DISTINCT NEUROMODULATION-INDUCED EEG-BEHAVIOR PREDICTION PATTERNS:
LOW-INTENSITY TRANSCRANIAL FOCUSED ULTRASOUND TARGETING THE RIGHT PREFRONTAL CORTEX INCREASES APPROACH AND DECREASES WITHDRAWAL BEHAVIOR VIA SPECIFIC INHIBITION OF MIDFRONTAL THETA

P. Ziebell1, J. Rodig, A. Forster1, I. Landwehr, T. Seibert, J. L. Sanguinetti2, J. J. B. Allen2, J. Hewig1

1 Institute of Psychology, University of Würzburg, Germany
2 Department of Psychology, University of Arizona, Tucson (AZ), USA

Introduction

Earlier studies: Low-intensity transcranial focused ultrasound (LITFUS) to the right prefrontal cortex (RPFC) can change subjective mood experiences

- Visual analogue scale (VAS) global affect (‘happy’ + calm – sad – tense) ↑ + emotion and mood network functional magnetic imaging activity ↓ [1]
- VAS global affect↑ + Penn State Worry Questionnaire [2]

Current study, preregistered at Open Science Framework [3]: Exploration of electroencephalography (EEG) and behavior as objective measures in a desktop virtual reality T-maze task paradigm

- EEG: 64 channels + current source density transformation for optimal effect localization
- EEG + behavior: Prediction of approach versus withdrawal based on LITFUS-induced conflict-related EEG midfrontal theta (MFT) inhibition

Background: MFT decreases have been related to decreased conflict experience / withdrawal-like negative affect and behavior, e.g. decreased anxious anticipation of social threat / more risky gambling decisions [4 – 7] – based on these findings and aforementioned earlier studies, RPFC LITFUS should lead to: MFT↓ withdrawal ↓ approach ↑

Methods

Outcome variable: Frequency differences of individual participants’ chosen behavior options withdrawal out of the T-maze = turn away from safety out of the T-maze = approach into the T-maze

Approach vs Withdrawal
- positive- and-positive (20 trials) cues sheep or monster (50 / 50 %)
- negative (20 trials) cues monster (100 %)

Midfrontal Theta
- negative- and-positive (20 trials) cues sheep and monster (100 %)
- ambiguous (20 trials) cues sheep or monster (50 / 50 %)

Low-Intensity Transcranial Focused Ultrasound
- positive (20 trials) cues sheep (100 %)

Electroencephalography
- credit gain if sheep is caught by participant
- credit loss if participant is caught by monster

Results

For ambiguous events, the LITFUS-vs.-Sham-induced MFT inhibition predicted:

- approach into the T-maze Beta = 0.205 (p = 0.011)
- approach towards safety out of the T-maze Beta = 0.201 (p = 0.002)
- withdrawal out of the T-maze Beta = -0.211 (p = 0.009)

Discussion

Summary of results: RPFC LITFUS can inhibit conflict-related MFT, predicting greater approach versus withdrawal behavior in a virtual T-maze

Limitations and future directions: LITFUS is a rapidly growing field, promising for research and practical applications [1, 2, 8 – 10]

- Benefits: Non-invasive + ease of application + avoidance of side effects like headache or skin irritation + high precision + target selection and energy dosage
- Further exploration of responder/non-responder-characteristics (e.g. gender differences, personality patterns, skull thickness) and adaptation of LITFUS parameters
- Potential implementation of LITFUS as a supportive intervention, e.g. before psychotherapy sessions for emotional and motivational disorders

References