APPEL A PROJETS DE THÈSE 2026
CONCOURS DE L'ED 658 – Sciences du vivant

Formulaire à compléter et déposer par les porteurs du projet de thèse HDR via l'adresse mail suivante :
ed658@univ-amu.fr OU/ET romane.haddadi@univ-amu.fr
MERCI DE METTRE EN SUJET DU MAIL : Concours ED 658 2026 porteur de projet
Ces dossiers seront publiés pour que les candidats postulent.

au plus tard le 3 mars 2026.

INTITULÉ DU PROJET

DECODING OF THALAMIC CONTROL OF HIPPOCAMPO–PREFRONTAL COMMUNICATION SUPPORTING SPATIAL ENCODING AND MEMORY CONSOLIDATION

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SPECIALITE : (Rayer les mentions inutiles)

Neurosciences

SOUS JURY POUR LE CONCOURS : (Rayer les mentions inutiles)
JURY 3 : NEURSOCIENCES

MERCI DE REMPLIR TOUTES LES INFRORMATIONS EN FRANÇAIS ET EN ANGLAIS

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Description de la problématique de recherche - Project description

Understanding how distributed brain regions coordinate their activity during sleep to support memory consolidation remains one of the central challenges in contemporary neuroscience. In particular, although it is well established that successful memory consolidation depends on coordinated interactions between the hippocampus and the medial prefrontal cortex, the mechanisms that orchestrate this long-range communication are still poorly understood. Our overarching project aims to investigate the role of the thalamic nucleus reuniens (NR) as a key hub in regulating hippocampo–prefrontal interactions that support memory consolidation.

More specifically, this PhD project will focus on determining how NR modulates and coordinates hippocampo–prefrontal dialogue during spatial learning and how this interaction is subsequently reorganized during post-learning sleep to enable memory consolidation. By linking neural dynamics observed during behaviour and sleep, the project seeks to identify the circuit-level mechanisms through which NR contributes to the stabilization and long-term storage of memory traces.

To address these questions, the project combines cutting-edge, high-density, multi-site electrophysiological recordings of both single-neuron activity and local field potentials across three interconnected brain regions simultaneously—the hippocampus, the medial prefrontal cortex, and the nucleus reuniens—in freely behaving rats performing spatial learning tasks. In parallel, a closed-loop experimental approach will be implemented in which ongoing neuronal activity in NR is detected in real time, allowing its firing patterns to be selectively perturbed using optogenetic or chemogenetic tools at precisely defined moments during task performance and/or during sleep.

By integrating these perturbations with advanced data-science pipelines (Python/Matlab), including statistical analyses, machine learning methods, and signal-processing approaches, the project aims to characterize large-scale neuronal population dynamics and their coordination across brain regions. This strategy will make it possible to causally test how NR regulates hippocampo–cortical communication and to determine its specific contribution to memory encoding during learning and memory consolidation during sleep.

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Mots clés – Keywords

memory, consolidation, Network, Hippocampus, Thalamus, cortex, behaviour, in vivo electrophysiology, systems neuroscience

Thématique / Domaine / Contexte - Theme / Field / Context

Memory consolidation represents a particularly important cognitive process, as memory fundamentally defines our identity as individuals. The consolidation of declarative memories occurs predominantly during sleep and involves a dialogue between two brain regions: the hippocampus (HPC), which initially encodes experiences, and the prefrontal cortex (PFC), which supports their long-term storage. Information acquired during behaviour is consolidated during sleep. This process relies on the progressive strengthening and integration of memory traces in the prefrontal cortex, through a dialogue with the hippocampus orchestrated by oscillatory events such as sharp-wave ripples, spindles, and slow oscillations. However, because these two structures lack direct reciprocal connections, their dialogue likely depends on an intermediary relay to function effectively. Many studies suggest the involvement of a third partner, the thalamic nucleus reuniens (NR). With its bidirectional connections to both structures, the NR holds a key position to relay information between the HPC and PFC, and potentially mediate their dialogue. While previous work demonstrated its role in coordinating hippocampo-prefrontal activity under anaesthesia, the mechanisms by which the NR orchestrates this dialogue during natural sleep, particularly following spatial learning, remain largely unexplored.

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Objectifs

To better understand its involvement in memory consolidation, this project aims to investigate the activity of the HPC-NR-PFC network in rats using high-density silicon probes recordings combined with a spatial memory task.
In order to test the causal role of NR on HPC-PFC communication during encoding and consolidation, the candidate will perform a closed-loop approach, in which ongoing NR activity will be decoded in real time, and its firing rhythm selectively perturbed with optogenetic or chemogenetic tools during selective moments within the task or during sleep.
By applying advanced data science pipelines in Python/Matlab, the candidate will quantify large-scale population dynamics, test causal mechanisms of hippocampo–cortical communication, and explore how NR contributes to information encoding and memory consolidation.

Méthode – Method

The student will work in a collaborative environment within a friendly, international team and perform the following approaches :

- Animal handling and in vivo electrophysiology
- Closed-loop neural decoding and optogenetic/chemogenetic manipulation
- Neural data analysis with modern data science tools
- Behavioural training
- Post-hoc histology

Références bibliographiques

https ://doi.org/10.1016/j.neubiorev.2021.02.025
https ://doi.org/10.1002/hipo.22997
https ://doi.org/10.1007/978-1-0716-4208-5_2
https ://doi.org/10.1038/s41583-021-00448-6

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Conditions scientifiques matérielles et financières du projet de recherche - Scientific, material, and financial conditions of the research project

The PhD work will take place at the Institut de Neurosciences des Systèmes (INSERM UMR1106, Aix-Marseille Université), within the PhysioNet team, and will be supervised by two researchers, Pascale Quilichini (HDR) and Marco Pompili. The project also involves an engineer and one PhD student.

The PhysioNet team is an international group that brings together neuroscientists, physicists, and engineers to understand how brain networks exchange information in both healthy and pathological conditions. We use high-density recordings of hundreds of single neurons across multiple brain areas simultaneously in freely behaving rats, combined with advanced data science pipelines (statistics, machine learning, signal processing).

All the materials, experimental setup and computing facilities are available on site.

The project is currently funded by an ANR.

Profil et compétences recherchées - Profile and skills required

- Honest, curious person who isn't afraid to ask questions
- Ready to work seriously and meticulously
- Happy to work as part of a team « dans la bonne humeur »
- Must be able to work in a collaborative environment
- Some coding proficiency— and even building custom little engineering solutions when needed
- A strong electrophysiology background (solid in theory, and good experimentally)
- Must be able to be working with rats (always under strict animal welfare standards)
- A strong background in neuroscience
- Able to communicate in English

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