Internship Proposal

Academic Year 2023-2024

Host Team

Research Unit (e.g. Department or Institute): NeuroSpin-UNIACT / U1141 Neurodiderot

Research Unit Director: S Dehaene

Research Team Director: L Hertz-Pannier

Team name: inDEV/NeuroDiderot @UNIACT/Neurospin (https://joliot.cea.fr/drf/joliot/en/Pages/research_entities/NeuroSpin/uniact/neuropediatrics.aspx)

Address :

NeuroSpin, Building 145

CEA Paris-Saclay

91191 Gif-sur-Yvette CEDEX

Supervisor of the Research Intern for this project: L Hertz-Pannier

E-mail : lucie.hertz-pannier@cea.fr

Internship project title:

AVCnnADO, Adolescence after a neonatal stroke: A window into long-term brain plasticity in children. Longitudinal neuropsychological and multimodal advanced MRI study.

Study of the structural connectome in relationship with functional hemispheric specialization

Internship Description :

Neonatal stroke is a 'model' for studying post-injury plasticity in the immature brain, which is said to have a better functional prognosis than in adults. Conversely, this early injury may impact a wider range of cognitive functions. How do deficiencies/capacities (motor skills, oral and written language, visuospatial functions, executive functions) evolve at adolescence? In particular, what do we know about the reorganization/relocation of functional networks secondary to the early lesion and of their structural correlates ? Can we better characterize the correlates of the “crowding effect” in imaging?

The AVCnnADO project is the continuation in adolescence of the longitudinal evaluation of the AVCnn cohort (Babies born in 2003-6 who suffered a neonatal stroke), by combining neuropsychology and advanced MRI of the structural and functional architecture of cognitive networks.

The project is taking place at Neurospin (CEA-Saclay), within the framework of a protocol combining extensive neuropsychological tests and 3T MRI, with morphometric, microstructural (diffusion MRI), functional, and resting state connectivity (rs-fMRI) studies

35 adolescents from the AVCnn cohort and a control group of 35 matched healthy adolescents have been included.

The specific objectives of the Master2 training course consist of the analysis of diffusion MRI data acquired at the age of 16 years, in relation to longitudinal (at 7 and 16 years) clinical and morphometric (brain growth, lesion volume) and functional MRI (language, mental calculation, motor tasks in the audio and visio modalities) data (already available, PhD thesis in progress) in comparison with the groups of age-matched control subjects. Particular attention will be paid to the difficulties linked to the presence of a brain lesion which distorts the cerebral anatomy.

The objectives of the analyses will be centered around the computation of the structural connectome of the contralesional hemisphere with regard to its functional specialization for language abilities.

Indeed, children with early left hemisphere lesions are able to develop a near-normal language thanks to the organization of language networks in the right hemisphere (while the left hemisphere is specialized for language in the vast majority of typical subjects). Ample data suggest that microstructural integrity and/or changes of the white matter fibers support the performances in corresponding cognitive functions.

Data : High quality diffusion MRI data have been acquired with 2 different b values (1000, and 1500 sec/mm2, 1,8 mm3 isotropic) to enable sophisticated analyses beyond the classical tensor model (ODF, Fixel-based analyses, NODDI …).

All subjects of the 2 groups (patients and controls) have performed a language fMRI task enabling to compute a hemispheric/regional lateralization index at the individual level. Thus, diffusion data will be analyzed by comparing structural connectomes in the left (language dominant) and right hemispheres in the controls, in patients with ‘typical’ left hemisphere language specialization, and in patients with right hemisphere language specialization (occurring as a result of the early left sided stroke).

A similar approach might be developed using functional data during mental calculation tasks, .

Results will be correlated with clinical data and language and cognitive tests (all data available)

The student will be in charge of all the steps of the analysis:

- Quality control (multimodal image registration issues, largely initiated in previous parts of the project)
- Definition of Regions of interest based on functional activations
- Choice of appropriate white matter bundles (based on atlases and/or tractography)
- Extraction of diffusion metrics
- Statistical analysis and interpretation.

He/she will be co-supervised by the PhD student in charge of the project, under the responsibility of the Principal Investigator (LHP), and with the help of the research engineer of the team.

Sought Candidate Profile

- Diploma prepared: Master or Engineer
- Training in neuroimaging – Medical Imaging- Bioengineering
- Interest in clinical neuroscience, curious, autonomous, methodical
- Programming skills (Python, bash)