Graduate Research at the Florey

The Florey Institute of Neuroscience and Mental Health is one of the world's leading brain research centres. At the Florey, we employ more than 500 staff and educate in excess of 100 post-graduate students each year. Our scientists comprise the largest neuroscience research team in Australia.

The Florey Department of Neuroscience and Mental Health at The University of Melbourne offers PhD and MPhil programs. MSc (Biomedical & Health Sciences) and Honours projects based at Florey are also offered by several laboratories, through enrolment in other departments.

Graduate researchers enrolled through the Florey can expect:

1. High quality and internationally recognised supervisors.
2. A highly supportive training environment with state-of-the-art facilities and equipment; an annual scholarship 'top-up' of $2,000; annual funding of up to $1,000 for 3 years for conference attendance and personal development expenses, in addition to other travel scholarships available competitively, such as e.g. the Melbourne Abroad Travelling Scholarship (MATS).
3. A sound foundation upon which to build the thesis' research project and networking before starting the research, through a doctoral-level short course (also open to MPhil students). This provides a broad overview of the multi-disciplinary field of neurosciences, introduces a wide range of contemporary methodologies and techniques, and facilitates critical reading of the literature.
4. Stimulating Seminar series all year-round; multiple scientific meetings, symposia and workshops.
5. Membership of Student of the Florey Institute (SOFI) student group & Student of Brain Research (SoBR) network, providing social and academic activities.

Neuroimaging projects at the Florey's Austin campus:

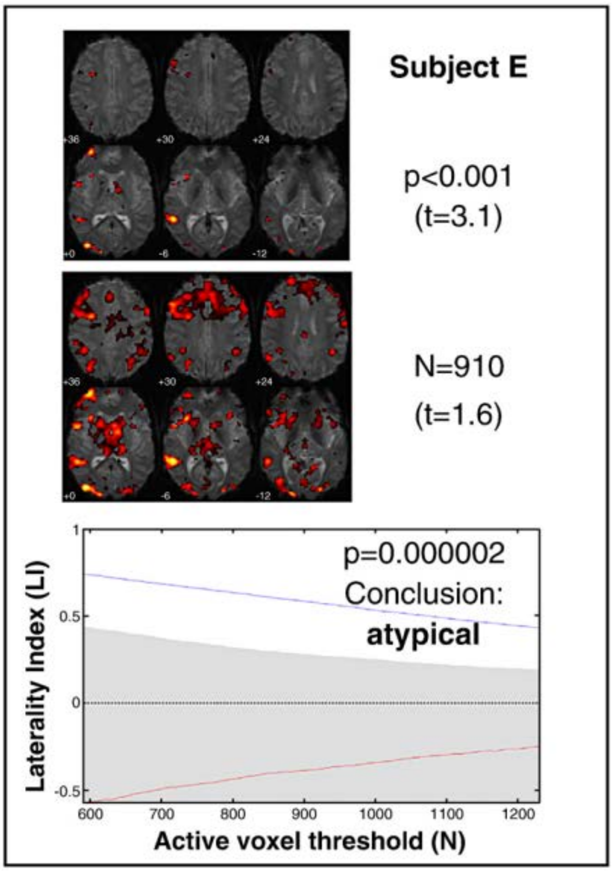
At its campus in Heidelberg adjacent to the Austin Hospital, the Florey has a state-of-the-art 3 tesla magnetic resonance imaging (MRI) facility (including two MRI scanners) primarily for research of the human brain. Research projects undertaken at the institute include development of image acquisition and analysis techniques. Such technical development projects usually require students of one or more of physics, mathematics, computer science, informatics, engineering and statistics. Other research at the institute includes application of techniques recently developed, to answer both basic science and clinical research questions. These projects often require students of one or more of neurology, neuroscience, psychology, physiology and medical imaging.

A selection of the available neuroimaging projects is provided on the following pages. Please contact the listed supervisor(s) for more information.

For information regarding other projects available at the Florey, please visit www.florey.edu.au/students

Projects

Epilepsy - Study of the effects of seizures on language organization in humans



This project will characterise language organization in the brain in patients with various epilepsy phenotypes and healthy controls. Recently developed analysis methods will be used to analyse neuroimaging data that has been collected over many years at the institute.

Supervisor(s): David Abbott

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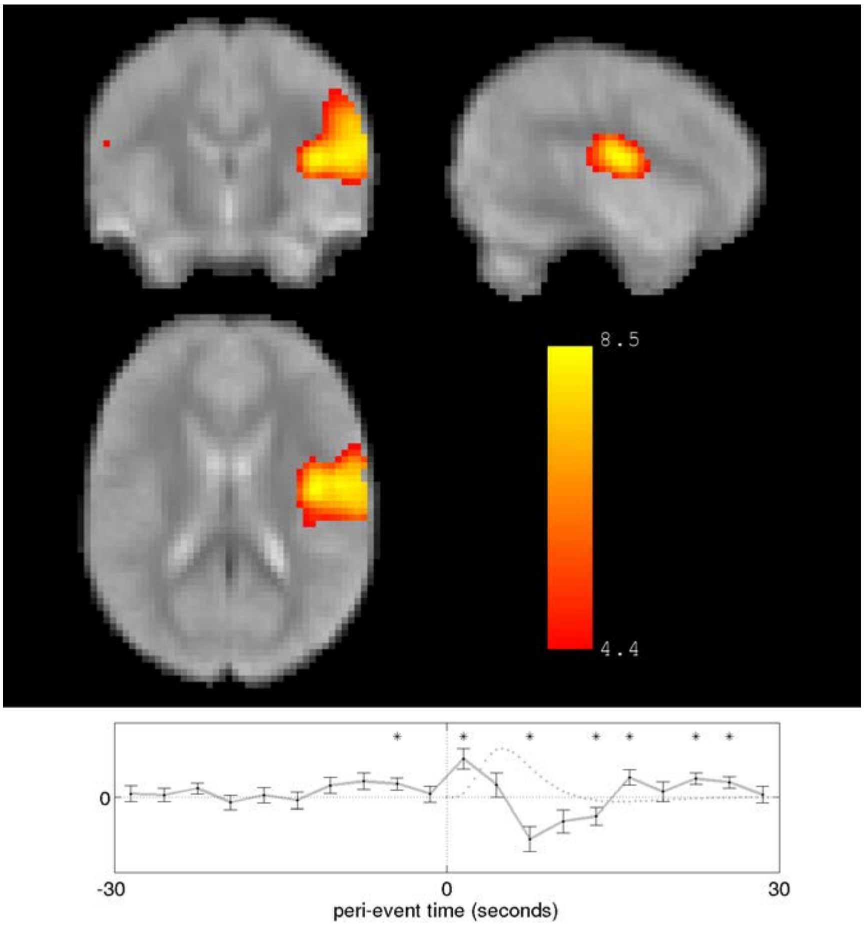
Projects

Epilepsy - The generators of epilepsy in the human brain

Combined functional magnetic resonance imaging (fMRI) and electro-encephalography (EEG) approaches can be used to define the brain networks in patients with epilepsy. The aim of this project is to develop and apply algorithms that can best identify the components of the network that are responsible for the generation of the hypersychronisation that is characteristic of the epileptic seizure. This project uses advanced neuroimaging methods in functional imaging including functional connectivity, signal processing and data-driven analysis methods. The project may suit a candidate with a background in physics, engineering, computer science, mathematics or statistics.



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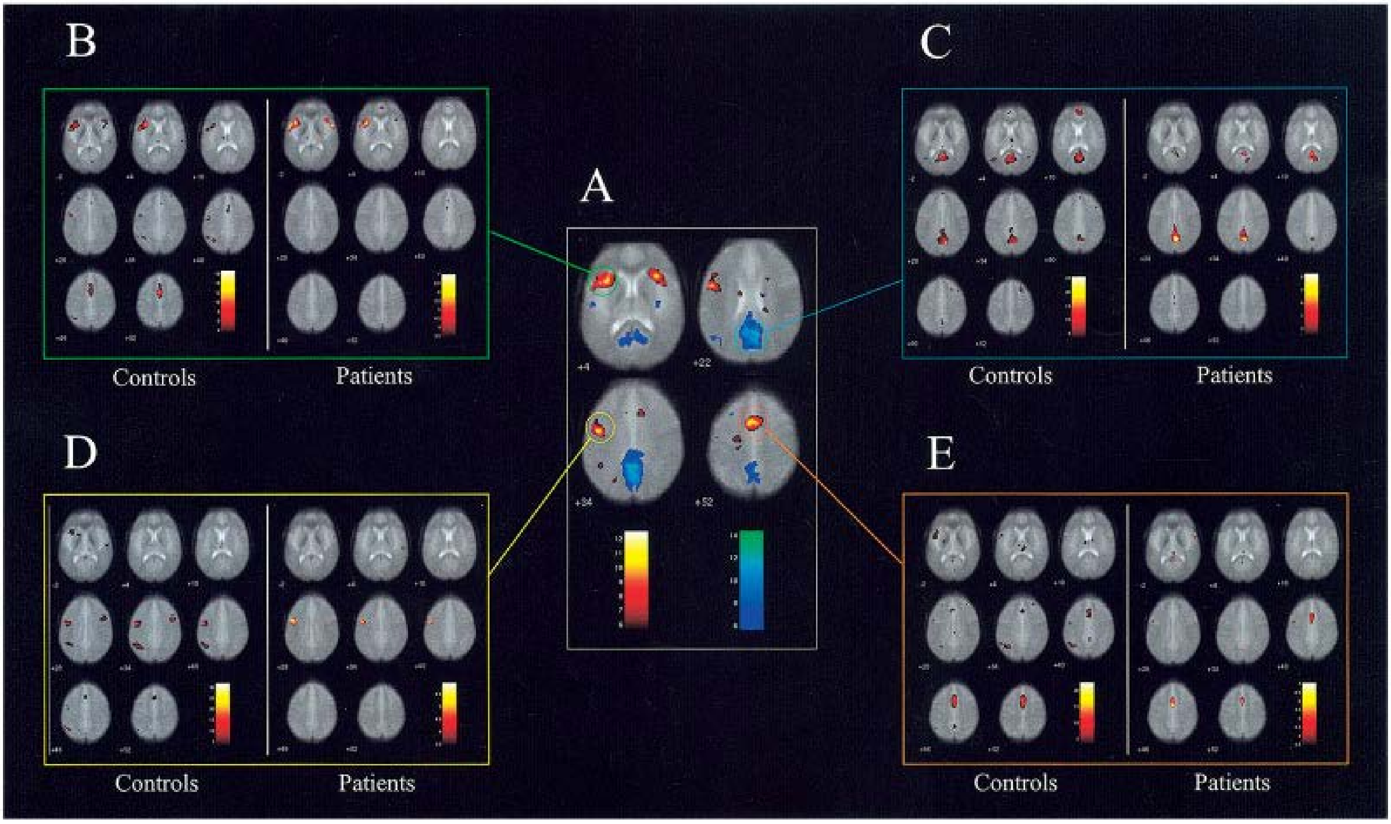
Projects

Epilepsy - Exploration of functional synchrony in brain networks using MRI

Functional magnetic resonance imaging (fMRI) is an MRI technique that makes use of an intrinsic contrast mechanism involving the different magnetic states of oxygenated and de-oxygenated haemoglobin. It is most often used to image the brain's response to specific stimuli, however it can also be used to interrogate neural networks in the resting human brain. This method, known as resting state functional connectivity magnetic resonance imaging (rs-fcMRI), quantifies distributed, coherent patterns of low-frequency (<0.1Hz) variation in the resting state blood oxygenation level dependent (BOLD) signal. The present project involves development of novel image analysis strategies to maximise information extracted from resting state fMRI time series, and to help determine how these techniques can best be applied to improve our understanding of brain networks in the healthy and diseased brain. It may suit a candidate with a background in physics, engineering, computer science, mathematics or statistics.



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Projects

Imaging - **Super-resolution imaging methods for the Human Brain Connectome**

Our group has shown that the technique of diffusion magnetic resonance imaging (MRI) can be used to obtain an estimate of the white matter fibre orientations at each location in the brain, which in turn can be used with a fibre-tracking algorithm to reconstruct a representation of the white matter pathways in the brain. For the case of whole-brain fibre-tracking, a very large number of tracks (also known as streamlines) are generated, thus providing an overall representation of white matter pathways throughout the brain. More recently, we have shown that these data can be used to generate images with resolution higher than the resolution of the acquired data (i.e. to achieve 'super-resolution'), in a technique we called super-resolution track-weighted imaging (TWI). This methodology provides a natural means to combine structural and functional connectivity information into a single image, and therefore can play a major role in the characterisation of the Human Brain Connectome (a comprehensive map of neural connections in the human brain). This PhD project will involve the development of novel methods for the analysis of super-resolution TWI, and their application to Connectomics. Following on the footsteps of the genome, Connectomics (or the study of the 'connectome') is a major growing field in neuroscience, with the ultimate aim of developing a comprehensive map of the structural and functional connections in the brain.

1. *Calamante F, et al. Track-weighted functional connectivity (TW-FC): a tool for characterizing the structural-functional connections in the brain. NeuroImage 70: 199–210 (2013).*
2. *Calamante F, et al. Super-resolution track-density imaging of thalamic substructures: comparison with high-resolution anatomical magnetic resonance imaging at 7.0T. Human Brain Mapping (in press, doi: 10.1002/hbm.22083).*
3. *Calamante F, et al. A generalised framework for super-resolution track-weighted imaging. NeuroImage 59: 2494-2503 (2012).*
4. *Cho ZH, Calamante F, Chi JG. 7.0 Tesla MRI Brain White Matter Atlas. Panmun Book Company; Seoul, South Korea (2103).*
5. *Calamante F, et al. Super-resolution track-density imaging studies of mouse brain: comparison to histology. NeuroImage 59: 286-296 (2012).*
6. *Calamante F, et al. Track density imaging (TDI): validation of super-resolution property. NeuroImage 56:1259-1266 (2011).*
7. *Calamante F, et al. Track Density Imaging (TDI): Super-resolution white matter imaging using whole-brain track-density mapping. NeuroImage 53: 1233–1243 (2010).*

Supervisor(s): Fernando Calamante, Alan Connelly

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Projects

Imaging - Perfusion MRI: novel methods to image blood flow and brain function

Magnetic Resonance Imaging (MRI) provides a powerful non-invasive tool to measure the rate of blood delivery to brain tissue (also known as cerebral perfusion). Perfusion plays an essential role in tissue viability and function. Our group is among the leaders in the development of perfusion MRI methods. This PhD project will involve the development of novel methods to measure and analyse Perfusion MRI data. These methods will then be used to investigate brain disorders (e.g. stroke, epilepsy, dementia, etc.), and/or to characterise brain networks (e.g. with connectomics) in the healthy brain.

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Projects

Stroke **- The influence of medications on brain volume after stroke**

Once a person has suffered a stroke, it is very important to reduce the risk of further stroke occurring. Medications play a major role in secondary prevention. Antihypertensives to reduce blood pressure, antiplatelet agents (such as aspirin) and anticoagulants (such as warfarin) are widely prescribed to stroke survivors. All have been shown to be very effective in preventing stroke. Yet these medications may also have other important effects. Studies have shown that some antihypertensive drugs (beta blockers, calcium channel blockers, diuretics) can have adverse effects on specific cognitive skills. The explanation for this is not clear; we have little understanding of how these medications may impact on brain structure and function.

The CANVAS (Cognition And Neocortical Volume After Stroke) study is currently being run at the Florey Austin site. It features longitudinal follow-up of stroke survivors, focusing on measures of brain volume and cortical thickness (using high resolution MRI imaging) and cognitive performance (using an extensive neuropsychological battery). The CANVAS study provides a unique opportunity to investigate the effects of common medications on brain volume in a large sample of stroke survivors.

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