

MASTER 2 Fundamental and Clinical Neurosciences

Internship proposal 2023-2024

(internship from January to June 2024)

Host laboratory: Stem Cell & Brain Research Institute, Inserm U1208 18 Avenue du Doyen Jean Lepine, 69500 Bron (Site of the "Hopitaux Est")



Host team : Neurobiology of Executive Functions <u>https://sbri.fr/teams/neurobiology-of-executive-functions/</u>

Internship supervisor :

Charlie Wilson, CRCN, Charles.wilson@inserm.fr

Project title :

The emergence of prefrontal neural dynamics through cognitive training – a neural basis for meta learning?

Project summary :

Our understanding of the neural dynamics of the prefrontal cortex (PFC) and its interactions with other structures in complex cognitive tasks is largely based on recordings in over-trained macaque monkeys. Although providing precious information, this approach ignores the crucial role of the PFC in cognitive training and learning more generally. Previous work shows that the PFC is a critical structure during cognitive training (Wilson & Gaffan 2008; Browning et al 2007), yet we know virtually nothing about its neural dynamics during this process. Learning to learn (or meta learning) is a separate process to learning per se, and much less well understood (Faraut et al 2016).

In the team we are addressing this problem by using novel longitudinal chronic neurophysiological recordings in naïve macaque monkeys learning cognitive tasks to provide data on how the PFC subserves cognitive training (for an example of this recording approach for a different research question see Wilson et al 2016). This approach allows us to track how the neural responses and dynamics of the PFC change as a monkey goes from naïve to expert

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in a task. In addition we track the role of PFC in motivation for these tasks. Motivation modifies both PFC neural activity and progression in cognitive training dynamics (Botvinick & Braver 2015).

This is therefore a fundamental research project, but the understanding it will bring should have important clinical implications. Cognitive training forms a critical part of remediation strategies in learning impairments as well as recovery from brain injury. Changes in PFC dynamics are implicated in a range of pathologies including ADHD and OCD, as well as in aging. This project therefore seeks to provide a firm, but currently missing neural evidence base for the PFC cognitive training process, and the motivation for it.

Our neurophysiological recordings generate lots of novel data, for which there are many interesting analysis questions. The proposed internship project is to investigate a specific question within this dataset – and there are many potential questions that we have yet to address. For this internship the student will be provided with new and exciting data of chronic intracortical recordings. We will construct the detailed content of the internship together with the interested student. Possible questions to pursue are:

• How do neural oscillations adapt to task learning?

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- Can we reveal a neural difference between learning and meta learning?
- How does becoming expert in a task change motivation and related brain states?
- How do bursts of oscillation coordinate frontal cortex functions?

To ensure M2 interns experience all elements of a monkey neurophysiology project, we provide students with already-acquired data to analyze, plus the opportunity to experience the current recordings in the lab. Analysis work is the core of the internship, but students will also gain extensive experience in the lab of how data are acquired, how the monkeys work, etc. We work hard to give a good internship experience that covers the whole process of our research, and potential candidates are encouraged to contact previous interns to discuss.

The student should have some knowledge of programming in R and one of Matlab or Python before the internship starts. We can offer lots of help to students who need to do this preparation between now and then - contact <u>Charles.wilson@inserm.fr</u> to discuss it. Close daily supervision will be provided to carefully guide the analyses, and the student will be able to work with current lab members working on similar questions. The data and the analysis approaches are highly promising. There is certainly the potential for a motivated student to obtain a good publication from the work in the internship.

Relevant publications from the team:

Wilson C.R.E., Gaffan D. (2008) Prefrontal-inferotemporal interaction is not always necessary for reversal learning. Journal of Neuroscience 28(21):5529-38. https://doi.org/10.1523/JNEUROSCI.0952-08.2008

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- Browning PG, Easton A, Gaffan D. (2007) Frontal-temporal disconnection abolishes object discrimination learning set in macaque monkeys. Cereb Cortex. Apr;17(4):859-64. https://doi.org/10.1093/cercor/bhk039
- Faraut, M. C. M., Procyk, E., & Wilson, C. R. E. (2016). Learning to learn about uncertain feedback. *Learning & Memory (Cold Spring Harbor, NY)*, 23(2), 90–98. <u>http://doi.org/10.1101/lm.039768.115</u>
- Wilson, C. R. E., Vezoli, J., Stoll, F. M., Faraut, M., & Leviel, V. (2016). Prefrontal Markers and Cognitive Performance Are Dissociated during Progressive Dopamine Lesion. *PLoS Biology*. <u>http://doi.org/10.1371/journal.pbio.1002576.s005</u>

Other references:

Botvinick, M., & Braver, T. (2015). Motivation and Cognitive Control: From Behavior to Neural Mechanism. *Annual Review of Psychology*, 66(1), 83–113. http://doi.org/10.1146/annurev-psych-010814-015044

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