The influence of self-regulating noradrenergic activity on cortical excitability and neuroplasticity

Weronika Potok-Szybinska, Sarah Meissner, Silvia Missura, Manuel Carro Dominguez, Marc Bächinger, Nicole Wenderoth

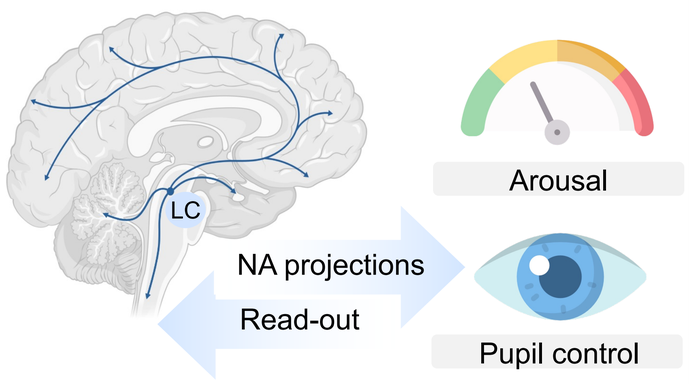
Neural Control of Movement Lab, ETH Zurich, Switzerland

e-mail: weronika.potok@hest.ethz.ch @WeronikaPotok @NCMLabETH

BACKGROUND

There is evidence for a **link between activity of the locus coeruleus (LC)**, a small brainstem structure and the main source of **noradrenaline** in the central nervous system, and **changes in pupil size**(1-4). We recently showed that **volitional modulation of pupil size:**

i. can be **trained** via pupil-based **biofeedback** (pupil-BF)
ii. is linked to changes in **LC activity**(5)

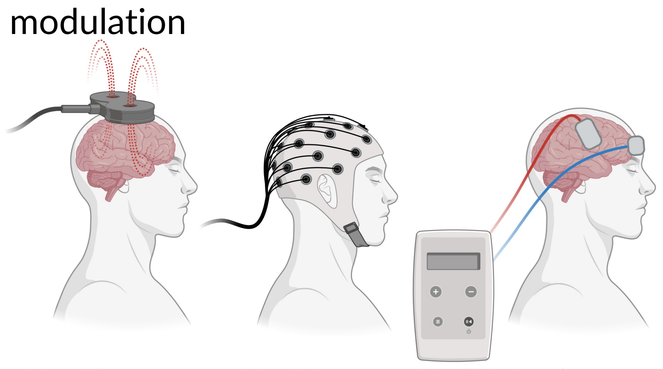


Pharmacological studies confirm that activating β- or α1-adrenoreceptors facilitates cortical excitability, neuroplastic effects, and influences the cardiovascular response of the peripheral sympathetic nervous system (6-17). Building on this, we investigated whether **volitional self-regulating of noradrenergic activity** influences:

i. cortical **excitability**
ii. electrophysiological and cardiovascular **arousal markers**
iii. **neuroplastic** effects

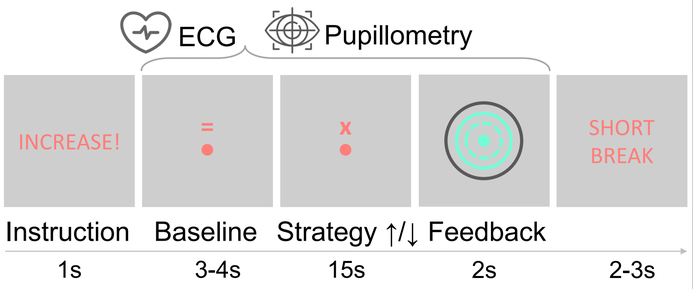
METHODS

Healthy participants previously trained in modulating (up- and downregulation) pupil size via the use of *mental strategies* and *pupil-BF* performed volitional pupil modulation



N=15 N=21 N=5 (pilot) N=6/4 (follow up)

- TRIAL DESIGN

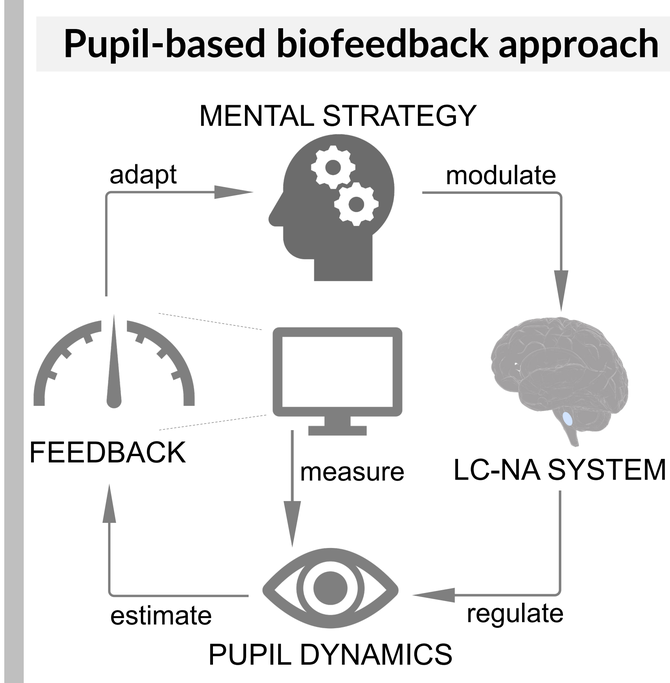


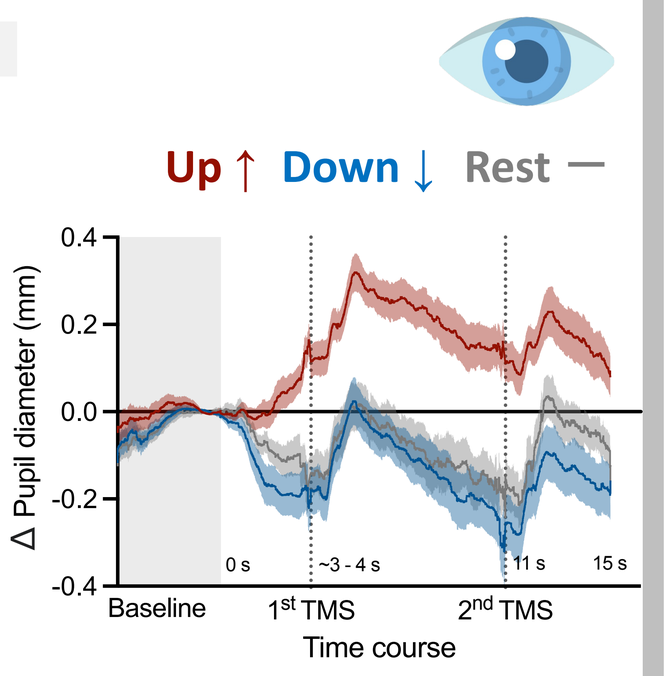
- cardiac data was recorded by ECG
- pupil data: preprocessing pipeline adapted from(18).
- computed baseline-corrected:

pupil diameter during modulation − **⌀ baseline pupil diameter**

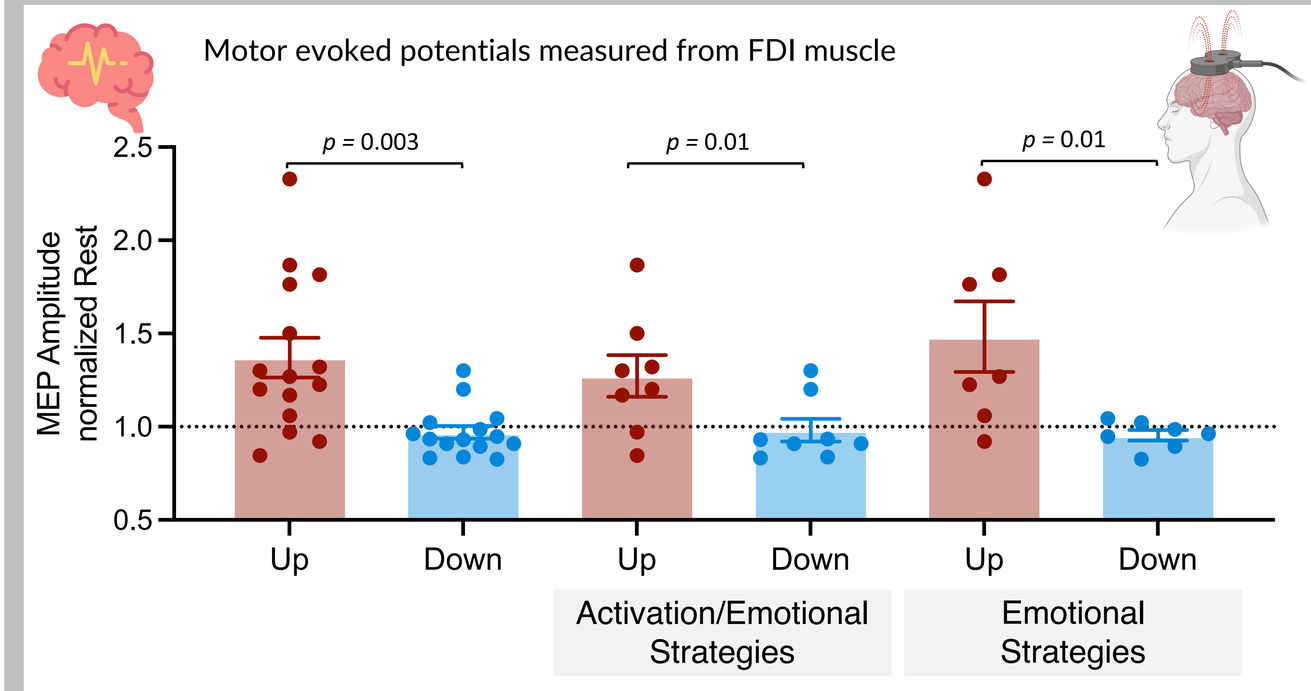
We can learn to **self-regulate pupil size** via **mental strategies** and **pupil-based biofeedback.**

Pupil-based biofeedback approach

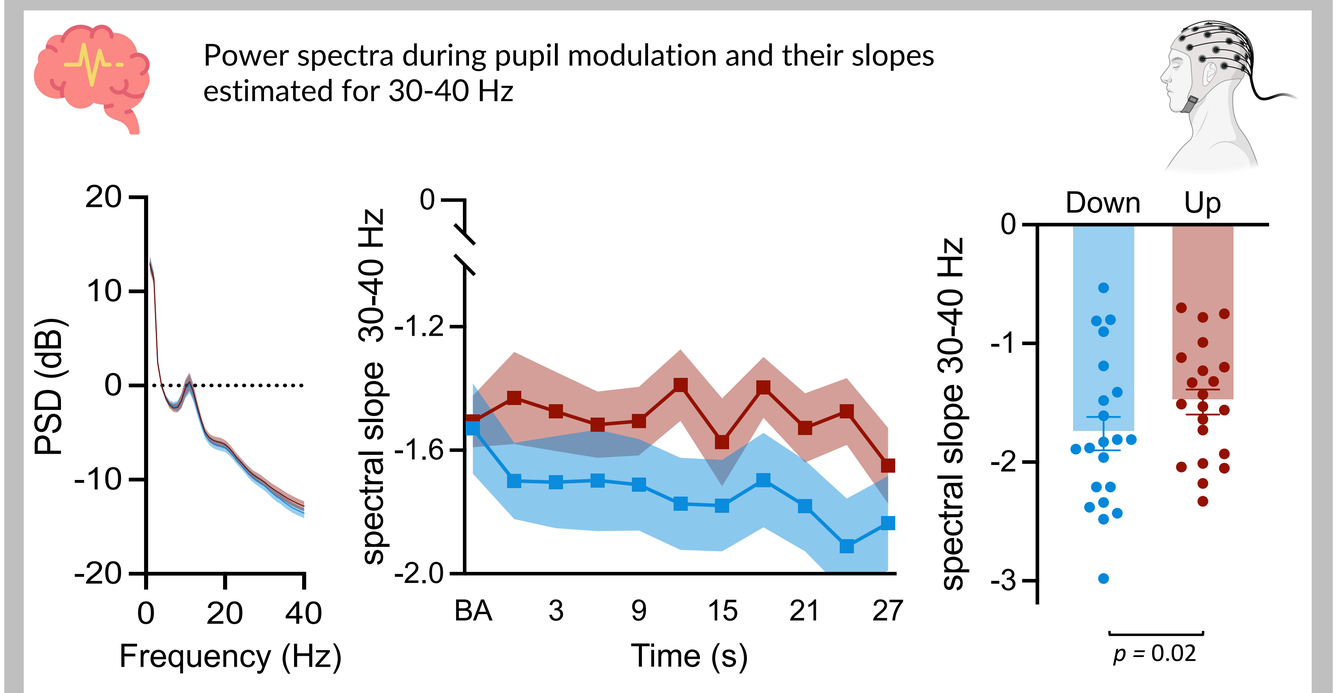




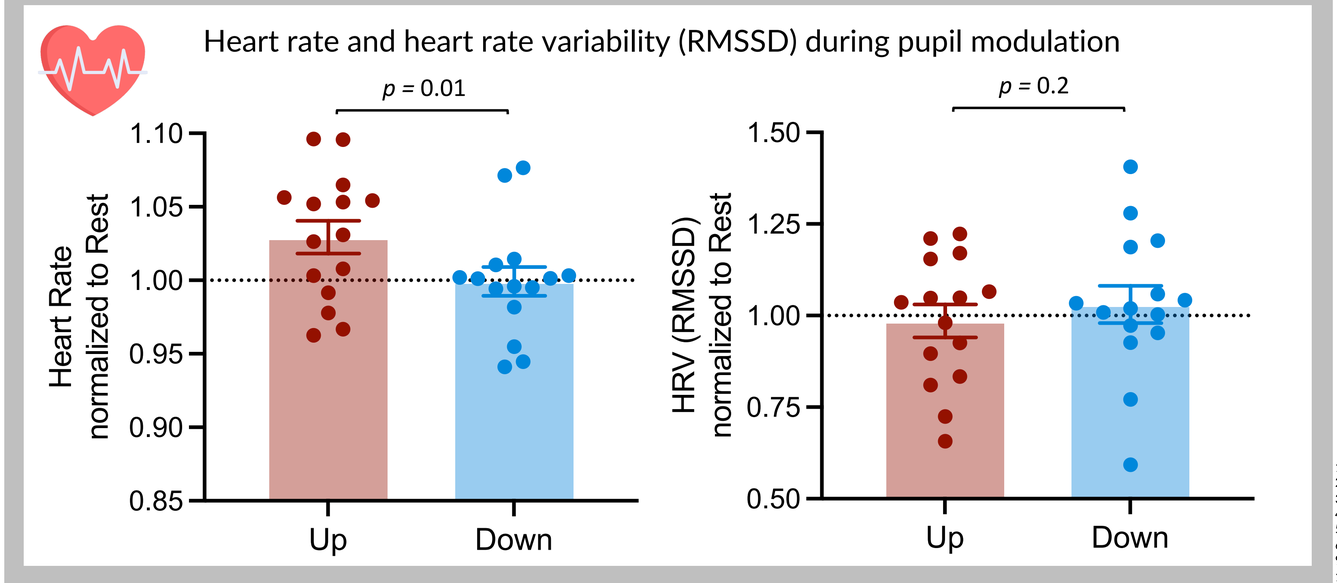
Such **self-regulation** is associated with **increase in cortical excitability,**



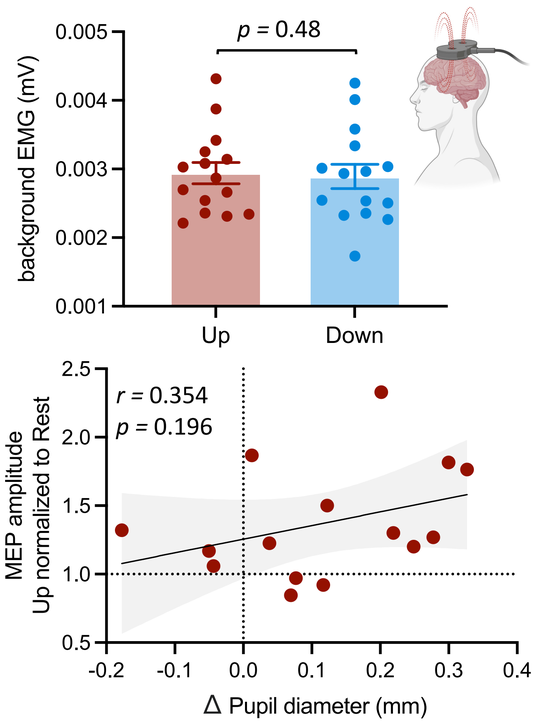
changes in **electrophysiological arousal markers,**

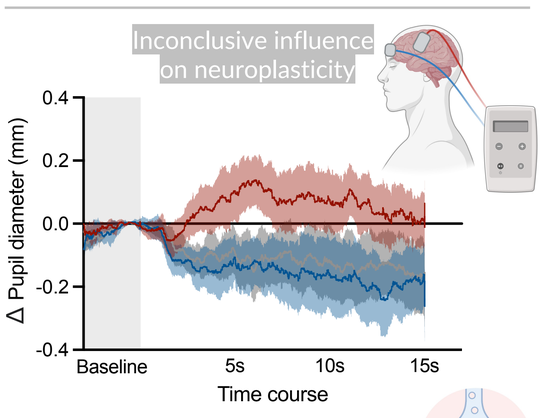


and **cardiovascular arousal markers.**



ADDITIONAL INFORMATION





TMS
- Over M1, FDI hotspot
- 120%RMT

Anodal tDCS
- M1/SO montage
- 1mA; 13min; fade in/out 30s (13)

EEG (pre-)processing
- Automagic pipeline(19)
- PSD calculated with Welch's method
- Estimation of the spectral slope using the FOOOF toolbox(20)

1 Aston-Jones & Cohen, 2005
2 Zerbi et al., 2019
3 Murphy et al., 2014
4 Joshi et al., 2020
5 Meissner et al., 2023
6-8 Plewnia et al., 2001, 2002, 2004
9 Herwig et al. 2002
10 Ilić et al., 2003
11 Korchounov et al., 2003
12 Kuo et al., 2017a
13 Kuo et al., 2017b
14 Korchounov et al., 2011
15 Mayer et al. 2006;
16 Samuels et al., 2008b
17 Wood et al. 2017
18 Kret & Sjak-Shie, 2018
19 Pedroni et al., 2019
20 Donoghue et al., 2020

SCAN ME