Title: PhD candidate in Neurosciences - M/F

The host institute:

The PhD thesis will be performed within the inDEV (Imaging Neurodevelopmental Phenotypes) team at the Inserm NeuroDiderot unit (Paris), the Institute (IHU) Robert-Debré du Cerveau de l'Enfant, and the NeuroSpin neuroimaging center (CEA Paris-Saclay). The team investigates the functional and structural variability of human brain development using advanced neuroimaging techniques and explores how this variability relates to neurological and cognitive functions, in particular in pathological models characterised by early antenatal or perinatal determinism.

- inDEV team: https://neurodiderot.u-paris.fr/equipes-de-recherche/indev/
- NeuroDiderot unit: https://neurodiderot.u-paris.fr/
- NeuroSpin Center: https://joliot.cea.fr/drf/joliot/recherche/neurospin

About the position:

A 3-year funded PhD position in developmental cognitive neuroscience is available within the inDEV team at NeuroDiderot unit, IHU Robert-Debré and NeuroSpin Center.

Project: Investigating the cerebral bases of sleep-dependent learning in early infancy and the impact of prematurity

Infancy is a period of rapid brain development and remarkable learning from the sensory environment [1,2]. To make sense of the external world, the developing brain must first encode sensory information and then consolidate these experiences into stable neural representations - a process known as memory consolidation. Studies in both animal models and adult humans have shown that memory consolidation is most effective during sleep, when recently acquired experiences are reactivated through the replay of neuronal firing patterns [3,4]. This process is supported by characteristic sleep oscillations, particularly sleep spindles and slow oscillations [5]. Although sleep occupies a substantial proportion of early life, the neural mechanisms underlying sleep-dependent encoding and memory consolidation in human infants remain poorly understood. Moreover, it is unclear how these early processes may be altered by perinatal stress associated with prematurity.

The first objective of this PhD project is to characterize the organization of brain activity during sleep at the developmental stage when sleep spindles first emerge. This axis will be based on an existing electroencephalography (EEG) dataset collected from infants at approximately two months of age. The rapid dynamics of brain activity will be investigated across different sleep states using microstate analysis [6], a method that identifies recurring spatiotemporal patterns of large-scale brain activity. This approach will enable the characterization of sleep-specific brain dynamics and their modulation by endogenous neural events, such as sleep spindles, as well by exogenous neural events related to perception of sensory stimuli (tactile stimulation). Comparisons between full-term and preterm infants will also allow the identification of alterations in sleep dynamics associated with prematurity [6,7].

The second objective of the PhD project is to gain insights into the mechanisms of sleep-dependent encoding and memory consolidation during the first postnatal months. To achieve this, the PhD candidate will develop and implement an experimental EEG study involving infants from birth to six months of age. The protocol will be designed so that infants participate in a sensory learning paradigm [8], to examine neural responses during the online encoding of

auditory sequences. EEG recordings will then continue during sleep immediately following the encoding phase, allowing the investigation of offline consolidation processes, using decoding approach [9]. A further goal of this study will be to determine when interactions between slow oscillations and sleep spindles first emerge during development, as this coupling is thought to represent a hallmark of mature, adult-like memory consolidation. This part of the project will involve piloting the experimental protocol, collecting EEG data in infants, and performing data analysis. There is potential for exploring these same questions in preterm born infants in comparison with fullterms in order to better understand the impact of prematurity on sleep-dependent consolidation mechanisms.

The student will work under the co-supervision of Jessica Dubois (Research Director, PhD, HDR) and Parvaneh Adibpour (Researcher CRCN, PhD), in collaboration with Ghislaine Dehaene-Lambertz (Research Director, MD, PhD, HDR, UNICOG laboratory) and the clinical teams of Robert-Debré Hospital (Departments of Neonatology, Functional Explorations, Child Psychiatry and Maternity). The PhD candidate will have opportunities for scientific exchange with collaborators: Claire Kabdebon (CNRS) and Arnaud Boutin (Paris-Saclay University). The project will be conducted within a highly interdisciplinary research environment and a stimulating national research network, promoting strong interactions between fundamental and clinical neuroscience.

Desired profile:

Applicants with a strong interest in the study of early development, brain explorations, and with prior experience in human experiment, signal processing and programming are particularly encouraged to apply. Candidates are invited to email a motivation letter, a CV detailing their academic background and 1 to 3 letters of recommendation to: parvaneh.adibpour@inserm.fr and jessica.dubois@inserm.fr.

- Education level or diploma: MSc degree in Biological sciences, Neurosciences, Biomedical engineering or other relevant domains.
- Languages: Fluency in written and spoken English, Knowledge or interest in learning of French is appreciated in order to interact with families.
- Expertise in data analysis tools: Prior experience in signal or imagine processing (in particular EEG analysis) and machine learning preferably with MATLAB, Python, and R is appreciated.
- Experience in conducting experiments with human participants: Familiarity with conducting neuroimaging or behavioural experiments in humans and an interest for conducting experiments in human infants is highly appreciated.
- Envisaged start date: December 2026
- Deadline for application: 30th September 2026

The doctoral candidate will receive a 36-months doctoral contract intended to cover living expenses. The amount of the salary is based on a monthly living allowance, adjusted based on the candidate's family situation. The student will enrol in the Doctoral School "Brain, Cognition and Behaviour" (ED3C: https://ed3c.sorbonne-universite.fr/en), with affiliation to the Université Paris Cité (UPC).

References:

1. Dubois, J., & Dehaene-Lambertz, G. (2015). Fetal and Postnatal Development of the Cortex: MRI and Genetics. Vol. 2.
2. Dehaene-Lambertz, G., & Spelke, E. S. (2015). The infancy of the human brain. *Neuron*, *88*(1), 93-109.
3. Ji, D., & Wilson, M. A. (2007). Coordinated memory replay in the visual cortex and hippocampus during sleep. *Nature neuroscience*, *10*(1), 100-107.
4. Staresina, B. P., Bergmann, T. O., Bonnefond, M., Van Der Meij, R., Jensen, O., Deuker, L., ... & Fell, J. (2015). Hierarchical nesting of slow oscillations, spindles and ripples in the human hippocampus during sleep. *Nature neuroscience*, *18*(11), 1679-1686.
5. Klinzing, J. G., Niethard, N., & Born, J. (2019). Mechanisms of systems memory consolidation during sleep. Nature neuroscience, 22(10), 1598-1610.
6. Adibpour, P., Nasser, H., Pedoux, A., Devisscher, L., Elbaz, N., Ghozland, C., ... & Dubois, J. (2025). Characterizing the temporal dynamics and maturation of brain activity during sleep: An EEG microstate study in preterm and full-term infants. *Imaging Neuroscience*, *3*, imag_a_00450.
7. Gonzalez-Carpinteiro, A., Nasser, H., Pedoux, A., Devisscher, L., Cai, K., Elbaz, N., ... Dubois J. & Adibpour, P. (2025). Characterization of aperiodic and theta activity in preterm infants using EEG: Insights into cerebral maturation and inter-individual variability. *Developmental Cognitive Neuroscience*, 2026
8. Fló, A., Benjamin, L., Palu, M., & Dehaene-Lambertz, G. (2022). Sleeping neonates track transitional probabilities in speech but only retain the first syllable of words. *Scientific reports*, *12*(1), 4391.
9. Gennari, G., Marti, S., Palu, M., Fló, A., & Dehaene-Lambertz, G. (2021). Orthogonal neural codes for speech in the infant brain. *Proceedings of the National Academy of Sciences*, *118*(31), e2020410118.