Investigation on the use of Multiscale Entropy analysis of TMS motor evoked potentials to understand the influence of tDCS

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Introduction: Transcranial Magnetic Stimulation (TMS) allows the investigation of cortical activity characteristics through electromiographic (EMG) evoked activity in a target muscle – the Motor Evoked Potential (MEP) [1]. Here we propose Multiscale Entropy (MSE) [2] as a way to assess MEP changes due to transcranial Direct Current Stimulation (tDCS) of the motor cortex. Our hypothesis is that tDCS would induce an increase in the corticomotor system complexity.

Materials and Methods: Cortical excitability was assessed through TMS (BiStim, Magstim, UK) on three different moments: 1) baseline; 2) immediately after anodal or cathodal tDCS over the motor cortex (20 minutes, 2 mA); 3) 15-minutes follow-up. A series of 20 single TMS pulses was delivered at each moment with real-time EMG recording (CED, UK) of the first dorsal interosseous of the hand. Participants were 23 healthy male volunteers allocated into three groups, anodal (n = 9), cathodal (n = 5),and sham stimulation (n = 9). For each evaluation a constructed time series was produced by 20 concatenated MEPs. A coarse- grained time series was constructed corresponding to the scale factor. In this work, we performed the analyses on scales one to 10. Entropy values obtained for each scale were averaged within groups for statistical analyzes. A two-way ANOVA was used to identify differences between and within groups at each assessment moment, with statistical significance set as $p < 0.05$. All statistical procedures were performed using OriginPro v. 8.5 (OriginLab, US).

Results: The results showed no significant statistical differences between or within groups at any time point. Figure 1 shows the mean comparisons between groups at each assessment moment. Figure 2 shows a trend for escalation of entropy values across scales, especially for the anodal tDCS group, with continuous increase at the follow-up assessment.

Figure 1.

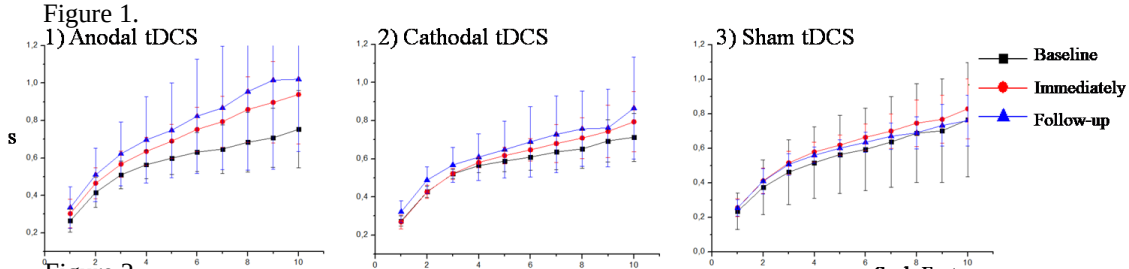
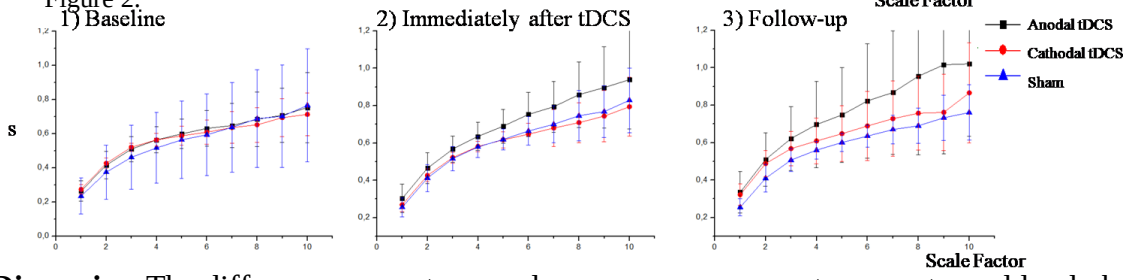


Figure 2.



Discussion: The differences on entropy values across assessment moments could only be noticed on higher scale values for the anodal tDCS group. Meanwhile no effect was shown for the sham group at any scale factor. The time scale influence on complexity analyzes has been previously stated in the literature by comparing healthy and pathological conditions using ECG recordings. Higher complexity across scales may suggest an adaptive capacity and better function of the system. This novel approach may be a potential resource to evaluate changes in motor excitability [2].

Conclusion: We found that MSE may be a worth technique to assess MEP changes in studies of cortical excitability.

References: [1]doi:10.1016/j.clinph.2012.01.010 [2] doi: 10.1103/PhysRevE.71.021906