MASTER 2 Fundamental and Clinical Neurosciences

Internship proposal 2025-2026

(internship from January to June 2026)

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
https://sbri.fr/teams/neurobiology-of-executive-functions/

Internship supervisor :
Charlie Wilson, CRCN, Charles.wilson@inserm.fr

Project title :
The prefrontal neural dynamics of cognitive training – a neural basis for meta learning?

Project summary :

We know a lot about the brain's processes of basic learning. But a separate process, learning to learn, allows our learning to become more efficient and flexible. This is what happens when we engage in cognitive training – be it in education or in general life – so that our learning and decision making become well adapted. This process is poorly understood, though work, including some from our team (Wilson & Gaffan 2008; Browning et al 2007), suggests it is a key role of the prefrontal cortex (PFC). Our current project seeks to describe the neural mechanisms of this learning to learn in PFC.

Our understanding of the neural dynamics of the prefrontal cortex (PFC) in cognitive tasks is largely based on recordings in heavily trained macaque monkeys. Although providing precious information, this approach ignores the crucial role of the PFC in cognitive training, because we record ***after*** the learning. We have been studying learning to learn (or meta learning) as a separate process to learning per se (Faraut et al 2016), and we have now turned to the neural dynamics of this process.

Please send your proposal to marion.richard@univ-lyon1.fr for publication on the Master of Neuroscience website.

We are addressing this problem by using longitudinal chronic neurophysiological recordings - as we have done previously in the context of Parkinson's disease (Wilson et al 2016). We make these recordings in macaque monkeys who start out naïve and then learn cognitive tasks, and we record ***throughout learning***. This approach allows us to track how the neural responses and dynamics of the PFC change as a monkey goes from naïve to expert 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.

The proposed internship project is to investigate a specific question within a rich new dataset of prefrontal recordings – there are many potential questions, and 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?
- 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 experiments 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 Charles.wilson@inserm.fr 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

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. http://doi.org/10.1101/lm.039768.115

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*. http://doi.org/10.1371/journal.pbio.1002576.s005

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