PROJET ATTACK-AVC

Like in other connected systems, studying the structure of the interactions between different brain regions has profound implications in the comprehension of emergent complex phenomena as, for example, the capability of the human brain to functionally reorganize after cerebrovascular "attacks" or stroke. This dynamic skill, which is known in neuroscience as neural plasticity, is not only interesting from a network science perspective, but it also plays a crucial role in determining the motor/cognitive recovery of patients who survive a stroke. As a critical innovation, the project ATTACK-AVC proposes to develop a systematic and rigorous approach based on neuroimaging techniques, signal processing, and network science for the modeling and analysis of temporally dynamic neural processes that characterize motor recovery after stroke.

To achieve these goals, the project is organized around the following objectives. The first one is acquiring a comprehensive longitudinal dataset of brain and behavioral/clinical data after stroke. Secondly, developing new analytic tools to characterize and generate temporally dynamic brain networks. And finally, developing network-based models of motor recovery after stroke, accounting for individual patients.

These objectives involve an intensive gathering of heterogeneous mass data, their processing, the subsequent outcome interpretation and statistical simulation, as well as the development of longitudinal models and network-based diagnostics of the patient's motor recovery progress. Results will unveil multiscale properties of dynamic brain networks and identify predictive neuromarkers for motor recovery after stroke.

This project has a two-fold impact on the society. On the one hand, it will provide new methods and robust tools to properly characterize and model temporally dynamic networks in neuroscience. On the other hand, it will provide longitudinal models of motor recovery in stroke patients that can potentially unveil the neural substrate that underpins rehabilitation, improve prognosis, and eventually lower cost of hospitalization time.

From a broader perspective this interdisciplinary project proposes a transformative approach to analyze large scale neural' systems. This research provides novel insights into the temporal interconnection structure of the human brain, and proposes entirely new methods to construct network-based models of neural plasticity from neuroimaging data. Results will foster the development of innovative predictive neuromarkers for monitoring outcome and treatment response of neurological diseases and psychiatric disorders. The inclusion of advanced neurofeedback and brain stimulation-based rehabilitation approaches, capitalizing on the brain reorganizational mechanisms, are the main current project's objectives.

Since 2020, the inclusion of patients follows its course, as 5 patients and 4 witnesses have been included in the study as of December 2020.

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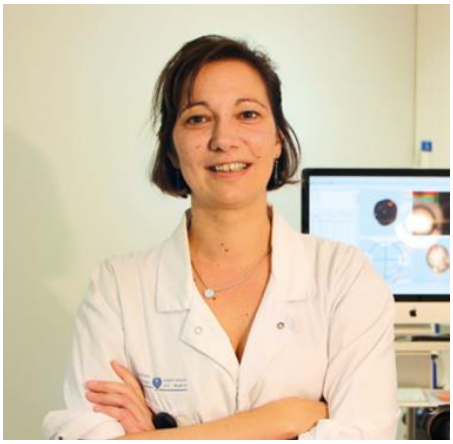
This process is separated in several visits. The first one is carried out, depending on the patient's condition, in the Cerebro-Vascular Emergency Department located on the site of the Pitié-Salpêtrière Hospital Group. It includes a presentation of the research, signature of consent and verification of inclusion criteria, scales, first assessment of disability, and a high-definition EEG.

The second visit begins with an MRI including anatomical sequences. The second disability assessment and the second high-definition EEG is included in this second visit. Visits, 3, 4 and 5 will consists in one disability assessment and one high-definition EEG.

Project leaders



Charlotte Rosso
– Neurologist and ICM researcher
Charlotte Rosso holds a MD in Neurology and a PhD in neuroscience. Now associate professor and hospital practitioner at the Neurovascular Emergency Unit of the Pitié-Salpêtrière Hospital, her research focuses on brain plasticity mechanisms and non-invasive brain stimulation techniques, specifically magnetic transcranial stimulation.

Fabrizio De Vico Fallani
– INRIA Researcher at ICM
Fabrizio De Vico Fallani holds a Master's degree in IT engineering and a PhD in Biophysics from the Sapienza University in Rome. Tenured researcher and expert in biological networks, his work focuses on neuroinformatics, specifically mathematical modelling, biological networks and brain-machine interfaces.