Effects of large-scale brain network neurofeedback training on stress in real life

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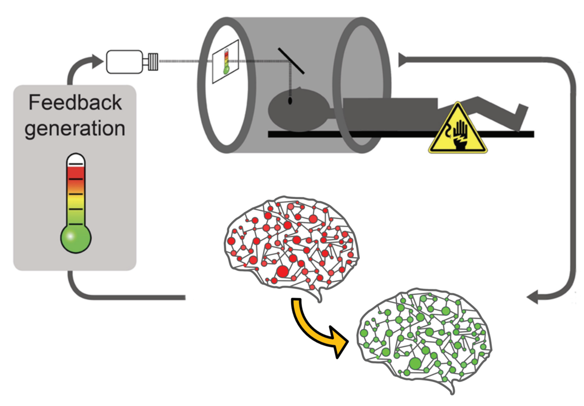
INTRODUCTION

Acute stress affects large-scale brain network balance, shifting resources from the executive control network (ECN) to the salience network (SN)[1,2]. Resilience to stress may be determined by the retained ability to adaptively reallocate those resources to restore balance[3]. We have previously shown that **individuals can learn mental strategies to self-regulate this balance** using real-time fMRI neurofeedback[4]. Here, **we investigated the transferability of those strategies to real life and their effects on every-day stress.**

METHODS

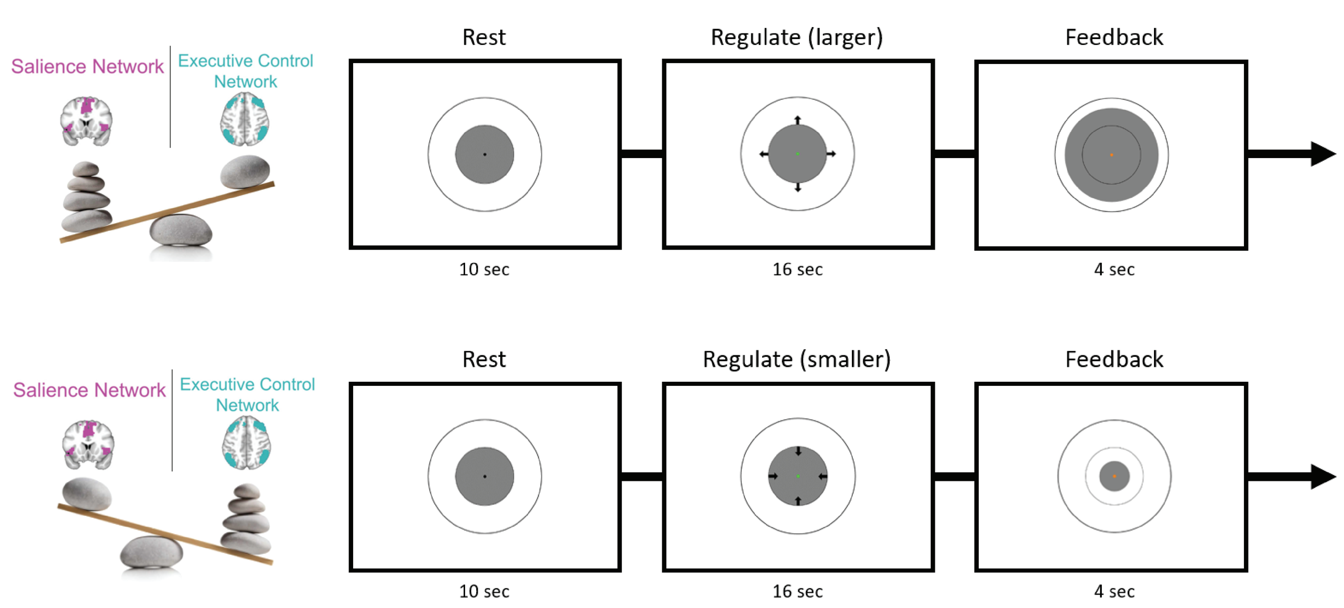
33 healthy participants were engaged in **network neurofeedback** training[4] and followed with **ecological momentary assessments (EMA)**[5].

NETWORK NEUROFEEDBACK



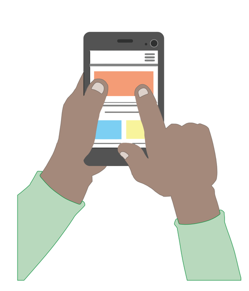
Session 1 - Localiser
A high-resolution anatomical image and a resting-state scan (5 min) were recorded to create individualised SN and ECN network masks using a custom NiPype pipeline: https://github.com/can-lab/IndNet.

Session 2/3/4 - Training
In six to eight runs (10 min each), the difference between the average SN and ECN activation was used as a neurofeedback signal to be presented to the participants in form of a grey disk. Participants were repeatedly asked to try to increase or decrease this disk "with their brain" and received feedback of their performance after each attempt. Participants who did not learn the self-regulation after three sessions (n=12) were offered a fourth session before they were excluded from further testing (n=7).



Session 5/6 - Transfer
In two final sessions - several days (Transfer 1) and several weeks (Transfer 2) after the training - participants' learning success was evaluated by engaging them in the same regulation task as during the training, but providing them with any feedback on their performance.

ECOLOGICAL MOMENTARY ASSESSMENTS



For three weeks, participants answered eight short surveys each day on their smartphones, with questions capturing event-/activity related as well as (virtual) social stress.

Week 1 - Baseline: Before neurofeedback training; baseline measure.

Week 2 - Control: After first transfer session; control for timing effects.

Week 3 - Regulation: After week 2; application of strategies (to ECN).

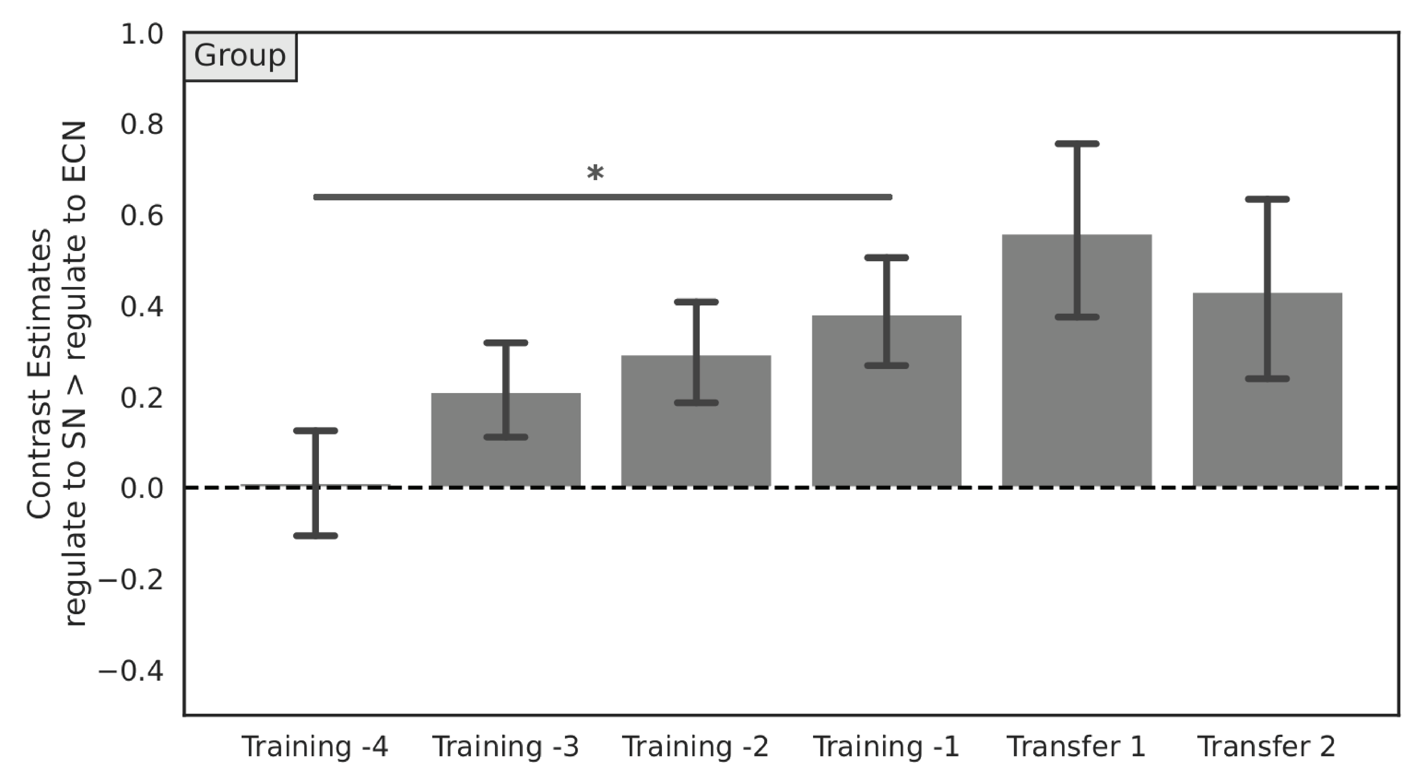
ANALYSIS

Neurofeedback
For each training/transfer session, the difference time courses between SN and ECN of all runs were high-pass filtered, normalized, and entered into a GLM, modelling the experimental conditions, head motion, and cardiac/respiratory noise. **Self-regulation performance** was tested with a contrast estimating the difference between the two regulation directions.

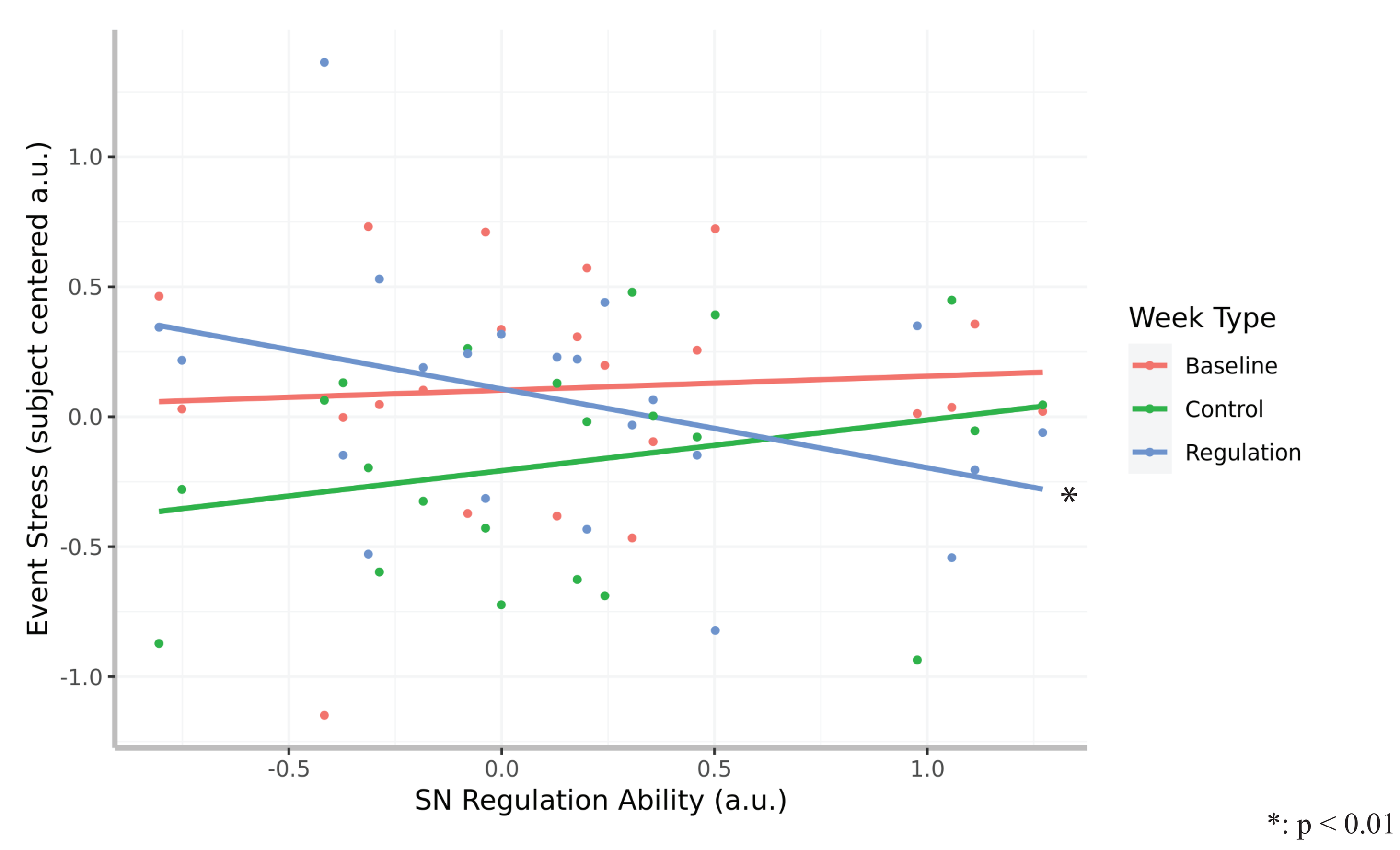
EMA
Data of participants with compliance>50% (n=22) were entered into linear mixed models to asses **differences in stress between the three weeks**. To test whether a potential effect depends on a specific way of regulating network balance (i.e. by changing SN, ECN or both), the models also included the regulation effects in the last transfer session for each network idnividually, as well as age, sex, and substance usage as further covariates.

RESULTS

Self-regulation performance in lab



Application of learned self-regulation strategies in real life



*: p < 0.01

CONCLUSIONS

(1) Self-regulation of stress-related large-scale brain networks is feasible (replication in independent/larger sample)

(2) Learned self-regulation strategies are transferable and lasting skills

(3) Application of learned strategies in real life can affect every-day event-related stress

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