TRANSCRANIAL DIRECT CURRENT STIMULATION IN THE POSTPARTUM PERIOD: COMPUTATIONAL MODELLING OF ELECTRIC FIELD STRENGTH IN TWO STANDARD MONTAGES FOR DEPRESSION

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Transcranial direct current stimulation (tDCS) has been suggested to treat peripartum depression (PPD) using the F3 (Anode) - F4 (Cathode; 10:10 EEG international system) montage with 2mA electric current. However, the electric field (EF) strength varies with brain morphology and during the perinatal period structural changes seem to take place in brain grey matter, in regions associated with motherhood. To our knowledge, peripartum morphological specificities were never taken into account when choosing tDCS protocols for PPD. Therefore, we aim to contribute to the field by informing about the distinctiveness of the EF strength induced in postpartum brains when using two standard tDCS montages in major depression. T1 weighted scans and clinical assessments of 25 postpartum women (3-months postpartum; 19-33 years [M=26.6, SD=4.0]) from the open-access Postnatal Affective MRI Dataset1 were included. According to the Center for Epidemiologic Studies Depression Scale (CES-D), 12 women presented depressive symptoms (M=20.4). With SimNIBS2 , we simulated EF using the F3-F4, and the F5-F6 montages (10:10 EEG international system; 2mA current intensity). Mean EF strengths were calculated on the Anterior Cingulate Cortex -ACC, the left and right Dorsolateral Prefrontal Cortex -DLPFC, and the Dorsomedial Prefrontal Cortex -DMPFC). We performed two-way mixed ANOVAs to estimate the interaction between montage and presence of depressive symptoms on EF strength across regions. Although the interaction was not significant (Figure 1), we found a main effect of montage, with the F5-F6 montage presenting the peak mean EF strength in the ACC, the right DLPFC and the left DLPFC. The F3-F4 montage presented the peak strength in the DMPFC. Although both montages enable the modulation of the commonly targetted brain areas in PPD using tDCS the clinical decision between the F5-F6 and the F3-F4 should account for the target area of interest when treating PPD.
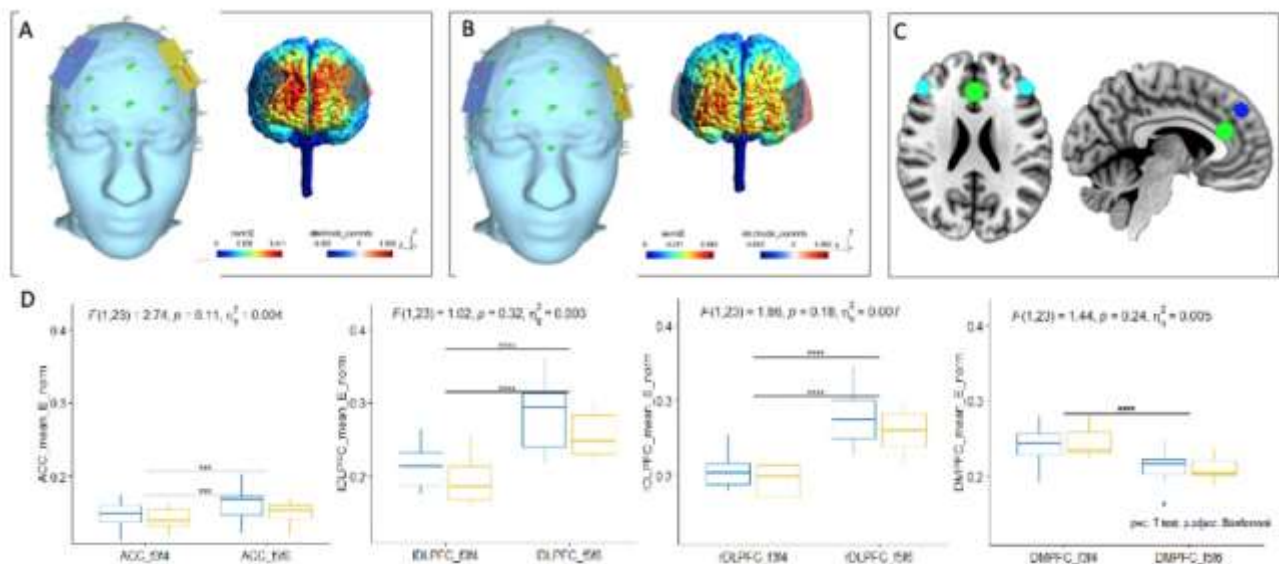

Figure 1. tDCS simulation montages, regions of interest (ROIs) and ANOVAs results. A. Left: tDCS montage F3 (Anode) - F4 (Cathode); 10:10 EEG International System. Right: Electric field (EF) simulation on gray matter (electrode current: 2mA, peak EF strength [normE]: 0.411 V/m). B. Left: tDCS montage F5 (Anode) - F6 (Cathode); Right: EF simulation on gray matter (electrode current: 2mA, peak EF strength [normE]: 0.483 V/m). C. Spherical ROIs over MNI template: anterior cingulate cortex (ACC; green), left and right dorsolateral prefrontal cortex (l and rDLPFC, light blue), dorsomedial prefrontal cortex (DMPFC, dark blue). D. ANOVA results: two-way mixed ANOVAs. Montage as within-group factor (F3-F4 vs. F5-F6) and presence of depressive symptoms (according to CES-D) as between-group factor. Left to right: results for mean EF strength in ACC, lDLPFC, rDLPFC, and DMPFC

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THE INTERACTION OF TRANSCRANIAL DIRECT CURRENT STIMULATION (tDCS) AND PACED BREATHING ON ACOUSTIC AND LEXICAL SPEECH FEATURES IN THE CONTEXT OF STRESS

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Speech features are increasing in popularity as potential biomarkers for stress and have shown promising results in the context of psychosocial stressors (1). Speech is actively influenced by numerous bottom-up physiological processes, such as cardiac activity and breathing (2). Whereas slow-paced breathing quickly and directly affects the afferent vagus nerve, transcranial direct current stimulation (tDCS) has been shown to modulate stress regulatory processes. In this between-subjects study, we aim to investigate whether combining slow-paced breathing and tDCS stimulation could beneficially interact in modulating affective and stress processes. As such, we collected high-quality free speech recordings in 160 healthy subjects at (1) baseline, (2) after a controlled breathing baseline (slow/fast), (3) after a combination block where tDCS (active/sham) is added to the breathing condition (slow/fast), and (4) after subsequent stress induction (TSST; Trier Social Stress Test arithmetic task; Figure 1).
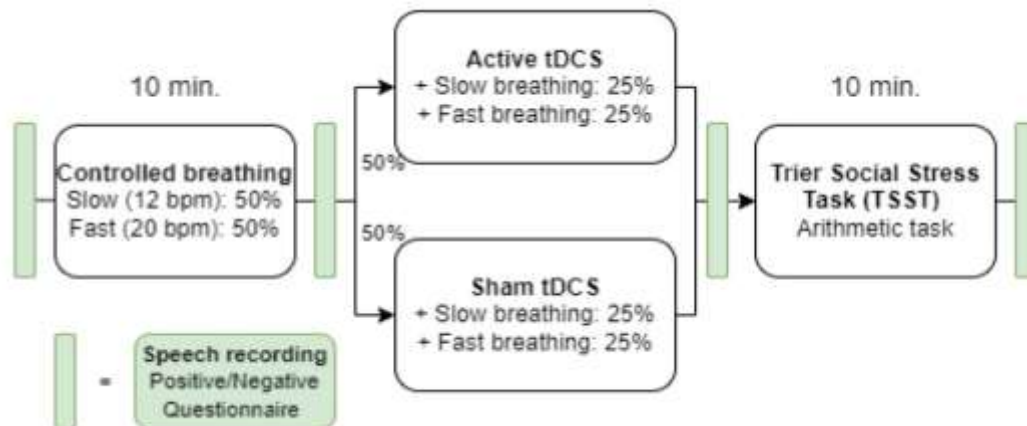

Figure 1. Study flow. Green blocks: speech and self-reported positive/negative affect collection. Participants were randomly assigned to one of four combined tDCS (active/sham) + controlled breathing (slow/fast) interventions; 4 groups. Abbreviations: bpm, breaths per minute; tDCS, transcranial direct current stimulation.

Interactive effects of controlled breathing and tDCS will be investigated on key acoustic features including F0, Jitter, and Shimmer, and lexical features including vocabulary size and use of personal pronouns. Specifically, we will compare the four groups in a 2 (active/sham tDCS) x 2 (slow/fast breathing) design using mixed models and ANOVA testing. These results will further unveil the complex dynamics of speech production and its relation to bottom-up (i.e., physiological activity) and top-down (i.e., tDCS) interventions. Moreover, due to the presence of a validated stressor post- manipulation, we can position these results in the context of stress and add to its potential as a novel biomarker for stress.

Keywords: *paced breathing – tDCS – stress – speech - biomarker*

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