

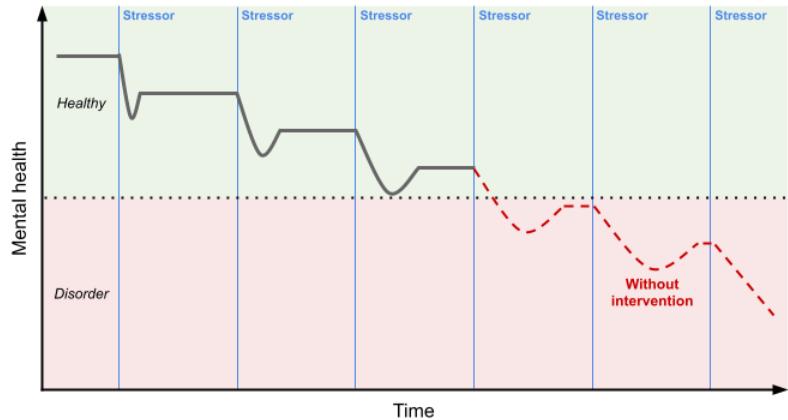
Building Resilience to Real-Life Stressors through Ecological Momentary Neuromodulation of Large-Scale Brain Networks

Florian Krause

Background

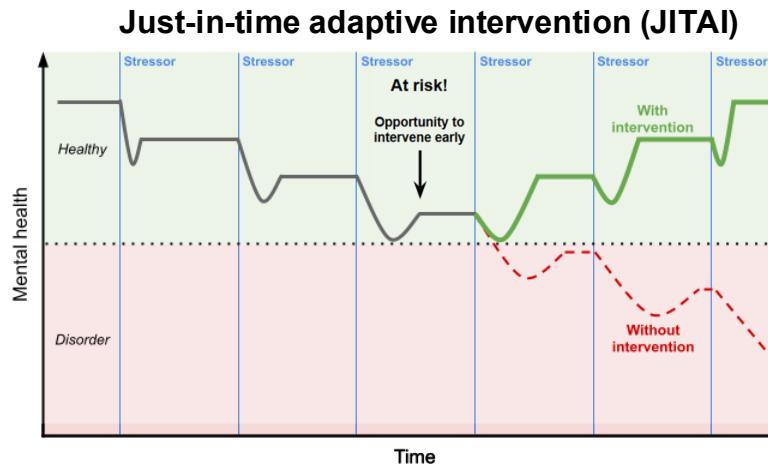
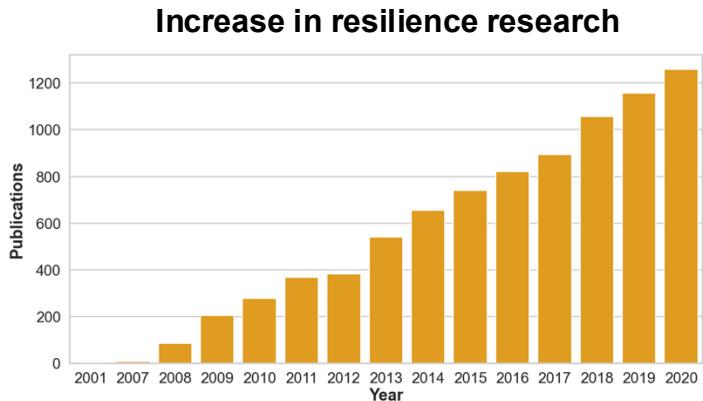
Stress-related mental health issues

- **Mental health issues are major global threat**
 - high prevalence
 - high disease burden
- Treatment → Prevention & health maintenance
- Critical transdiagnostic factor for mental illness: **prolonged/repeated exposure to stressors**



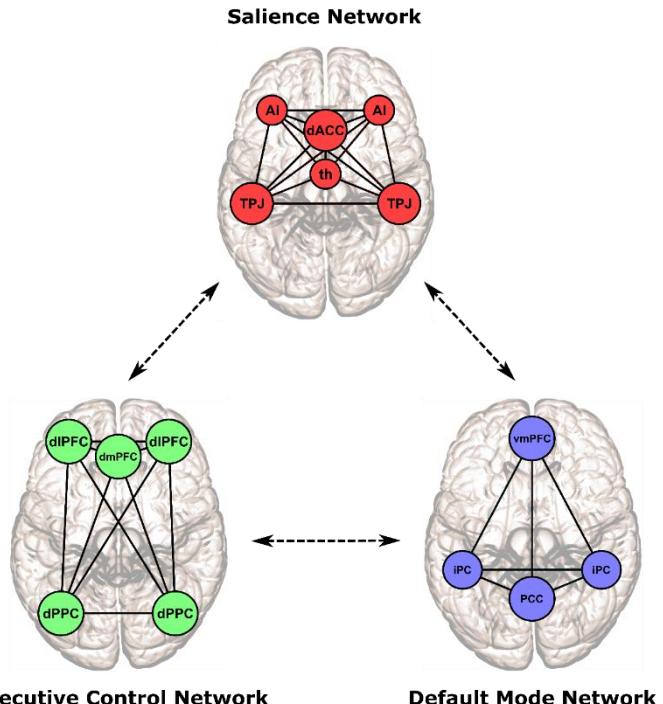
Background

Resilience

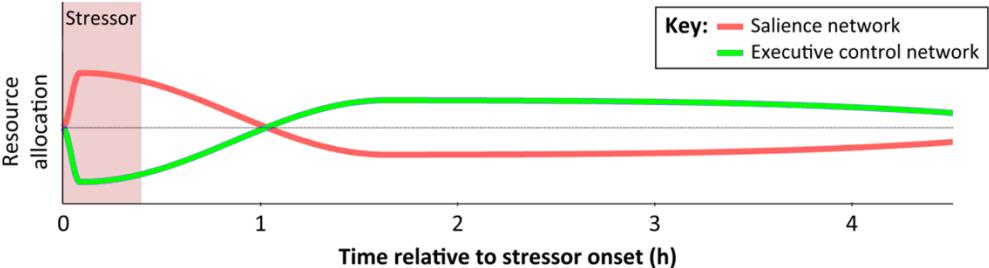


Background

Brain network disorders



Brain systems level

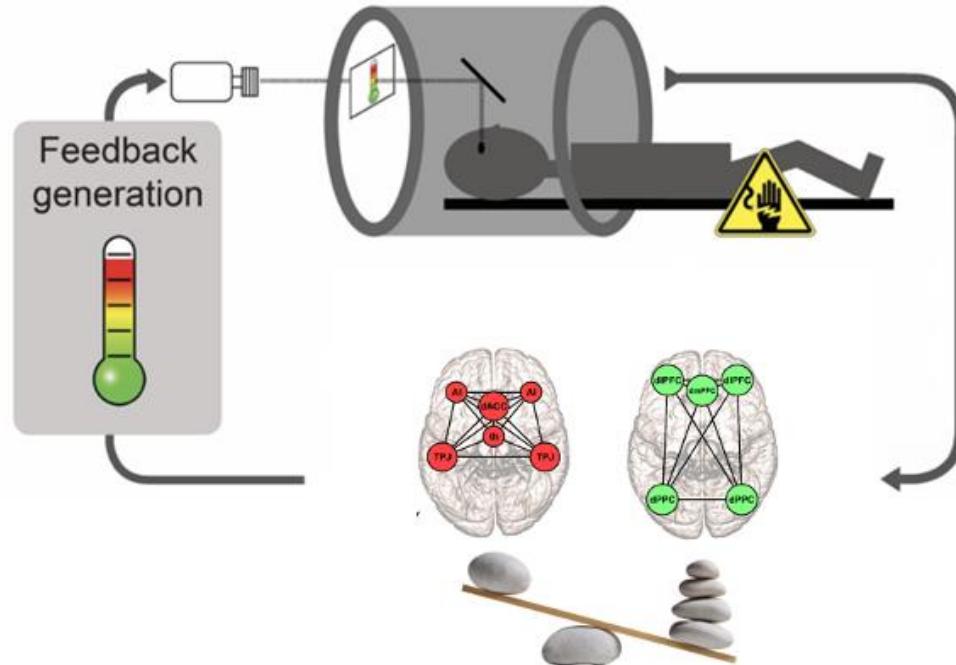


Hermans et al., 2014; 2011



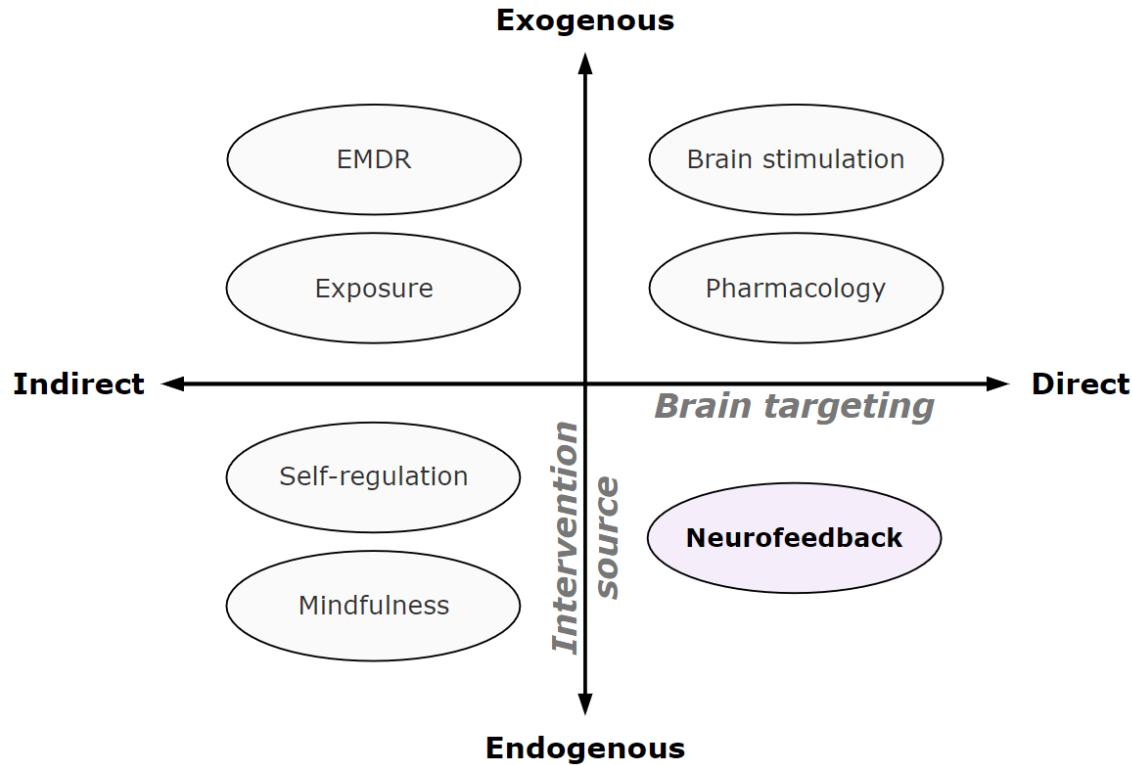
Neurofeedback

Real-time fMRI neurofeedback



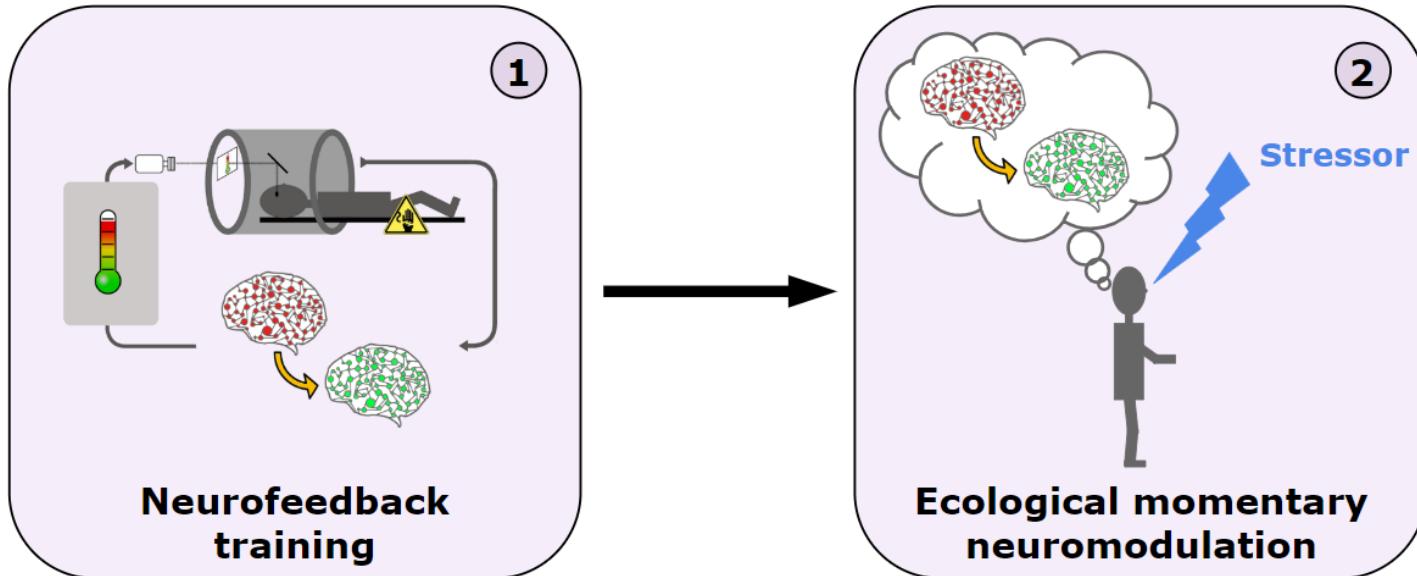
Neurofeedback

Endogenous neuromodulation



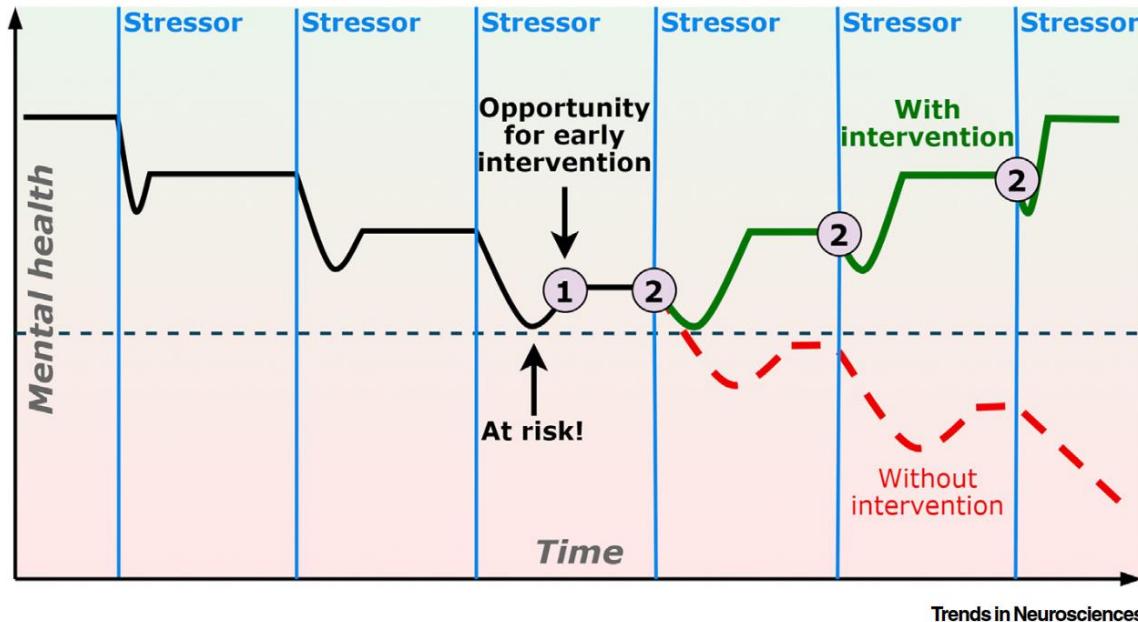
Neurofeedback

Transferable skill → Application in daily life



Neurofeedback

Neuroscience-based intervention strategy





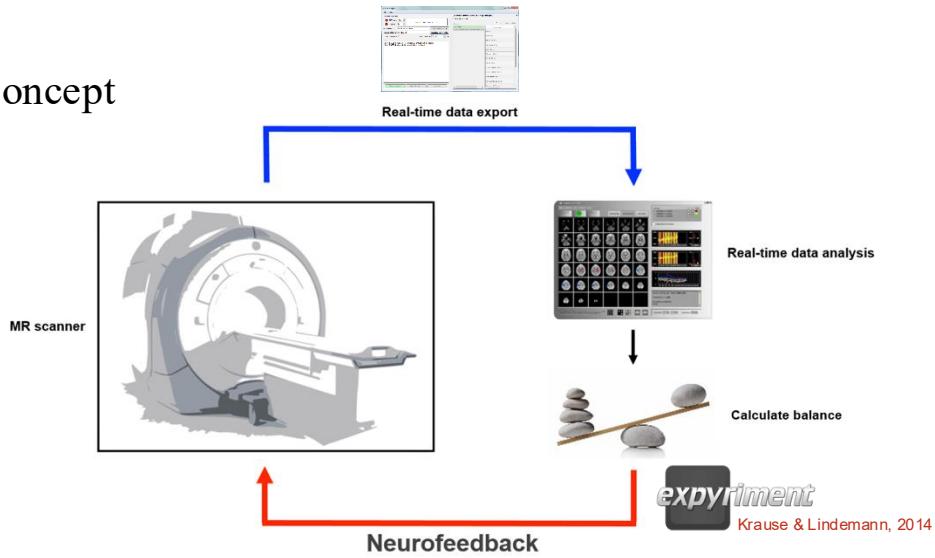
Study 1 – Proof-of-concept

Research questions

- **Can individuals learn to self-regulate large-scale network balance?**
- **Can they apply learned strategies in the absence of feedback?**
- **Can they apply learned strategies under acute stress?**

Study 1 – Proof-of-concept

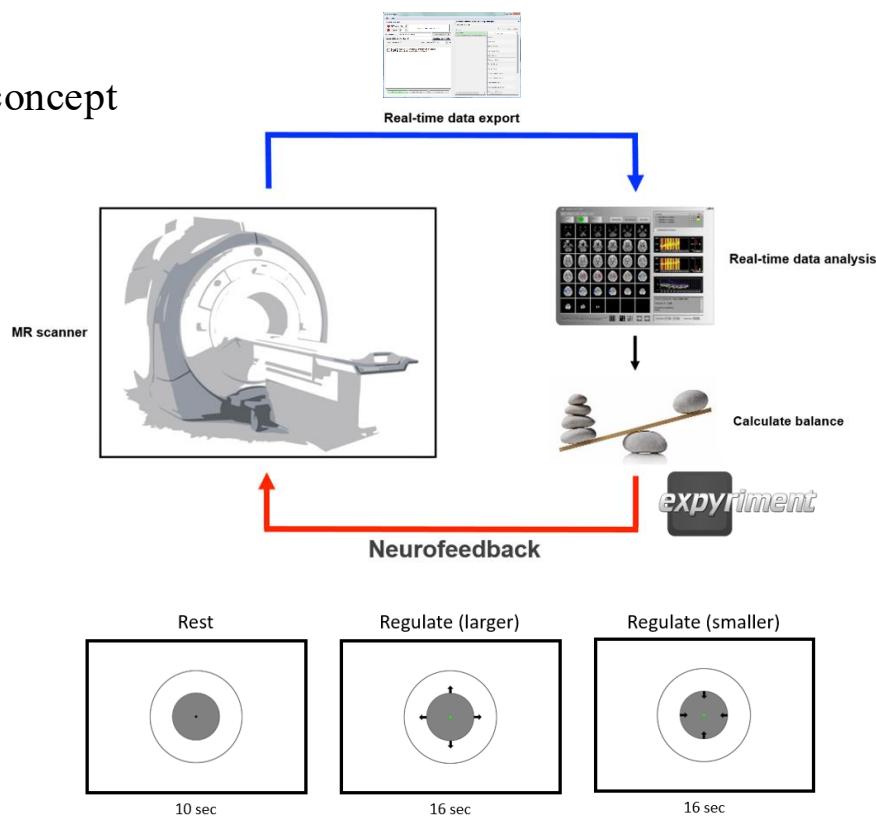
Training



"Try to either increase or decrease the size of the disc on the screen with your brain, depending on the orientation of the surrounding arrows in each trial. You can achieve this by thinking of something specific, performing some mental task internally, or getting into a certain mood, emotion, feeling, or state of mind."

Study 1 – Proof-of-concept

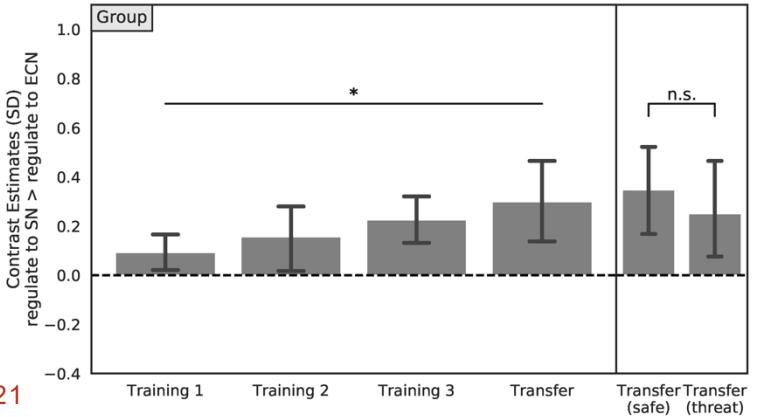
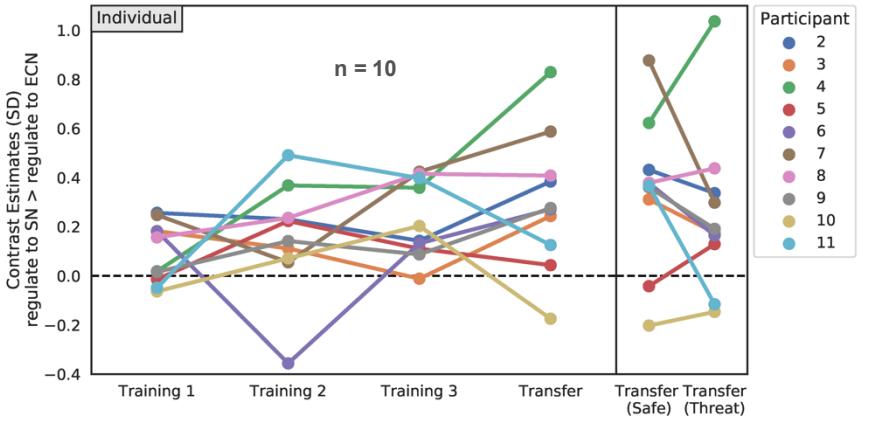
Transfer



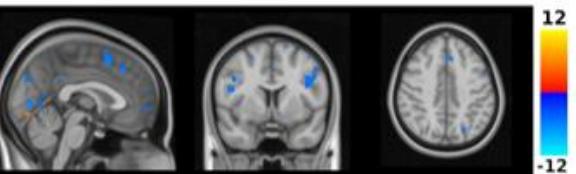
Study 1 – Proof-of-concept

Results

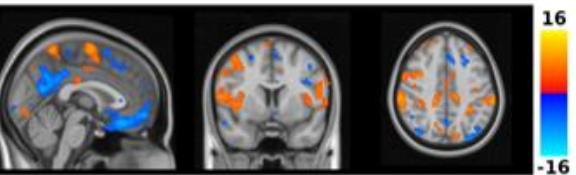
Self-regulation performance



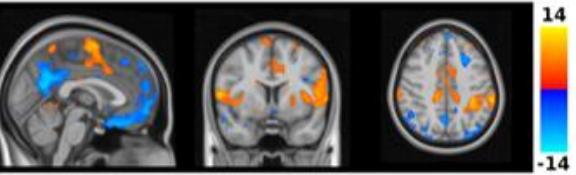
Training 1



Training 2



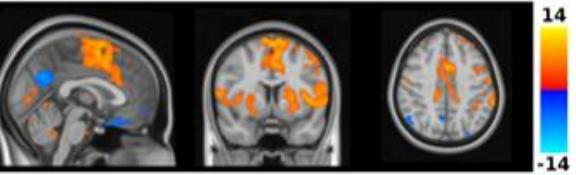
Training 3



Transfer



Improvement





Study 1 – Proof-of-concept

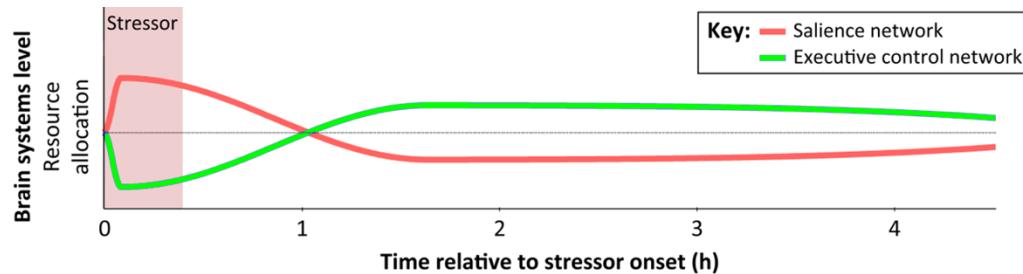
Successful proof-of-concept!

- **Using real-time fMRI neurofeedback to train self-regulation of large-scale network balance is generally feasible**
- Learned regulation strategies are applicable in (1) the absence of feedback and (2) under acute stress, suggesting that they may be used to train control over the central response to stressors
- Tested individuals in particular learned to downregulate SN, which is the clinically relevant direction

Study 2 – Applicability in daily life

Just-in-time intervention in daily life

- Time-dependent changes in response to acute stressors



Hermans et al., 2014; 2011

- Stressors occur in real-life, not in the lab or treatment facility





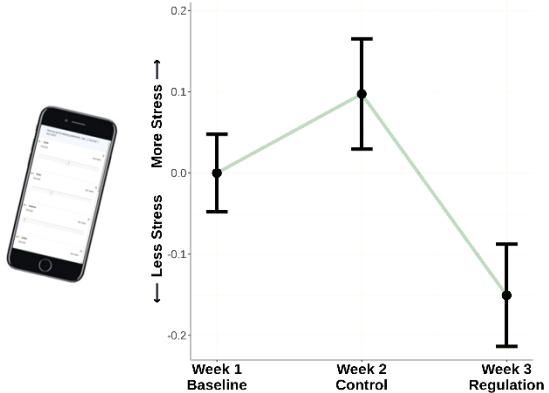
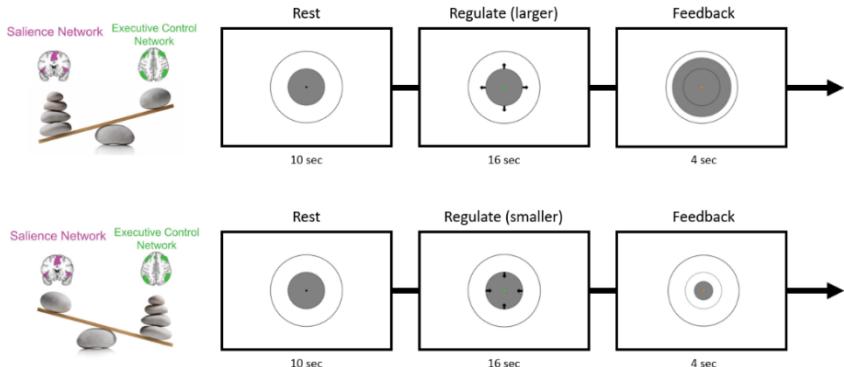
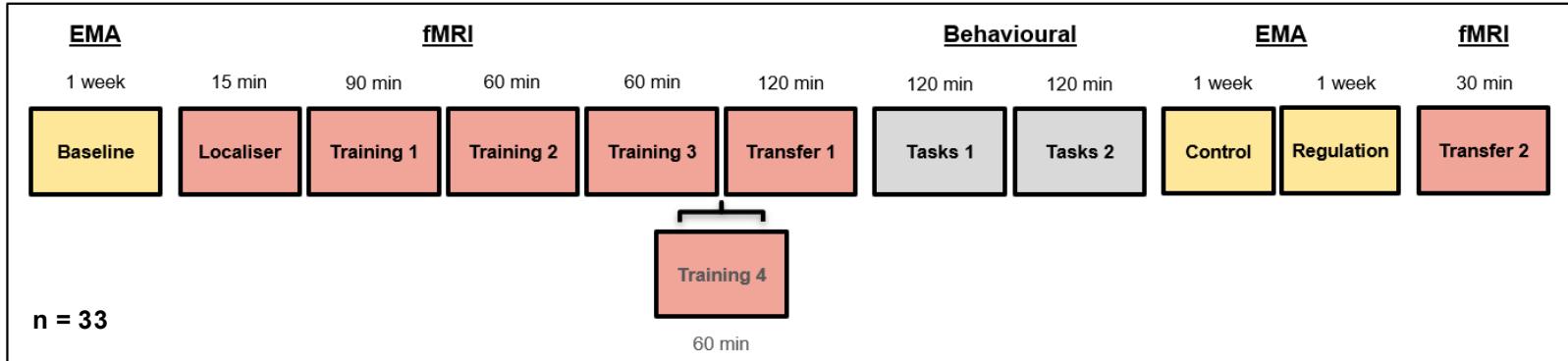
Study 2 – Applicability in daily life

Research questions

- **Are strategies learned from NF training a learned skill that lasts?**
- **Can individuals apply these strategies in daily life?**
- **Does their application in daily life affect real-life stress measures?**

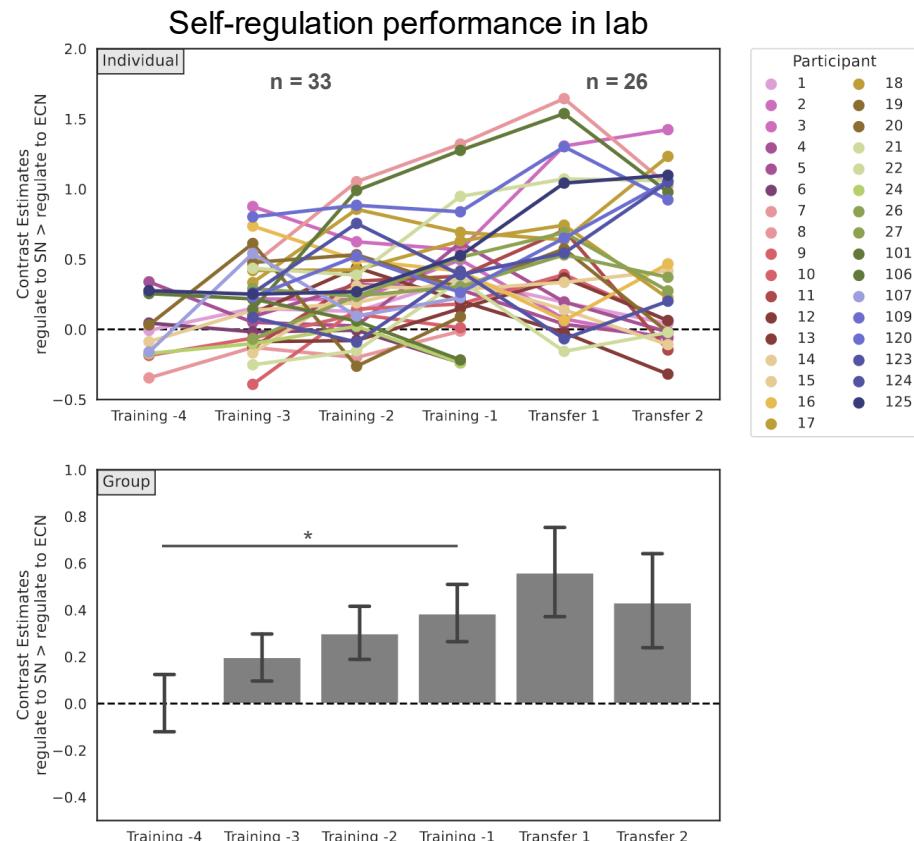
Study 2 – Applicability in daily life

Design

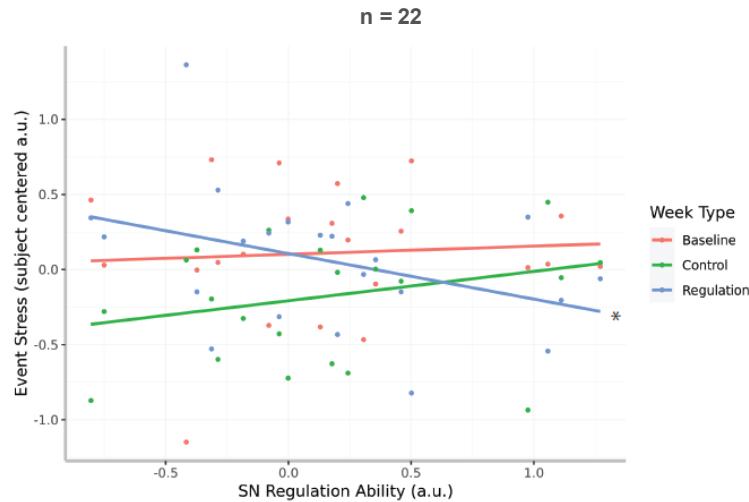


Study 2 – Applicability in daily life

Results



Application of learned strategies in real life





Conclusion

- Replication of previous results in independent and larger sample
- **Learned self-regulation strategies seem to be a transferable and lasting skill**
- **Application of that skill in daily life affects real-life stress reports** (with effect being modulated by SN regulation ability)



Academische Alliantie Fonds 2021

Getting Trauma Under Control: Learning to Self-Regulate PTSD Brain Networks Through Prospective Neurofeedback Training

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Begeleidingsteam:

Erno Hermans (RadboudUMC, Cognitive Neuroscience)

Bart Rutten (Maastricht UMC+, Psychiatry)

David Linden (Maastricht University, FHML)

Koen Schruers (Maastricht University, FHML)



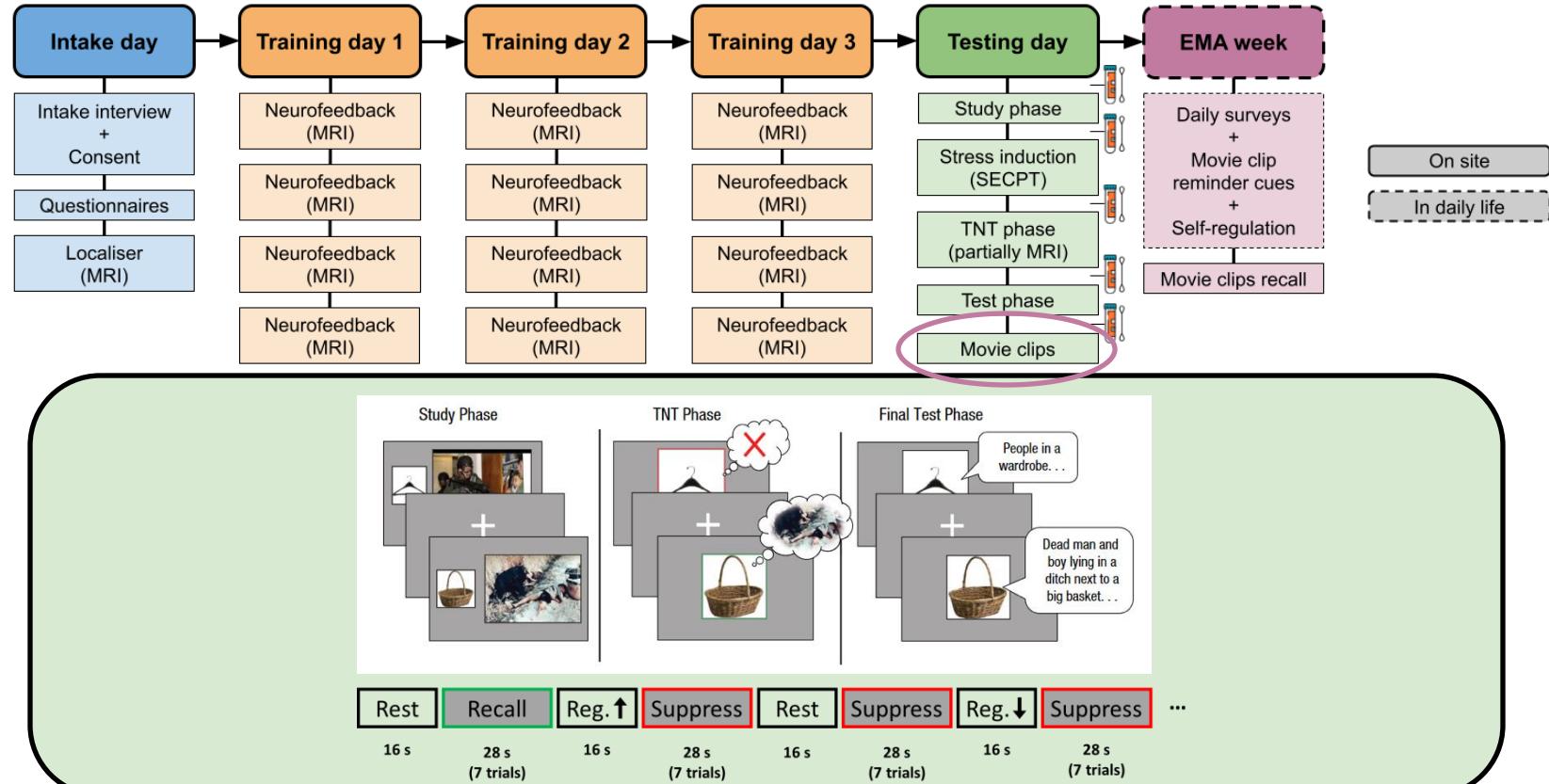
Study 3 – Application to PTSD symptomatology

Research questions

- Can we use this NF paradigm to train self-regulation strategies for active suppression of (unwanted) memories
- Does their application in response to (induced) intrusions in daily life modulate stress reactivity

Study 3 – Application to PTSD symptomatology

Overview of experimental sessions



Side-application: Mindfulness training

MindRest



Kogias et al. BMC Psychology (2023) 11:194
<https://doi.org/10.1186/s40359-023-01220-4>

BMC Psychology

STUDY PROTOCOL

Open Access

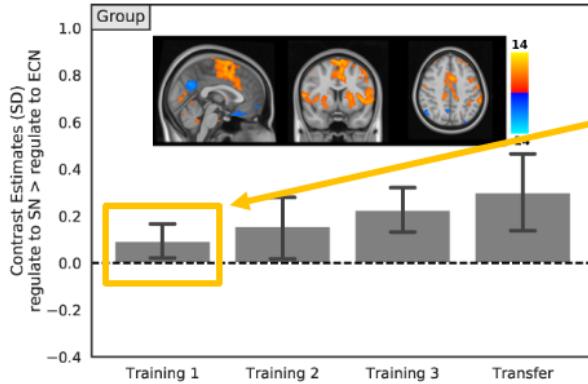


Study protocol for a randomised controlled trial investigating the effects of Mindfulness Based Stress Reduction on stress regulation and associated neurocognitive mechanisms in stressed university students: the MindRest study

Nikos Kogias^{1*}, Dirk E. M. Geurts^{1,2}, Florian Krause¹, Anne E. M. Speckens^{1,2} and Erno J. Hermans¹



SN-ECN Balance Self-Regulation Performance

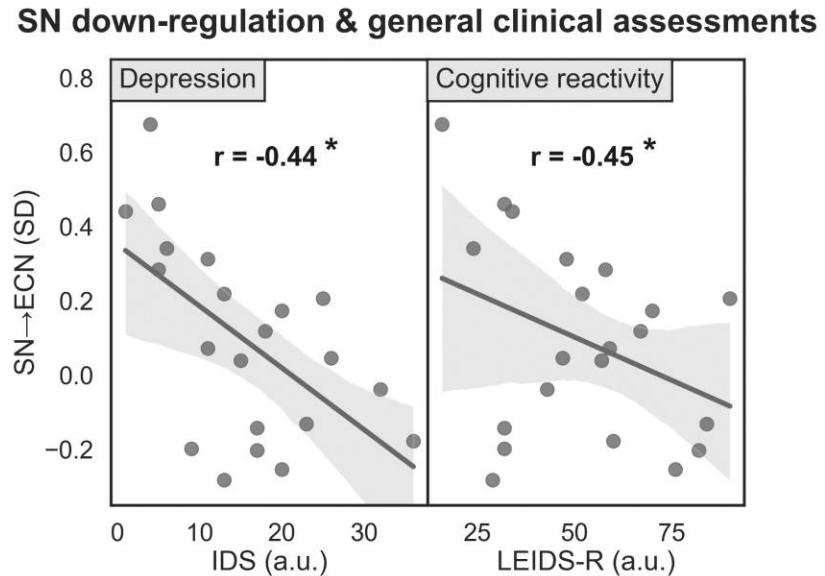
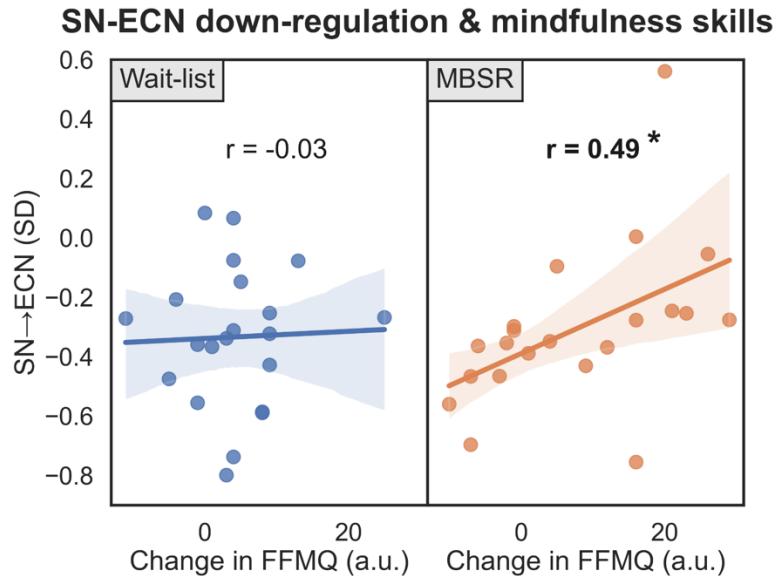


Current study

- No training, but read-out
- Single session with 3 runs

Side-application: Mindfulness training

Individual differences in self-regulation ability

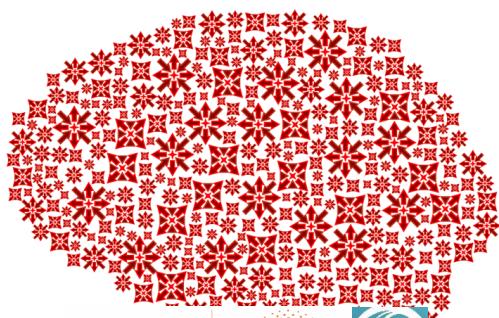


→ MBSR might specifically improve the ability to explicitly/endogenously down-regulate SN

Take-home message

Neurofeedback is a promising candidate for a personalized preventive neuroscience-based intervention strategy that focuses on the ecological momentary neuromodulation of stress-related brain networks in response to actual stressors in daily life.

Thank you!



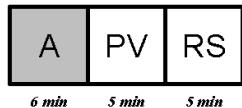
Collaborators

Nikos Kogias
Maud Schepers
Rengin Yoldas
Rayyan Tutunji
Martin Krentz
Eliana Vassena
Michael Lührs
Rainer Goebel
David Linden
Erno Hermans

Study 1 – Proof-of-concept

Study overview

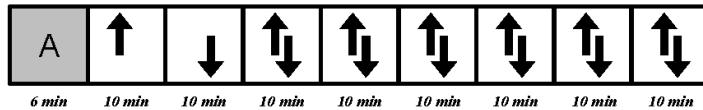
Session 1
(Localiser)



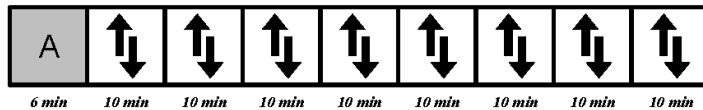
n = 10

A: Anatomy
PV: Passive Viewing
RS: Resting State

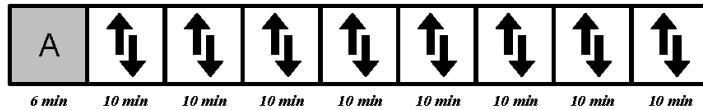
Session 2
(Training 1)



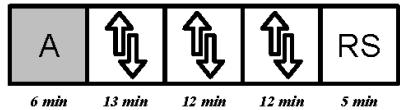
Session 3
(Training 2)



Session 4
(Training 3)



Session 5
(Transfer)

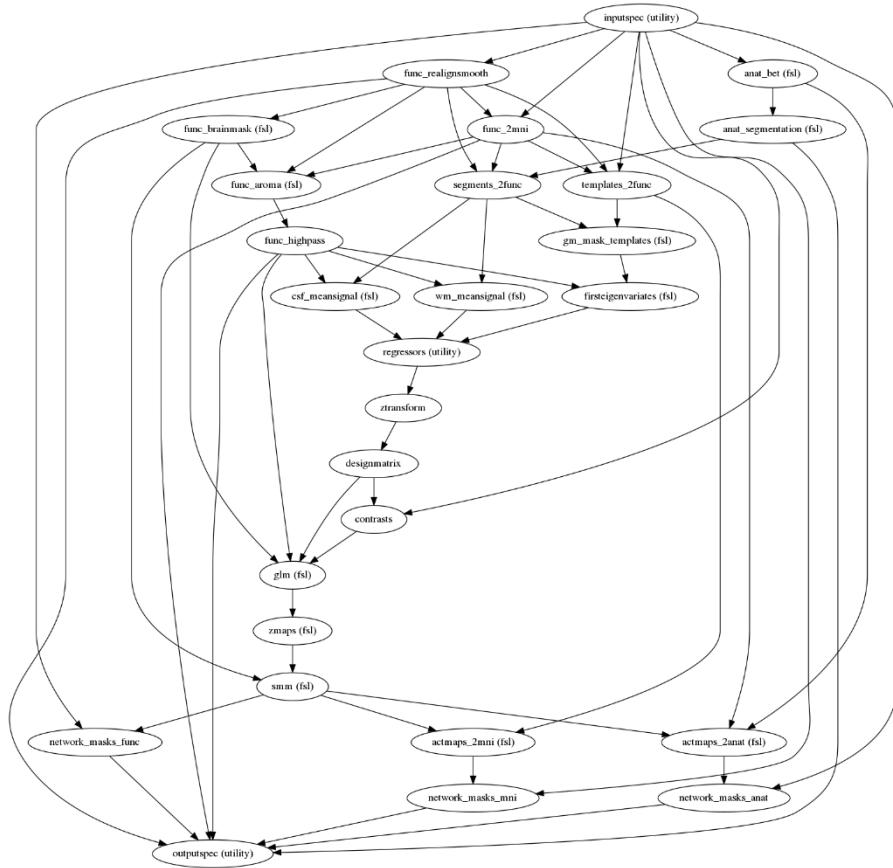


Physiology

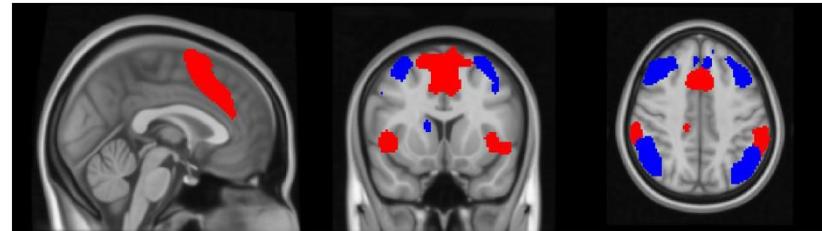
- Pulse
- Respiration
- Pupil size
- Skin conductance

Study 1 – Proof-of-concept

Localiser



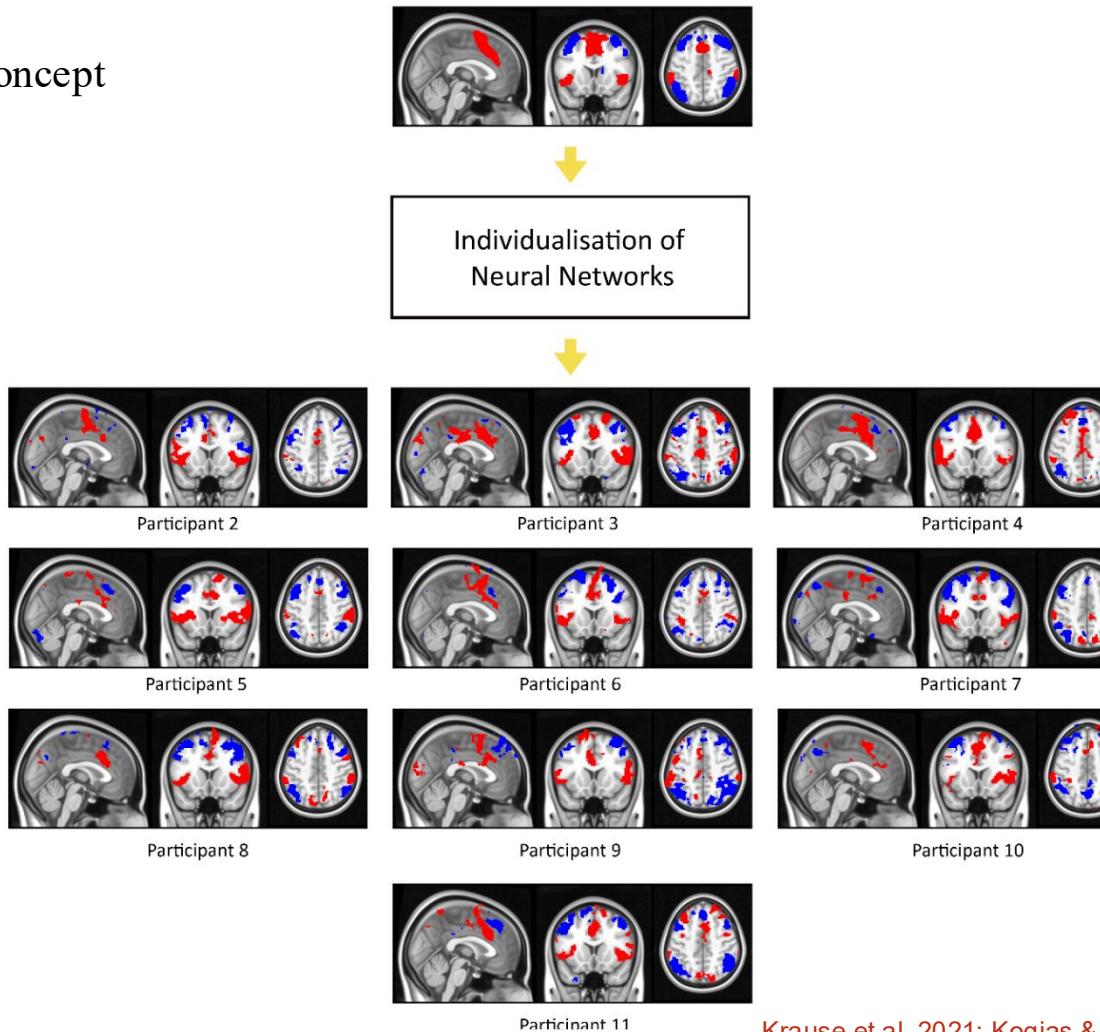
IndNet (Krause & Kogias)
<https://github.com/can-lab/IndNet>



Shierer et al. 2012

Study 1 – Proof-of-concept

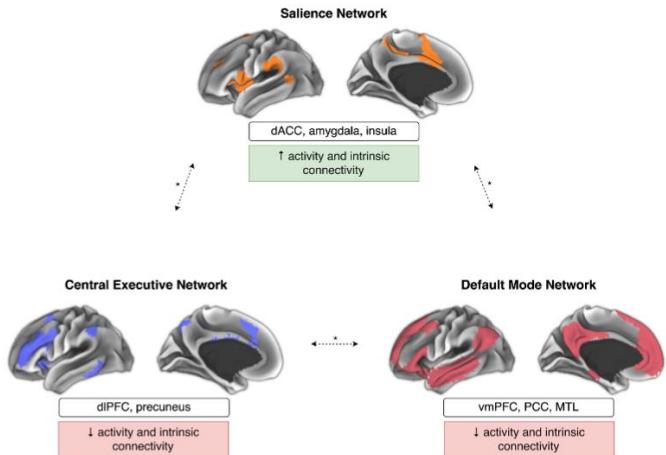
Localiser



Research question

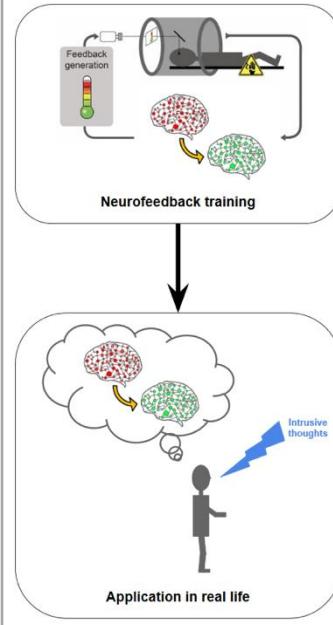
PTSD and large-scale brain networks

PTSD network changes



Akiki et al., 2017; Szeszko & Yehuda, 2019

SN-ECN balance neurofeedback



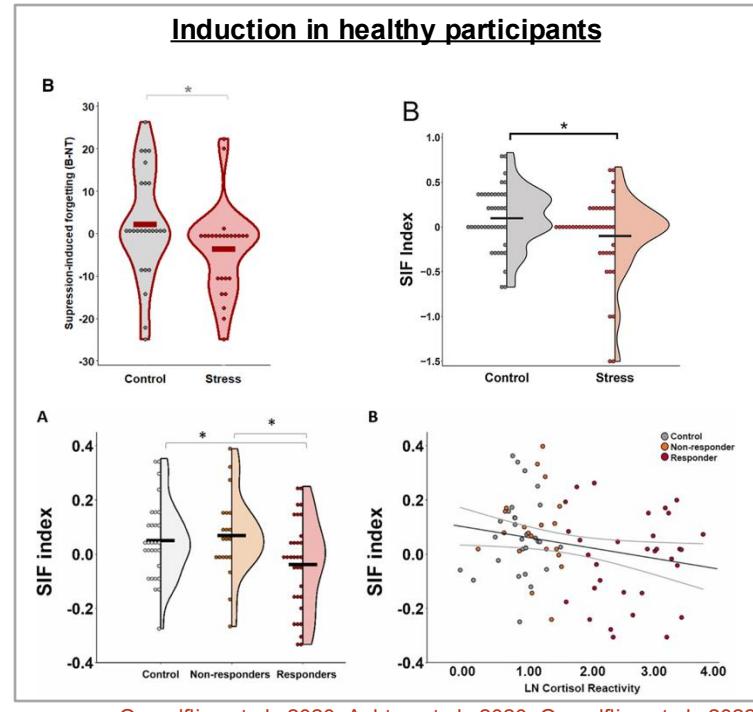
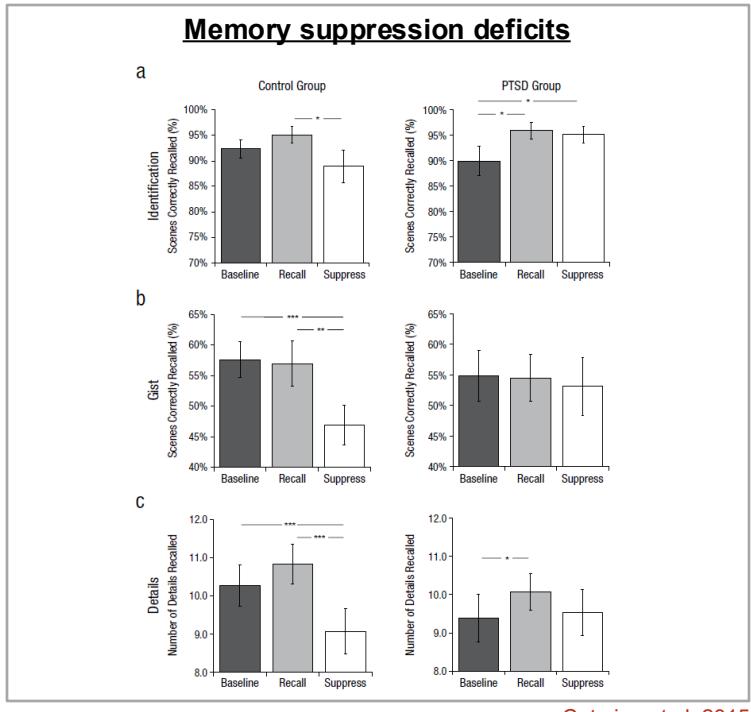
Can we *restore active suppression of memories*?

Can we equip patients with the means to optimally control *forthcoming intrusive thoughts*?

Krause et al., 2021

Theoretical background

PTSD and intrusions of unwanted memories and thoughts



Side-application: Mindfulness training

MindRest



Kogias et al. BMC Psychology (2023) 11:194
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BMC Psychology

STUDY PROTOCOL

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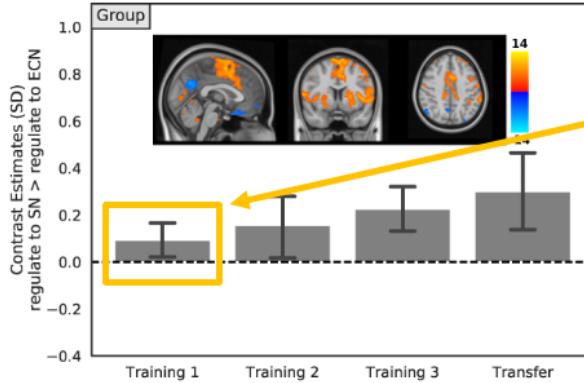


Study protocol for a randomised controlled trial investigating the effects of Mindfulness Based Stress Reduction on stress regulation and associated neurocognitive mechanisms in stressed university students: the MindRest study

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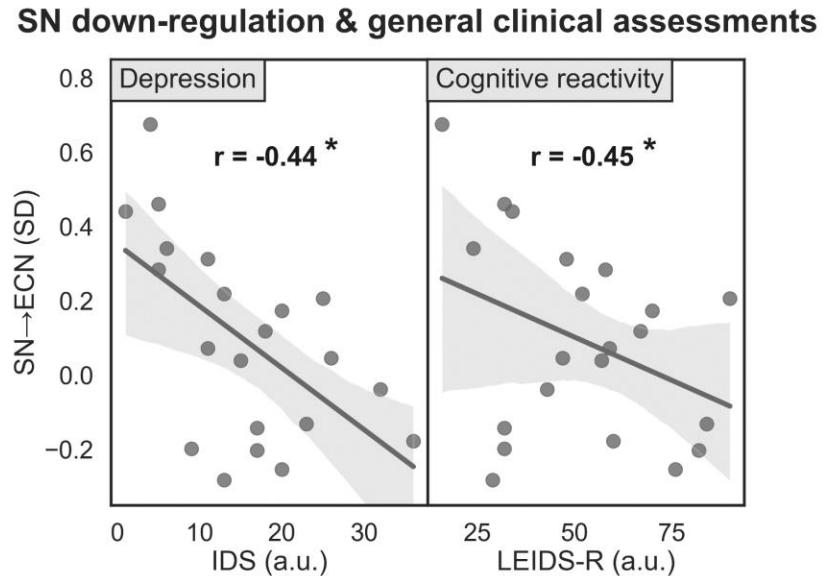
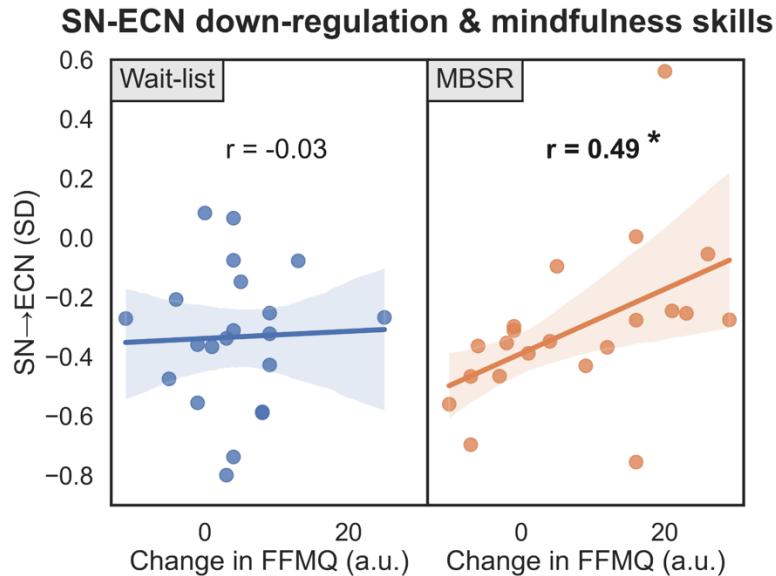


Current study

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- Single session with 3 runs

Side-application: Mindfulness training

Individual differences in self-regulation ability



→ MBSR might specifically improve the ability to explicitly/endogenously down-regulate SN

Method

Randomized Controlled Trial



Clinical assessments

- Mindfulness skills (FFMQ)
- Psychological inflexibility (AAQ)
- Stress resilience (CD-RISC)
- Depression (IDS-SR)
- Cognitive reactivity (LEIDS-R)
- ...

Neurocognitive assessments

- Self-regulation of brain networks
- ...

