7th Marseille's fMRI Centre Workshop

May 16th, Amphithéâtre faculté d'Odontologie & INT, Campus de la Timone

The objective of this one-day workshop is to get together with leaders in the use and development of modern MRI tools in human structural and functional neuroscience. This parallels the beginning of a new era for the MRI centre with the acquisition of a new state-of-the-art MRI machine dedicated to human and primate neuroscience. One session will focus on advances on anatomical imaging, the second on functional investigation of the human brain, each combining international, national, and local speakers.

Program

Morning session: Imaging brain structure

Moderator: Olivier Coulon

9h00-9h10: Welcome address: Pascal Belin

9h10-10h10: Keynote: Heidi Johansen-Berg

10h10-10h50: Zhong Yi Sun

10h50-11h10: Coffee Break and poster session

11h10-11h50: Guillaume Auzias

11h50-12h30: Lisa Vaugier

12h30-14h00: Lunch and poster session

Afternoon session: Imaging brain functions

Moderator: Thierry Chaminade

14h00-15h00: Keynote: Matthew Rushworth

15h00-15h40: Etienne Koechlin

15h40-16h10: Coffee break and poster session

16h10-16h50: Jennifer Coull

16h50-17h30: Fabien Cignetti

Abstracts

Imaging structural brain plasticity with learning and recovery

Heidi Johansen-Berg
Wellcome Trust Senior Research Fellow, FMRIB Centre, University of Oxford

Animal studies show that the adult brain shows remarkable plasticity in response to learning or recovery from injury. Non-invasive brain imaging techniques can be used to detect systems-level structural plasticity in the human brain. This talk will focus on how brain imaging has allowed us to monitor healthy brains learning new motor skills, to assess how brains recover after damage, such as stroke, and how they adapt to change, such as limb amputation.
Although imaging is useful to detect such adaptations, many brain imaging measures are non-specific and do not allow us to pinpoint the underlying cellular changes that are driving observed effects. The talk will also discuss studies in animal models in which both imaging and histological approaches can be used to shed light on the underlying biological drivers for structural plasticity detected using MRI.

Cortical folding and beyond: Hidden patterns and information

Zhong Yi Sun
CNRS Senior Research Fellow, Laboratoire de Neuroimagerie Assistée par Ordinateur, Neurospin, CEA.

Cortical folding is one of the most directly observable gross anatomical traits of the cerebral cortex. Extensive work has been done to characterize folding variability; interesting links have been found between folding patterns and function. In this presentation, recent findings in terms of the characteristics of variability in cortical folding are presented, which links folding anatomy to behaviors such as handedness; and to function such as movements of hands and silent reading. These findings rely on a simple and reliable shape analysis method. Such study is extended to the understanding of other anatomical traits such as the fiber bundle shapes and their link to pathologies such as bipolar disorder. Much information behind cortical folding, and brain morphology in general, can be revealed regarding fundamental issues in neuroscience.

Defining correspondences across brains: means and meanings

Guillaume Auzias
Research fellow, Institut de Neurosciences de la Timone, Aix Marseille Université - CNRS

Defining correspondences across brains is mandatory for group studies, whether the focus of the work is on functional or structural aspects, and based on either healthy or pathological individuals. Despite the fact that several neuroimaging tools allow for an entirely automated processing of this crucial step, several distinct strategies can be considered, each one relying on different assumptions and implementation choices. In this talk, I will discuss how and why these considerations must be taken into account at the time of interpreting the resulting group-level statistics. The influences of the technical aspects on the interpretability will be introduced through the description of two very different methods that I developed, and illustrated through applications in morphometry, localization of functional activations and connectivity analysis.

Advances in structural Neuroimaging in Epilepsy

Lisa Vaugier
Neurologist, Département de Neurophysiologie Clinique, Assistance Publique-Hôpitaux de Marseille

Partial epilepsies are an heterogeneous group in which seizures start from a localized regions of the brain cortex. In approximately 30 % of cases, seizures are persisting despite antiepileptic drugs and patients may benefit from surgical treatment. In this context, neuroimaging research is particularly active to develop non-invasive tools to find neuroanatomical correlates to the epileptogenic process. Particularly, since last decade, diffusion imagery, DTI and tractography has endeavoured to define markers of the epileptogenic networks. Tractography probabilistic algorithm is able to define structural connectivity of grey matters regions. We will present a study in which we investigated the structural connectivity of brain regions involved in the epileptogenic zone (EZ) in patients with temporal lobe epilepsy (TLE). We used connectivity-based segmentation to determine connectivity patterns of mesial temporal regions (EZ) with different cerebral targets. We found decreased connectivity with lingual gyrus ipsilateral to EZ and increased connectivity with the temporal superior gyrus contralateral to EZ. Our results highlight the notion that TLE are not focal diseases but are associated with long distance changes in connectivity that largely extend out of the EZ. The links between these alterations and clinical date will be discussed.

Connexions and interactions of ventral frontal cortex

Matthew FS Rushworth
Professor of Cognitive Neuroscience, Department of Experimental Psychology, University of Oxford.

The connexions of a brain area constrain and determine the information it receives and the influences it can exert. Each brain area has its own unique connexional fingerprint. It is possible to estimate this connexional fingerprint using diffusion-weighted magnetic resonance imaging (DW-MRI) and resting state functional magnetic resonance imaging (fMRI) inter-areal coupling measures. We used these techniques to identify distinct component regions of human ventrolateral frontal cortex (vlFC) and to compare them with ventrolateral frontal cortical regions in another primate species – the macaque. We were able to show important similarities between brain areas in the two species although some areas such as the lateral frontal pole were only found in humans. We have also investigated the relationships between vlFC and representations in temporal cortex that are mediated by these connexions. A combination of transcranial magnetic stimulation (TMS) and fMRI studies suggest vlFC is able to facilitate representations of stimuli that are attended but it does not seem to actively inhibit representations. Other TMS protocols can be used to selectively enhance vlFC pathways to specific brain regions. The impact of these protocols on the inter-regional coupling of brain signals can be investigated.

Adaptive behavior and reasoning in the human prefrontal cortex

Etienne Koechlin
Director, Laboratoire de Neurosciences Cognitives, Ecole Normale Supérieure Paris

I will present recent works from our lab combining computational modelling, experimental psychology and fMRI describing how the prefrontal cortex subserves reasoning in the service of adaptive behaviour. I will show how the ventromedial, dorsomedial, lateral and polar prefrontal regions along with the striatum forms an unified system combining inferential and creative abilities for efficient behaviour in uncertain, variable and open-ended environments.

Dopaminergic modulation of timing in basal ganglia and SMA

Jennifer Coull
CNRS Senior Research Fellow, Laboratoire des Neurosciences Cognitives, Aix-Marseille Universite, France

Functional neuroimaging has consistently identified a core timing network, comprising basal ganglia, Supplementary Motor Area (SMA) and right prefrontal cortex. In parallel, psychopharmacological studies in animals and humans have shown that timing can be perturbed by modulation of dopaminergic function. By combining fMRI with psychopharmacological techniques, we can pinpoint the elements of the core timing network that are modulated by dopamine and thereby result in an altered sense of time. We have found that dopaminergic manipulation modulates activity in basal ganglia and SMA during initial encoding of stimulus duration but has no effect on prefrontal mediation of temporal decision processes. These data not only identify the neuroanatomical substrates of the neurochemical modulation of timing, but also provide some cognitive insight into the stage of temporal information processing affected by dopamine.

Imaging muscle tendon vibration to reveal the neural basis of motor awareness

Fabien Cignetti
Research fellow, Laboratoire des Neurosciences Cognitives, Aix Marseille Université - CNRS

Studies on the neural basis of motor awareness suggest that the conscious experience we are moving is generated within the posterior parietal cortex. On the other hand, studies outside the movement domain support the hypothesis that conscious experience is not limited to this specific brain region but relies on a large-scale fronto-parietal network. In the present talk, I will provide evidence, using tendon vibration paradigm and contrasting subjects who experience kinaesthetic illusory movements from those who do not, that motor awareness is rooted within a right inferior fronto-parietal network. In particular, our recent data tend to demonstrate that activation of this network alone is insufficient to drive subjective experience of movement but needs to reach a certain threshold. Further findings obtained in pre-adolescents and adolescents, showing that activation of this network is age-dependent and is related to structural maturity, will be also discussed.