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Paradigms for Enhancing Electrical and Magnetic Stimulation Efficacy in the Treatment of Brain Disorders

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In recent years, there has been a growing interest in non-invasive brain neuromodulation for the treatment of brain disorders. Non-invasive stimulation techniques generate/induce an electric current in the brain via coils placed near the scalp or electrodes attached to the scalp. Recent studies have shown recovery of brain functions, improvement of cognitive processes, or treatment of major depression disorders [1],[2]. However, there is limited evaluation of the optimal electric current in the brain, and less is known about the relationship of electric current features (e.g., intensity, distribution, duration) and physiological responses in part due to lack of in vivo measurements of the electric currents distributions in the brain. Electromagnetic computational modelling has permitted estimating the generated electric currents as the physical agent of neuromodulation [3],[4]. For more accurate predictions, human head models accounting for anatomical features have been employed [5]–[7] that can be used to determine the electric field at the individual level. One disadvantage of individual-level computation in clinical practice is that it requires imaging data of the subject and accurate localization of the coil/electrode during treatment, which could be costly and time-consuming for some applications. Another approach that overcomes these limitations is identifying a priori the optimal stimulation of the target subject based on group-level optimization in a group of subjects with similar characteristics [8].

In this study, electromagnetic dosimetry is used to investigate and optimized the electric currents to specific brain targets based on the two paradigms: individual-level and group-level. Both approaches are compared and discussed for targeting brain region related to different brain disorders.

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