Abstract

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Mathematical Modeling of Neurostimulation for Post-Traumatic Stress Disorder: A Migration towards Multiscale Modeling to Assess Neural Response to Transcranial Direct Current Stimulation Treatments

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Abstract: Post-traumatic stress disorder (PTSD) is a neurological condition which results from a traumatic experience caused by physiological shock or physical harm. Clinical results show success in combating the symptoms of PTSD with a neurostimulation treatment called transcranial Direct Current Stimulation (tDCS). Though effective, the underlying mechanisms of the treatment and its success are not fully comprehended. In order to elucidate reasons for its efficacy, a mathematical model of tDCS has been implemented to quantify the electrical energy delivered by this treatment. Computational simulation results of various PTSD-focused electrode montages on a three-dimensional, MRI-derived cranial cavity with biologically-based tissue conductivities parallel results from published literature and clinical experiments. Specifically, regions of the brain thought to be targeted by tDCS treatments are confirmed with in silico experiments. Finally, an extension of this model to a unique multiscale mathematical model of tDCS is presented, which adds the ability to quantify neural tissue response via tDCS-induced transmembrane voltage polarization, the first of its kind for tDCS simulations for PTSD.