Imperial College London

Literature review and thesis proposal
MRes. Neurotechonlogy

Investigating plasticity in Cortico-Basal Ganglia-Thalamus models to improve stimulation-based treatments

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Aaron Panaitescu
(*CID:* 02054726)

Supervisor:
Hayriye Cagnan

Word Count: ????

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Contents

1 Introduction / Abstract?

Stylistically, I would prefere to do an abstract here and breakdown the concepts in the following section

2 Background and literature review

start this off nicely with a diagram of the research gap

2.1 Parkinson's Disease

Outline [Del Rey et al., 2018]

** 1. Loss of SNc dopaminergic neurons.**

** 2. indirect GPe → STN pathway ↑, hyperdirect Cortex → STN pathway ↓. (dimmer switch model [Helmich et al., 2012], [West et al., 2022])**

** **add diagram** **

** 3. Hypersynchrony in the Basal Ganglia.**

2.2 DBS: theory and practice

DBS as the state of the art in treatment.

Limitations of DBS (invasiveness, side effects, it needs to be on permenently, why 130Hz? when tremors are ∼ 20Hz)

⇒ plenty of things to be improved

citations needed

also should probably add a bit on other types of stimulation

(e.g. tACS [Saturnino et al., 2017] [Schwab et al., 2020] [Schwab et al., 2019])

2.3 Stimulating at the right time?

important [Cagnan et al., 2017] [Beudel et al., 2018] [West et al., 2022]

2.4 Plasticity to recover network states

mention [Lebedev and Nicolelis, 2017] [Cramer et al., 2011]

2.5 Neuron-level vs. Mean-field models

briefly, in general and expand in the context of plasticity

cover [Jansen and Rit, 1995] ([Hodgkin et al., 1952] does this really need to be cited?)

important [Terman et al., 2002] [Rubin et al., 2012] [Duchet et al., 2023] [Shupe and Fetz, 2021] [Schwab et al., 2020]

2.6 **Other ways of improving stimulation-based treatments**

stimulation parameter optimizations, closing the loop (e.g. aDBS [Beudel et al., 2018]) *Maybe this can be folded into the stimulating at the right time part since they are pretty closely related. Also should mention the idea that these methods are not mutually exclusive, meaning that in principle they could be combined, adaptive stim closing the loop, with inducing plastic changes as target*

3 Project Plan

3.1 Aims

1. Model neuroplasticity in a Parkinsonian CGBT network
2. Investigate the viabillity of harnessing plasticity to remove the system from the pathological state and analyze the dynamics that follow

   here i care about things like for how long and how does the network change. To what degree can we induce changes etc.

   should look into viable timescales + noise analyze how long does it take to rebound to pathological state
3. Try to link potential results to potential stimulation protocols?

3.2 Methodolgy

How indeed? HH/IF Pakrkinsoni model + plasticity rules, trying different stimulation-based protocols (link with experimental data?)

look into how to tune IF model parameters from experimental data

3.3 Timeline

Gant chart thingy

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Appendices

A First appendix

B Second appendix