Unexpected CBF response to anxiety reinforcing transcranial direct current stimulation

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Background: anxiety vs. fear

Grillon et al. (2004), *Behav Neurosci*
Sustained anxiety is a key symptom of anxiety disorders.

Anxiety magnitude is negatively correlated to the activation in the right inferior parietal lobe (rIPL).

— Particularly under the threat of an unpredictable shock, but not under neutral or predictable shock conditions (Hasler et al. 2007, J Neurosci).
Background: **Aim of study**

- Causal role of right inferior parietal lobe on anxiety
Background: region of interest – rIPL

> Lower CBF in anxiety (Kimblell et al. 1999, Biol Psychiatr)

> Resilience factor of stress in unpredictable threat situations
  (Hasler et al. 2007, J Neurosci)

> Decision making in ambiguous situations (Huettel et al. 2006, Neuron)

> Spatial attention and distractibility (Small et al. 2003, NeuroImage)
Methods: tDCS setup
Background: tDCS

- Cathodal tDCS $\rightarrow$ decrease of cortical excitability

Nitsche et al. (2003), *Clin Neurophysiol*
Methods: anxiety-inducing task

> Threat-of-shock-paradigm

Schmitz & Grillon (2012), Nat Protoc
Methods: Experimental procedure

- tdCS active/sham
- MPRAGE/PCASL
- Threat-of-shock-paradigm
  - U: Unpredictable condition
  - P: Predictable condition
  - N: No shock condition


Grieder et al. (in prep.)
Hypotheses

> tDCS reduces cerebral blood flow in the rIPL (Zheng et al. 2011, *NeuroImage*).

> tDCS increases anxiety levels relative to sham tDCS, in the unpredictable threat condition (Hasler et al. 2007, *J Neurosci*; Nitsche et al. 2003, *Clin Neurophysiol*).

> Possible effect of tDCS on the CBF time course in neuronal networks that are either hyperactive or hypoactive in anxiety disorders (Jensen et al. 2003, *Neuron*; Etkin & Wager 2007, *Am J Psychiatr*).
Results: Anxiety

- anxiety levels: U > P > N ($F = 207.15, p < 0.001, \text{partial } \eta^2 = 0.91$)
- tDCS augmented anxiety only in U ($F = 27.6, p < 0.001, \text{partial } \eta^2 = 0.57$)

Grieder et al. (in prep.)
Results: **Cerebral Blood Flow**

Anxiety hyperactivation network

Anxiety hypoactivation network

right IPL (cathode region)

Grieder et al. (in prep.)
> Right inferior parietal lobe cathodal tDCS reinforces anxiety response to unpredictable threat situations, but does not alter cerebral blood flow in the same region.

> CBF-finding might have been influenced by anodal DLPFC stimulation
Discussion

Reinforced anxiety due to a dysbalanced activation in neuronal networks related to sustained anxiety.

CBF-increase in hypoactivation network might reflect relief after concluding shock-paradigm (caudate & putamen as reward system, Jensen et al. 2003, Neuron)
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