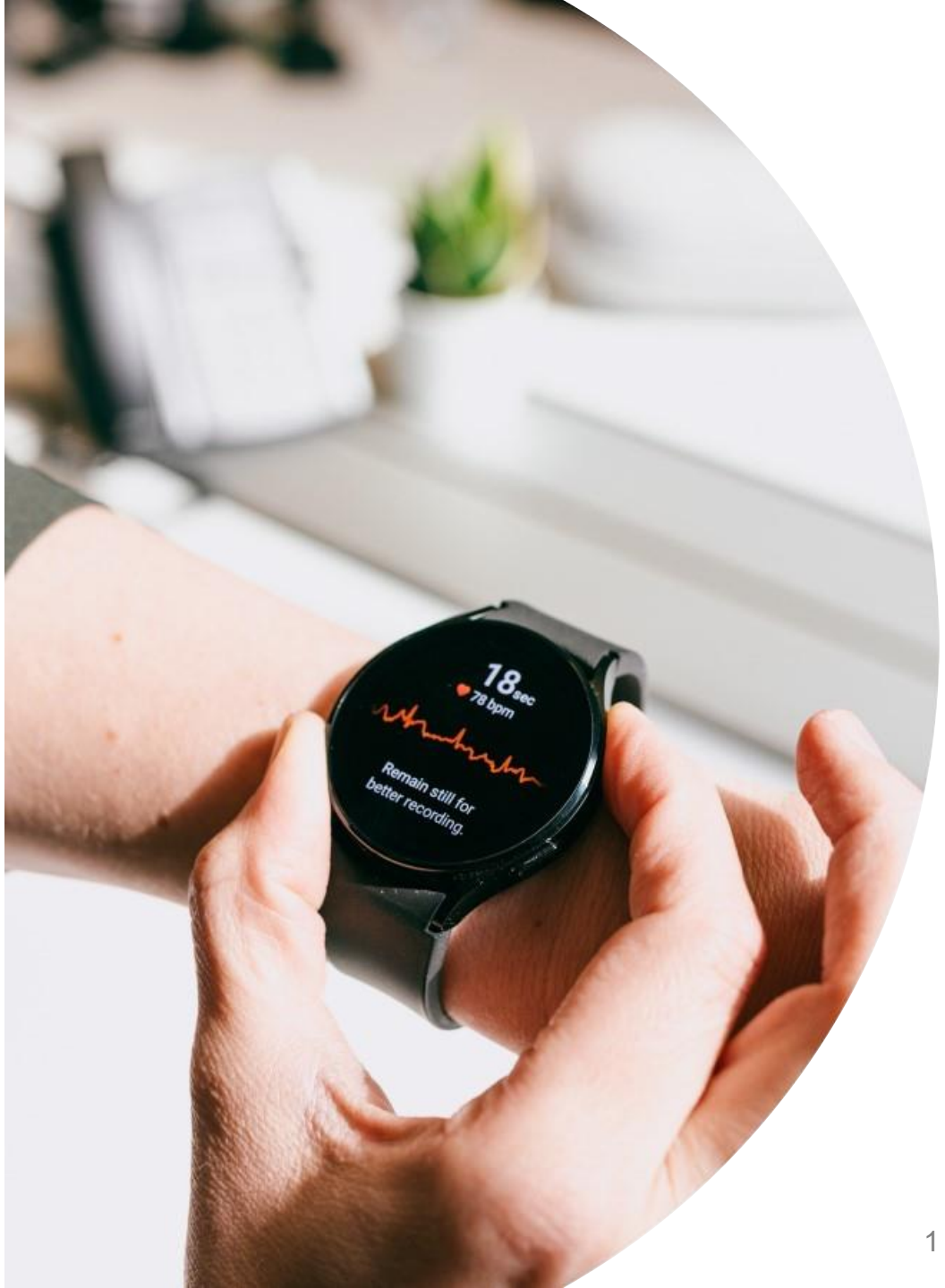
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Monitoring daily stress using wearables and self-report

Investigating data quality and longitudinal patterns in the StressTRACS study

Toon Colman





Why monitor stress?

- A student participating in a group intervention for test anxiety
- A nurse enrolled in a preventive well-being program
- A client receiving individual counseling from a psychologist

→ Data collection (research)

→ **Increased awareness**, can be a first step toward coping with stress (Wysocki et al., 1987)

Two components of stress

*"Stress is the process in which environmental demands tax or exceed the adaptive capacity of an organism, resulting in **psychological** and **biological** changes that may place persons at risk for disease."*

(Cohen, Kessler, and Gordon, 1995)

1) Physiological

- Autonomous nervous system
- Heart rate (variability)
- Physical activity
- Sleep
- …

2) Psychological

- Subjective experience
- Tension
- Worry
- Loss of control
- …

1) Physio: Wearables

Advantages: continuous, objective, low participant burden

Limitation: wearable does not measure stress, but physiological signals that may be associated with stress.

→ E.g., Heart rate: Stress?
Physical activity? Coffee?
Enthusiasm?





2) Psycho: Self-Report

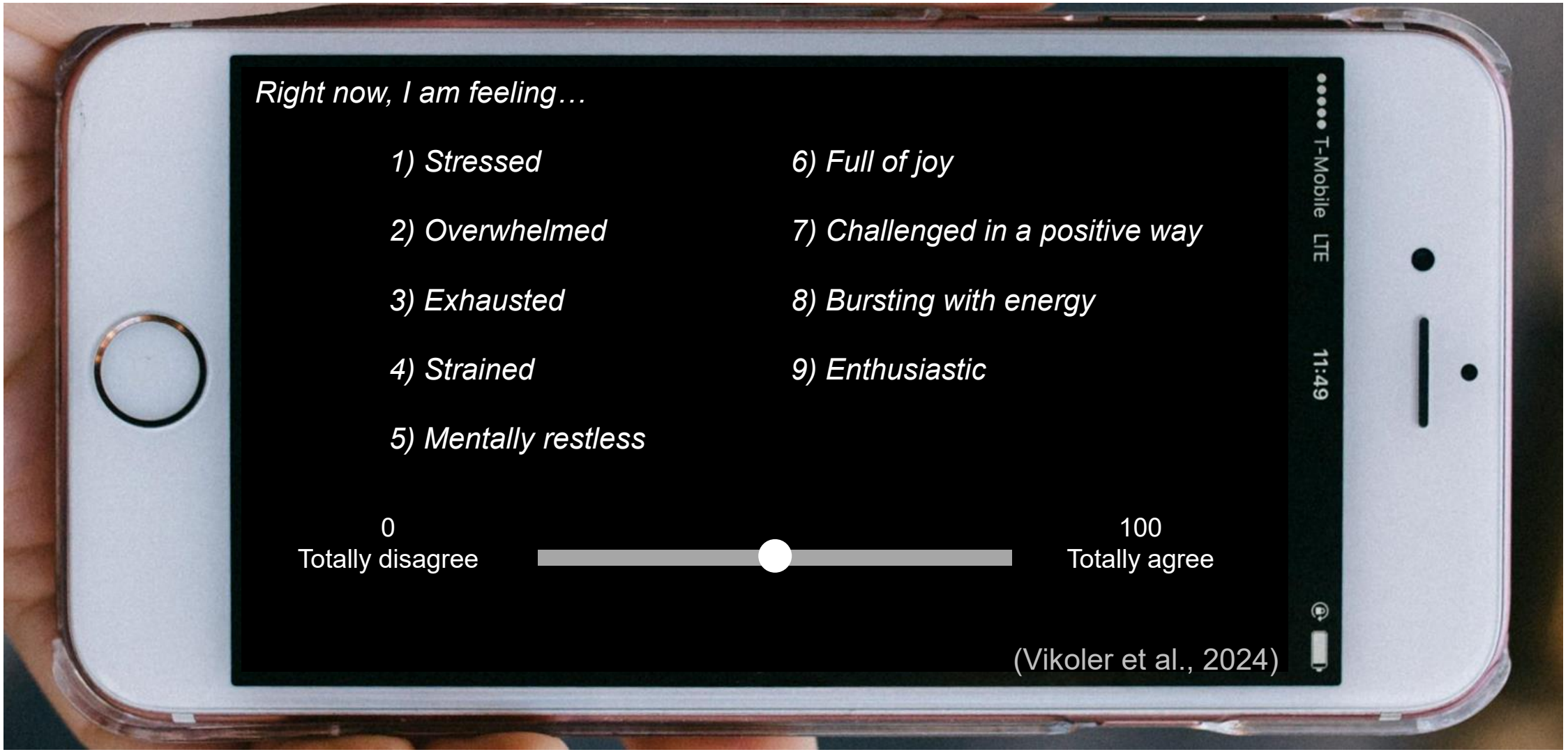
Essential to also assess the subjective experience of stress

→ **Smartphone-based EMA** (Ecological Momentary Assessment)

- Short questionnaires in smartphone app
- Repeatedly, in daily life

Scoping Review: Proliferation of methods, but limited psychometric studies (Colman et al., 2026, in press)

DESS: Distress Eustress State Scale



StressTRACS: Physio + Psycho

- New method developed to monitor stress over long term in daily life through

1) Commercially available **wearables**
   heart rate, sleep, physical activity,…
2) Daily smartphone-based **self-report**
   "today I feel…"

→ Personalized stress score
(machine learning algorithm)

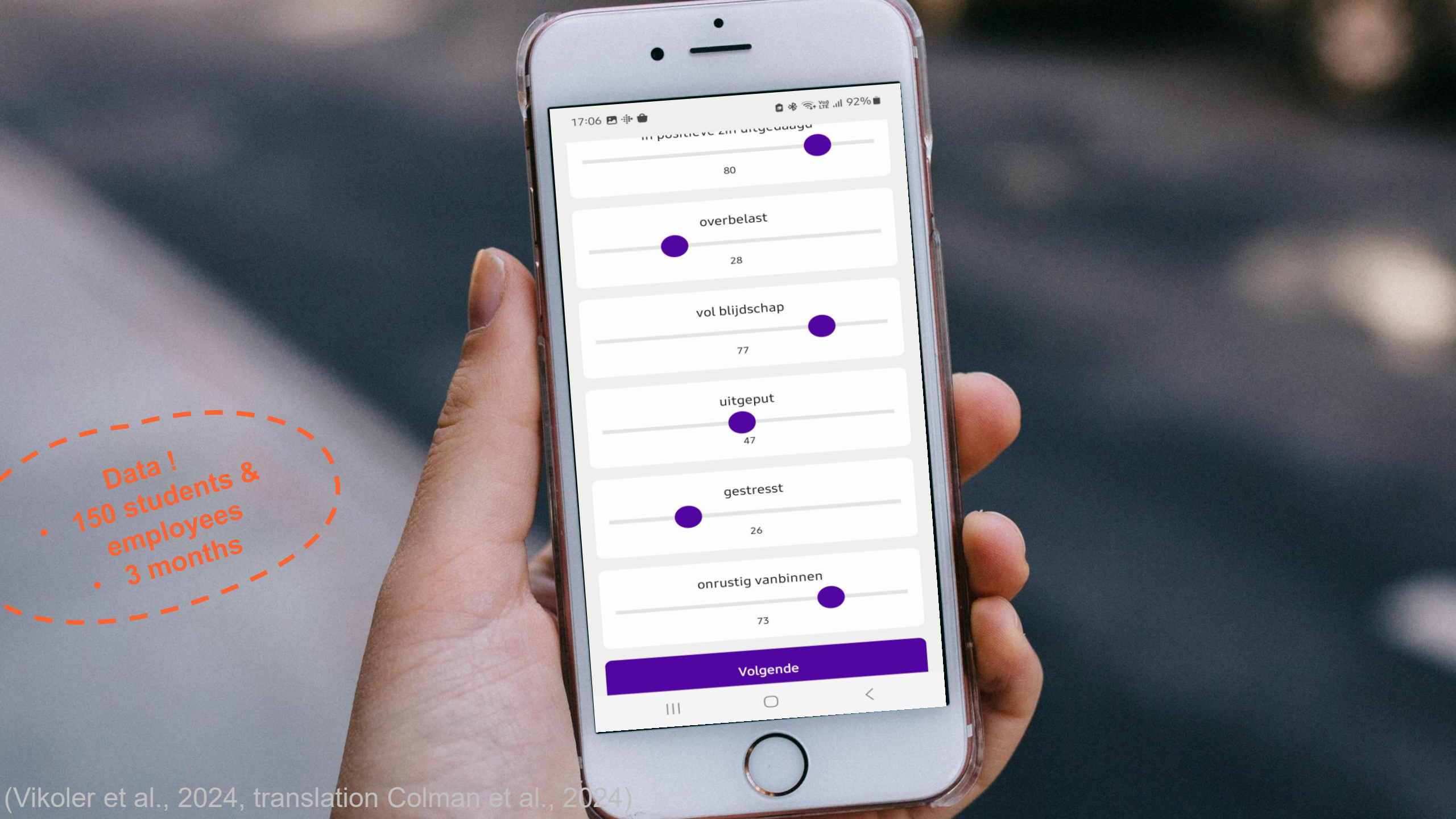
(Debard et al., 2026, submitted)




Data !
150 students &
employees
3 months
22:02
64%
Vandaag
Stressbalans
Gespannen
Ontspannen
Zelfrapportage
Geef aan hoe je je voelt
Rusthartslag
69 bpm
Actieve minuten
32
Slaapduur



(Vikoler et al., 2024, translation Colman et al., 2024)



(Vikoler et al., 2024, translation Colman et al., 2024)

Let's look at the data

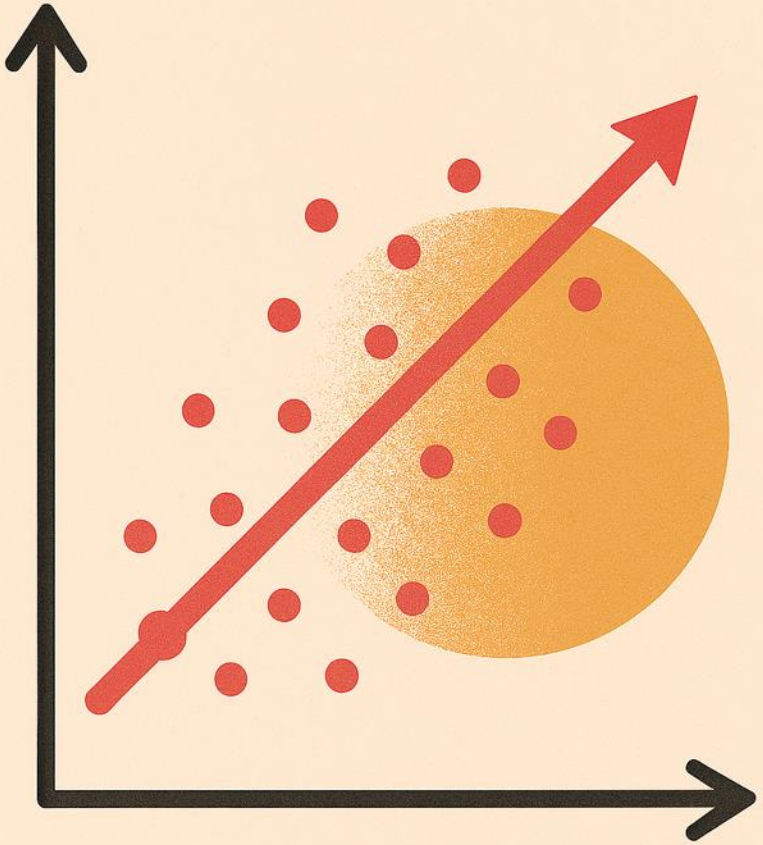
Longitudinal patterns in self-report and wearable data

Psychometric validation of our smartphone-based self-report

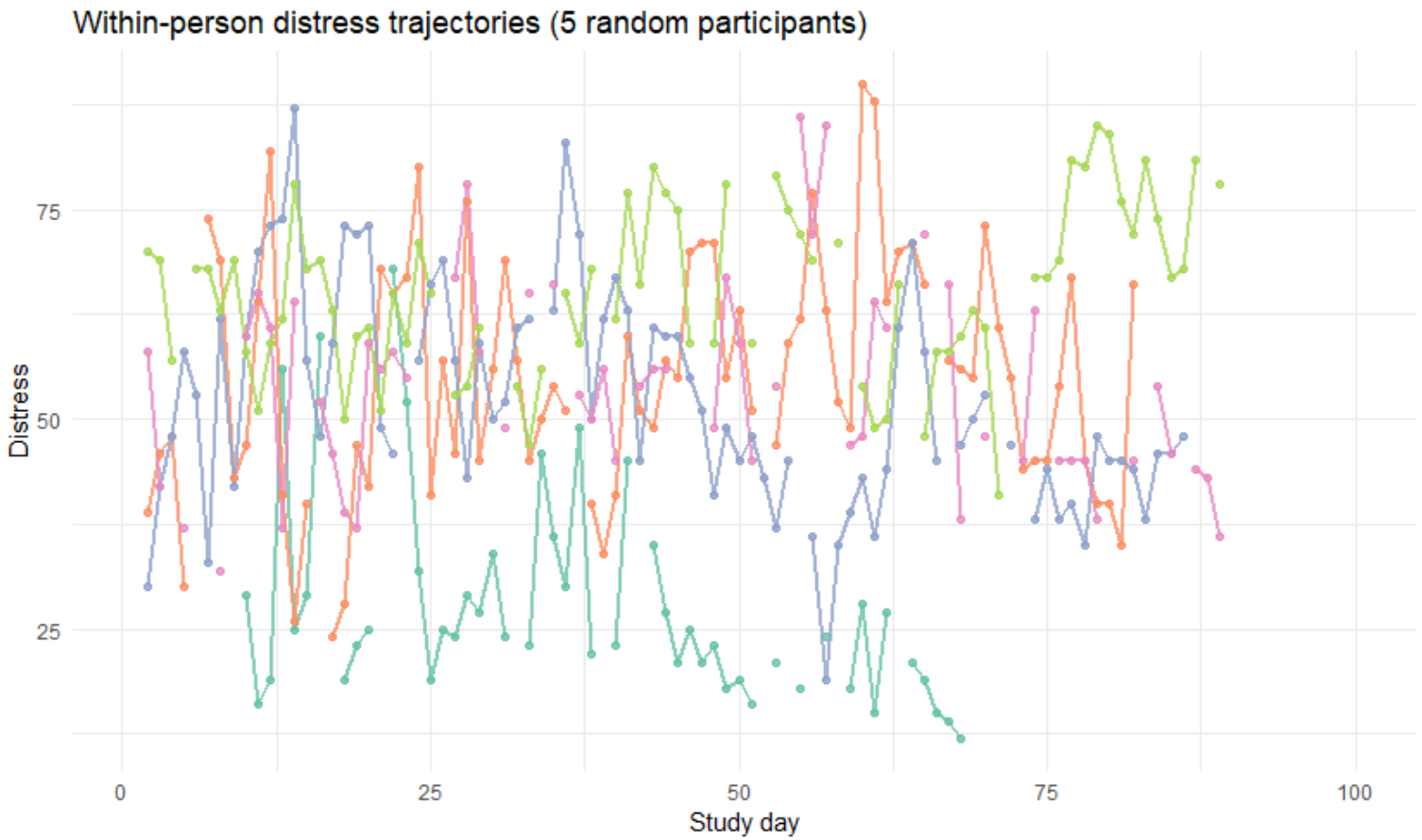
→ Di- Eu- Stress State (DESS) scale

(Vikoler et al., 2024)

→ Forward-backward translation from German to Dutch

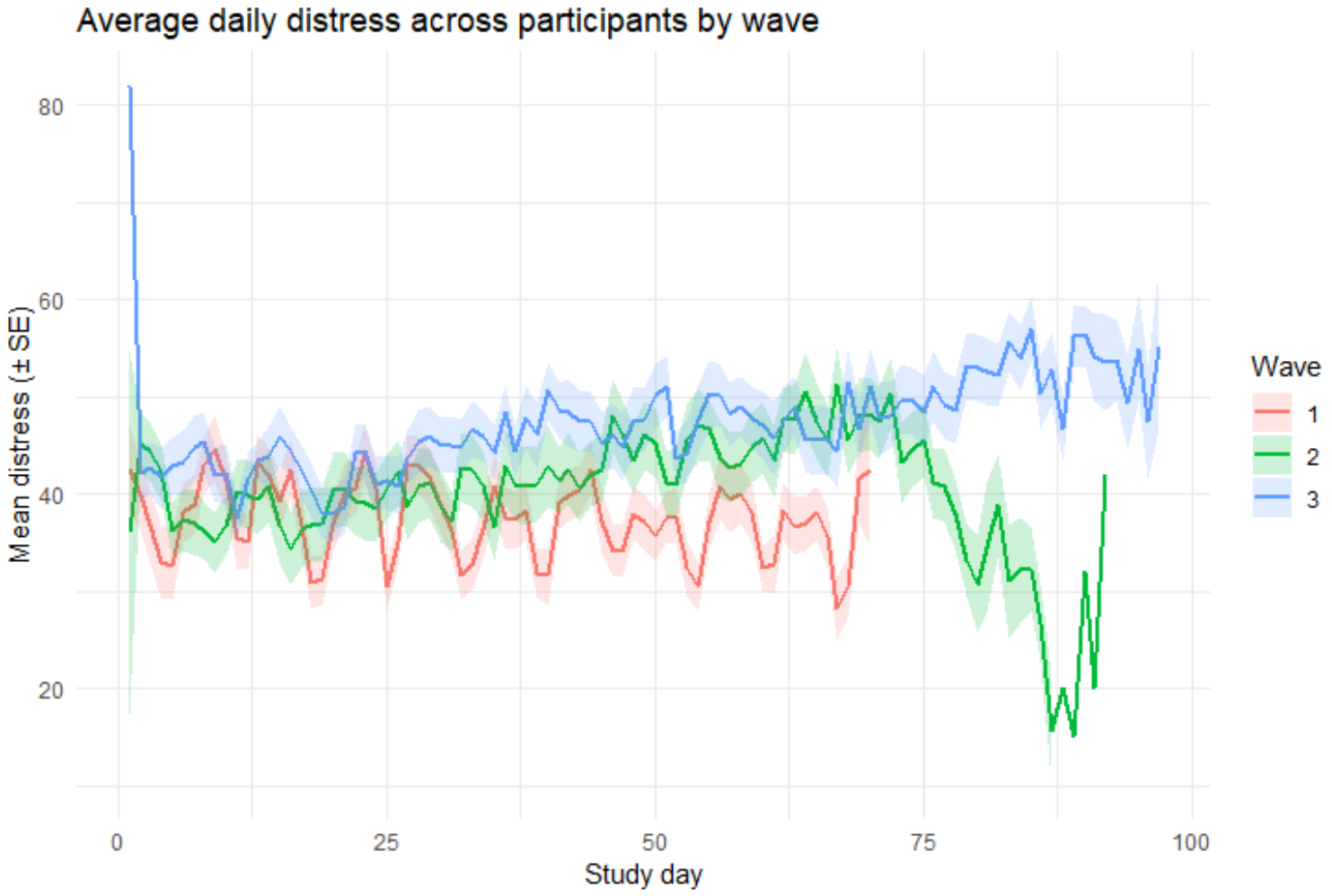


Smartphone-based self-report



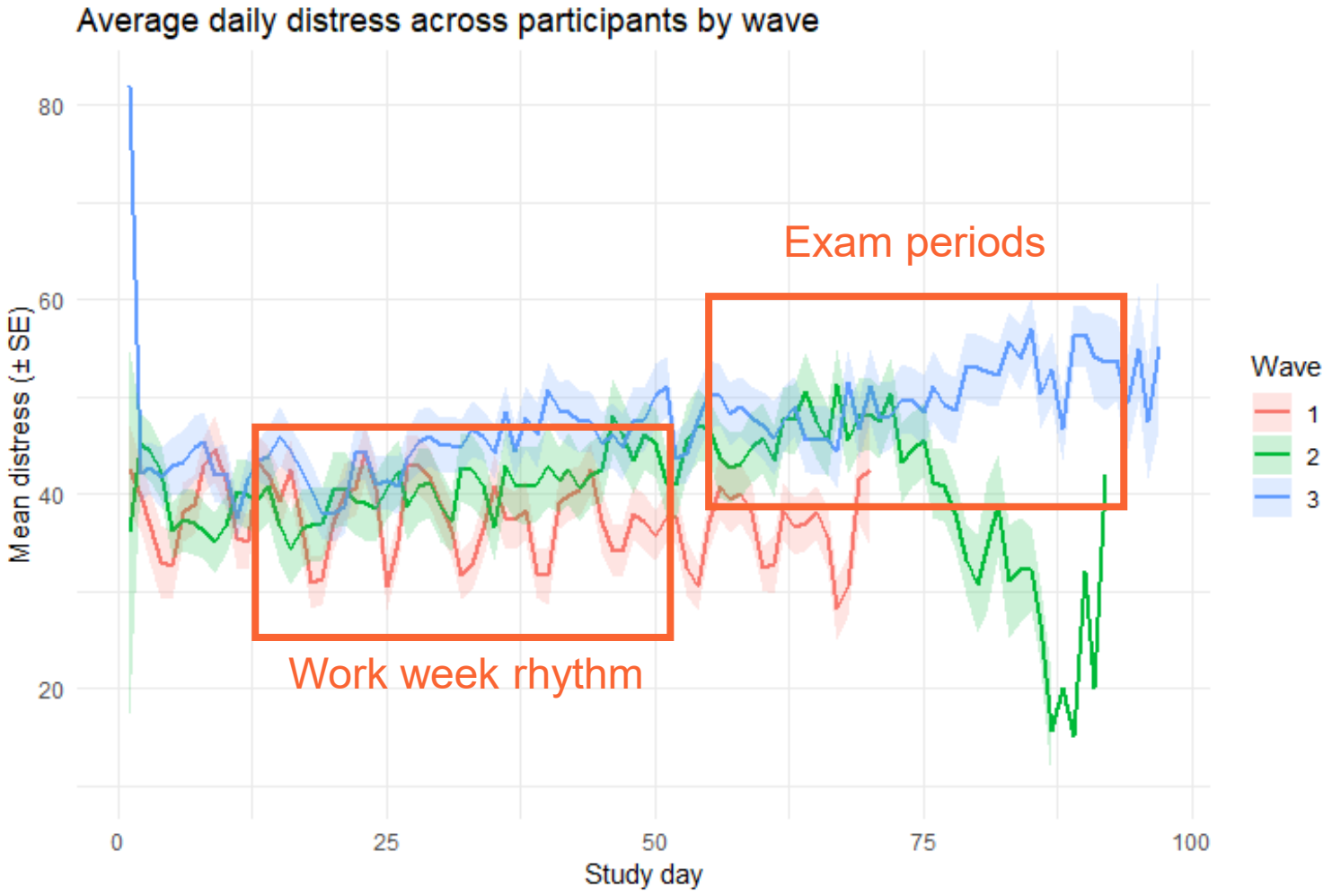
- Intra-individual variation

Smartphone-based self-report



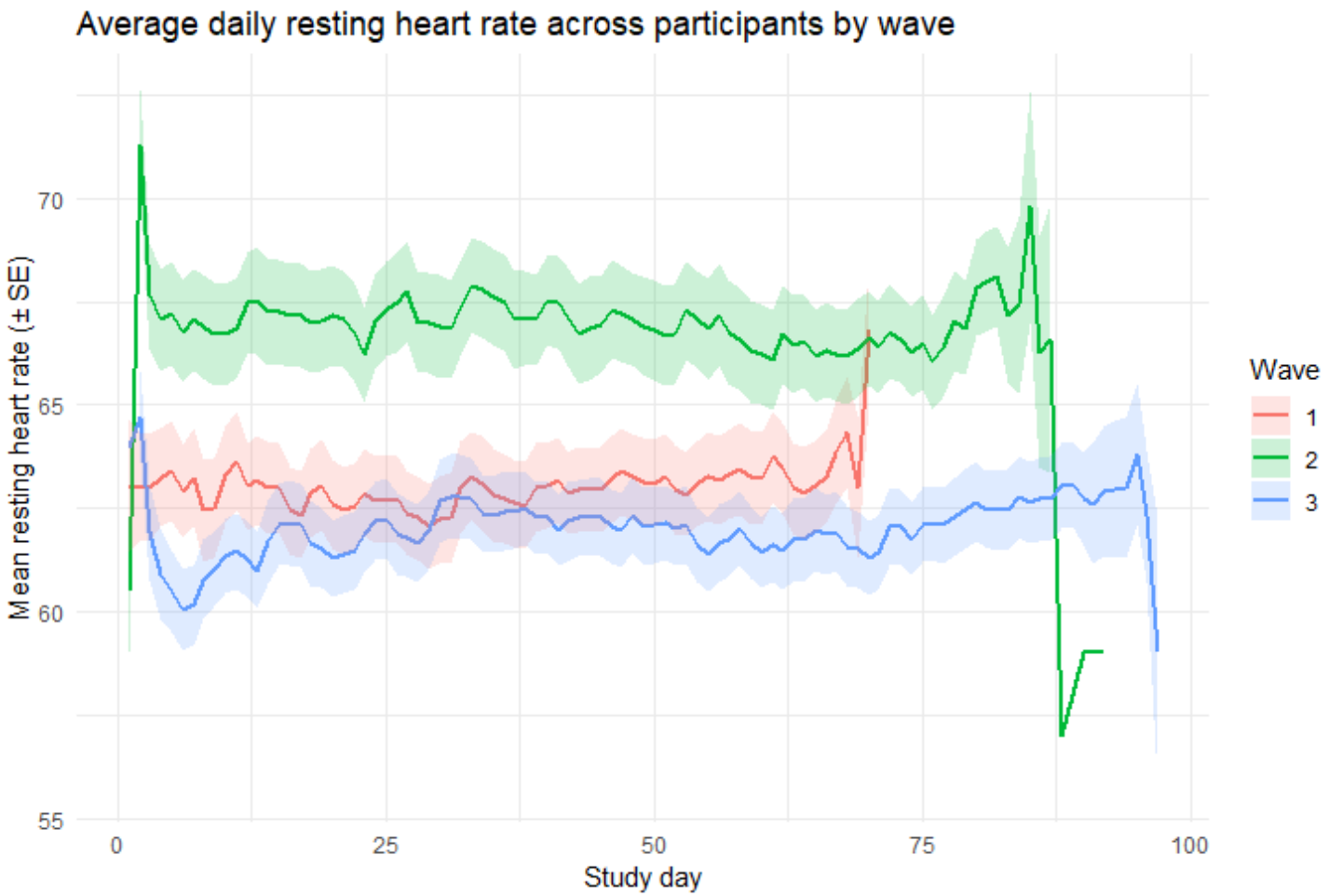
- Intra-individual variation
- Averaging: general trends

Smartphone-based self-report



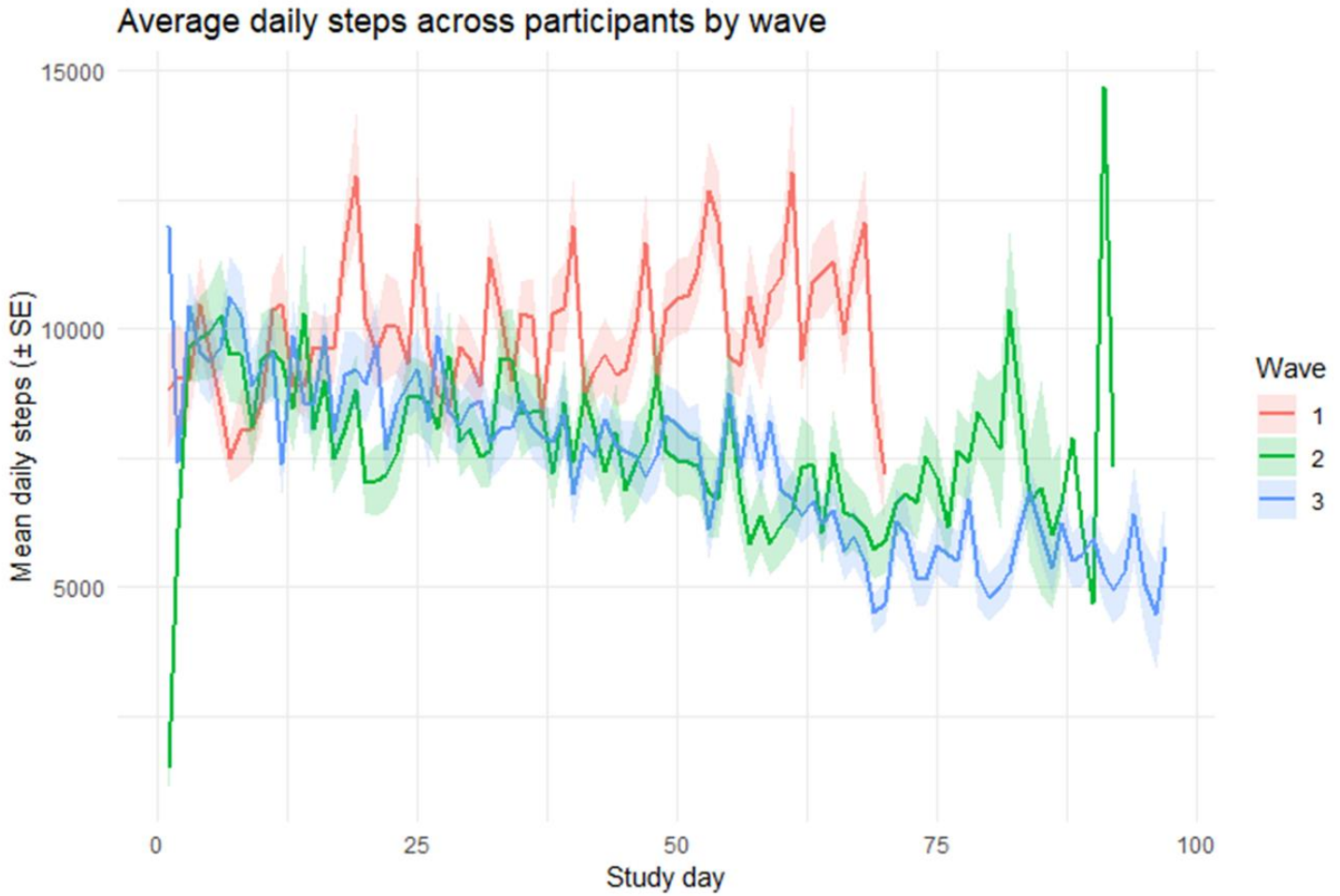
- Intra-individual variation
- Averaging: general trends
- Sensitivity: exam and holiday periods

Wearable data



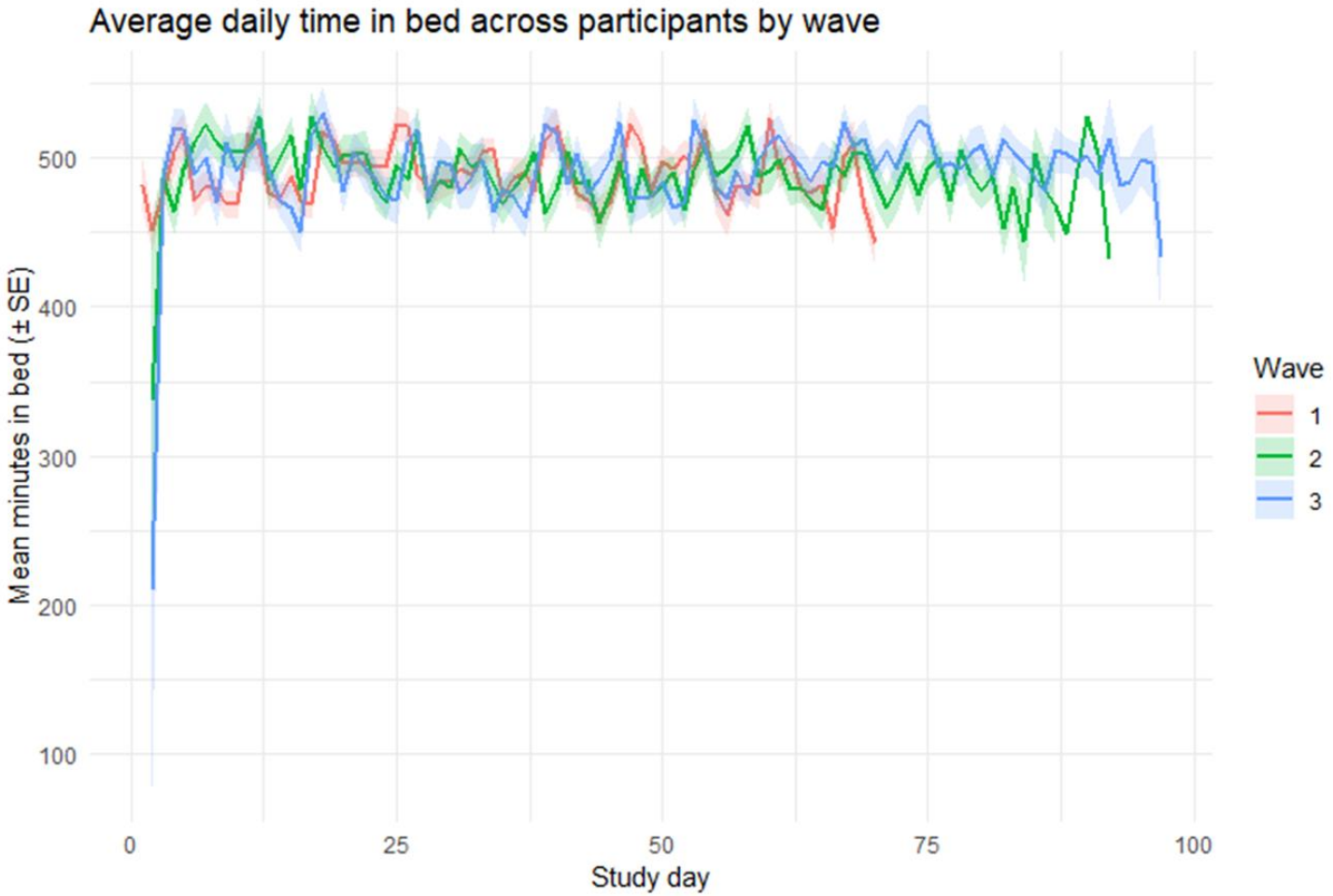
- Heart rate

Wearable data



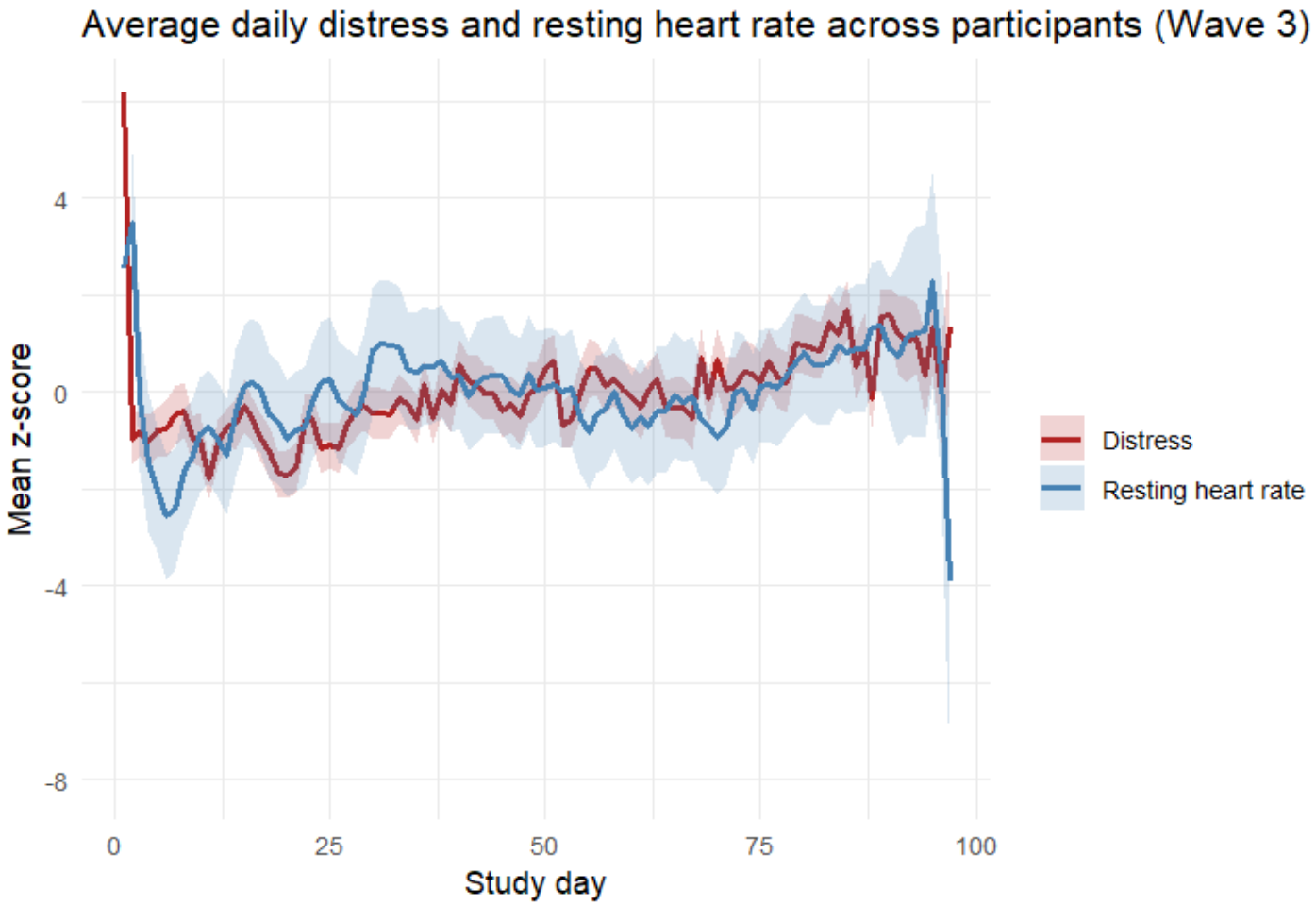
- Heart rate
- Physical activity

Wearable data



- Heart rate
- Physical activity
- Sleep

Self-report x wearable associations?



- What is the relationship between e.g., distress and heart rate?
- **Validation** of measurement strategy

→ Psychometric analyses DESS

DESS: Psychometric

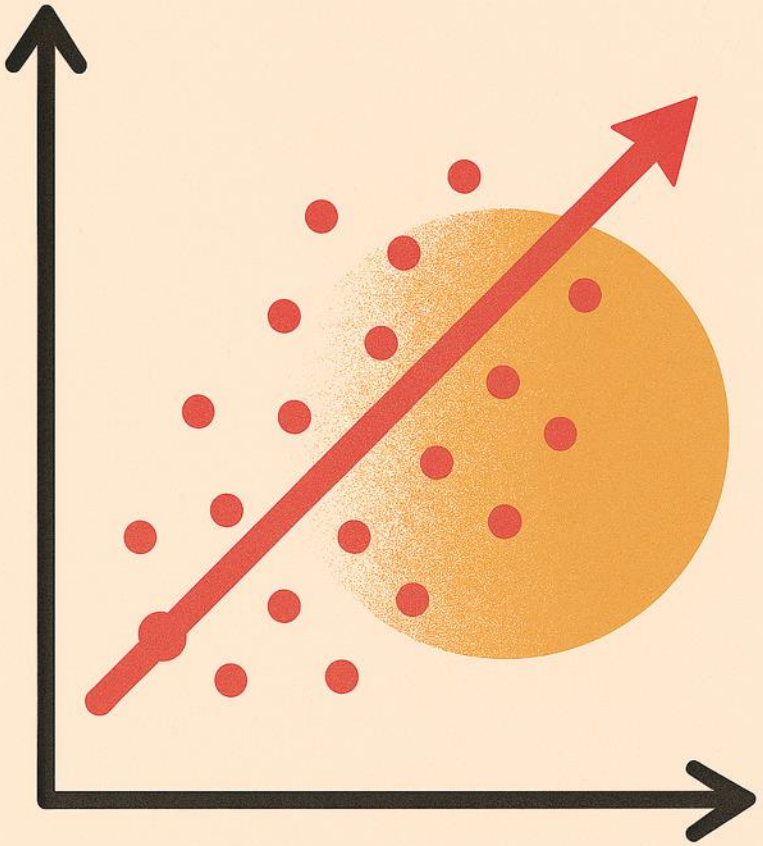
Construct Validity: Multilevel Confirmatory Factor Analysis (MCFA)

→ Distress & Eustress factor, within and between persons?

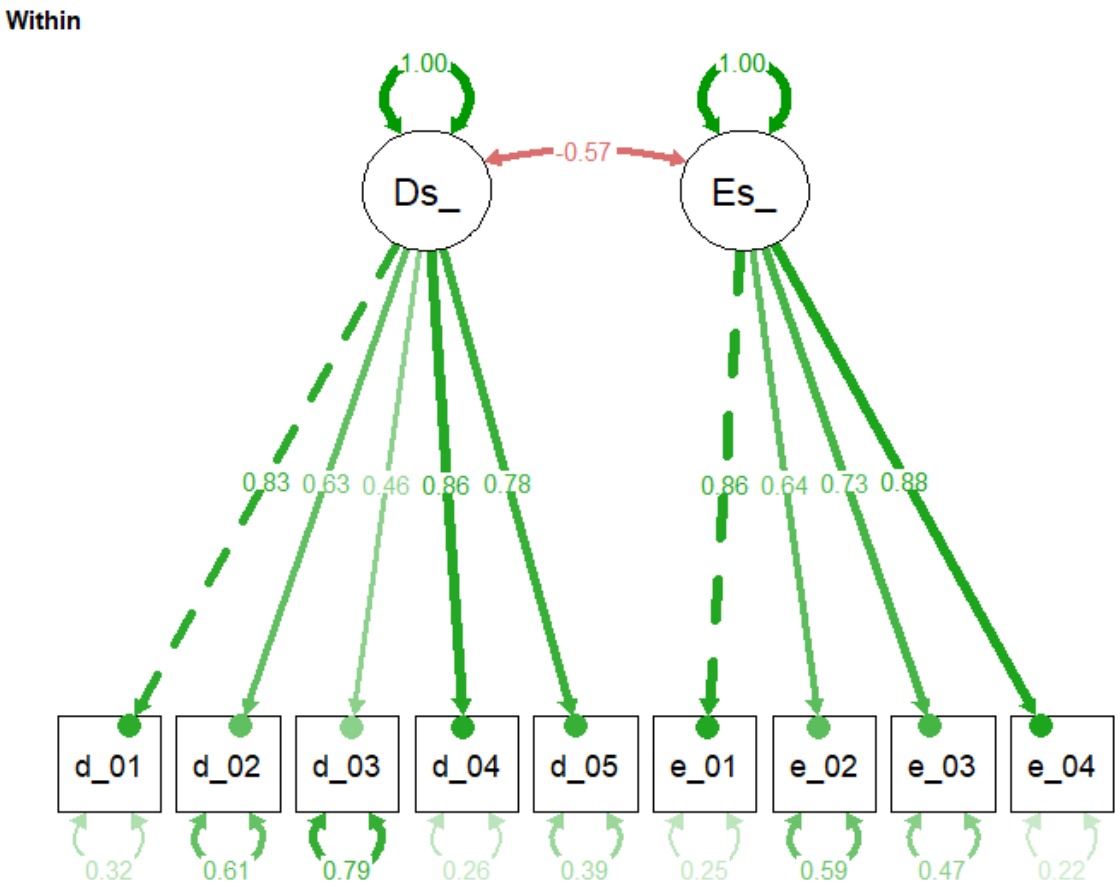
Reliability within and between persons

Convergent / Discrimiant validity

→ Associations in the data

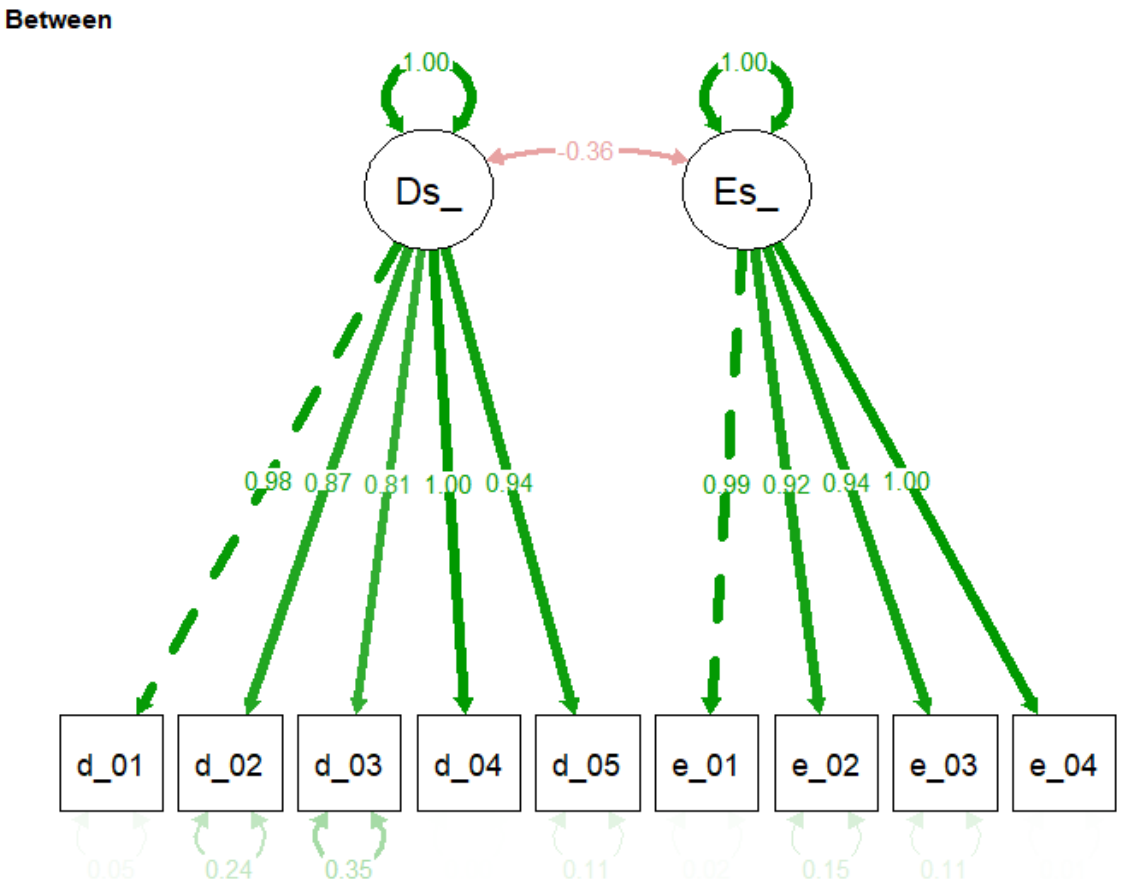


Construct validity – MCFA (within)



- Items load as expected on distress and eustress factor
- Negatively related
- Borderline acceptable fit indices
  - → Additional energy/fatigue dimension?
- Reliability: .84 (distress) and .86 (eustress)

Construct validity – MCFA (between)



- Items load as expected on distress and eustress factor
- Negatively related
- Borderline acceptable fit indices
  - → Additional energy/fatigue dimension?
- Reliability: .97 (distress) and .98 (eustress)

Convergent / Discriminant validity

	Distress	Eustress
PSS (stress)	**.71 *****	**-.49 *****
WEMWBS (well-being)	**-.61 *****	**.61 *****
SSS (somatic symptoms)	**.55 *****	**-.37 *****
PSQI (sleep quality)	**.54 *****	**-.39 *****

- **Established questionnaires**: very strong evidence!

→ Between-person stat. signif: high number of measurements!

Convergent / Discriminant validity

	Distress	Eustress
HR	**.20 ***	-.22
HRV	-.03	.01
Daily steps	-.11	**.18 ***
Minutes bed	-.02	-.09

- **Established questionnaires**: very strong evidence!

→ Between-person stat. signif: high number of measurements!

- **Wearable data**: much more noise

→ Directions still as expected



Conclusions

- **Wearables** and **smartphone-based self-report** are complementary in measuring daily stress
- **(Psychometric) validation** is crucial
- From measurement to awareness to intervention… e.g., JITAI?

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Thank you!

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This study is part of the StressTRACS project: https://thomasmore.be/en/stresstracs

References

- https://www.pexels.com/photo/man-with-hand-on-head-6333503/
- Wysocki, J., Chemers, M. M., & Rhodewalt, F. (1987). Situational Demand and Self-Reports of Stress and Illness: The Moderating Influence of Self-Monitoring. Basic and Applied Social Psychology, 8(3), 249–258. https://doi.org/10.1207/s15324834basp0803_5
- Cohen S, Kessler RC, Gordon LU. Strategies for measuring stress in studies of psychiatric and physical disorders. In: Measuring Stress: A Guide for Health and Social Scientists. Oxford University Press; 1995:3-26. ISBN:978-0-19-508641-6
- https://www.pexels.com/photo/close-up-of-hands-holding-a-smartphone-outdoors-29685331/
- Vikoler, T., Dániel, K., & Traut-Mattausch, E. (2024). The Di-Eu-Stress State Scale (DESS Scale) Development and Validation of a Scale Measuring State Distress and Eustress. EUROPEAN JOURNAL OF PSYCHOLOGICAL ASSESSMENT. https://doi.org/10.1027/1015-5759/a000829
- https://www.pexels.com/photo/person-holding-silver-iphone-6-442161/
- https://www.pexels.com/photo/clear-bulb-beside-white-notepad-on-white-surface-1252814/