NICOLAS DOYON, Laval University

Modelling rTMS, how electric field can cure you

Electric stimulation, either through transcranial direct current stimulation (tDCS) or repetitive transcranial magnetic stimulation (rTMS), is gaining increasing attention as an alternative or complementary therapeutic approach to pharmacological treatments. Healthcare practitioners must choose among a large number of possible stimulation protocols, each specifying parameters such as stimulation intensity and location.

Mathematical simulations can help guide this choice by relating stimulation protocols to the resulting electric field distributions across different brain regions. These simulations rely on the finite element method (FEM) to solve partial differential equations and are often performed using software such as SimNIBS.

In this presentation, we first discuss the inherent mathematical challenges involved in electric field simulations and the numerical methods used to perform them. We examine potential sources of numerical error, including the complexity of brain geometry and uncertainties in model inputs, such as skull thickness. We show that, although these sources of error can lead to substantial uncertainty in the estimated electric field magnitudes, they have a more limited impact on the relative ranking of the most strongly stimulated brain regions.

We then combine electric field values extracted from simulations in different regions of interest with findings from published meta-analyses to investigate how stimulation patterns across brain regions relate to treatment efficacy, focusing on applications in tinnitus and addiction treatment.