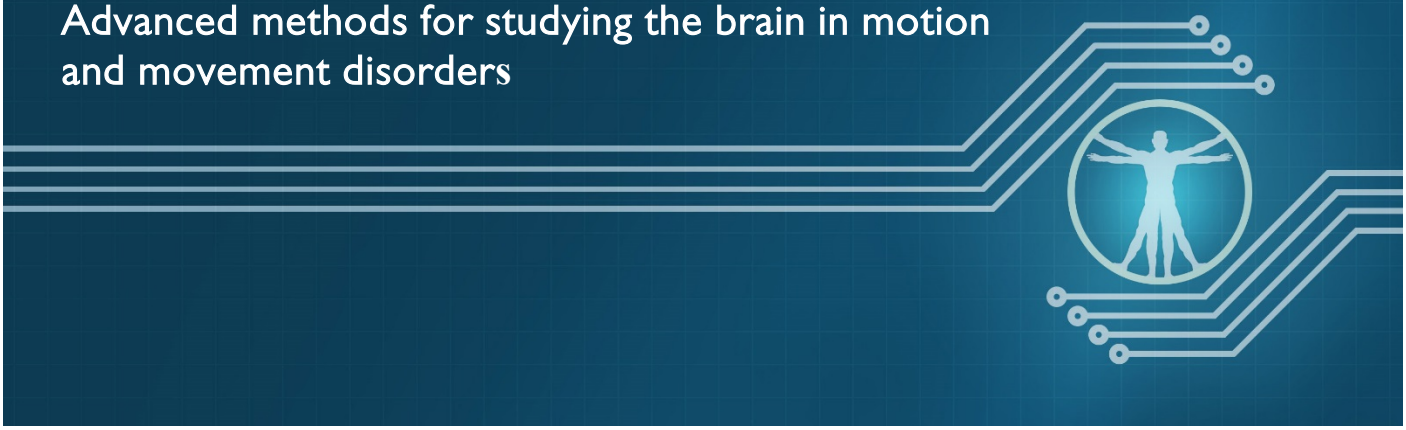
PERFORM Methodological Talks – May 16th 2018

Advanced methods for studying the brain in motion and movement disorders



In addition to our annual conference dedicated to "Health and Technology", we are happy to announce the organization of our methodological talks. Studying carefully the brain "in motion", when notably considering realistic lifestyle experiences, involving physical exercise, gait or balance, requires specific investigations, where portable neuroimaging techniques are playing a key role.

Investigating the brain in motion is even more important in the context of further characterizing brain motion disorders, promoting the emergence for new therapeutic and intervention strategies to treat those patients. In this context, this proposed methodological will be designed to carefully assess what are the challenges and state of the art approaches to study the brain "*in motion*", exploring either bioelectrical neuronal activity using ***Electro-Encephalography (EEG)*** or cortical hemodynamic processes measured using ***Near Infra-Red Spectroscopy (fNIRS)***. Our first two talks will be dedicated to present some promising approaches to handle these difficult problems and how one could consider those methods to study gait and balance. Our last keynote presentation by Yves Burnod, Ph.D. will address more **fundamental mechanisms associated with neurodegenerative diseases** and notably Parkinson disease, combining anatomical and functional imaging with gene expression to predict the evolution of those disease.

Schedule

14h-14h45 – Daniel Ferris, Ph.D.
Mobile Brain Imaging with High-Density EEG

Traditionally, it has been very difficult to quantify brain activity related to human locomotor control because most brain imaging modalities require individuals to remain motionless while seated or supine. Many brain imaging modalities also have relatively poor temporal resolution, detecting activity on the scale of 1-10 seconds. Recent hardware and software developments in high-density electroencephalography (EEG) are now enabling us to probe different brain areas involved in locomotor control with much finer temporal resolution (on the order of 1 ms). Dan Ferris will discuss how EEG can provide new insight into brain activity during human locomotion and provide an update on the future of the technology for mobile brain imaging.

14h45-15h30 – Ted Huppert, Ph.D.
Functional Imaging of the human brain during movement using fNIRS and EEG.

Functional near-infrared spectroscopy (fNIRS) is a non-invasive brain imaging method that uses low levels of red/nIR light (650-900nm) to measure changes in blood volume and oxygenation in the brain during functional tasks. This technology is lower cost and more portable then other modalities and does not require a specialized or isolated testing environment, which makes it ideally suited for brain imaging in a more ecologically-valid environment. In this talk, I will present an overview of my lab's use of fNIRS to measure cortical brain signals during movement, gait, and vestibular function sign fNIRS and concurrent fNIRS-EEG. I will discuss some of our applications, unique findings, and some of the challenges (and solutions) to imaging the brain during movement tasks. I will also give a prospective of where the fNIRS field is headed towards the goal of imaging the brain during unrestricted movement challenges.

15h30-15h50 – Coffee Break

15h50-16h – Presentation of the Keynote speaker by Habib Benali, Ph.D.

16h-17h – Keynote presentation: Yves Burnod, Ph.D.
Relation between network anatomo-functional connectivity and gene expression resulting in predictions in Parkinson and Alzheimer degeneration.

Results in Parkinson and Alzheimer degeneration have shown gradual changes in their network anatomo-functional connectivity, together with changes in their regional gene expression. We have systematically analyzed the relations between anatomical connections, resting state networks (RSNs) and task based networks (TBNs) as referenced in large databases of fMRI activation studies, and gene expression (as provided by the Allen Human Brain Atlas). We show that functional cortical networks (Resting State and Task Based) are organized as two large networks shaped like two rings. The first ring comprises visual, auditory, somatosensory, and motor cortices that process real time world interactions. The second ring comprises parietal, temporal, and frontal regions with networks dedicated to cognitive functions, emotions, biological needs, and internally driven rhythm.

Furthermore, we found that the patterns of expression of the 1000 genes most differentially expressed across the cortex organized the cortex into two sets of regions that match the two rings. We found that several of the proteins–coded by genes that most differentiate the rings–were involved in neuronal information processing such as ionic channels and neurotransmitter release. The results showed strong congruence between the preferential expression of subsets of genes, temporal properties of the proteins they code, and the preferred processing modes of the anatomo-functional networks in the two rings.

These results allow to make predictions on the dynamic relations between gene expression, and functional networks changes with their clinical consequences in Parkinson and Alzheimer degeneration.