Groundbreaking wearable devices that will reshape healthcare

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Autonomic nervous system

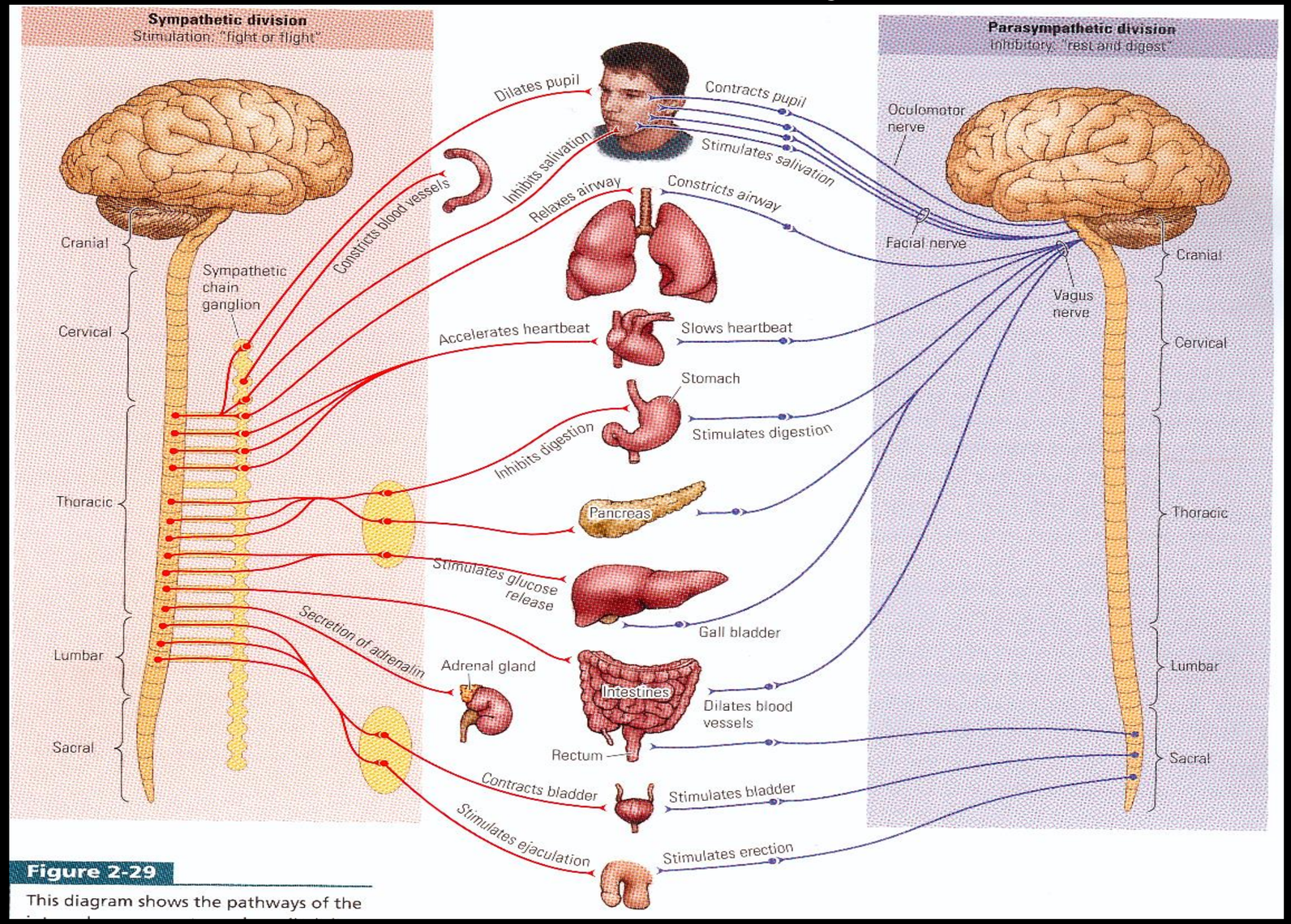
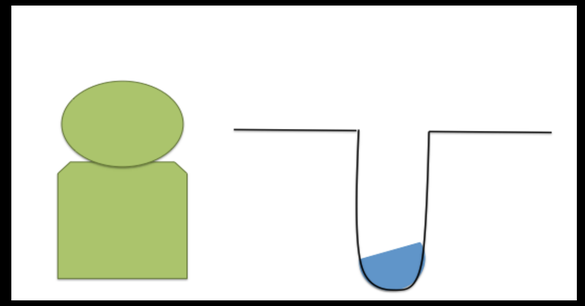
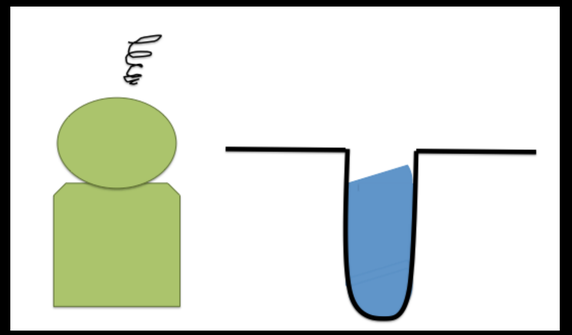


Figure 2-29

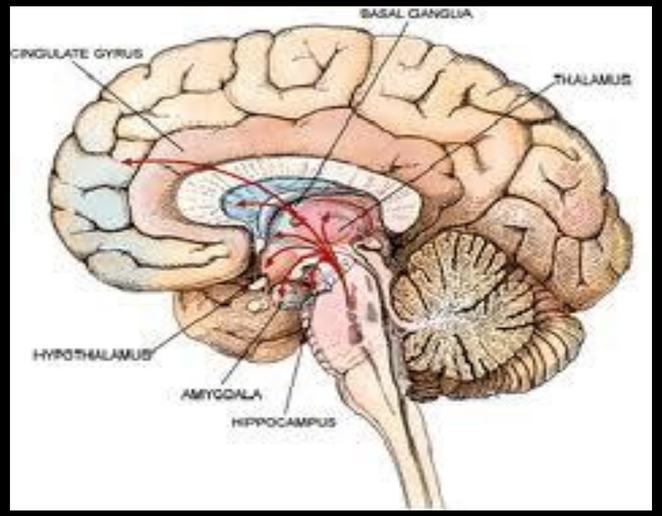
This diagram shows the pathways of the

Super simplified sweat gland model

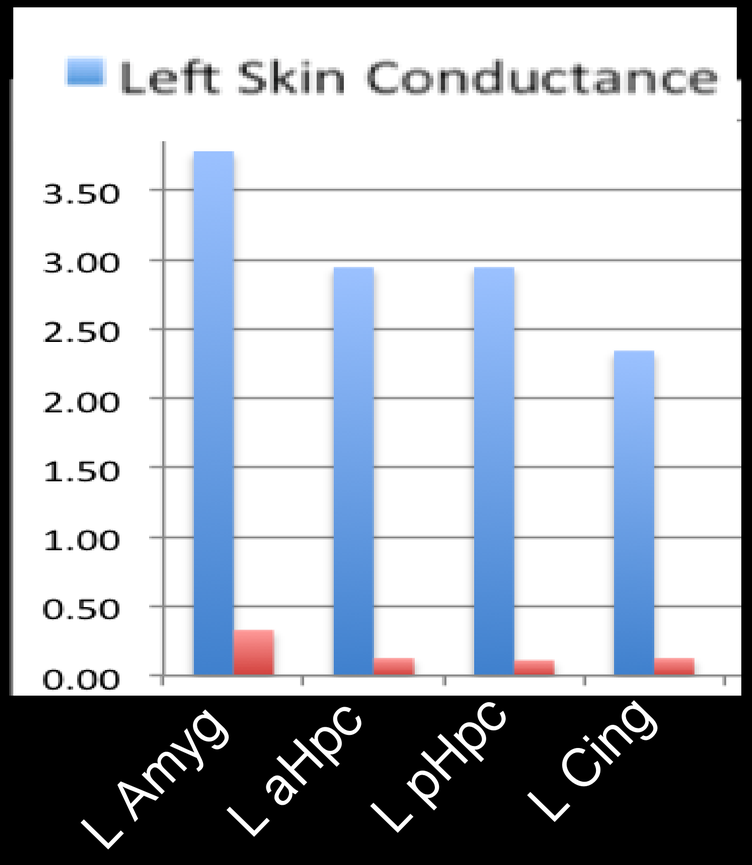


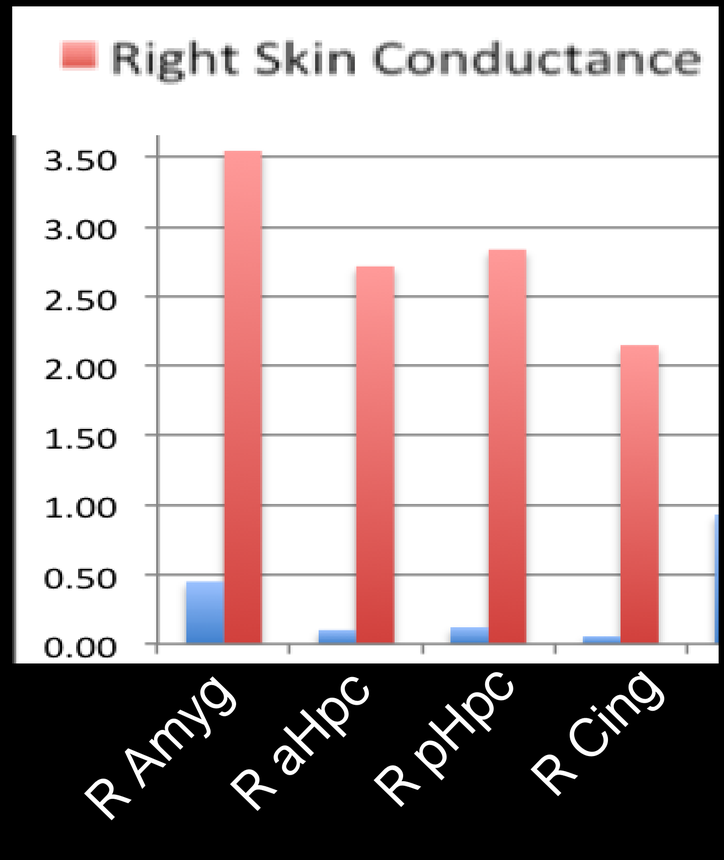


Left *deep* brain regions give largest left-side EDA

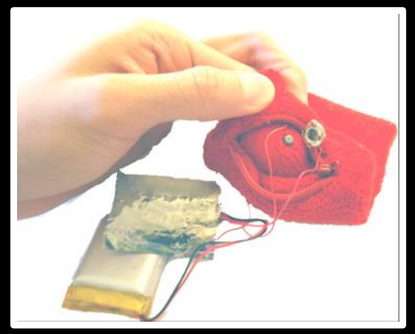


Right *deep* brain regions give largest right-side EDA

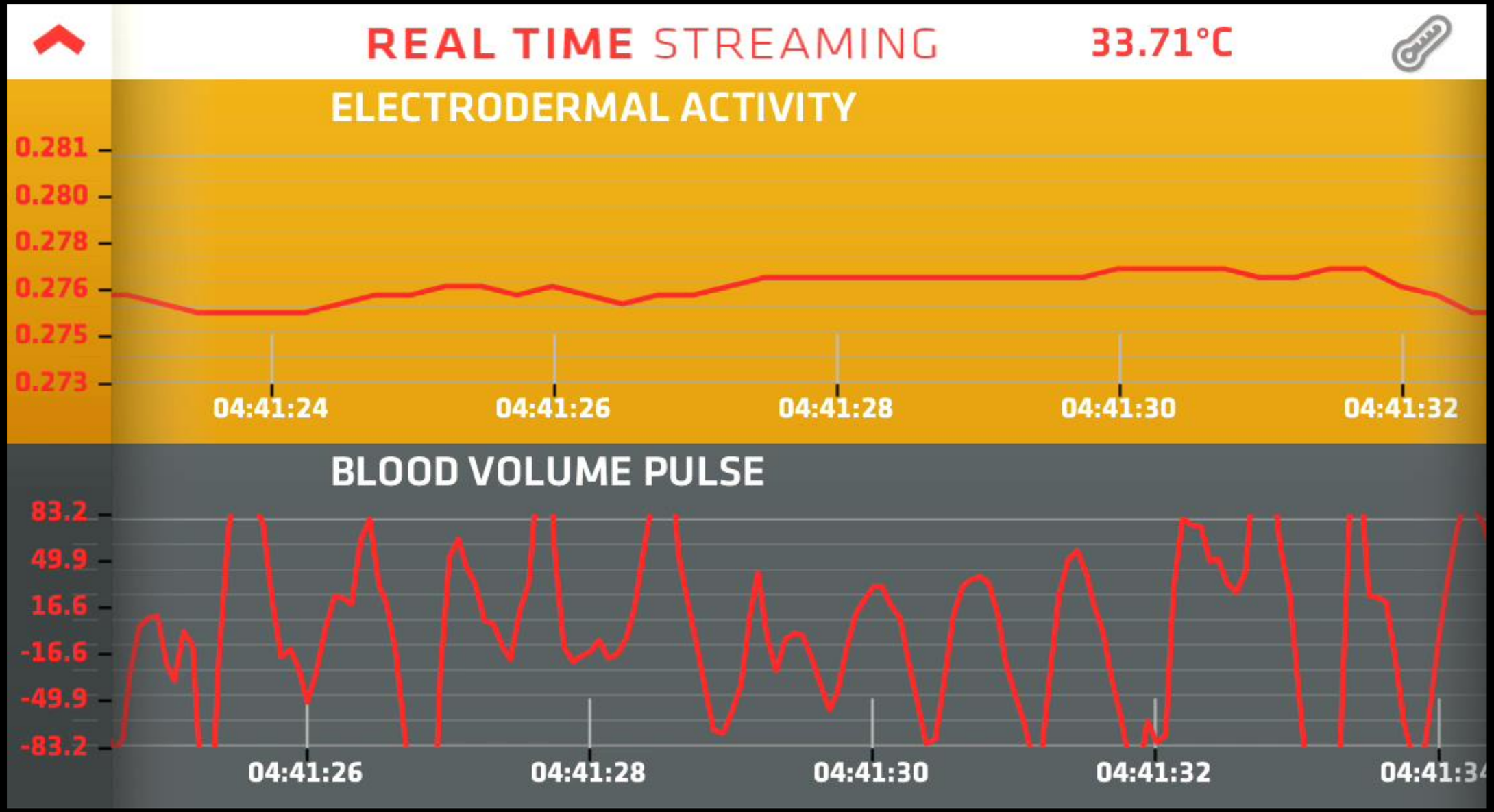




Mangina & Beuzeron-Mangina 1996, Int. J. Psychophysiology 22(1996)1-8.

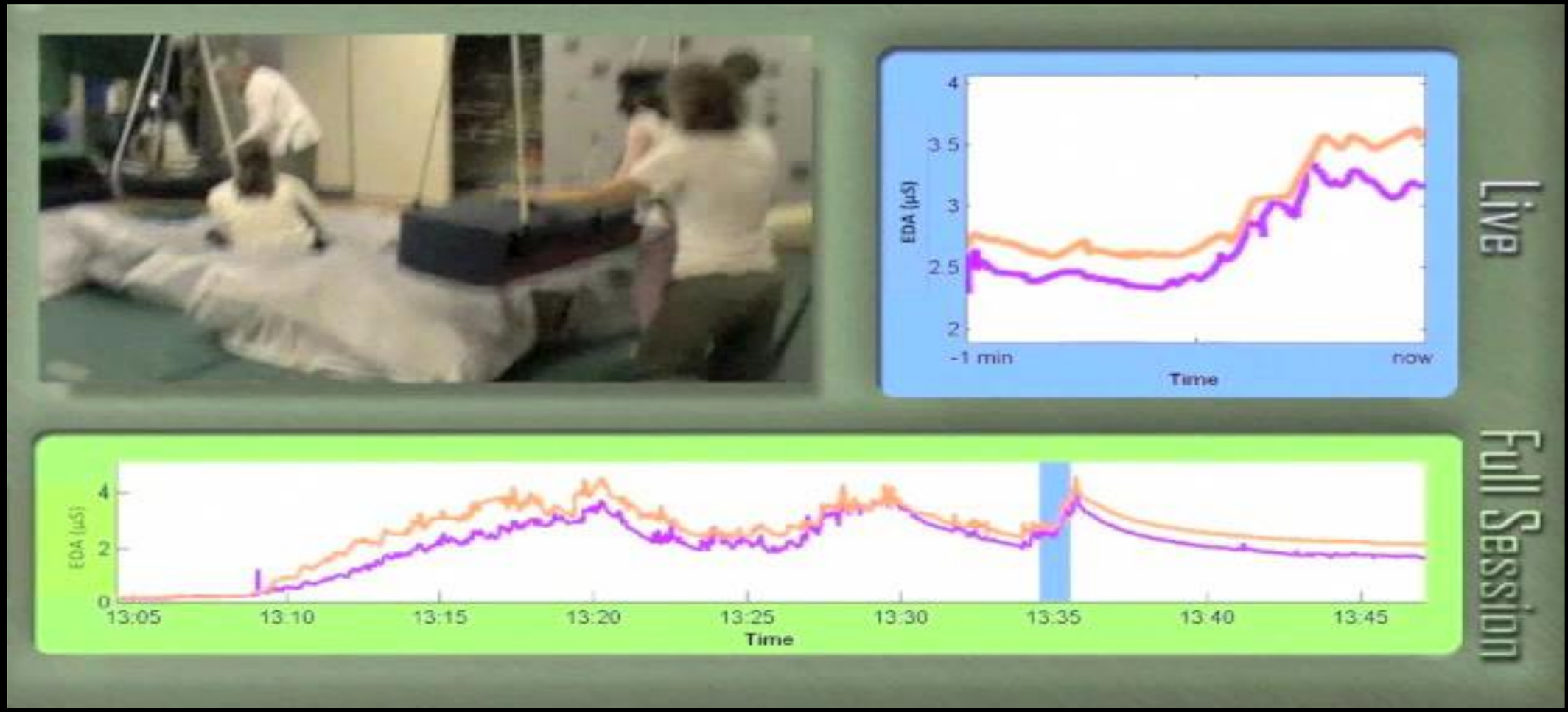




- Motion
- Temperature
- BVP (HR/HRV)
- Electrodermal activity



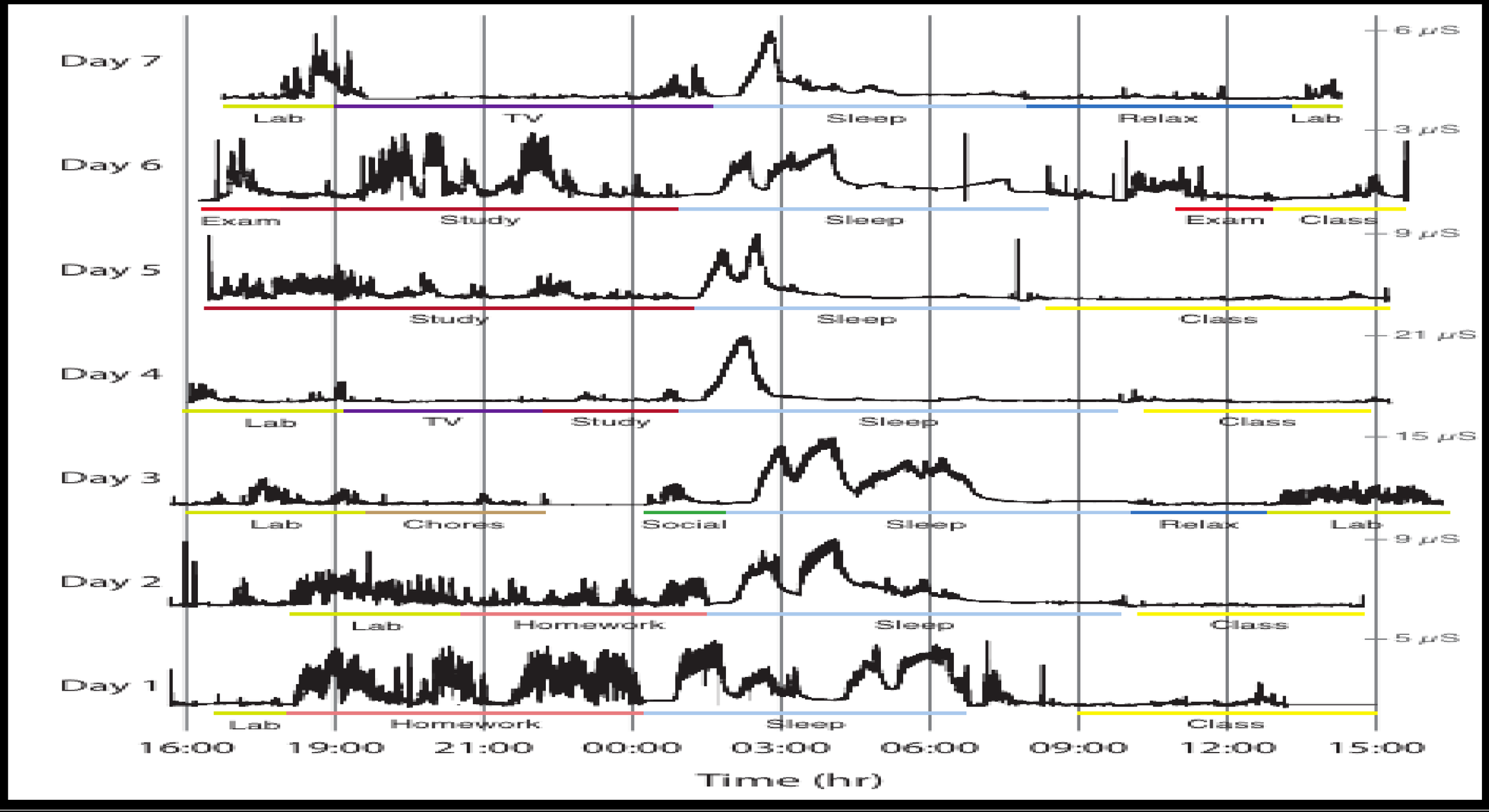
Empatica E4 sensor data

EDA in autistic children



Measuring electrodermal activity (EDA): Calm during swinging

MIT Student, 7 days, 24 hours/day



College Sleep Project

- 50 MIT undergrad students/semester
- Socially connected
- 30 days
- N > 400 (5 year project; 4 year data collection; so far about N=170)

-Physiology
Skin conductance
Skin temperature

-Behavior
Acceleration data

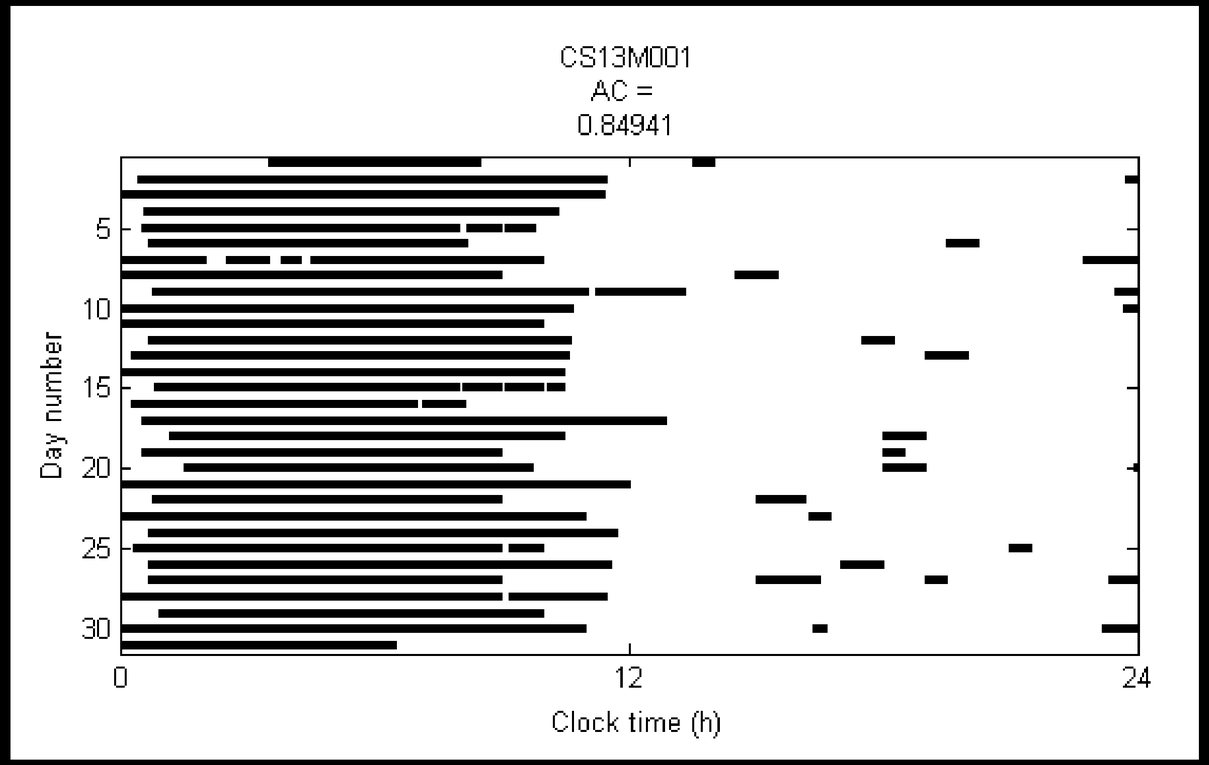
-Environment
Light Exposure

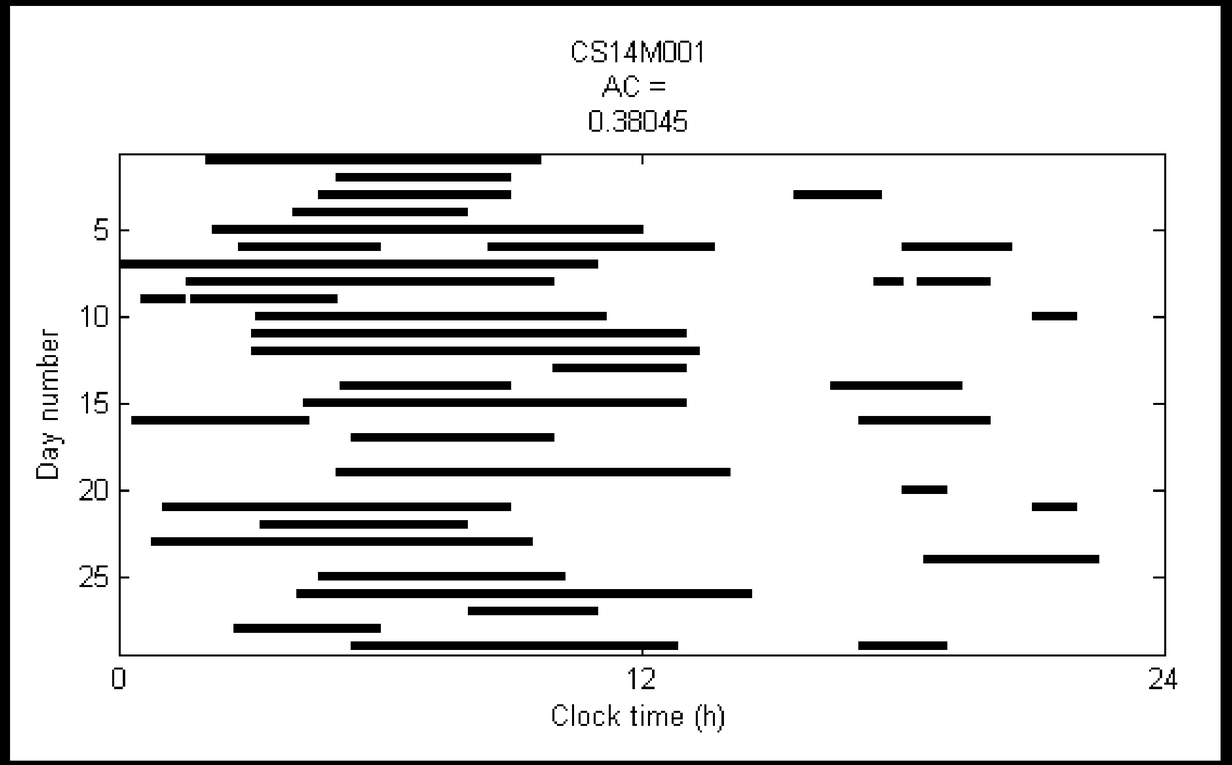
-Social Interaction
Phone / Email usage
Surveys (every morning/evening)

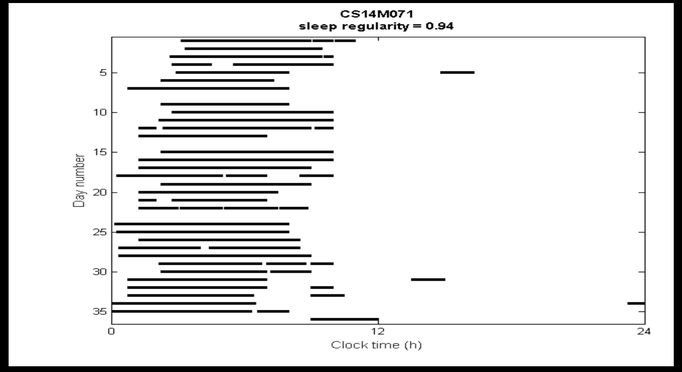
-Lab Measurement
Melatonin
Cognitive performance
Stress task responses

Personality Type
Sleep Habits
Perceived stress level
State-Trait Anxiety Inventory
Social network patterns
GPA

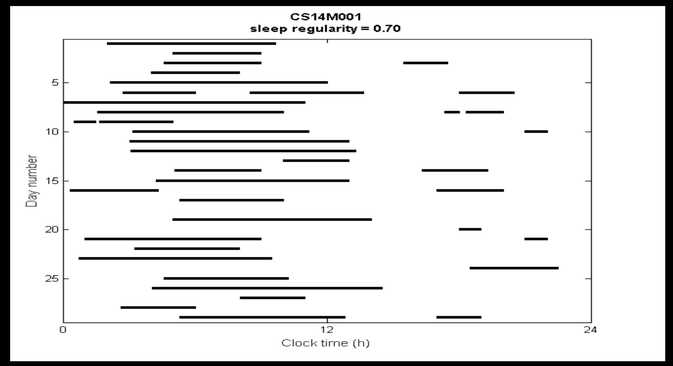
Regular vs irregular sleepers







Regular Sleepers

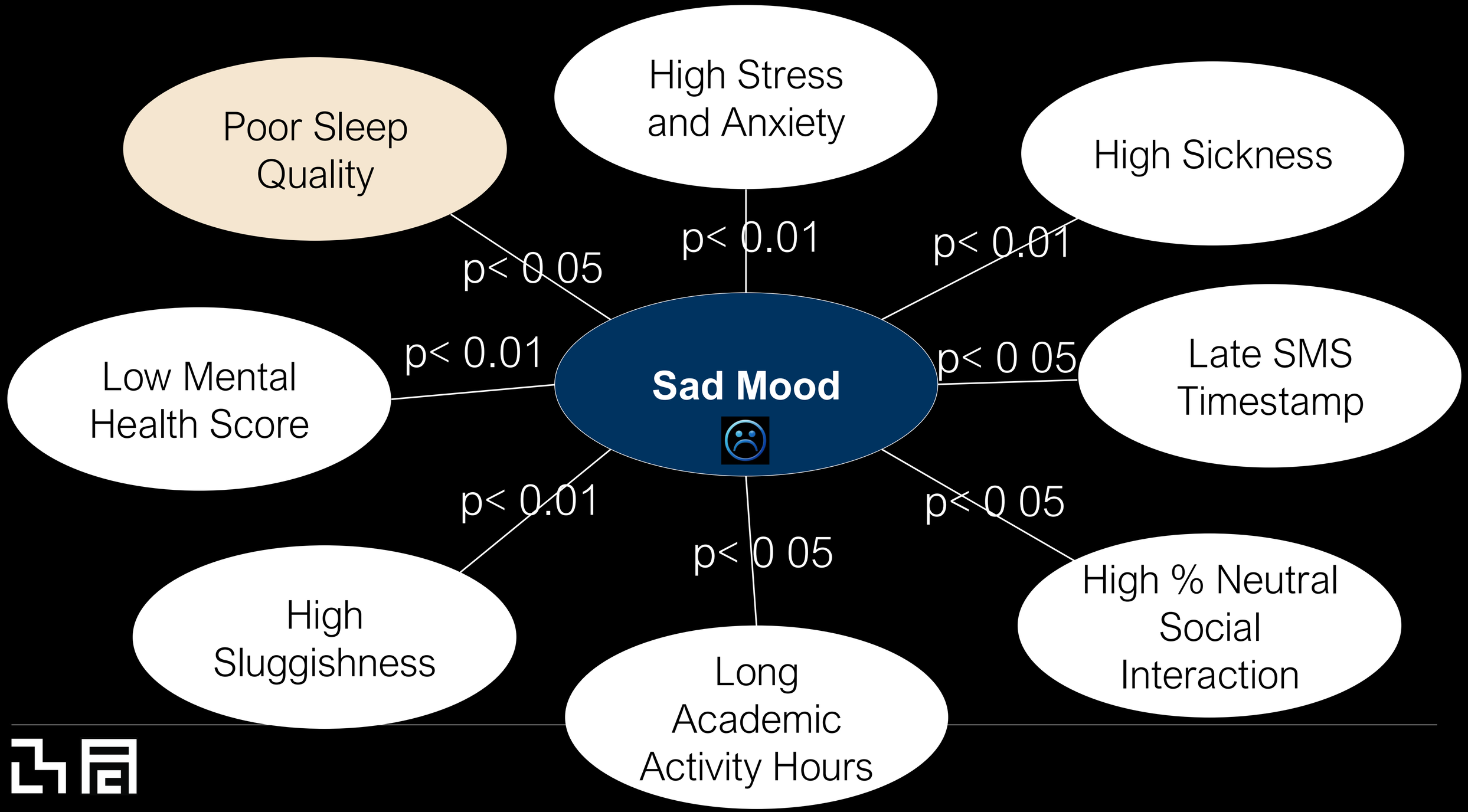


Irregular Sleepers

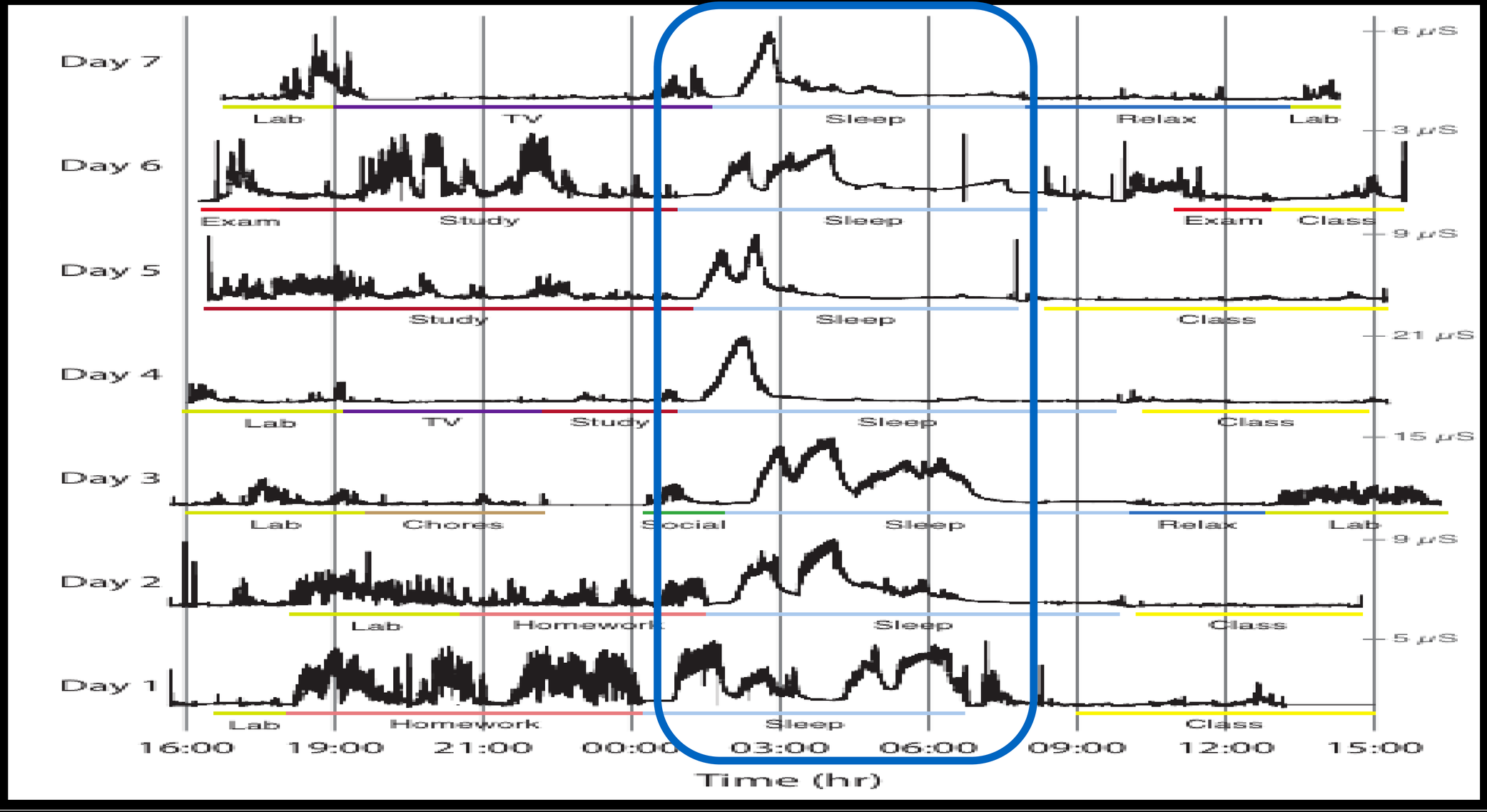
Irregular sleepers have worse health outcomes

43.9	**Mental Health**	37.3
66.6	**Morning Happiness**	58.1
46.0	**Morning Alertness**	41.2
61.6	**Morning Energy**	48.8

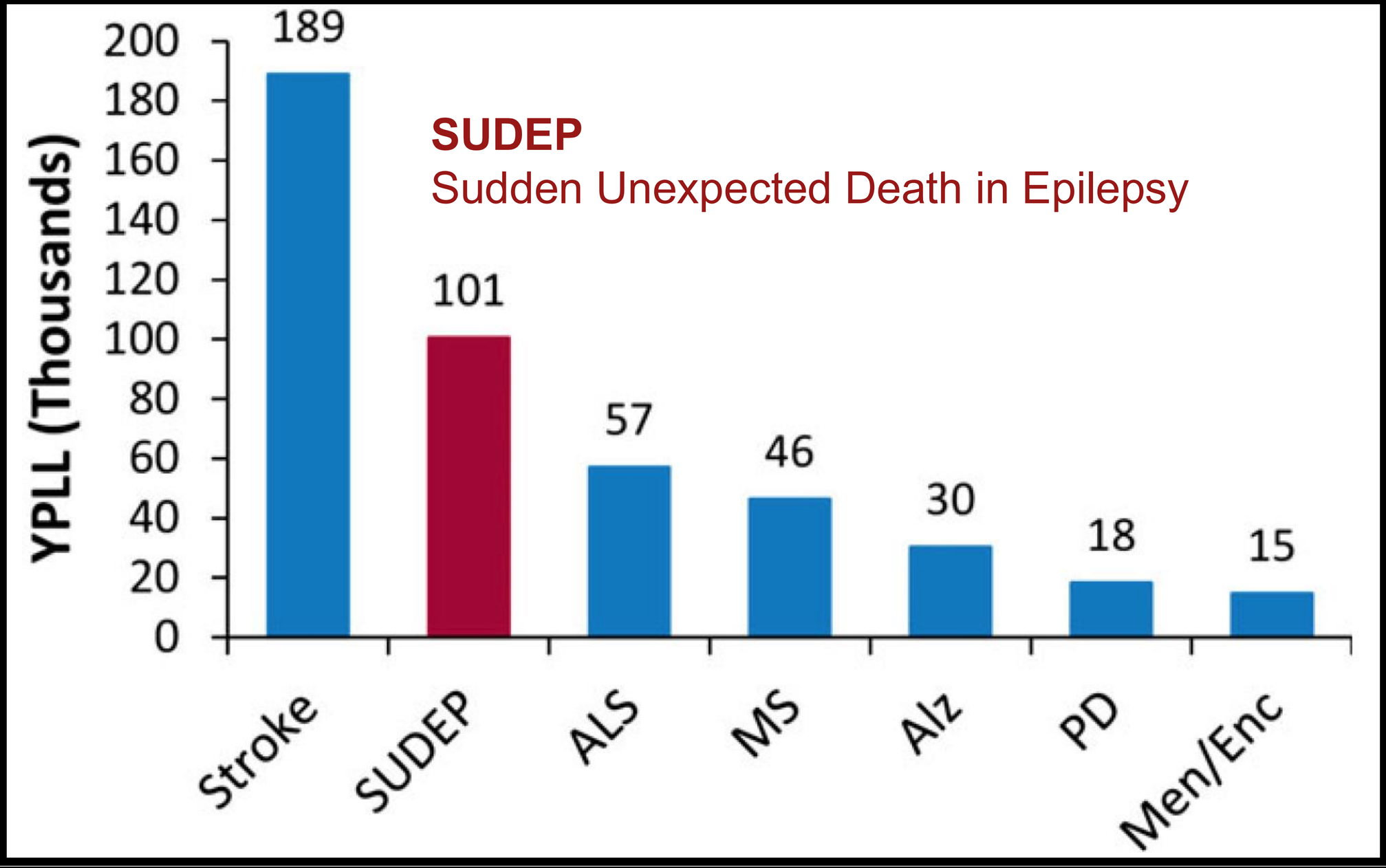
Results statistically significant, $p < 0.05$ or $p < 0.01$. Controlled for sleep duration, gender, and stress, using 30 nights of sleep per participant


Poor Sleep Quality
High Stress and Anxiety
High Sickness
p< 0 05
p< 0.01
p< 0.01
Low Mental Health Score
p< 0.01
Sad Mood
p< 0 05
Late SMS Timestamp
p< 0.01
p< 0 05
p< 0 05
High Sluggishness
Long Academic Activity Hours
High % Neutral Social Interaction

MIT Student, 7 days, 24 hours/day



Why are there such large peaks of “arousal” during sleep?



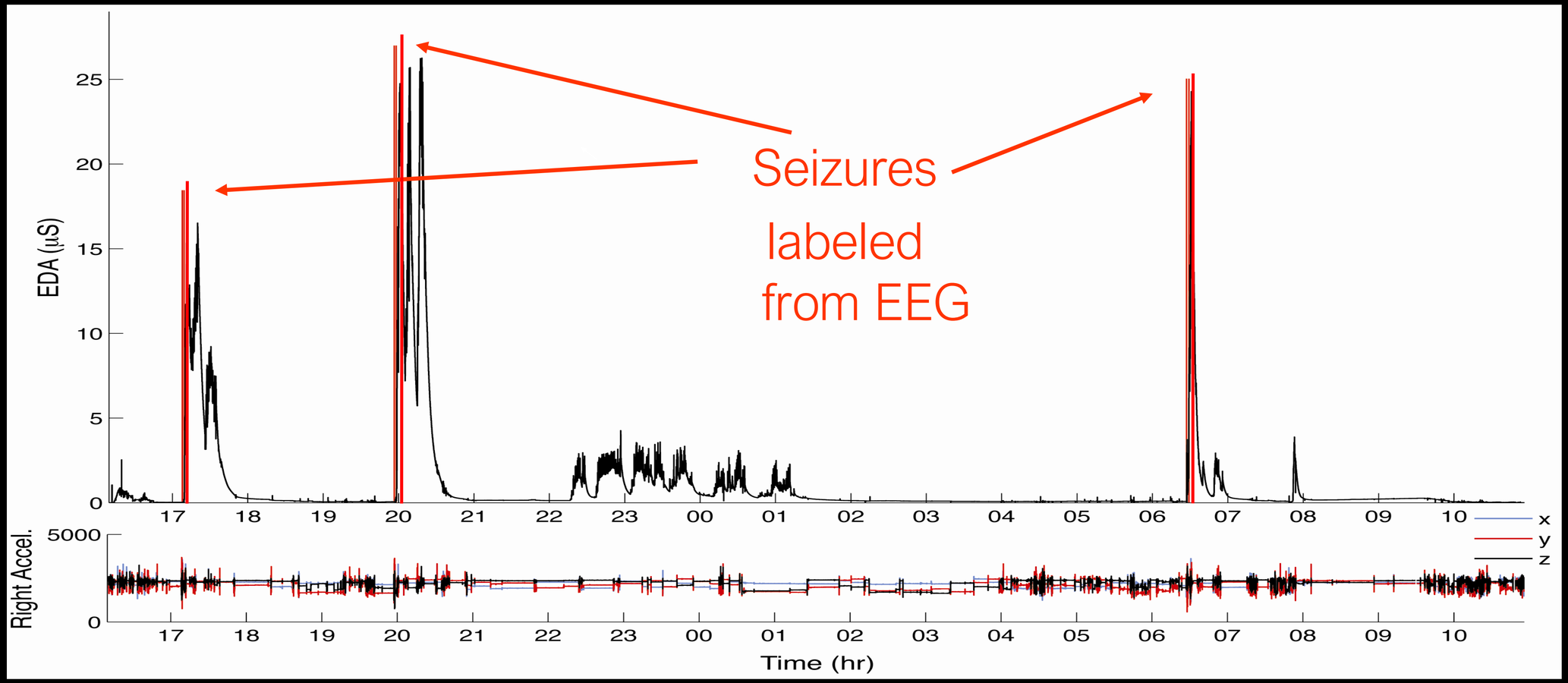
Neurologic diseases that cause death, Thurman et al. 2014

An alert could prevent most seizure deaths

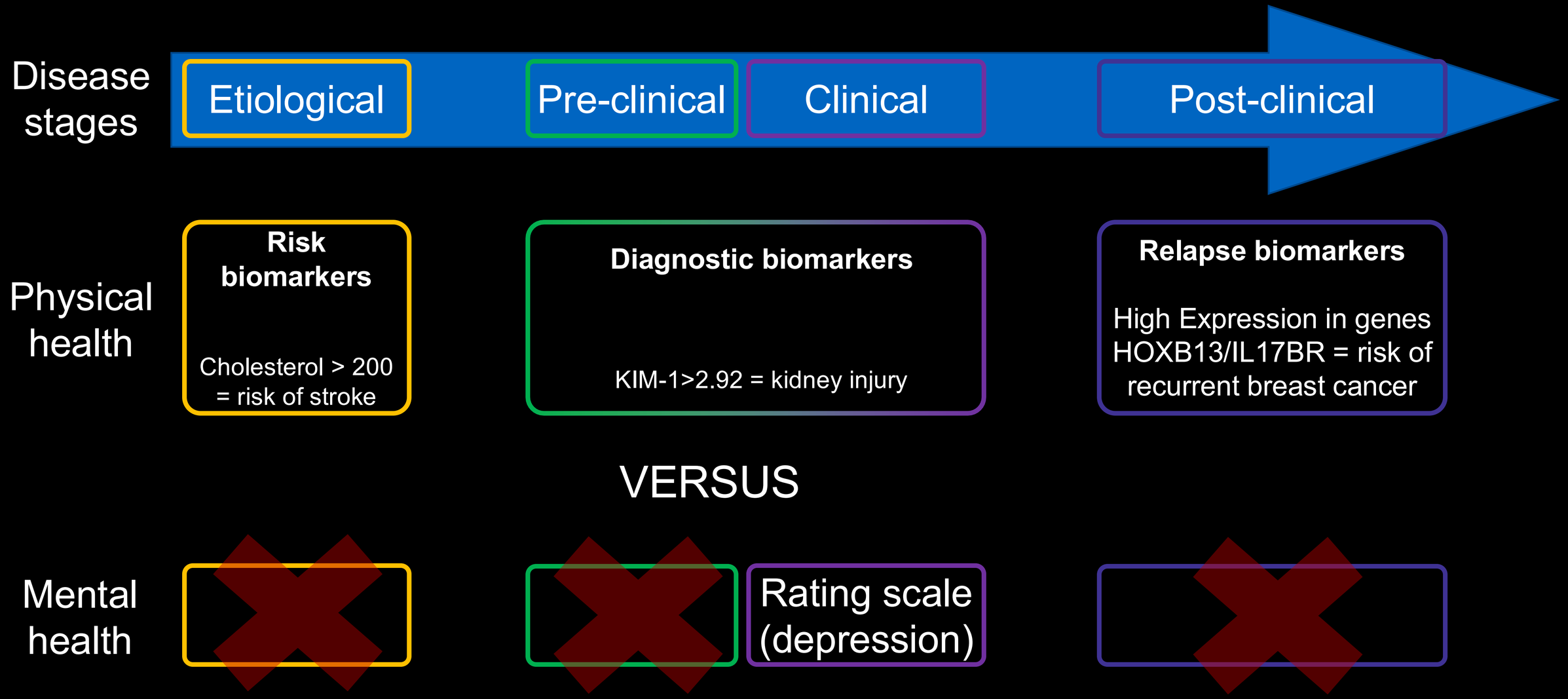
Seizures are like little electrical fires in your brain
Deaths from seizures kill more people than house fires

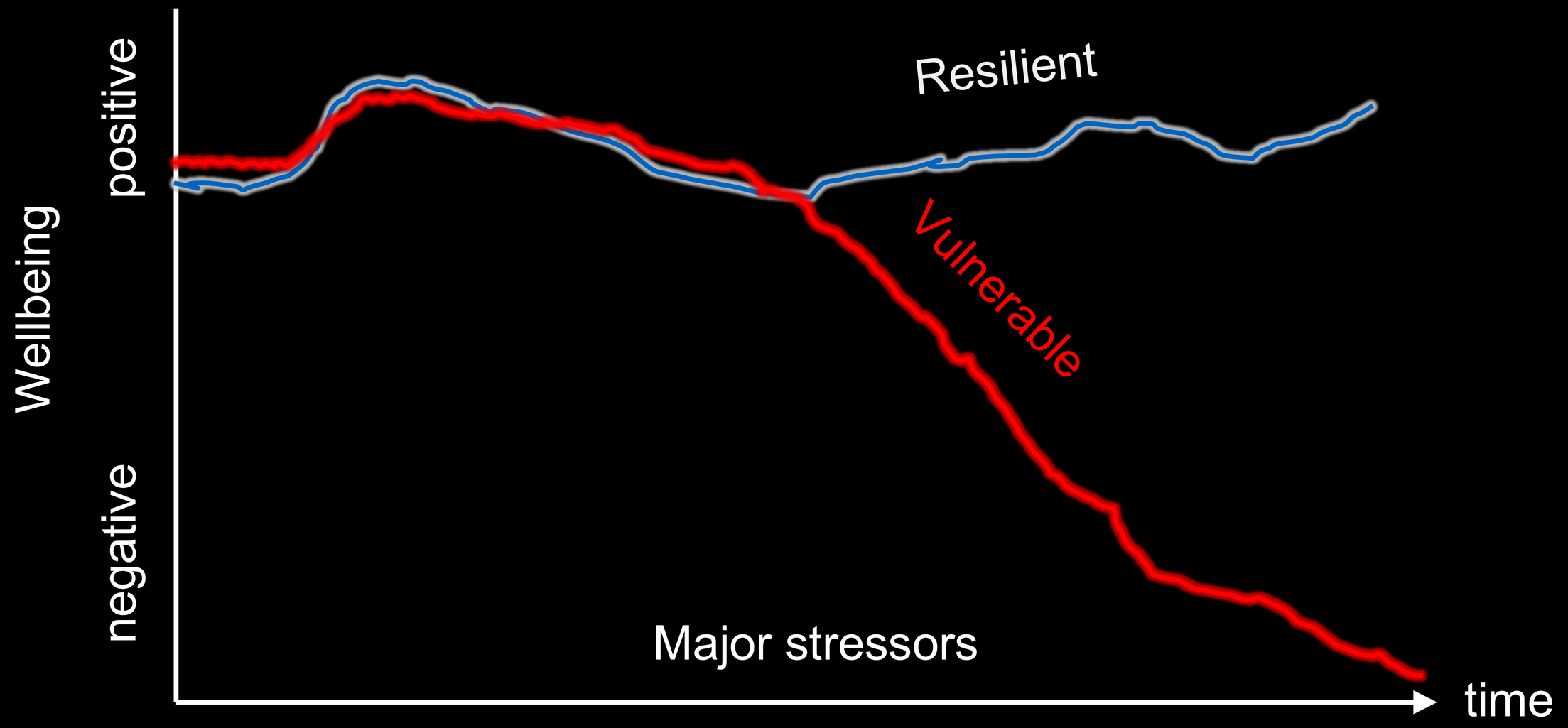
94% accurate convulsive seizure detection using a wrist-worn electrodermal activity and accelerometry biosensor.

Poh et al (2012), ***Epilepsia***.



Send a subtle vibration with changing autonomic or activity patterns:
Communicate your state to somebody who can understand…


Disease stages
Etiological
Pre-clinical
Clinical
Post-clinical
Physical health
Risk biomarkers
Cholesterol > 200 = risk of stroke
Diagnostic biomarkers
KIM-1>2.92 = kidney injury
Relapse biomarkers
High Expression in genes HOXB13/IL17BR = risk of recurrent breast cancer
VERSUS
Mental health
Rating scale (depression)


Wellbeing
positive
negative
Resilient
Vulnerable
Major stressors
time

Thank you!

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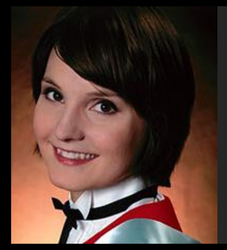

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