Spatio-temporal connectivity as a biomarker for neurodevelopmental pathologies.

Context:

The PROFouNd project will develop new functional cerebral connectivity assessments and evaluate their potential added value for the early diagnosis of neurodevelopmental disorders (NDDs), both in animal models and on in-human data. NDDS are a major societal and public health burden, affecting one million newborns each year in Europe. These disorders, ranging from severe motor deficit and cerebral palsy to autism spectrum disorders (ASD) and schizophrenia, are often diagnosed late due to the lack of tools to establish an early diagnosis, in childhood or as a neonate. This hampers in some cases the deployment of effective therapies.

Project

Many **neurodevelopmental disorders (NDDs)** are associated with perturbations of functional interactions between cerebral areas. This makes the quantitative and non-invasive assessment of those interactions a potential efficient biomarker to ensure early detection and better prognosis of these pathologies. However, limitations in the currently available neuroimaging techniques in terms of spatiotemporal resolutions and clinical applicability has hindered the wide clinical deployment of such functional connectivity-based diagnosis. Our project tackles this challenge by developing **spatiotemporal functional connectivity (STFC)**, an innovative characterization of multiscale (mesoscopic to large scale) brain activity expected to offer unprecedented sensitivity and specificity. It leverages **functional UltraSound (fUS) neuroimaging**, a cutting-edge brain imaging modality with high translational potential, and innovative post-processing techniques focusing on propagative brain activity. The ultimate goal is **to identify potential fUS-based STFC biomarkers of NDDs suitable both for preclinical and clinical neonatal imaging.**

Specifically during the PhD we will develop a **set of descriptor tools tailored to specifically capture propagative activity** in neural (Optical and fUS) data and further derive **a STFC processing technique, relying on these descriptors**, to estimate repetitive propagative spatiotemporal patterns. Secondly, we will benchmark the performance of these methods in scoring spontaneous cortical dynamics associated with distinct animal states (e.g., active, quiet, sleep phases, sedation), using calcium and intrinsic optical imaging data recorded synchronously in GCaMP6 mice. **Our final aim is to validate that fUS-based STFC can efficiently score pathological brain states**. We will assess the potential of STFC applied on fUS data as an early biomarker for NDDs in a relevant cross-species (mice and ferrets) preclinical model of NDDs. Building from those biomarkers in animals we will then search for comparable STFC signatures in fUS data acquired in human neonates.

Candidate

We are looking for a very transdisciplinary profile, with background in wave physics, biomedical engineering, coding, and a marked taste for neuroscience. Please send CV, cover letter, one recommendation letter and copy of master's grades to charlie.demene@espci.fr