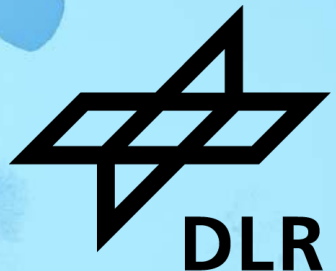


HMI4RAIL

SMART SENSOR FOR HUMAN FACTORS IN RAILWAY SYSTEMS

Conference on Rail Human Factors, Berlin

Esther Bosch & Andrea Valerio





Challenge

- Mental fatigue during GOA2
- Ironies of Automation

Solution

- Smart Train Driver Garment
 - Electrocardiogram
 - Electroenzephalogram
 - Skin conductance
 - Blinking
 - Breathing

Project Partners HMI4Rail



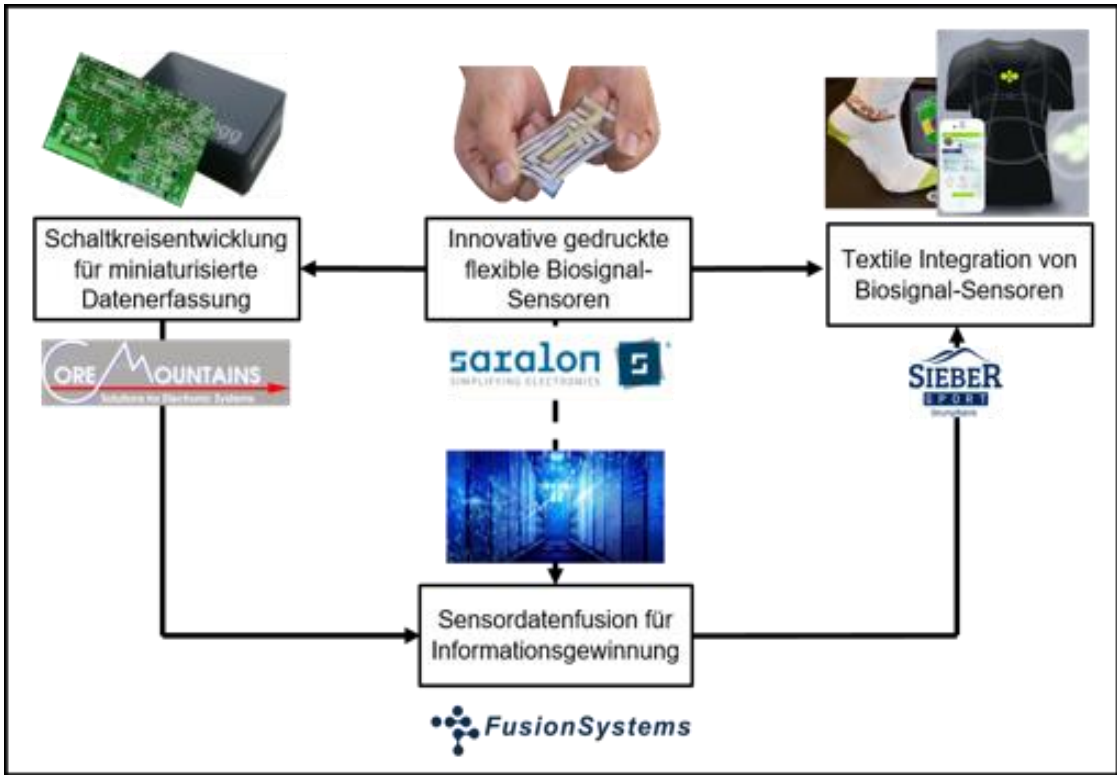
coordination of research infrastructure



engineering for human-centered
technology design



technologies and methods for Rail
Human Factors



A high-speed train, sleek and aerodynamic with a blue and white color scheme, is shown traveling on a bridge over a lush, green valley. The landscape is characterized by steep, rocky mountains and a misty atmosphere. The sun is low on the horizon, creating a warm, golden light. The train's windows show passengers inside. The overall scene is a digital rendering or a highly stylized photograph.

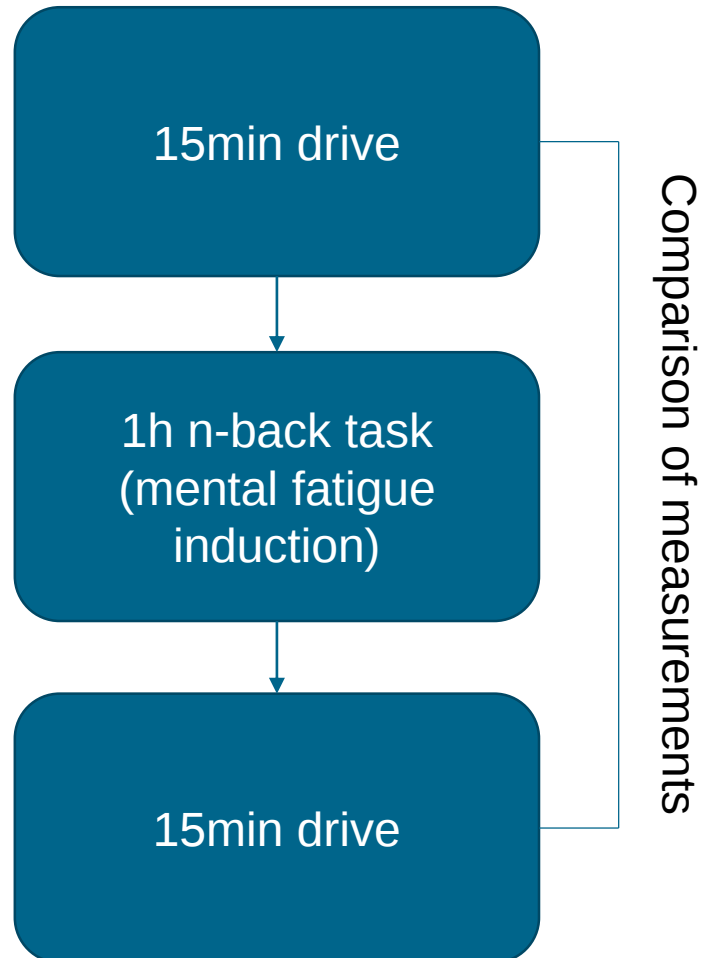
WHICH SENSORS? – STUDY 1

Study Setup

N = 14; 14 +/- 15 years of experience; 1 female



Study Design



Measurements



- Psychophysiological sensors
- Mistakes in n-back
 - To exclude participants with less than 80% up to 3-back
- Missed SIFAS
- Self-reported mental fatigue

Hypotheses in comparison of drive 2 to 1

- Electrocardiogram: Lower Heart Rate
- Electroencephalogram: Increased frontal Theta Power
- Skin conductance: Decrease in SRC peaks
- Blinking: Longer & less frequent blinks
- Breathing: slower breathing rate
- Higher self-reported fatigue
- More missed SIFAS



<https://www.polar.com/de/sensors/h10-heart-rate-sensor>



<https://pupil-labs.com/products/core>



<https://www.shimmerensing.com/product/shimmer3-gsr-unit/>

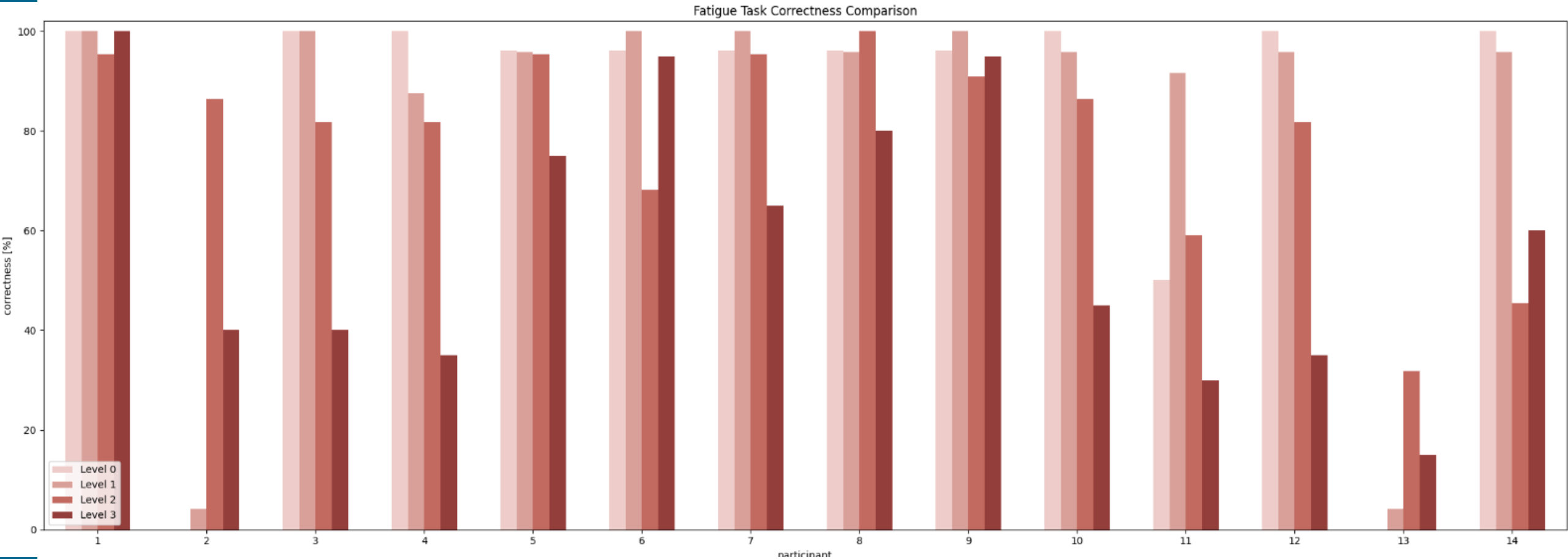


<https://www.vernier.com/product/go-direct-respiration-belt/>



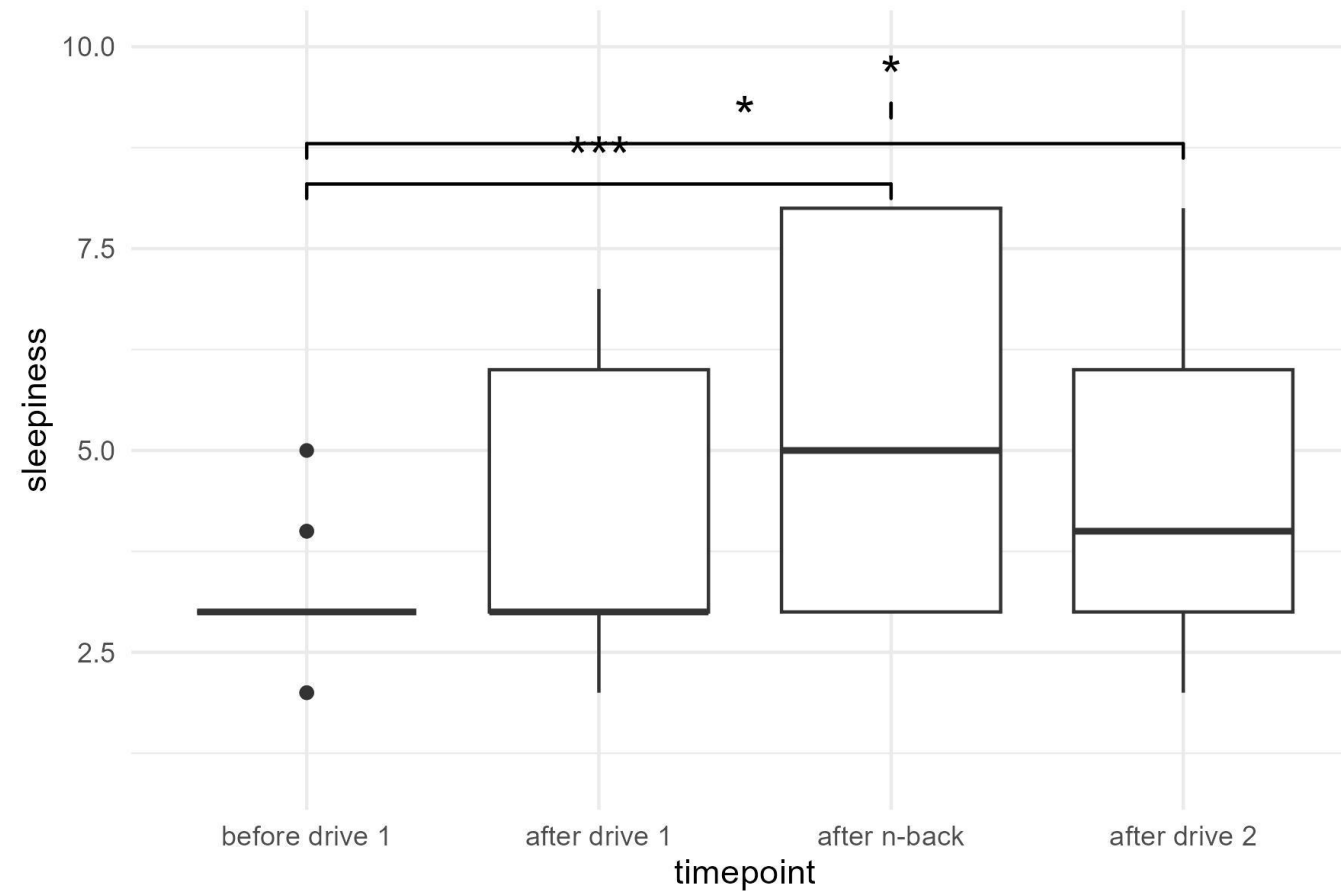
<https://www.brainproducts.com/solutions/liveamp/>

n-back correctness

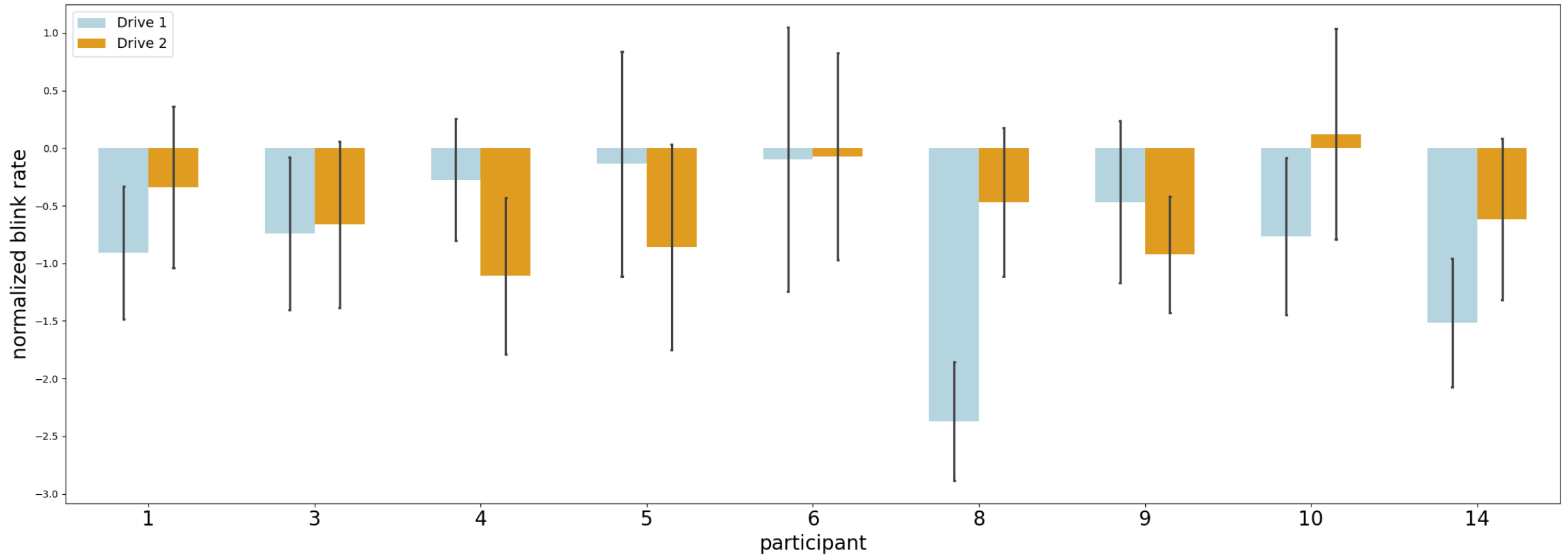


→ Exclude participant 13, maybe 2

Karolinska Sleepiness Scale



Missed SIFAs

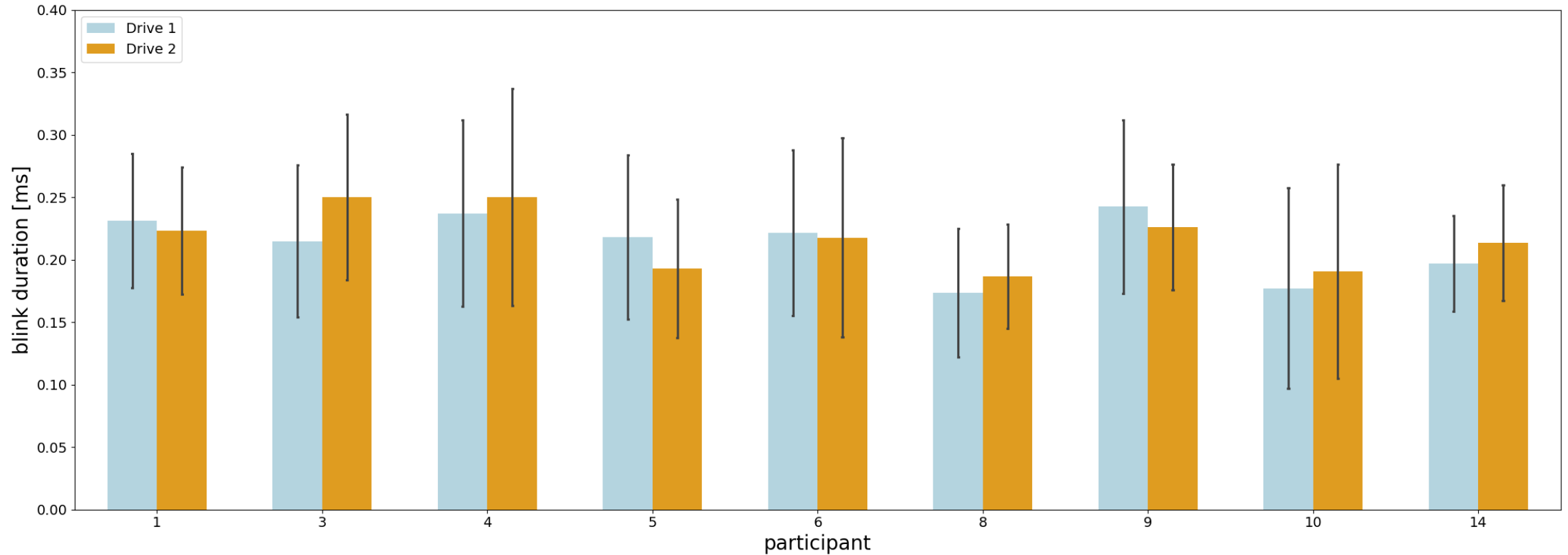


Bars = standard deviation

More missed SIFAs

- In drive 1: 8 participants
- In drive 2: 2 participants ←

Blink Duration

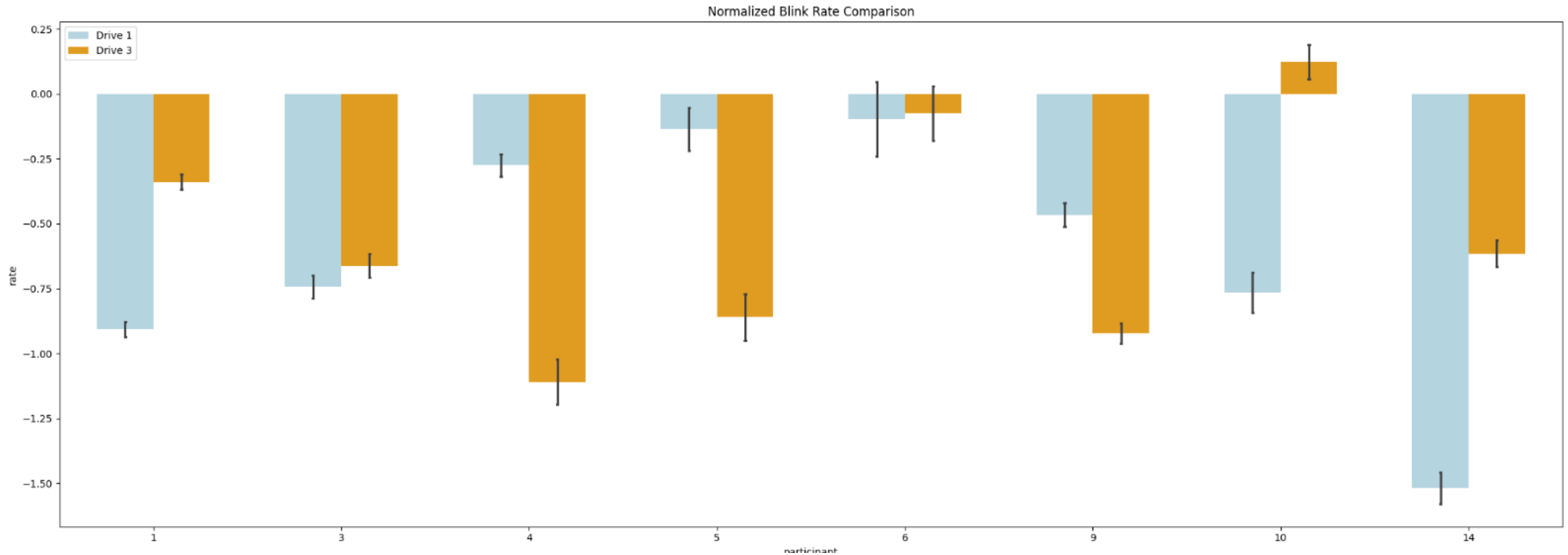


Bars = standard deviation

Longer blink duration

- In drive 1: 4 participants
- In drive 2: 5 participants ←

Blink Rate



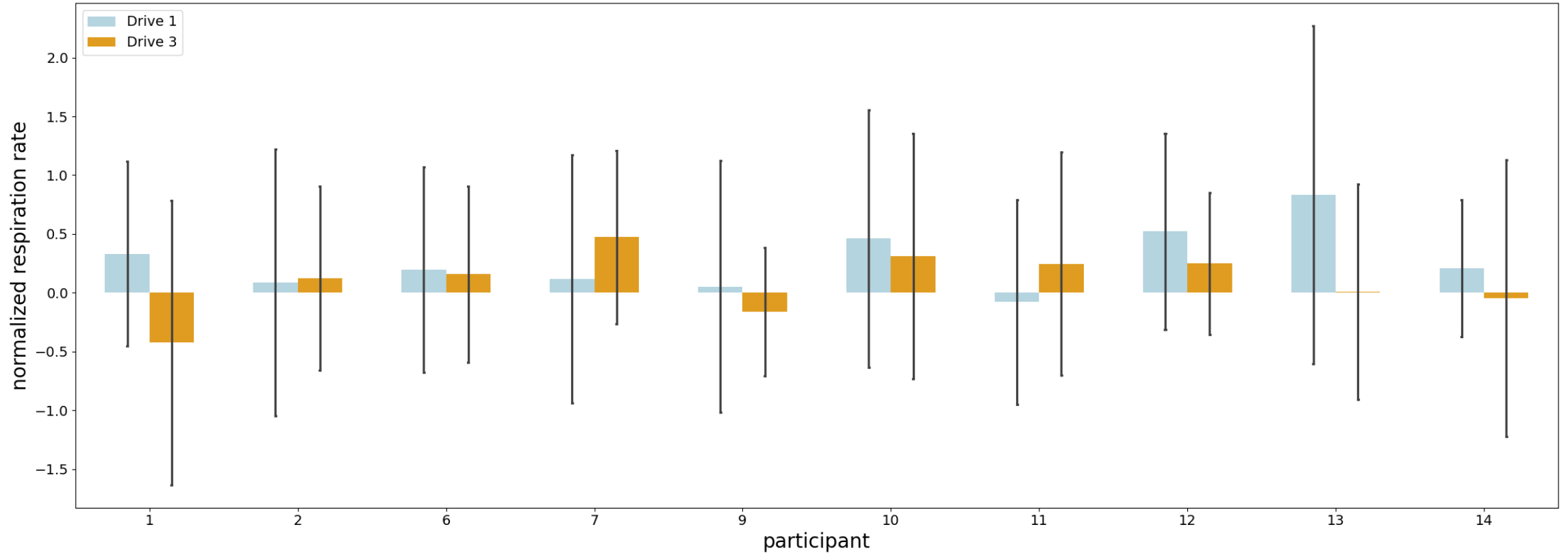
Bars = standard deviation

Lower blink rate

- In drive 1: 4 participants
- In drive 2: 4 participants ←



Respiration Rate

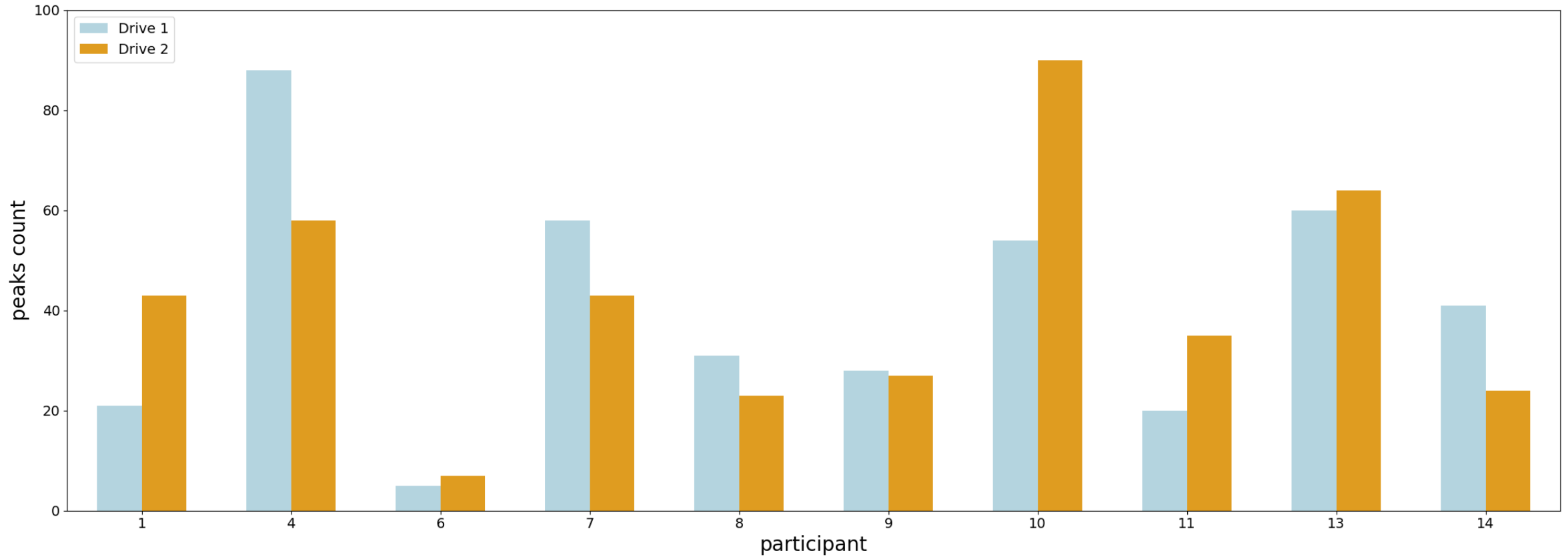


Bars = standard deviation

Lower respiration rate

- In drive 1: 3 participants
- In drive 2: 7 participants ←

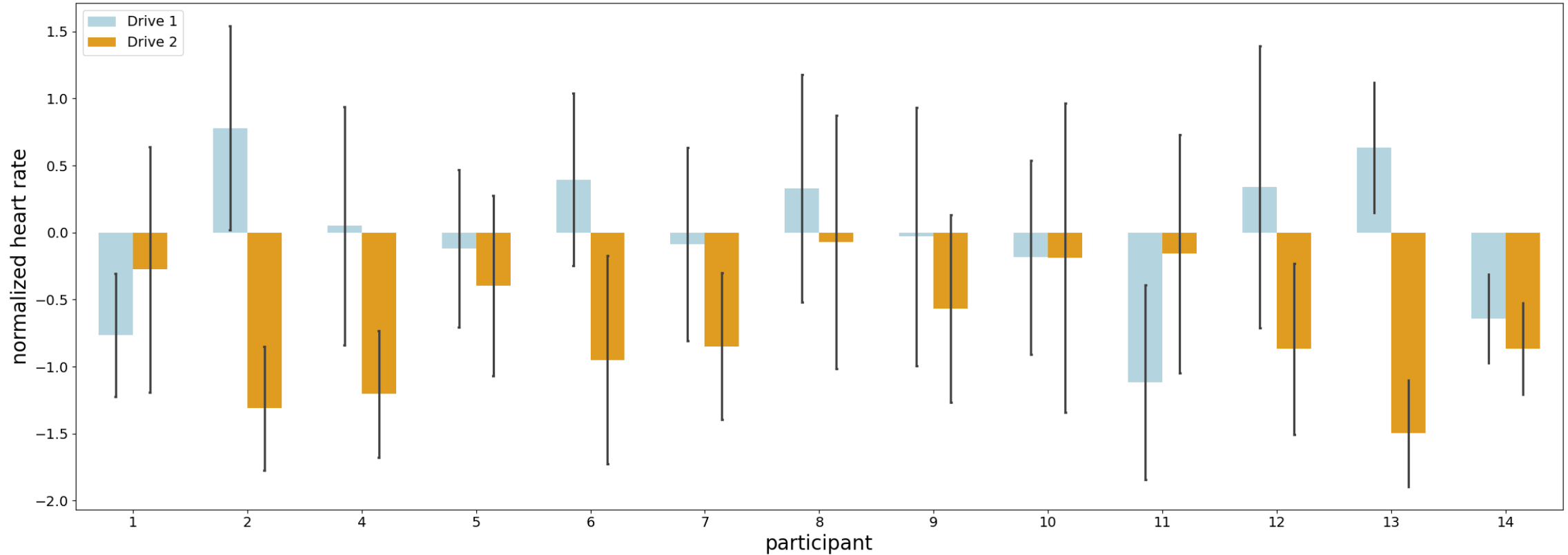
Skin conductance



Less SCR peaks

- In drive 1: 5 participants
- In drive 2: 5 participants ←

Heart rate

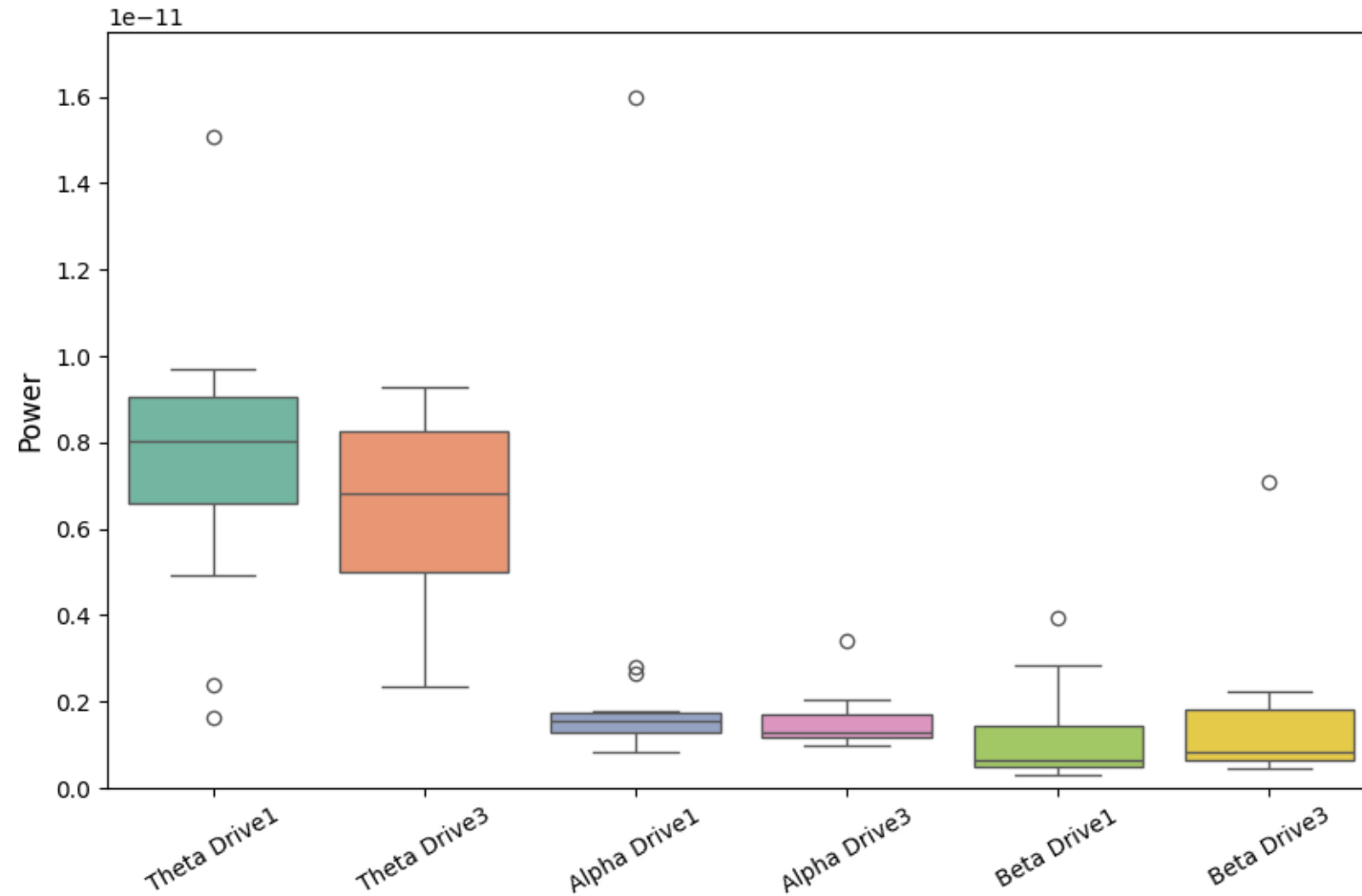
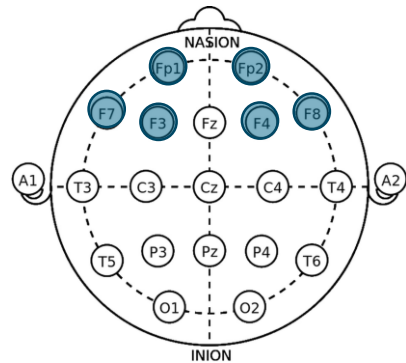


Bars = standard deviation

Lower heart rate

- In drive 1: 2 participants
- In drive 2: 11 participants

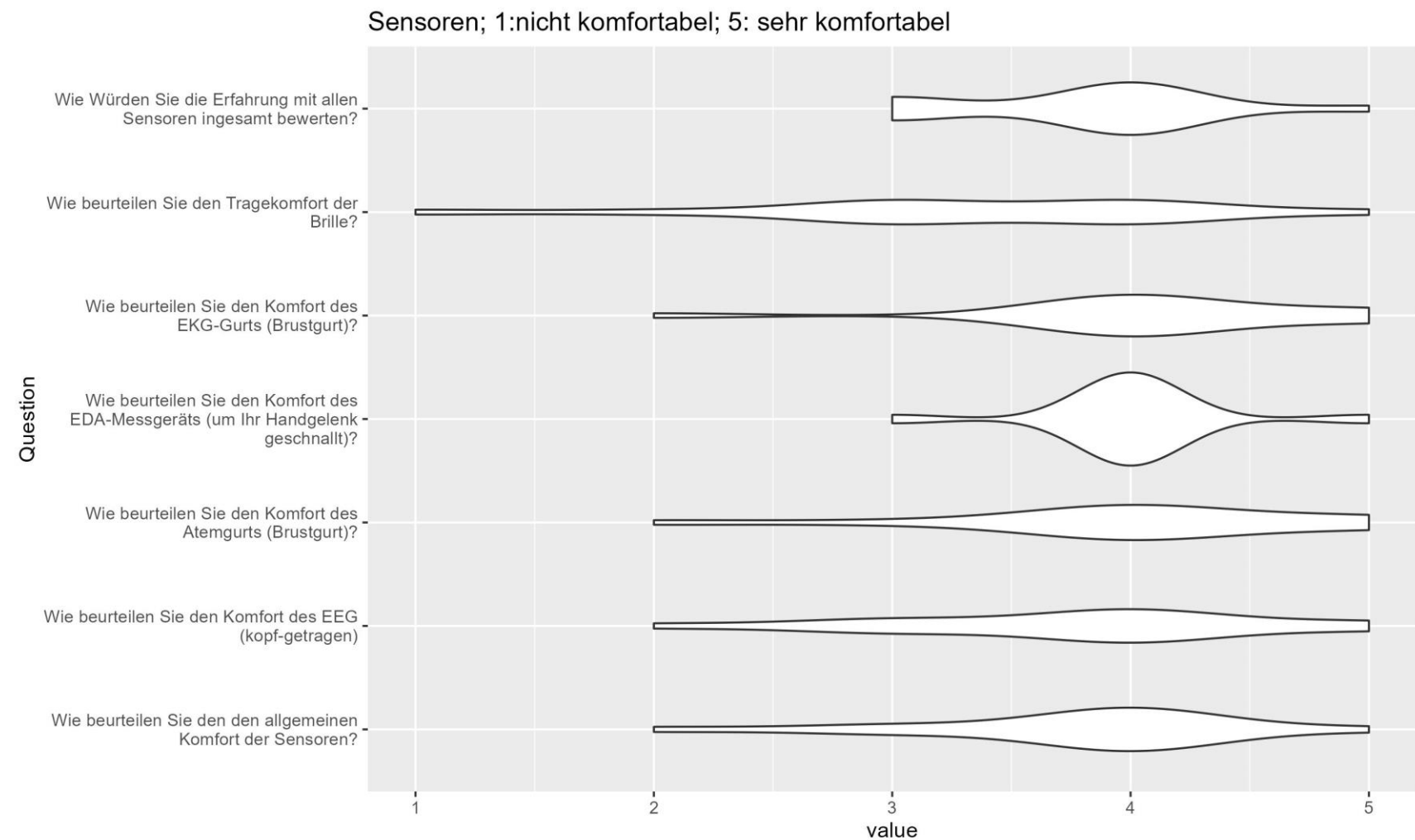




Lower frontal theta

- In drive 1: 7 participants
- In drive 2: 7 participants ←





Outlook

- 5 participants during real train driving
 - Exactly the same study design & sensors
 - Testbed of SRCC and Erzgebirgsbahn
- ‚more sophisticated‘ processing, e.g. frequency-domain analysis of skin conductance and heart rate
- Workshop with train operator companies
- Most promising: combination of ECG and EEG



<https://www.olbernhau.de/anreise-mit-der-erzgebirgsbahn>