PhD Research Proposal Form
China Scholarship Council (CSC)
2025

A remplir en français ou en anglais en fonction de la langue qui sera utilisée pour la thèse

FIELD
Neuroscience / biology

(eg: Mathematics, Physics, Sociology, ….)

Thesis subject title:

Neuro-glia interactions during behavioural state transitions

Name of the French doctoral school/Ecole doctorale: PSL Sciences du vivant

Name of the Research team/Equipe de recherche: Neural circuit dynamics and behaviour
Website: www.zebrain.biologie.ens.fr

Name of the Supervisor/Directeur de thèse: German Sumbre
Email: sumbre@ens.fr

Lab Language/ Langue de travail: English

Research Proposal Abstract/Présentation du sujet:

Zebrafish have a special type of radial glia called radial astrocytes (RAs). In contrast to those of mammals, RAs do not degenerate and display analogous functions to those of astrocytes. Previous studies showed that RAs in the hindbrain enable larvae to switch to a quiescent behavioral state. In the forebrain, perturbations of the glia-neuron interactions lead to the emergence of epileptic seizures?. In a recent study, we found that in the optic tectum of zebrafish, RAs synchronize their Ca2+ transients immediately after the end of a spontaneous escape behavior. Using two-photon Ca2+ imaging, optogenetics and ablations we showed that RA synchronous Ca2+ events are mediated by the locus coeruleus. The RA synchronizations modulated the direction selectivity and the functional correlations among tectal neurons. This mechanism supports freezing behavior following a switch to an alerted state. Here, we propose to investigate the neuronal pathways and mechanisms underlying the behavioural-state transition. For this purpose, we will use transgenic zebrafish expressing the genetically encoded Ca2+ indicator GCaMP7f and the opsin ReaChR (optogenetic stimulation of neurons), in combination with a 3D two-photon system and a digital micromirror device for pattern illumination for opsin activation.
Supported by preliminary results, we will investigate the hypothesis that the medula oblangata gates the behavioral-state transitions, by integrating information from the internal state of the animal (e.g. sensory inputs form the gut and/or oxygen levels). In addition, we will investigate the downstream

neuronal and glial pathways following the spontaneous activation of the medula oblangata. Overall, this study will shed light on the neuronal and glia pathways and mechanisms across the entire brain, underlying the behavioral-state transitions.

References:

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2. Lloyd, E., McDole, B., Privat, M., Jaggard, J. B., Duboué, E., **Sumbre G***, & Keene, A*. (2022) Blind cavefish retain functional connectivity in the tectum despite loss of retinal input. ***Current Biology.*** 32(17):3720-3730.e3

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4. Privat, M.; and **Sumbre G**. (2020) Naturalistic Behavior: The Zebrafish Larva Strikes Back.***Current Biology.*** 30(1): R27-R29.

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8. Marachlian, E.; Avitan, L.; Goodhill, G., J.; and **Sumbre G.** (2018) Principles of Functional Circuit Connectivity: Insights From Spontaneous Activity in the Zebrafish Optic Tectum. ***Front. Neural Circuits***, 12(June): 1-8. 6 2018.

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Type of PhD :

1.Full PhD

- Joint PhD/cotutelle (leading to a double diploma) : YES
- Regular PhD (leading to a single French diploma) : YES

2. Visiting PhD (students enrolled at a Chinese institution who come to ENS for mobility period) : YES

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