MASTER 2 Neurosciences Fondamentales et Cliniques

Internship proposal 2021-2022

(internship from January to end of May 2022)

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

SBRI Stem-cell & Brain Research Institute Lyon

Host team :
Neurobiology of Executive Functions
https://www.sbri.fr/team/6neurobiology-executive-functions

Internship supervisors :
Charlie Wilson, CRCN, Charles.wilson@inserm.fr (Supervisor of proposed stage)
Emmanuel Procyk, DR2, Emmanuel.procyk@inserm.fr (Team leader)

Project title :
What is the neurophysiological basis of attentional effort and motivation in prefrontal cortex?

Project summary :

Motivation has a profound effect on the neurophysiology of prefrontal cortex (PFC, Botvinick & Braver 2015), but the way motivation interacts with the other things PFC does is not well understood. Motivation drives task performance through the application of attentional effort (Sarter et al 2006). Attentional effort is linked to *both* intrinsic motivation *and* specific factors of the task itself, for example how engaging and rewarding it is. It may reduce over time, for example in the "time-on-task" effect (Boksem et al 2006).

In our team we have used chronic neurophysiology in macaque monkeys, to study how attentional effort is implemented in PFC. We revealed an intriguing effect of strong and specific modulation of the beta oscillations in frontal cortex around pauses in work that monkeys make (Stoll, Wilson et al, 2016; Wilson et al 2016).

This work is very promising, but there remains much to be done. The proposed internship project is to further investigate these neurophysiological mechanisms in several datasets from monkeys, and to help design specific protocols for the next set of experiments. There are many potential questions to answer in this project. We will construct

the detailed content of the internship together with the interested student. Possible questions to pursue are:

- How does the brain change between motivated and non-motivated states?
- What factors determine attentional effort in a given session?
- How do bursts of oscillation contribute to attentional effort on a task?
- What is the effect of pauses on task performance, and can we predict pauses?
- How does the brain integrate different factors impacting motivation?
- How can we design cognitive protocols to capture and modulate attentional effort?

Monkey neurophysiology projects are very long (2-5 years) and it is unfortunately impossible for M2 students to collect and analyze data for a whole study. Instead, we provide students with already-acquired data to analyze, plus experience of current recordings in the lab. Analysis work is the core of the internship, and students gain extensive experience to see 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.

For this internship the student will be provided with lots of great data – two large datasets of electrocorticography (ECoG) recordings in macaque monkeys recorded in-house, and one even larger dataset of intracortical recordings provided by collaborators. All datasets cover prefrontal and premotor cortex, and two additionally cover parietal cortex and some visual areas. The monkeys are performing learning and decision-making tasks in long sessions that tax their motivation and attentional effort (Stoll, Wilson et al, 2016; Faraut et al., 2016; Dotson et al 2018).

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 in addition the student will be able to work with current lab members working on similar questions. The data and the analysis approaches are highly promising, and a significant amount of initial work has been completed. 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:

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

Stoll*, F. M., Wilson*, C. R. E., Faraut, M. C. M., Vezoli, J., Knoblauch, K., & Procyk, E. (2016). The Effects of Cognitive Control and Time on Frontal Beta Oscillations. *Cerebral Cortex (New York, NY : 1991)*, *26*, 1715–1732. http://doi.org/10.1093/cercor/bhv006

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

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:

Boksem MAS, Meijman TF, Lorist MM. 2006. Mental fatigue, motivation and action monitoring. Biol Psychol. 72:123–132. https://doi.org/10.1016/j.biopsycho.2005.08.007

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

Dotson, N. M., Hoffman, S. J., Goodell, B., & Gray, C. M. (2018). Feature-Based Visual Short-Term Memory Is Widely Distributed and Hierarchically Organized. *Neuron*, *99*(1), 1–17. http://doi.org/10.1016/j.neuron.2018.05.026

Sarter M, Gehring WJ, Kozak R. 2006. More attention must be paid: the neurobiology of attentional effort. Brain Res Rev. 51: 145–160. https://doi.org/10.1016/j.brainresrev.2005.11.002