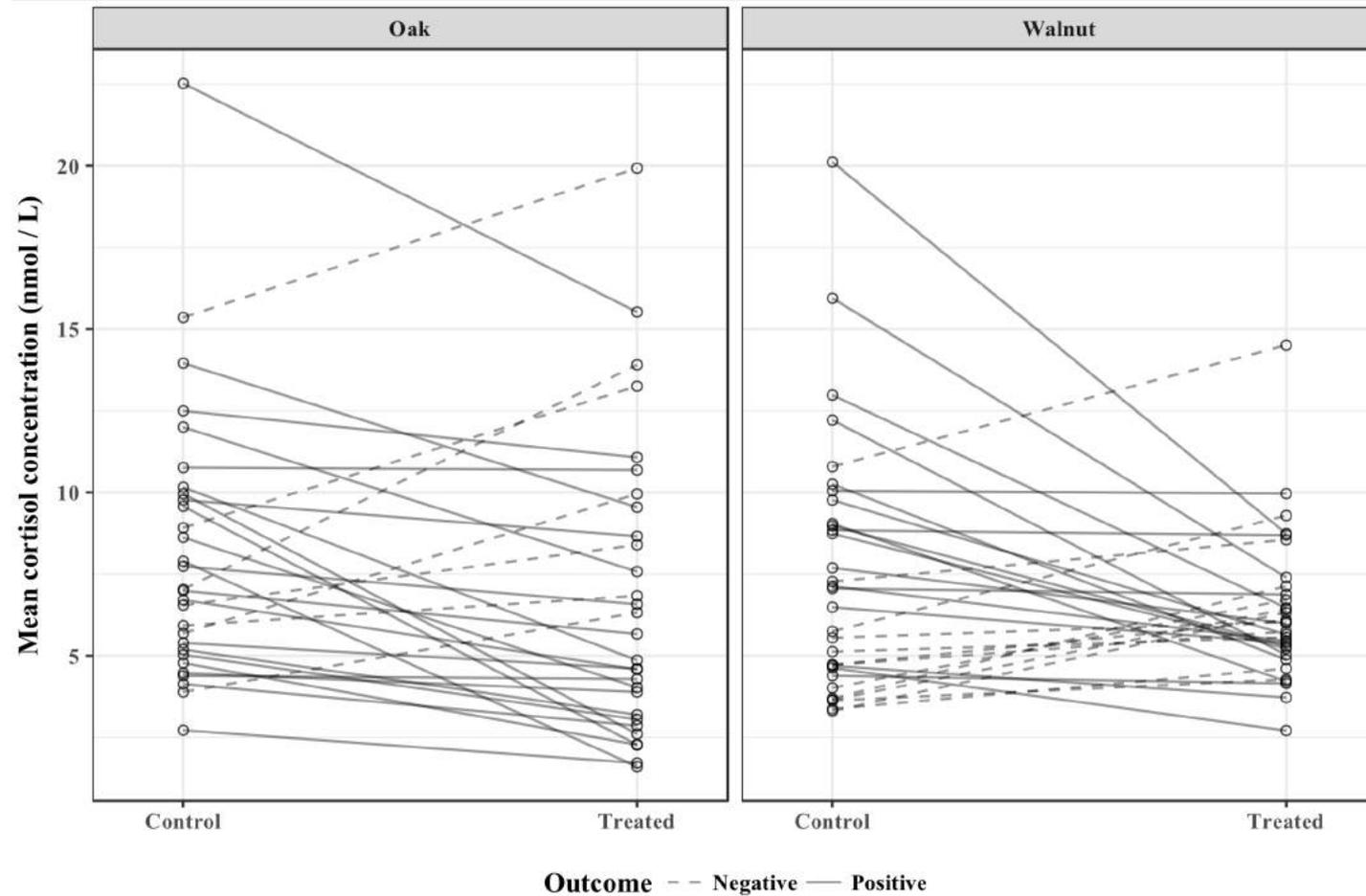
Results: cortisol patterns

Stress response variations with recovery



Results: Full test

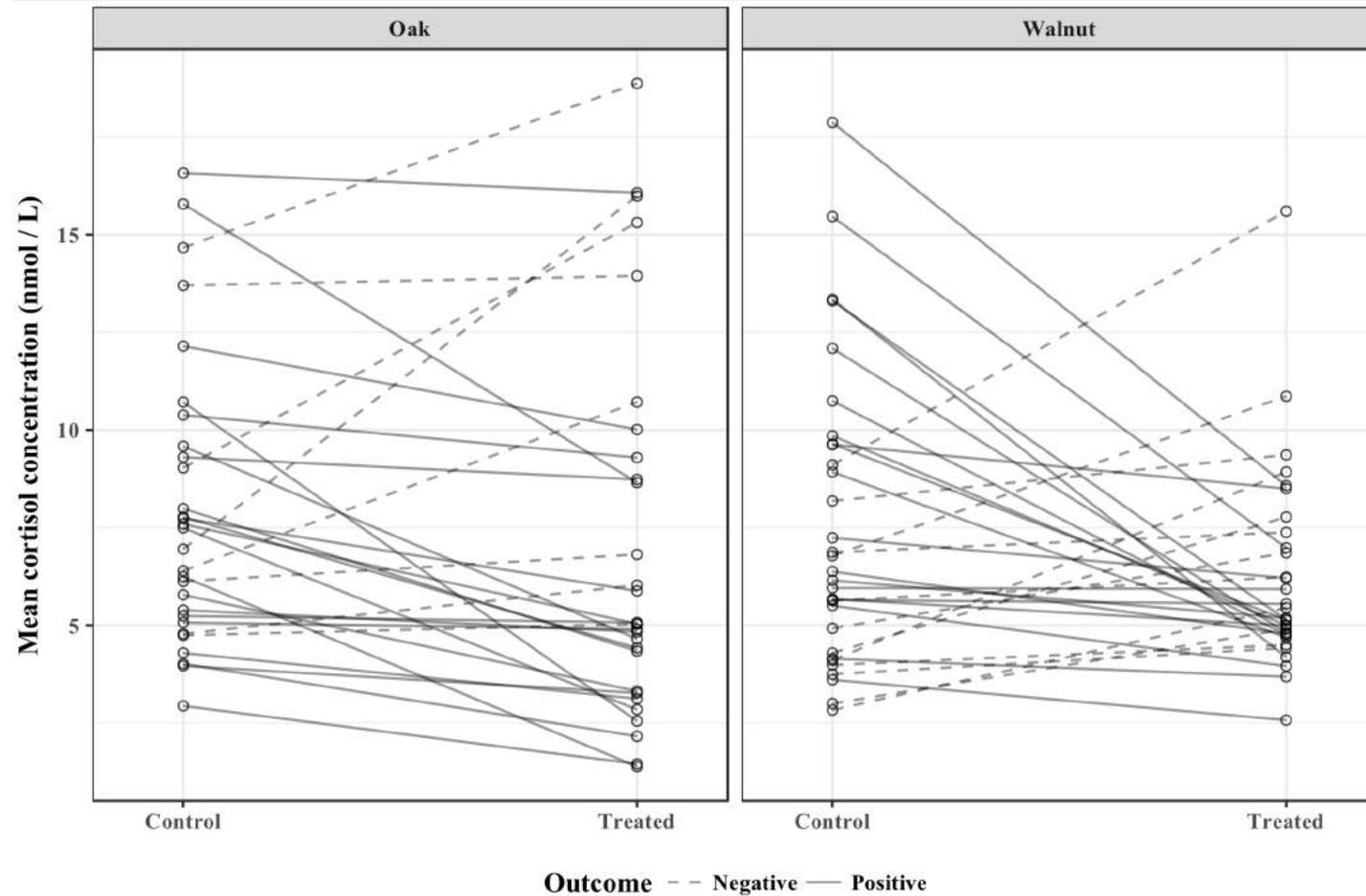
- Lower cortisol in Oak room than control.
- No difference between Walnut and control.



Comparison	Median difference (nmol/L)	95 % CI (1-sided)	p-value
Office A:Control – Office A:Oak	1.33	0.25 to ∞	0.015 *
Office A:Control – Office A:Walnut	0.85	- 0.23 to ∞	0.105

Results: Response period

- Lower cortisol in Oak room than control.
- No difference between Walnut and control.



Comparison	Median difference (nmol/L)	95 % CI (1-sided)	p-value
Office A:Control – Office A:Oak	1.15	0.23 to ∞	0.017 *
Office A:Control – Office A:Walnut	0.98	- 0.16 to ∞	0.108



Discussion: Human stress in offices

- Efforts to control room conditions worked... Lighting kept constant, lux at desk level varied. Walnut room was noticeably darker. May have effected results.
- Interaction with other environmental states is important!



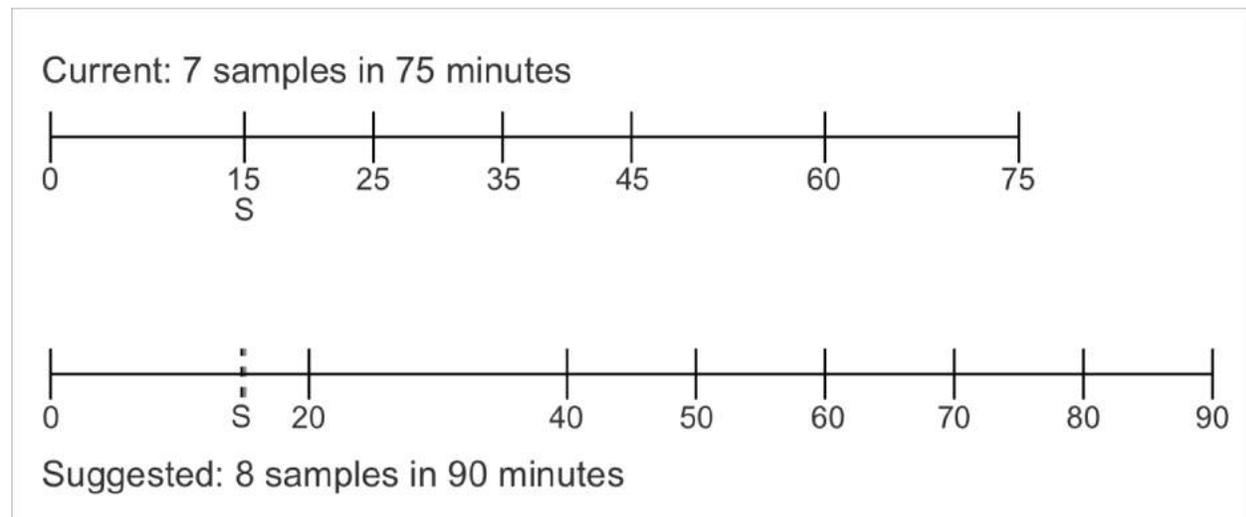
Discussion: Human stress in offices

- Specific material characteristics that lead to different responses remain unknown.
- The experiment was not long enough to gain a full picture of restoration & recovery.



Discussion: Human stress in offices

- Change sampling procedure to gain higher fidelity during **response & recovery** periods.
- Extend test period.





Discussion: Human stress in offices

- Other stress indicators may make experiments more manageable.
- Other than stress?
 - Cognition
 - Performance
 - Neurological indicators
 - All can be used to assess restoration as well, but may require significant alterations to experimental design.



Conclusion: restoration and wood, what do we know?

- All signs point to positive restorative outcomes, but...
 - Psychophysiological restoration needs more research
 - Attention restoration, cognition, & performance need considerable research
 - Theoretical foundation focused on outdoor nature... how can we adapt indoor environments or supplement theory?
- New lab dedicated to this topic opening in Slovenia, 2020.



InnoRenew CoE

Livade 6, 6310 Izola/Isola, Slovenia, T: +386 40 282 944, E: coe@innorenew.eu, www.innorenew.eu



Thank you for your time.



References

- McEwen, Bruce S. 1998. "Protective and Damaging Effects of Stress Mediators." Edited by Jeffrey S. Flier and Lisa H. Underhill. *New England Journal of Medicine* 338 (3): 171–79. doi:10.1056/NEJM199801153380307.
 - Tyrväinen, Liisa, Ann Ojala, Kalevi Korpela, Timo Lanki, Yuko Tsunetsugu, and Takahide Kagawa. 2014. "The Influence of Urban Green Environments on Stress Relief Measures: A Field Experiment." *Journal of Environmental Psychology* 38. Elsevier Ltd: 1–9. doi:10.1016/j.jenvp.2013.12.005.
 - USGBC. 2010. Green building and LEED core concepts. USGBC United States Green Building Council (USGBC), Washington, DC
 - Burnard, Michael, and Andreja Kutnar. 2015. "Wood and Human Stress in the Built Indoor Environment: A Review." *Wood Science and Technology* 49 (5). Springer Berlin Heidelberg: 969–86. doi:10.1007/s00226-015-0747-3.
 - Hartig, Terry. 2004. "Toward Understanding the Restorative Environment as a Health Resource." *Engaging with the environment*. Edinburgh, 2004. OPENspace Research Centre. <http://www.openspace.eca.ac.uk/conference/proceedings/PDF/Hartig.pdf>
 - Kaplan R, Kaplan S. 1989. *The experience of nature: a psychological perspective*. Cambridge University Press, Cambridge
 - Ulrich R, Simons R, Losito B, Fiorito E, Miles M, Zelson M. 1991. Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology* 11(3):201–230
 - Wilson, E. O. 1984. *Biophilia*. Harvard University Press. <http://www.hup.harvard.edu/catalog.php?isbn=9780674074422&content=reviews>
-



References

- Kellert SR, Heerwagen JH, Mador ML. 2008. *Biophilic design: the theory, science and practice of bringing buildings to life*, 1st edn. Wiley, Hoboken
 - Derr V, Kellert SR. 2013. Making children's environments "R.E.D.": restorative environmental design and its relationship to sustainable design. In: Pavlides E, Wells J (eds) *Proceedings of the 44th annual conference of the environmental design research association*. Providence, Rhode Island, 29 May–1 June 2013
 - Fell D. 2010. *Wood in the human environment: restorative properties of wood in the built indoor environment*. PhD Dissertation, University of British Columbia, Vancouver, BC, Canada
 - Burnard, Michael, Anders Q. Nyrud, Kristian Bysheim, Andreja Kutnar, Katja Vahtikari, and Mark Hughes. 2017. "Building Material Naturalness: Perceptions from Finland, Norway and Slovenia." *Indoor and Built Environment* 26 (1): 92–107. doi:10.1177/1420326X15605162.
 - Burnard, Michael. 2017. "Bio-Based Materials and Human Well-Being in the Built Environment." In *Performance of Bio-Based Materials*, edited by Dennis Jones and Christian Brischke, 1st ed., 365–72. Duxford: Woodhead Publishing.
-