High-definition transcranial direct current brain stimulation of word processing (147)

Svetlana Malyutina, Dirk den Ouden
University of South Carolina, Columbia, SC

Introduction: High-definition transcranial direct current stimulation (HD-tDCS) is a novel brain stimulation method that modulates neuronal excitability by transmitting low current through electrodes placed on the scalp. HD-tDCS is designed to exceed other brain stimulation methods in safety and focality, increasing its potential as a clinical tool. The aims of the present study were twofold: 1) to obtain more methodological information about this novel method; 2) to investigate whether HD-tDCS can modulate language processing in healthy speakers and thus to obtain baseline data for its clinical investigations in individuals with neurogenic language disorders.

Methods: Twenty-six healthy participants received three types of HD-tDCS stimulation (anodal, cathodal, sham) for 20 minutes on separate days. A novel approach to sham was used: continuous stimulation bypassing the cortex, rather than the more common method of applying stimulation very briefly. We stimulated Broca's area and left angular gyrus in 13 participants each. Immediately after each stimulation session, participants performed two language processing tasks: picture naming and word/non-word decision.

Results: In a survey, participants gave low ratings of experienced pain and unpleasantness on a 1–10 scale (beginning of stimulation: mean 2.4, SD 1.4 for pain, mean 2.6, SD 1.4 for unpleasantness; end of stimulation: mean 1.0, SD 0.0 for pain, mean 1.1, SD 0.2 for unpleasantness). Eight out of 26 participants (chance level) correctly guessed which session applied sham stimulation. Analysis of performance on language tasks yielded effects of stimulation (cathodal stimulation made participants faster on the naming task) and interactions between stimulation type and order of stimulation sessions (effects of anodal and cathodal stimulation depended on which session they were administered at).

Conclusions: Low pain and unpleasantness ratings indicate high tolerability of HD-tDCS, suggesting a potential for routine clinical use. The new approach to sham stimulation provided sufficient blinding and can be potentially used for blinded clinical trials. HD-tDCS modulated speed and accuracy of language processing, warranting further clinical research in neurogenic language disorders. The data challenge the traditional view of anodal stimulation as excitatory and cathodal stimulation as inhibitory: cathodal stimulation increased the speed of language processing, and, importantly, effects of anodal and cathodal stimulation depended on the order of their administration, suggesting either carry-over effects or an impact of novelty of the task. Lastly, high individual variability suggests a contribution of individual gyral structure to the effects of brain stimulation.

Disclosures: S. Malyutina: ASPIRE-I grant of the University of South Carolina. D. den Ouden: ASPIRE-I grant of the University of South Carolina.

Differential subthalamic nucleus LFP suppression according to phenotype in PD (229)

Ilknur Telkes, MS,[1] Nuri Firat Ince, PhD,[1] Anish Neeraj Sen, MD,[2] Ashwin Viswanathan, MD,[2] Joohi Jimenez-Shahed, MD[2]
[1]University of Houston, Houston, TX, [2]Baylor College of Medicine, Houston, TX

Introduction: Two phenotypic subtypes of Parkinson's disease (PD) exist: tremor-dominant (Tr) and postural instability–gait disturbance (PIGD); in which bradykinesia, rigidity, and gait disturbance predominate (Jankovic et al, 1990). Subthalamic nucleus (STN) deep brain stimulation (DBS) is an effective therapy for advanced PD but the precise mechanism of action remains unclear (Montgomery & Gale, 2008). Hypotheses exist to explain potential therapeutic mechanism(s) at the local (STN/Globus pallidus) and system (basal ganglia–thalamic–cortical) level (Mcintyre, Savasta, Goff, & Vitek, 2004; Montgomery & Gale, 2008). We postulate that different electrophysiological responses to stimulation may be seen as a result of stimulation of the same structure, and that these variances my provide insight into DBS mechanisms in different PD phenotypes. We therefore sought to investigate whether a differential response to STN DBS exists according to patient phenotype.

Methods: Local field potential (LFP) activity was recorded in two PD subjects (one Tr and one PIGD) who underwent STN DBS placement. LFPs were recorded with 1.2 kHz and 16-bit A/D resolution by using the DBS macro electrode (model # 3389, Medtronic) at rest and during a stimulation and sensing paradigm. Parameters of stimulation were selected once the first beta band suppression was seen after gradual increase of amplitude from 0 V. Stimulation parameters were 1 V/150 Hz/60 µs and 0.1 V-0.2 V/130 Hz/60 µs in each subject, respectively.

Results: Time-frequency analysis of LFPs recorded by macro electrodes revealed a strong beta band activity within the STN in both cases but stimulation yielded variable results. In the PIGD patient, 1 V stimulation decreased beta band activity at moderate levels only in the post-stimulation period, while in the Tr patient, 0.1 V stimulation showed a significant decrease and 0.2 V stimulation totally suppressed beta band activity both during and after stimulation. In both cases, stimulation of the optimal contact failed to suppress beta band activity sensed at the distant contact.

Conclusions: The observation of similar LFP characteristics within the STN in two phenotypically distinct subjects, but with different stimulation effects suggests that there might be specific foci within the STN that suppress beta band activity with relevance at the micro-circuit rather than the network level. It is possible that different foci should be stimulated in different PD phenotypes for optimal clinical benefit. These preliminary findings warrant further investigation, and have implications for optimization of DBS especially in a closed loop system.

Disclosures: I. Telkes: None. N. Ince: None. A. Sen: None. A. Viswanathan: None. J. Jimenez-Shahed: None.