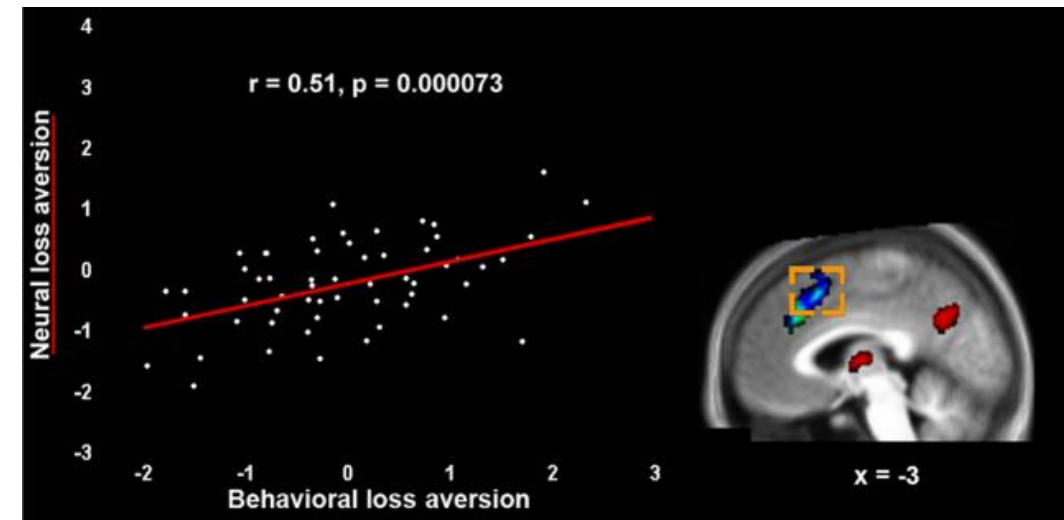
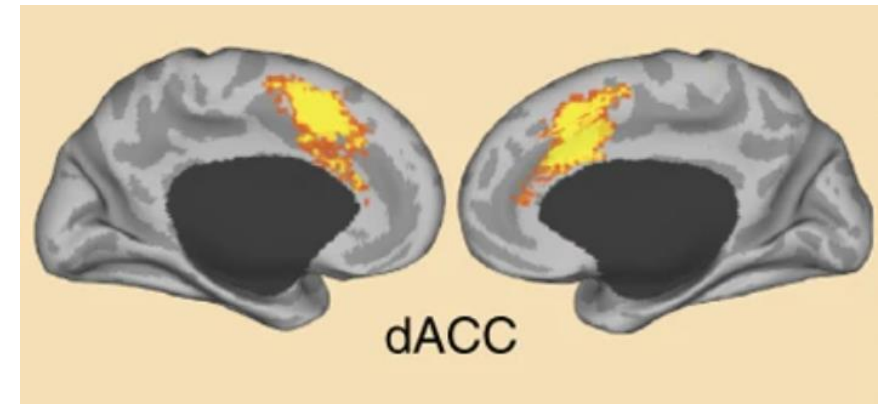


# HIGH-DEFINITION TRANSCRANIAL DIRECT CURRENT STIMULATION OF THE DORSAL ANTERIOR CINGULATE CORTEX MODULATED DECISION-MAKING AND EXECUTIVE CONTROL

Giulia Mattavelli, Sara Lo Presti, Diana Tornaghi, Nicola Canessa  
Scuola Universitaria Superiore, IUSS, Pavia

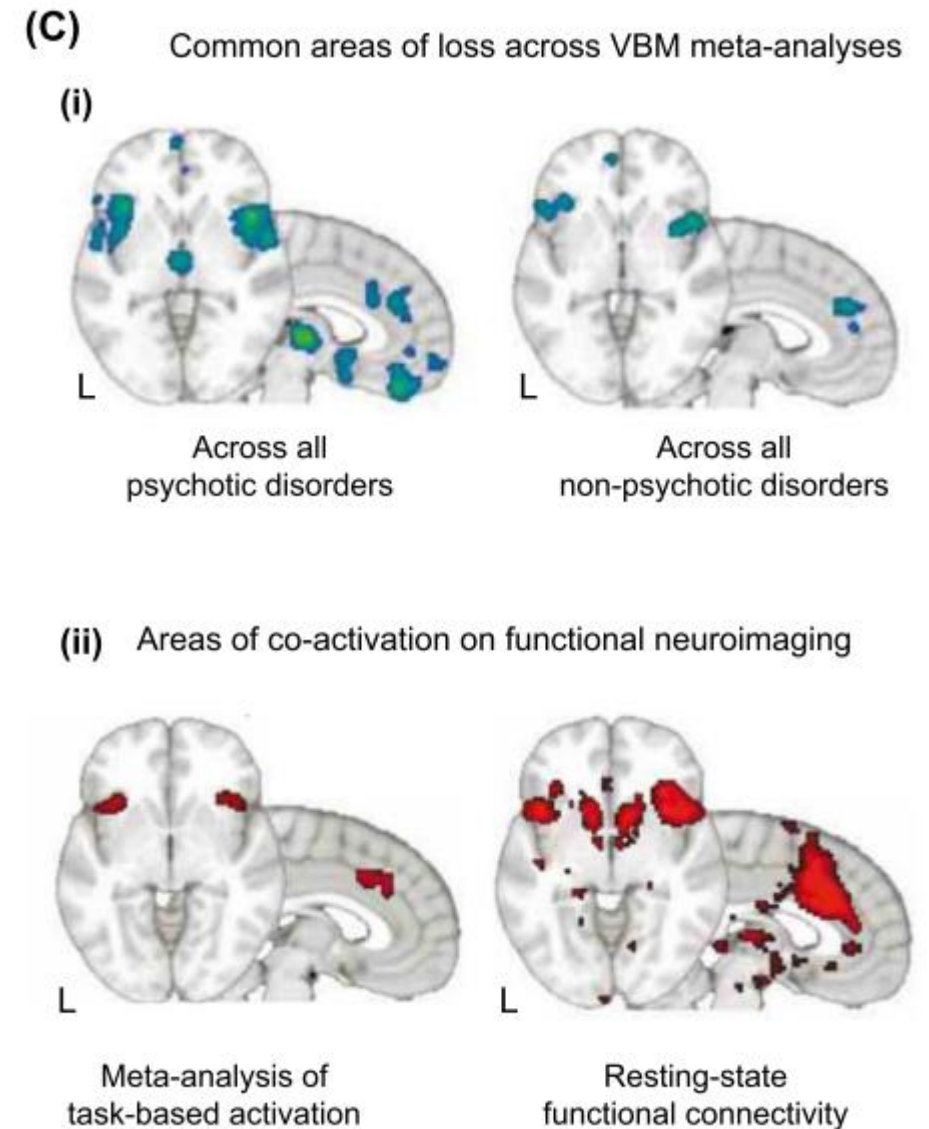
# Background

- Dorsal anterior cingulate cortex (dACC): a key node for executive control
  - conflict monitoring (Weissmane et al., 2003)
  - error processing (Holroyd et al., 2004)
  - decision-making (Shenhav et al., 2016)
  - behavioural loss-aversion (Canessa et al., 2013)



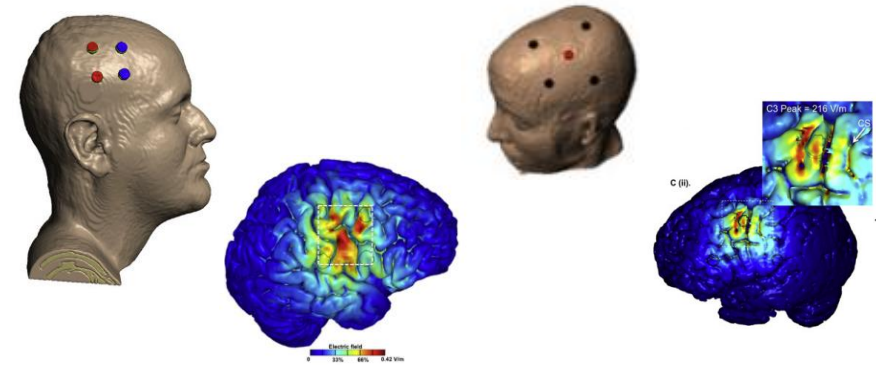
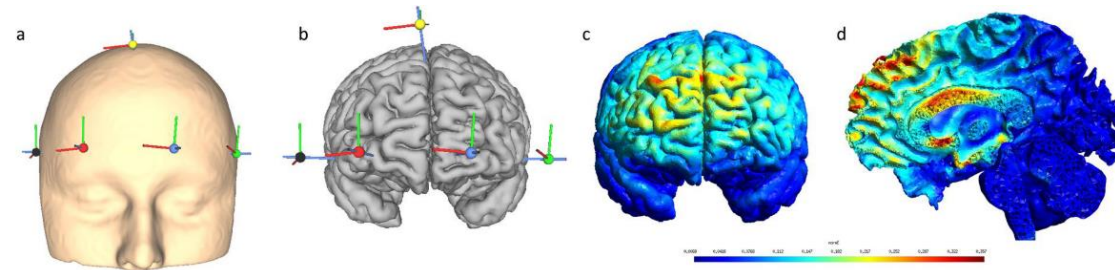
# Background

- dACC is one of the center 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

- Targeting dACC with neuromodulation:
  - High-definition (HD-) tDCS



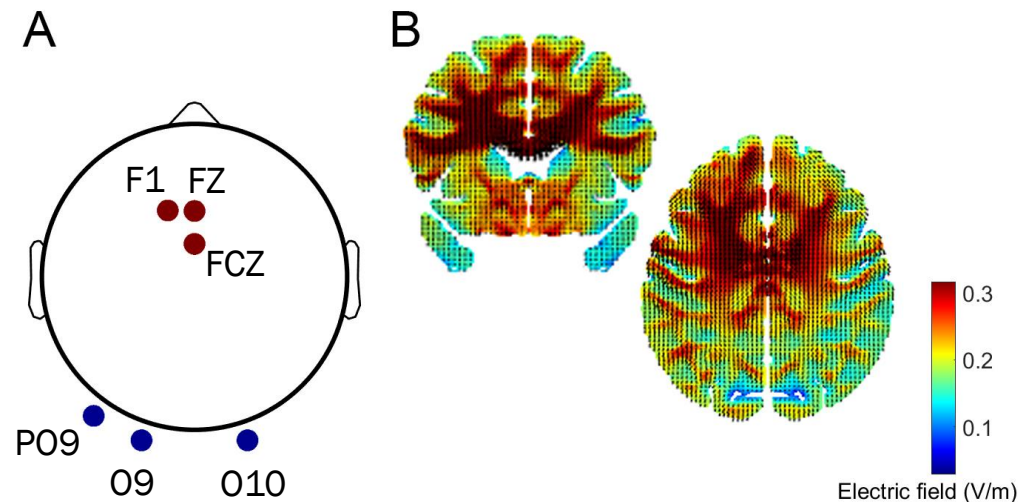
- Previous controversial results:
  - Effects of anodal and cathodal HD-tDCS on cognitive and emotional Stroop task (To et al., 2018)
  - Effects on motor-inhibition and error processing EEG components, although in the absence of behavioural inhibitory control modulation (Verveer et al., 2021)

# Objective

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

# Method

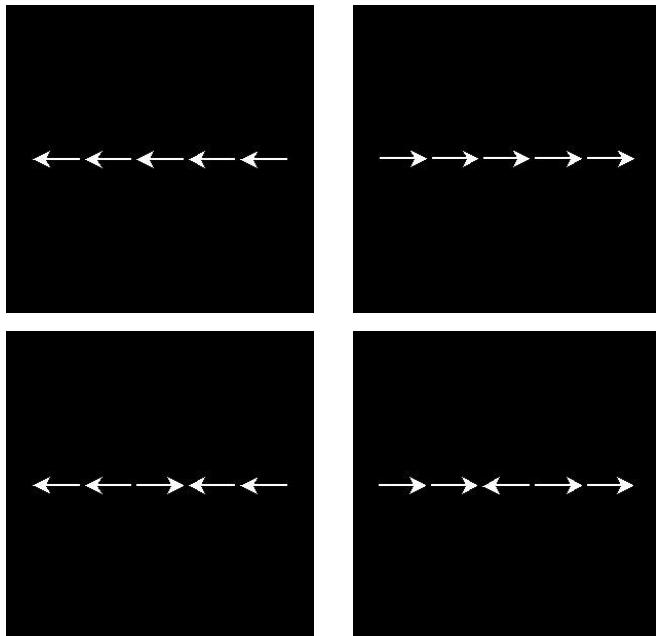
- Modelling/targeting procedure to define the optimal montage with ROAST (Huang et al., 2019).
- 3x3 (6 mm radius) anods-cathods solution: 20 minutes 0.667 mA current intensity (current density of 0.59 mA/cm<sup>2</sup>) at each anode (total delivered current of 2 mA).
- 3 HD-tDCS sessions (anodal, cathodal, sham) in a within-subject design (N=20)



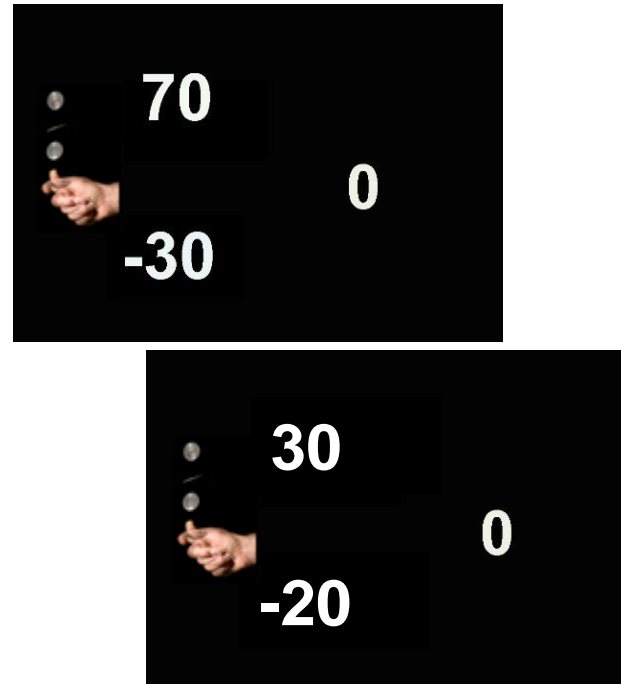
# Method

- 3 tasks in counterbalanced order following the stimulation.

Flanker



Loss Aversion



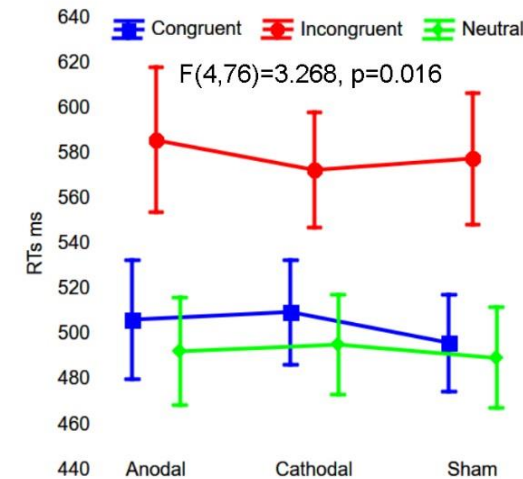
Risk Aversion



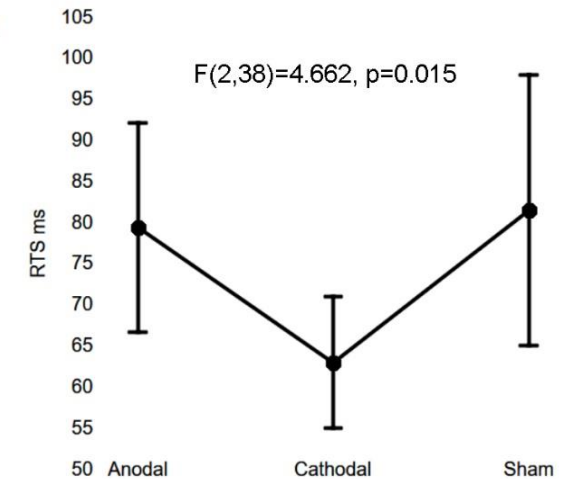
# Results

- 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.

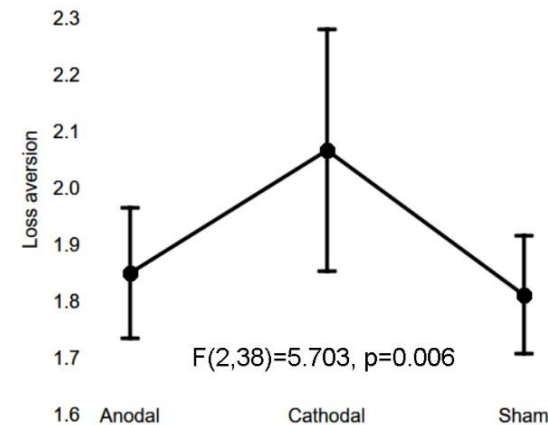
**A. Flanker response time**



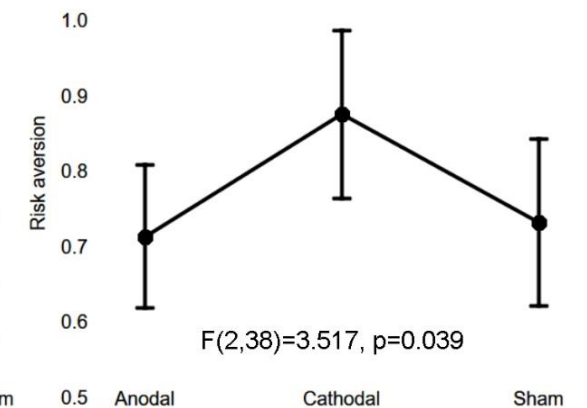
**B. Flanker conflict effect (Incongruent minus congruent)**



**C. Loss aversion**



**D. Risk aversion**





# Discussion

- dACC has a causal role in multiple facets of executive control, from conflict detection and resolution to decision-making.
- 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).*
- Effectiveness of the model-based HD-tDCS approach to modulate dACC.

Sara Lo Presti  
Diana Tornaghi  
Nicola Canessa

GRAZIE!