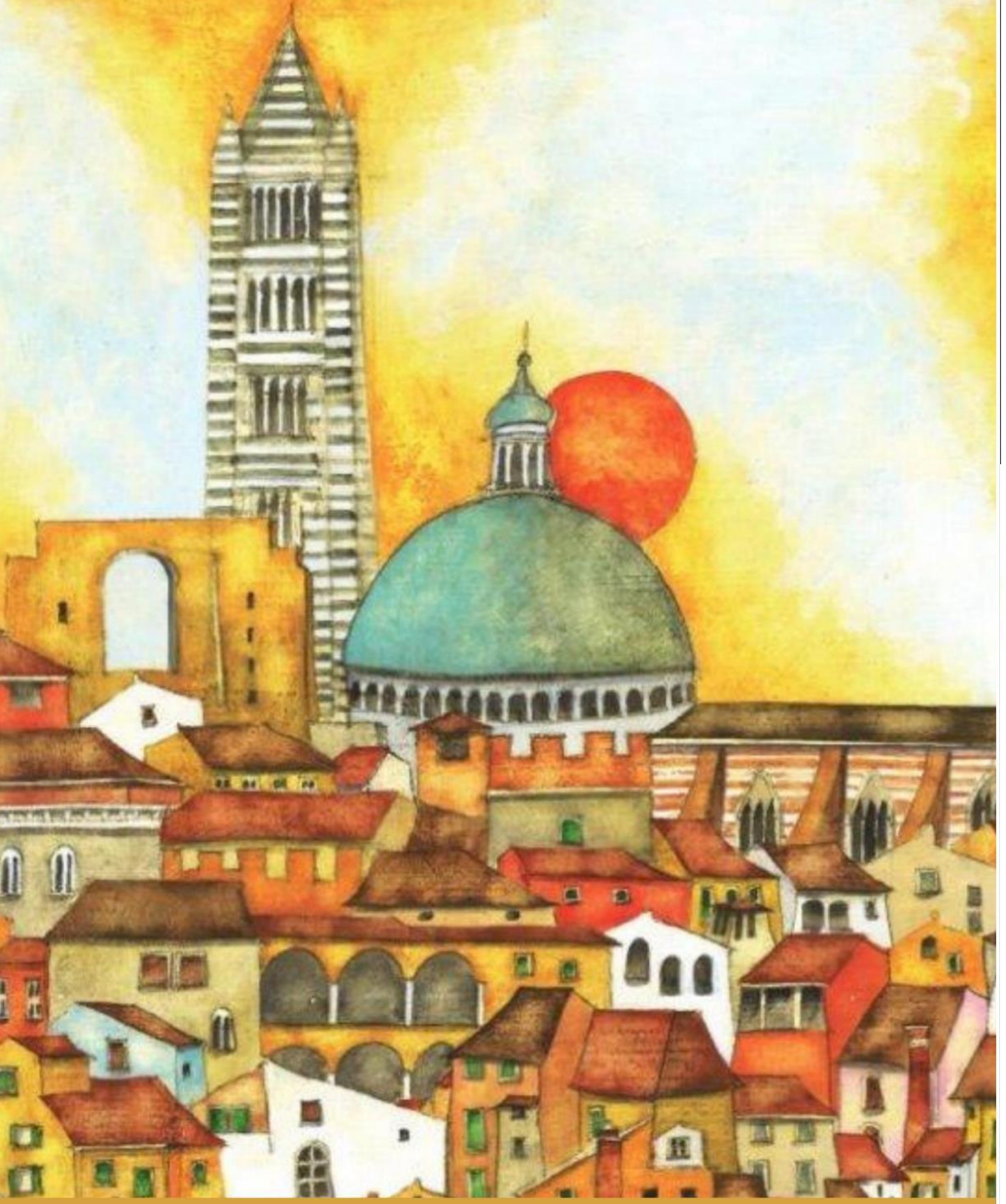


XXXI CONGRESSO NAZIONALE SIPF

Siena 9-11 novembre 2023

Museo Santa Maria della Scala

SIPF

Società Italiana di Psicofisiologia e Neuroscienze Cognitive

Past, Present and Future Brains

11.30 – 12.30 SIMPOSIO XV

FUTURE NIBS: HINTS ON STIMULATION PROTOCOLS REFINEMENT

Chairs: Leonor J. Romero Lauro (Milano) and Giulia Mattavelli (Pavia)

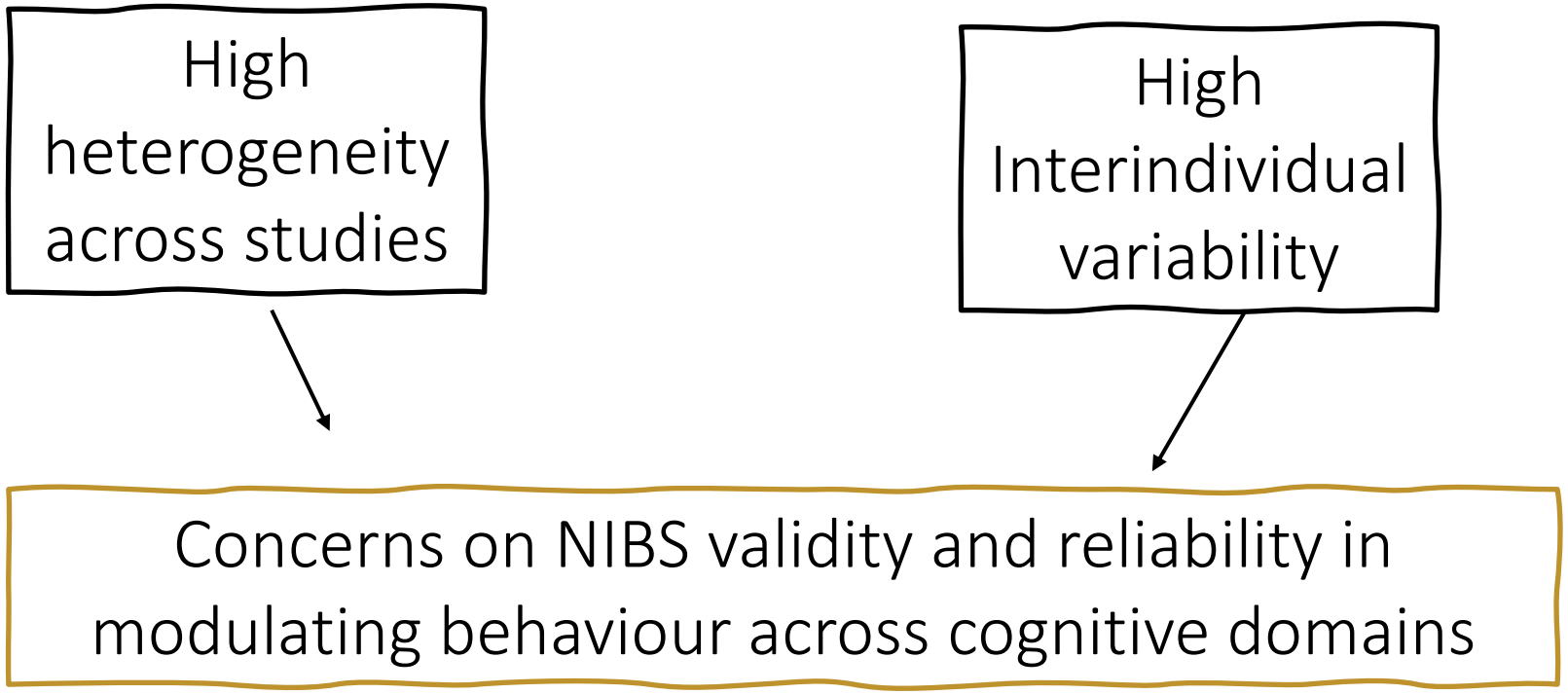
Testing the effect of high-definition transcranial direct current stimulation of non- superficial cortical targets to modulate decision-making and executive control
Giulia Mattavelli (Pavia)

Optimizing tDCS protocols by looking for the most effective timing of stimulation with respect to task execution
Sarah Feroldi (Milano)

New perspectives in neuromodulation: personalization of TMS-based protocols and biomarkers
Elias Casula (Roma)

PREMISE

Extensive use of NIBS does not a correspond to an in-depth understanding of their underlying neurophysiological mechanisms



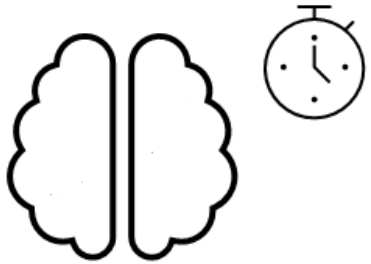
PREMISE

➢Relevance of research on **protocols refinement**

Question to answer:

Where stimulating

When stimulating



How Stimulating

IUSS
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Testing the effect of high-definition transcranial direct current stimulation of non-superficial cortical targets to modulate decision-making and executive control.

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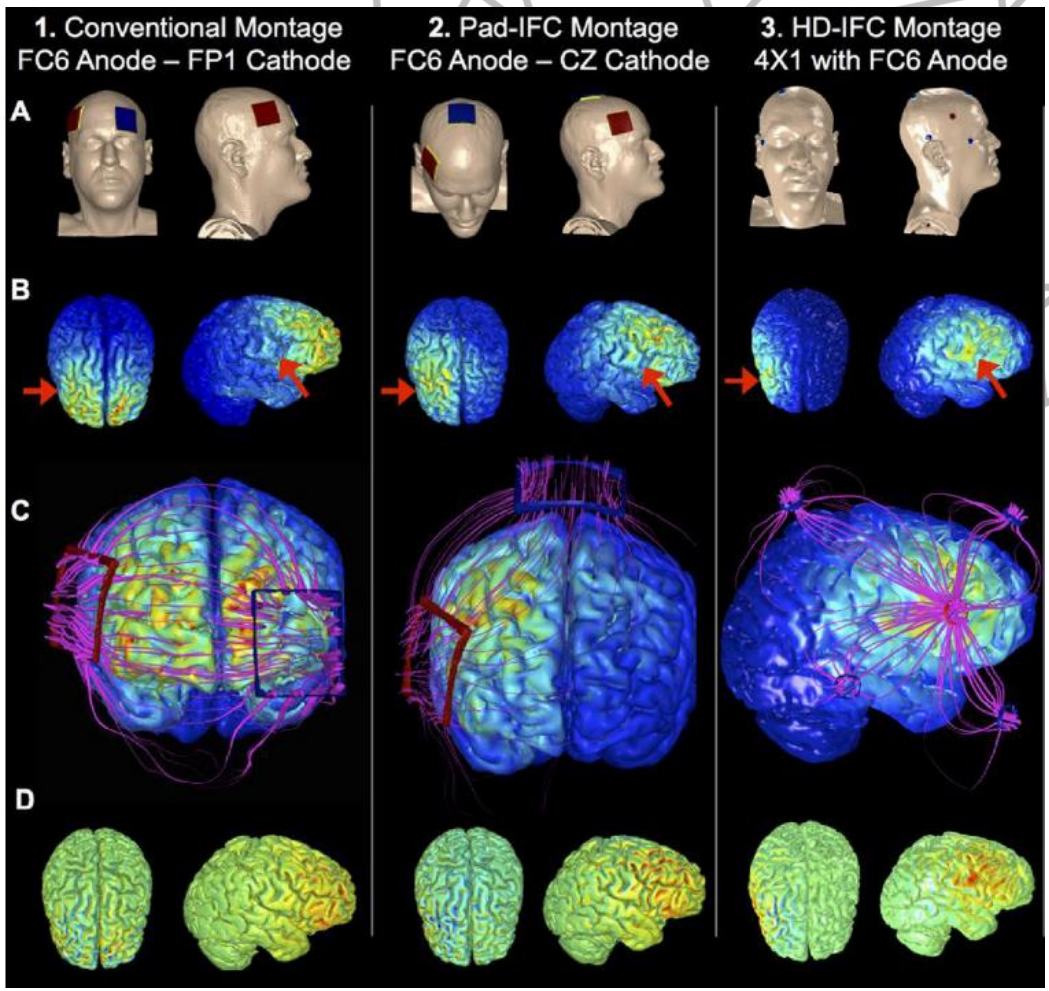
Background: electrode montages

From bipolar montage with active electrode over the target site

↓

To computational models of current flow in the brain

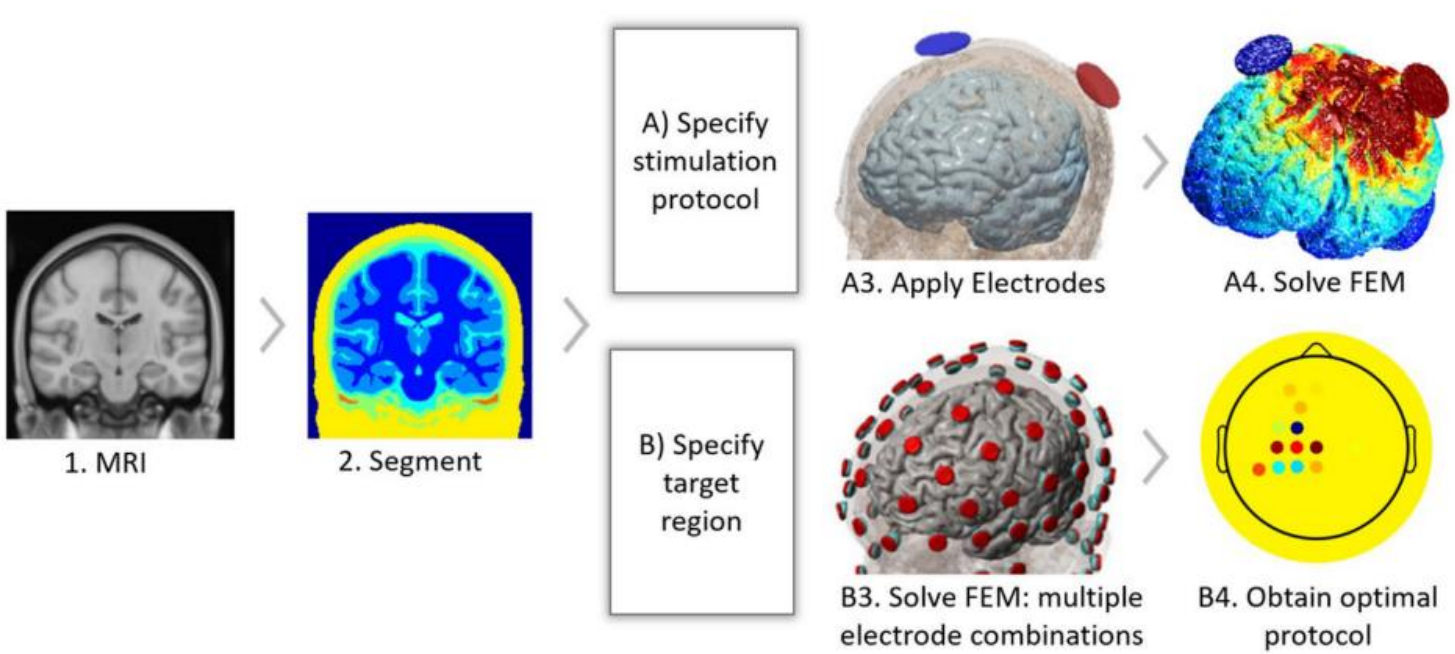
- Modulation of cortical activity in a relatively larger area than that covered by the target electrode
- Current spreads between the electrodes
- Individual variability



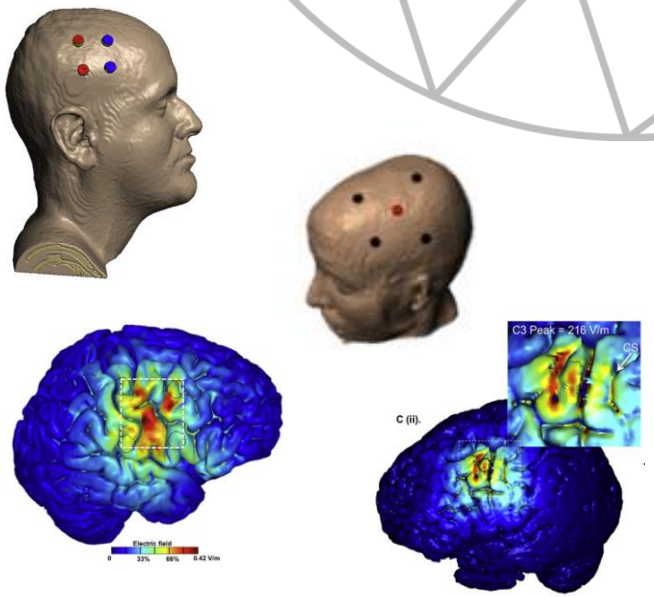
Hogeveen et al., 2016

Background: HD-tDCS

Protocol optimization based on intensity–focality trade-off



Lee et al., 2021



Edwards et al., 2013

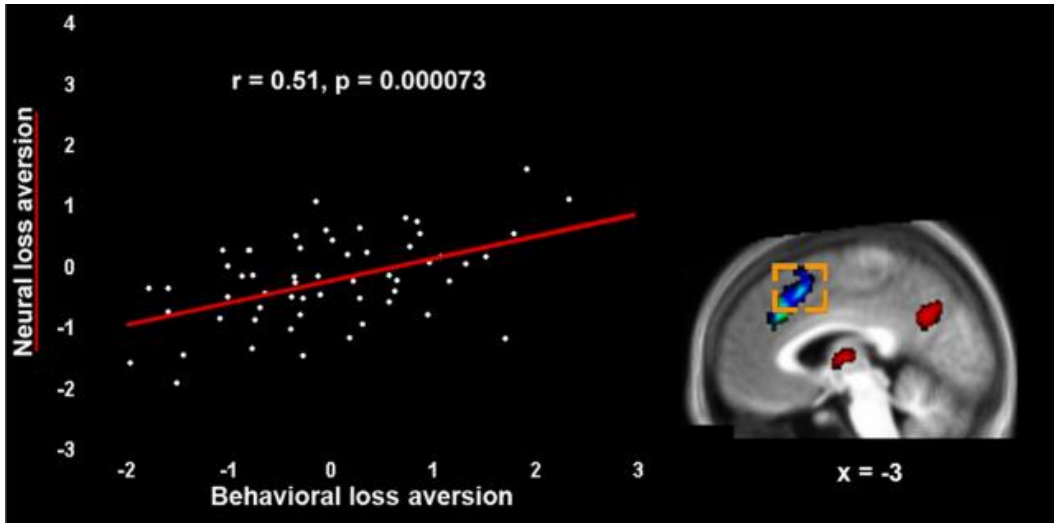
Background: dACC and insula

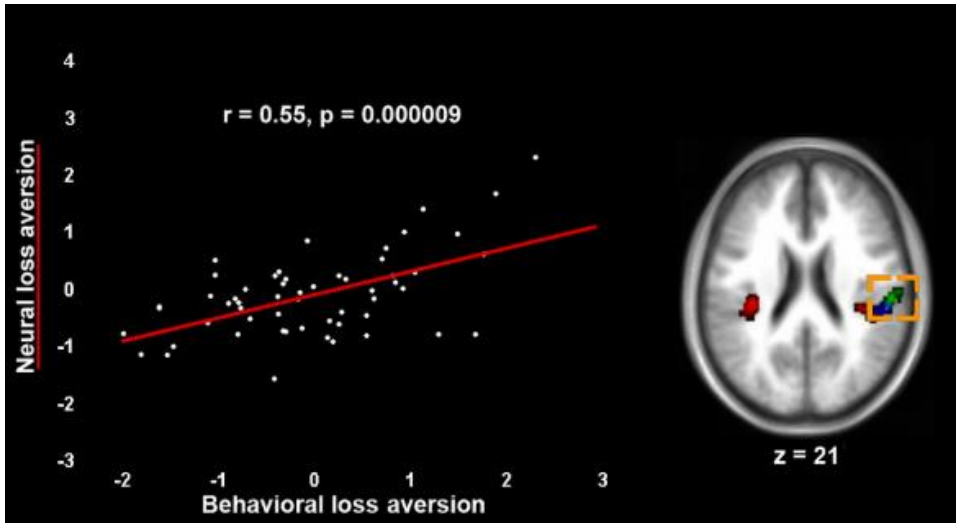
The dorsal anterior cingulate cortex (dACC) and the insula are key nodes for executive control

- conflict monitoring (Weissman et al., 2003)
- error processing (Holroyd et al., 2004)
- decision-making (Shenhav et al., 2016)
- feelings, empathy and uncertainty (Singer et al., 2009)

Background: dACC and insula

- Behavioural loss-aversion (Canessa et al., 2013)

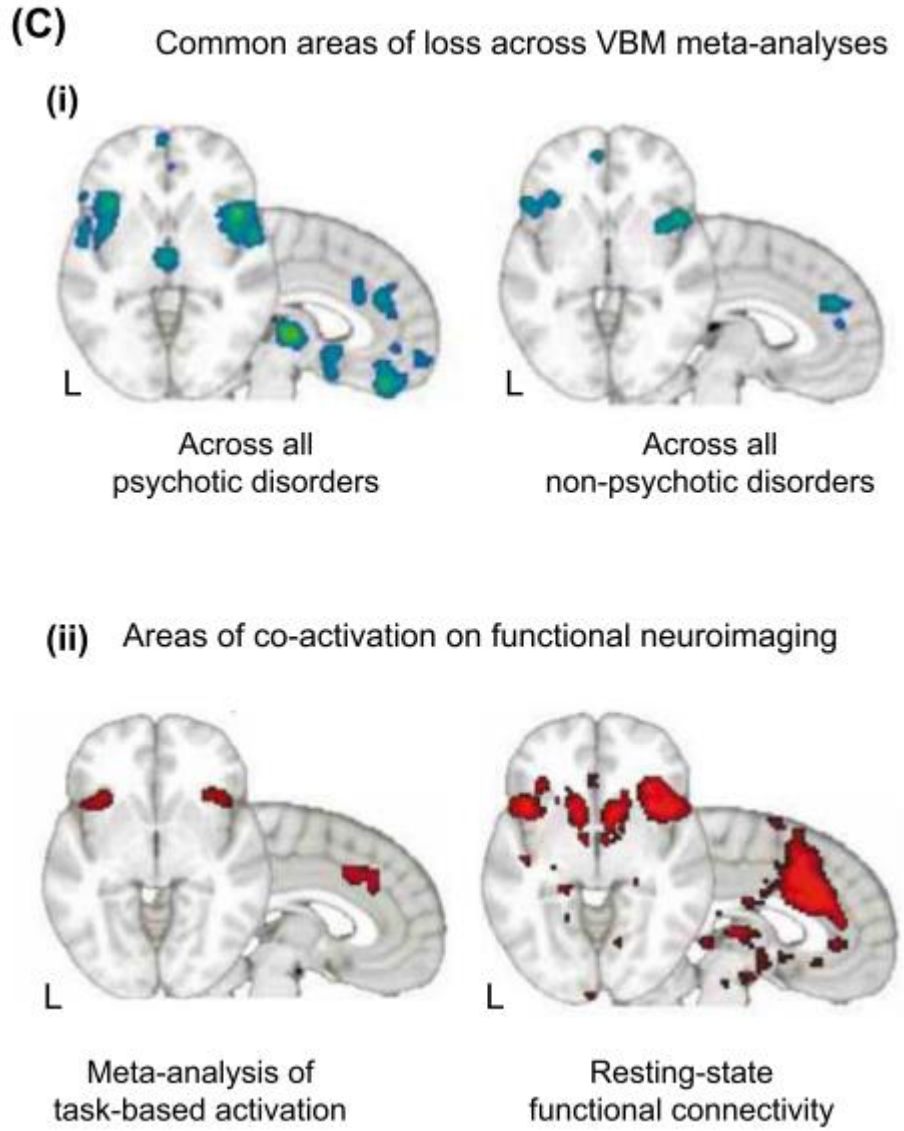




Background: dACC and insula

The dACC and insula are nodes of a core network underpinnings behavioural self-control and emotion regulation dysfunction in neuropsychiatric conditions (Downar et al., 2016).

- Emerging target for brain stimulation

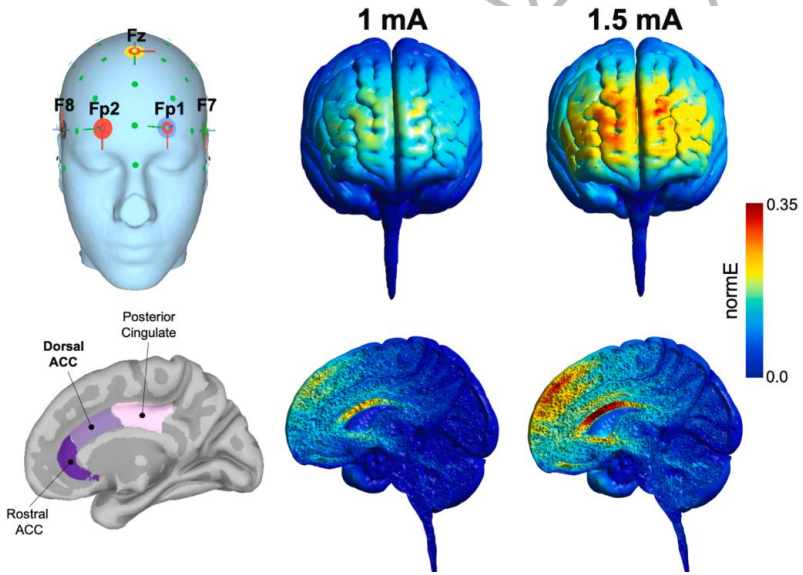


Background: dACC and insula

Targeting dACC and insula with neuromodulation:

- (HD-) tDCS

- Effects of anodal and cathodal HD-tDCS on cognitive and emotional Stroop task (To et al., 2018)
- Effects on motor-inhibition and error processing EEG components, although in the abcence of behavioural inhibitory control modulation (Verveer et al., 2021)
- Bipolar insular-tDCS on interoceptive ability and compassion motivation (Sagliano et al., 2019; Di Bello et al., 2023)



To et al., 2018

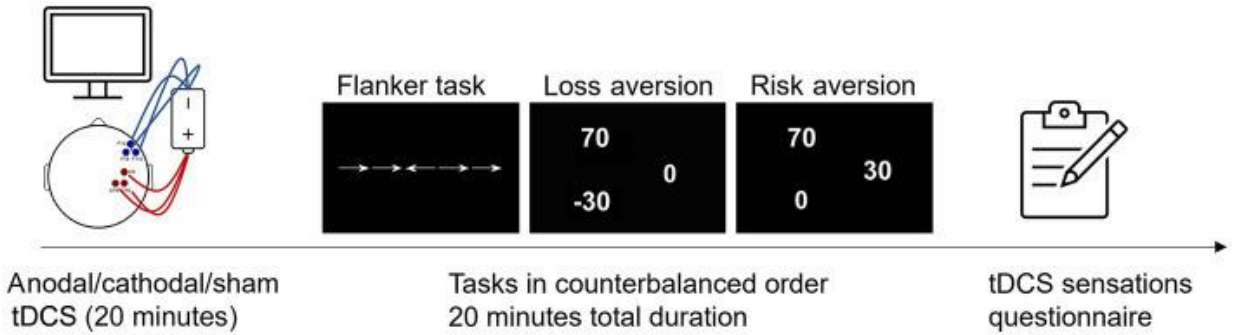
Objective

- To assess the effectiveness of HD-tDCS on dACC and insula
- To compare the modulatory effects of anodal and cathodal stimulation on different facets of executive control and decision-making

Mattavelli, G., Lo Presti, S., Tornaghi, D., Canessa, N. 2022; Gorrino, I., Canessa, N., Mattavelli, G. 2023

Method

- Targeting –modeling procedure to define the optimal montage with ROAST (Huang et al., 2019)
- 3x3 (9.5 mm radius) anodes-cathodes solution: 20 minutes 1 mA current intensity (current density of 0.35 mA/cm2) at each anode (total delivered current of 3 mA)
- 3 HD-tDCS sessions (anodal, cathodal, sham) in a within-subject design with offline stimulation
- dACC n=20
- Insula n=22



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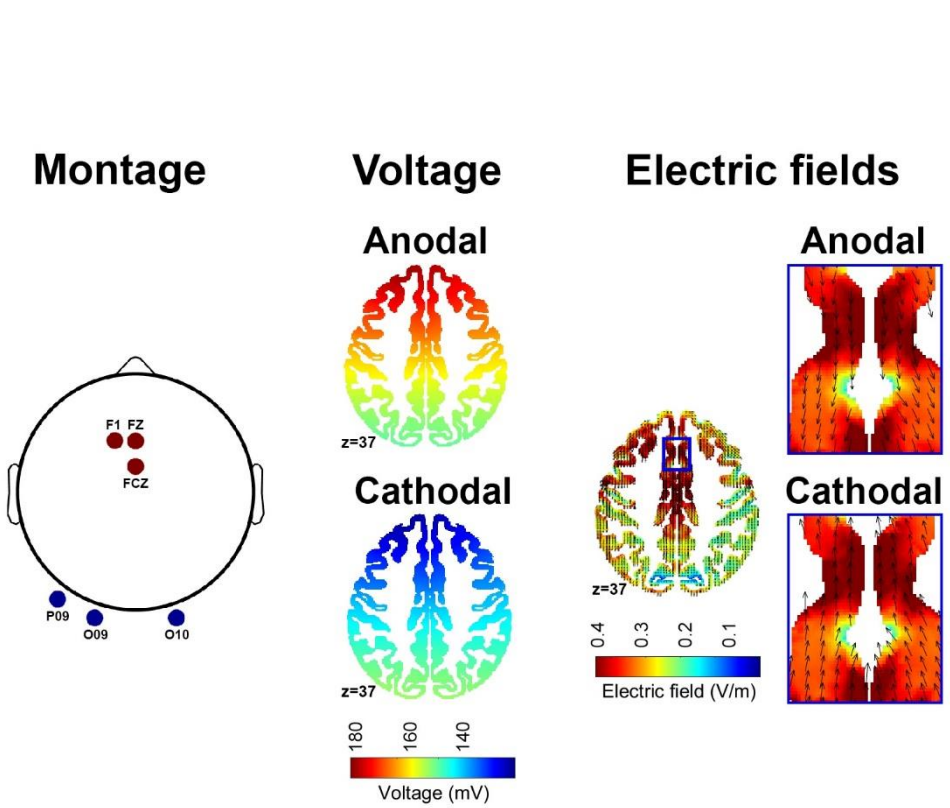
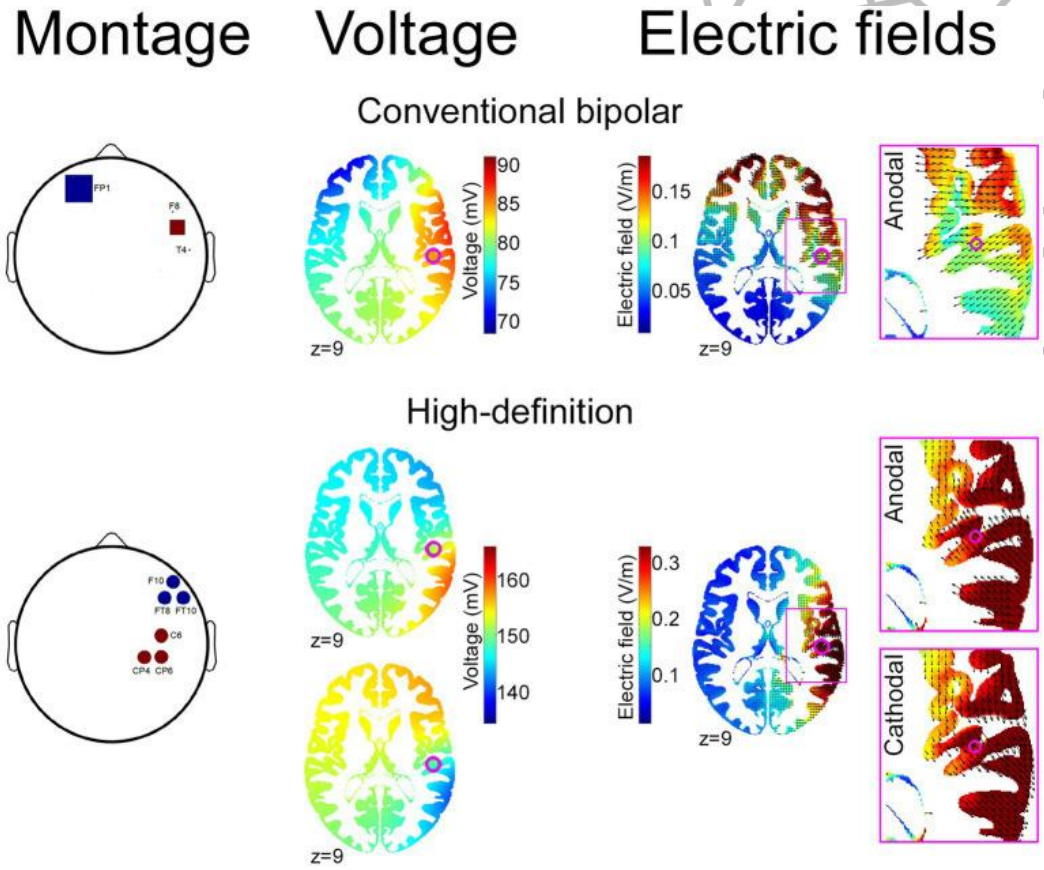
Method



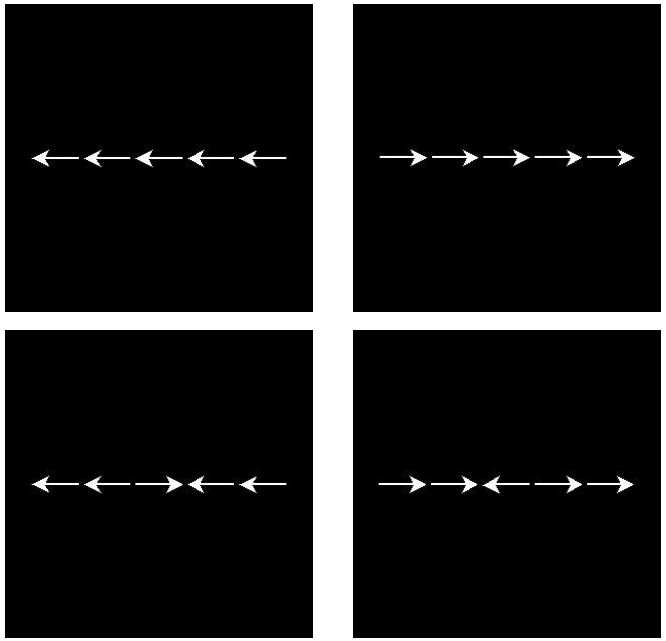


Mattavelli, G., Lo Presti, S., Tornaghi, D., Canessa, N. 2022; Gorrino, I., Canessa, N., Mattavelli, G. 2023

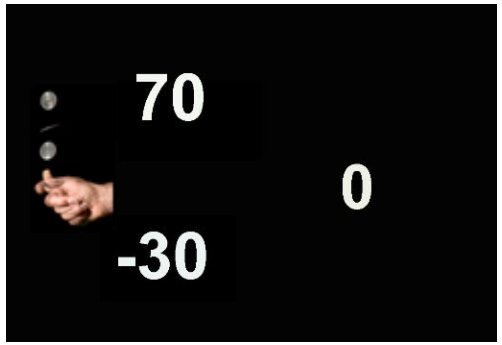
Method

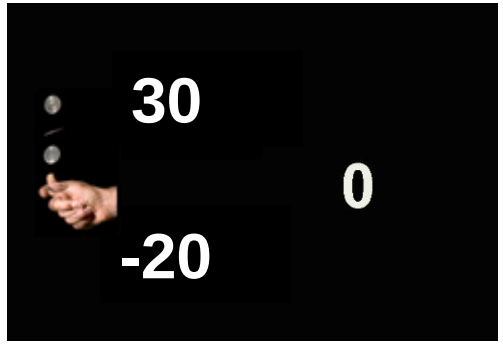
- 3 tasks in counterbalanced order following the stimulation

Flanker

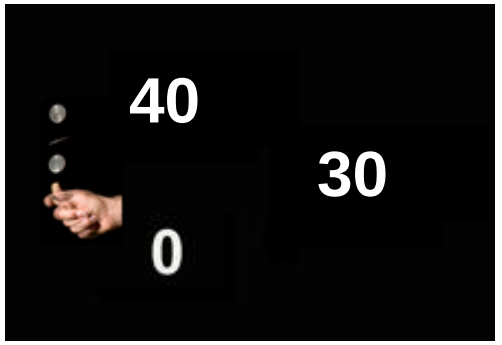


Loss Aversion





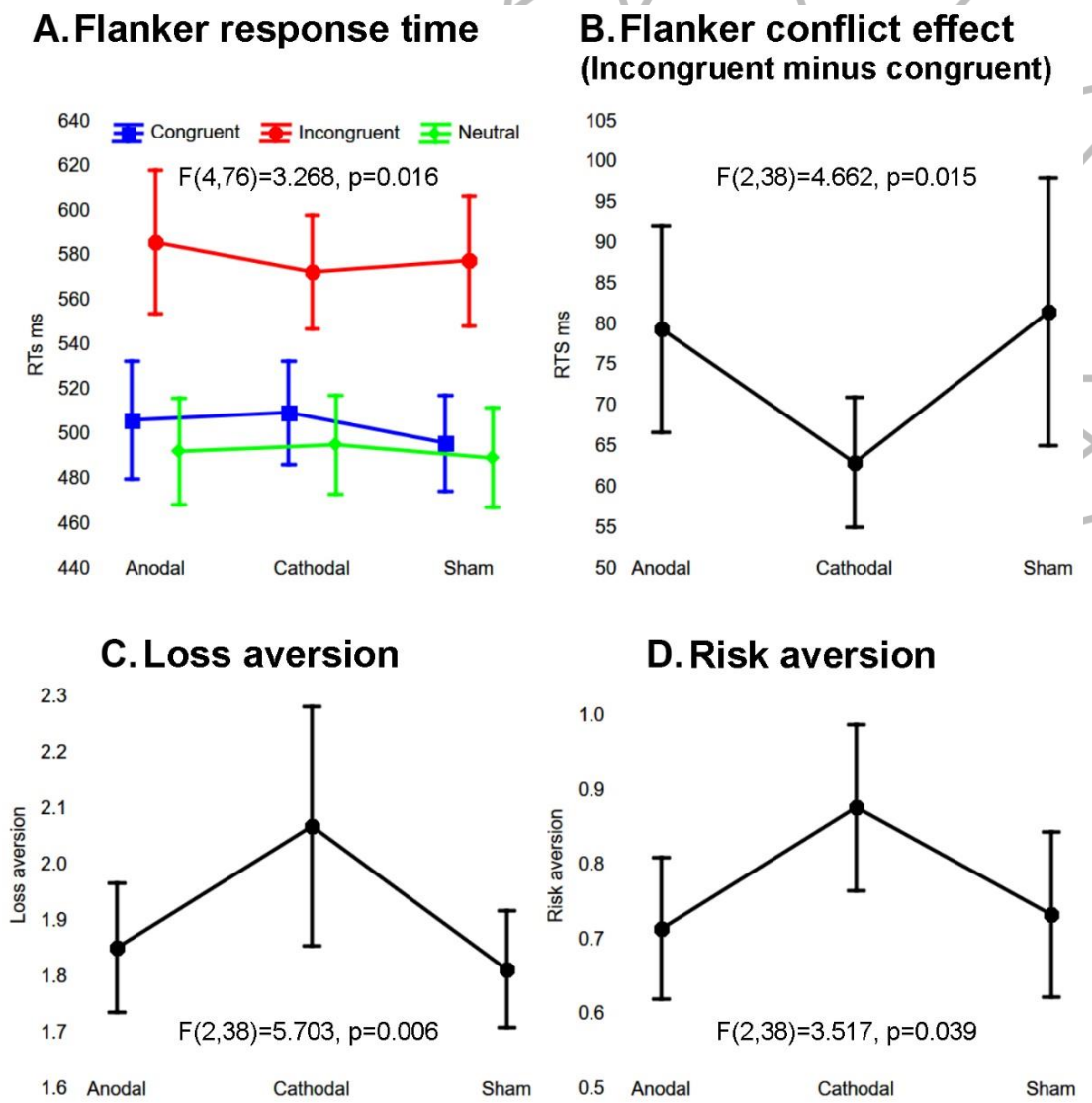
Risk Aversion



Results dACC

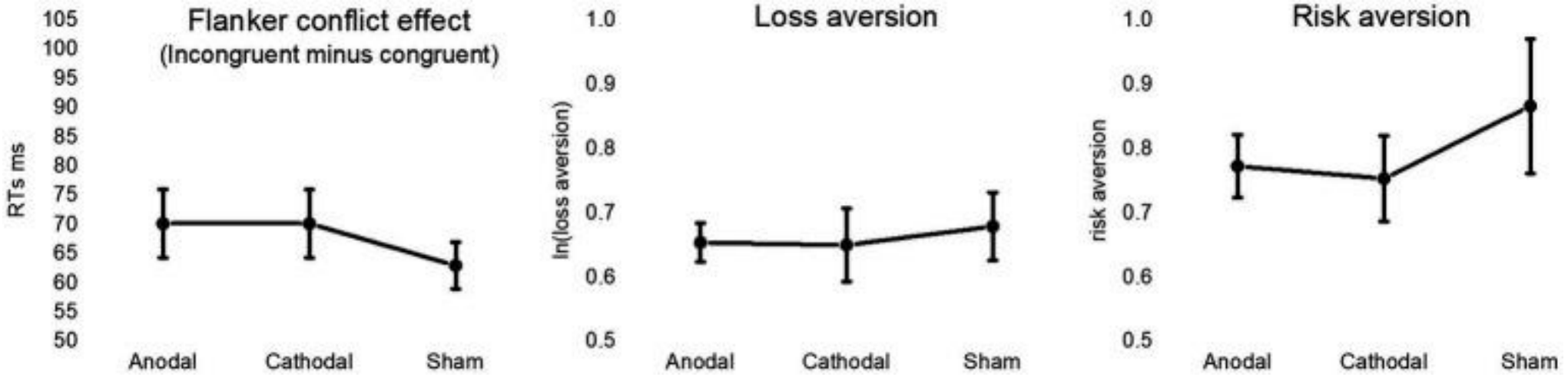
- ❑ Cathodal HD-tDCS reduced Flanker conflict effect.
- RTs incongruent trials: cathodal < anodal
- RTs congruent trials: cathodal > sham

- ❑ Cathodal HD-tDCS increased loss- and risk-aversion.



Results insula

- Bayesian repeated measures ANOVA provided moderate support for the null hypothesis
- Flanker: BF10= 0.28
- Loss aversion: BF10= 0.15
- Risk aversion: BF10= 0.21



Discussion

- ❑ Effectiveness of the model-based HD-tDCS approach to modulate dACC
- ❑ Cathodal HD-tDCS increased executive control:
  - noise filter for irrelevant stimuli (Jones and Berryhill, 2012; Weiss et al., 2012)
  - level out activity of competitive activation patterns elicited by perceptually complex tasks (Antal et al., 2004)

- ❑ Absence of modulatory effect of HD-tDCS on the insula

Future direction

- Exploring the advantages of HD and individualised stimulation
- Increased electric field focality could come at cost of increased interindividual variability (Mikkonen et al., 2020)

Additional equipment, expertise, and time required to implement modeling

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More consistent results, response prediction

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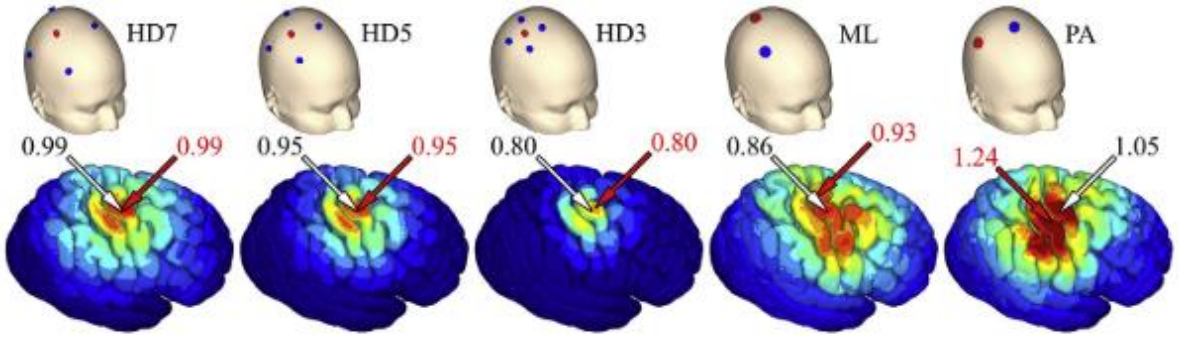
Improved outcomes



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Thanks

Nicola Canessa
Irene Gorrino
Riccardo Pirone

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