

## MASTER 2 Fundamental and Clinical Neurosciences

### Internship proposal 2026-2027

(internship from January to June 2027)

**Host laboratory:** Centre de Recherche en Neurosciences de Lyon  
Team located at : 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](mailto:Charles.wilson@inserm.fr)

**Project title :** The prefrontal neural dynamics of cognitive training and learning to learn

#### Project summary :

We know a lot about learning processes in the brain. But a separate process, **learning to learn**, also referred to as meta-learning, allows our learning to become more efficient and flexible, for example through cognitive training in education or in general life. 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 learning to learn in PFC.

Our understanding of the neural dynamics of the PFC in cognitive tasks is based on recordings in heavily trained macaque monkeys. This approach ignores the crucial role of the PFC in cognitive training, because we record **after** the training. 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.

We use longitudinal chronic neurophysiological recordings - as we have done previously in the context of Parkinson’s disease (Wilson et al 2016). Macaques in these experiments start out naïve and then learn cognitive tasks, and we record **throughout learning**. This 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. We also study 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 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?
- How does the PFC in the two hemispheres coordinate during learning?

We provide students with already-acquired data to analyze in an active research project, and we also provide 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 of how data are acquired, how the monkeys work, etc. We work hard to give a good internship experience; potential candidates are encouraged to contact previous interns to discuss.

The student should have some knowledge of programming in R and Python before the internship starts. We can offer help to students who need to do this preparation between now and then - contact [Charles.wilson@inserm.fr](mailto: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>