UNDER REVIEW

RESCIENCE C

Replication / Computational Neuroscience

[Re] Stimulation-Based Control of Dynamic Brain Networks

Nicolas Roth[1], Teresa Chouzouris[1], Cristiana Dimulescu[1], Klaus Obermayer[1], and Christoph Metzner[1,2,]

[1]Neural Information Processing Group, Institute of Software Engineering and Theoretical Computer Science, Technische Universität Berlin, Berlin, Germany – [2]Biocomputation Group, Centre for Computer Science and Informatics Research, University of Hertfordshire, Hatfield, United Kingdom

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Introduction

Transcranial electrical and magnetic stimulation (TES and TMS, respectively) have been increasingly used in studies over the last decades and have been found to alter and enhance cognitive processes[1,2,3]. Furthermore, deep brain stimulation (DBS) has shown remarkable results in the treatment of tremor symptoms in Parkinsons disease[4] and also great potential in the treatment of psychiatric disorder such as obsessive-compulsive disorder[5]. However, despite this growing success in clinical settings, a principled understanding of the effects of stimulation on the dynamical processes in the brain is still lacking and, hence, stimulation parameters and target areas are currently not being optimized in a systematic fashion.
Therefore, Muldoon et al.[6] develop a framework to explore the effects of targeted transcranial or deep brain stimulation on overall brain dynamics. In their framework they use data-driven computational model based on subject-specific structural connectivity and a nonlinear model of regional brain activity (the so-called Wilson-Cowan model[7]). Furthermore, they demonstrate that structure-based measures from linear network control theory can predict the functional effect of targeted stimulation.
In this work, we present an implementation of the modelling framework from Muldoon et al.[6] writtem im pure Python, where we exchanged the model of regional brain activity to a faster, phenomenological model, the FitzHugh Nagumo model[8]. We report a *partial/full(?)* replication of their results.

Methods

Briefly recapitulate

- FitzHugh Nagumo
- Oscillatory transition parameters
- Intraclass correlation coefficient (ICC)
- Linear network control theory
- Functional and structural effect, fractional activation

Correspondence should be addressed to Christoph Metzner (cmetzner@ni.tu-berlin.de)
The authors have declared that no competing interests exists.
Code is available at https://github.com/ChristophMetzner/Muldoon-Replication.

Reproduction of experiments

- Replicate Figure 2 (b),c) and d)), 3 states of the FitzHugh Nagumo and comparison to the Wilson-Cowan in b), and for c) our box plots for all subjects, and d) bar plots with our data
- Replicate Figure 3
- Replicate Figure 4 c)
- Replicate Figure 5 a)-d)
- Replicate Figure 6 (?)

I don't think we need to replicate Figure 7 (Structure-function landscape)

Reimplementation

- Details on the new implementation (packages/dependencies, other stuff?, maybe just a paragraph in the methods section)

Discussion

- Main similarities and differences between our and original results. Replication: full, partial or not at all?

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