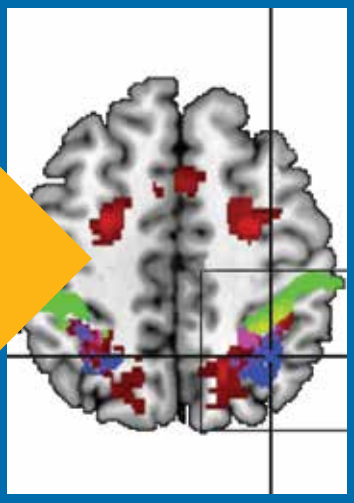
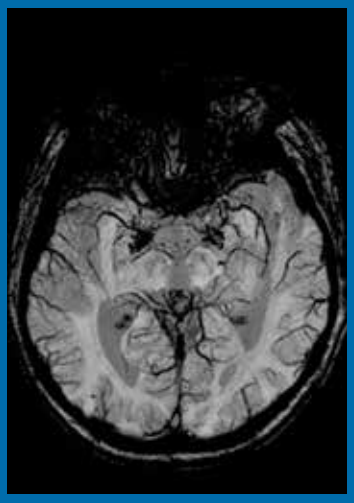
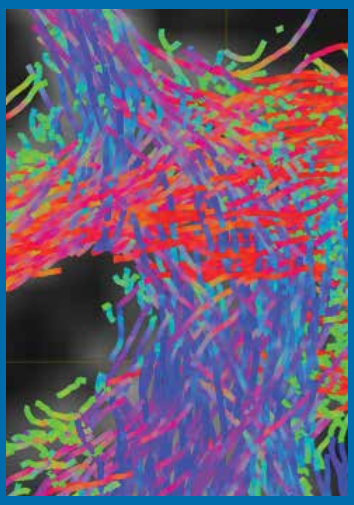
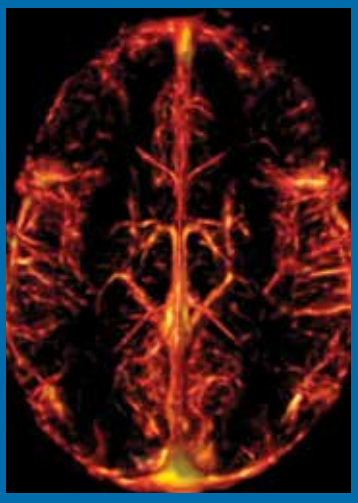
MONASH University

GROUP OF EIGHT AUSTRALIA

Monash Biomedical Imaging and Linked Laboratories Annual Report 2015

AUSTRALIA ▸ CHINA ▸ INDIA ▸ MALAYSIA ▸ SOUTH AFRICA

Monash Biomedical Imaging

Member

VBIC

National Imaging Facility

incf
National Node of Victoria, Australia

Supporters

State Government Victoria

Australian Government
Department of Innovation Industry, Science and Research

ARMI
AUSTRALIAN REGENERATIVE MEDICINE INSTITUTE

Collaborators

CSIRO

Australian Synchrotron

MonashHealth

Partners

SIEMENS

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Vice Provost's Report

Monash Biomedical Imaging Highlights of 2015

- Continued growth in the provision of research imaging services to the Monash research community
- Successful establishment of the Science and Industry Endowment Fund supported Biomedical Materials Translational Facility MR-PET imaging facility, in partnership with the Commonwealth Scientific Industrial Research Organisation
- Continued co-operation with the Australian Synchrotron Imaging and Medical Beam Line, particularly applications in renal and respiratory medicine
- Contributions to the Victorian Platform Technology Network and the Australian Research Infrastructure Network
- Continued leadership of the Victorian Biomedical Imaging Capability and contributions to the National Imaging Facility
- Expanded co-operation with the Australian Nuclear Science and Technology Organisation (ANSTO) and Monash Health
- Continuation of the ASPREE healthy ageing brain imaging study
- Poised for significant growth of biomaterials and medical device industry links in 2016

Throughout 2015 Monash Biomedical Imaging continued to experience growth in the provision of research imaging services, with expanded and increased research utilisation and collaborative links with the broader Monash research community.

Following the success of the Science and Industry Endowment Fund (SIEF) grant application in 2014, the expanded partnership with the Commonwealth Scientific Industrial Research Organisation (CSIRO) has enabled establishment of the Biomedical Materials Translational Facility MR-PET imaging facility. The selection of a Siemens MR-PET scanner has further strengthened our partnership with Siemens Healthcare, and resulted in one of the most comprehensive biomedical imaging facilities in the world. The establishment of the facility has demonstrated Monash's long-term collaborative approach with its partners, particularly CSIRO.

With substantial financial support from the Faculty of Medicine Nursing and Health Sciences, during 2015 the MBI research platform was significantly enhanced with large animal holding and experimental laboratories that have direct access to the research dedicated MR and PET imaging scanners. With the large animal MR-PET scanner now installed and operational, MBI has unsurpassed facilities to undertake simultaneous cellular and molecular imaging in human volunteers and large animal models of disease.

Co-operation between the Australian Synchrotron Imaging and Medical Beam Line (IMBL) and MBI scientists in preclinical models of renal, respiratory and cardiovascular disease has continued. Initial discussions regarding the use of the MBI preclinical facilities for fundamental cardiovascular research and testing of therapeutic interventions in animal models has been completed. The future establishment of the Victorian Heart Hospital as a specialist cardiac university hospital on the Clayton campus is expected to accelerate the use of the new MBI facilities for cardiac imaging and cardiovascular research.

The Monash Institute for Cognitive and Clinical Neuroscience has two research laboratories located at MBI including the Brain and Mental Health and the Monash Neuroscience of Consciousness linked laboratories. MBI is also the headquarters of the Australian Research Council Centre of Excellence for Integrative Brain Function, that provides a critical springboard for advancing the international reputation of MBI in biomedical imaging and brain research.

The Monash University platform technologies continue to systematically improve the research platform operations to ensure that each platform's systems and processes are operating to world's best practice. In 2015 the Monash Biomedical Imaging platform was operated using the Australian Research Infrastructure Network (ARIN) system. This system provides researchers with streamlined access to the biomedical imaging equipment and expertise at MBI.

MBI's involvement in communities of interest including the Victorian Biomedical Imaging Capability (VBIC) and the National Imaging Facility (NIF) continues to enable the platform to have a major impact amongst researchers across Melbourne and Australia. Notably, during 2015 co-operation with ANSTO on the construction of a gas hyperpolariser will enable novel research into the mechanisms of respiratory diseases and neonatal lung development.

In the coming year MBI is poised for significant further development based on the growth of industry links. I know that 2015 was another successful year for MBI and I look forward to the forthcoming experimental research program (including the MR-PET facility) getting underway in 2016, and the expanded translation of scientific discoveries and their application to industry innovation and process transformation.

Ian Smith
Vice Provost
(Research and Research Infrastructure)

Director's Report

I am delighted to report that during 2015 Monash Biomedical Imaging continued to grow in the breadth and depth of biomedical imaging research services provided to the Monash University and Victorian research communities.

One of the key achievements in 2015 was the construction and installation of new facilities for real time imaging using MRI and molecular imaging. Capital funding was provided from CSIRO's SIEF, Monash Strategic Initiative Funds and from the Monash Faculty of Medicine and Nursing Health Sciences. The Biomedical Materials Translational Facility (BMTF) has been established to provide three synergistic areas critical to the translation of biomedical materials research, including: clean room materials synthesis: fabrication and surface coating; high throughput biological testing and evaluation of materials; and real time non-invasive simultaneous MR-PET imaging in preclinical studies.

During the past two years a project has been underway at MBI to construct a laser based hyperpolariser to magnetically hyperpolarise helium-3 and xenon-129 gases. The system has the potential to greatly enhance our scientific understanding of animal and human lung physiology and pathophysiology. The project was funded by an ARC Large Equipment Infrastructure grant and has been undertaken in collaboration with Dr Hal Lee from ANSTO. During 2015 the project achieved a number of important milestones with the first production of helium-3 hyperpolarised gas successfully achieved in March, and the first successful xenon-129 hyperpolarised gas production and MR scanning test successfully completed in December.

Throughout 2015 MBI has continued to support researchers from the School of Psychological Sciences and the newly formed Monash Institute of Cognitive and Clinical Neurosciences, as well as the School of Biomedical Sciences in the Faculty of Medicine, Nursing and Health Sciences. The Brain and Mental Health (BMH) Laboratory led by Professor Murat Yücel and Associate Professor Alex Fornito has continued to expand the breadth and collaborative nature of human systems neuroscience research undertaken at MBI. The Monash Neuroscience of Consciousness (MoNoC) Laboratory, jointly led by Associate Professor Nao Tsuchiya and Associate Professor Jeroen van Boxtel has undertaken novel research into understanding the neural basis of consciousness.

Throughout 2015 MBI has continued to support researchers from the School of Psychological Sciences and the newly formed Monash Institute of Cognitive and Clinical Neurosciences, as well as the School of Biomedical Sciences in the Faculty of Medicine, Nursing and Health Sciences.

The Australian Research Council Centre of Excellence for Integrative Brain Function (CIBF) is headquartered at MBI. The co-operation between the MBI administrative staff and the CIBF research support staff is providing mutual benefits for both the Centre and MBI. The Victorian Biomedical Imaging Capability (VBIC) is a strategically important Victorian based biomedical imaging research community that is led from Monash University and MBI. MBI is a node of the National Imaging Facility (NIF) and continues to provide state-of-the-art high quality biomedical imaging research infrastructure to NIF users and researchers from across Melbourne and Australia. The success of the SIEF application was underpinned by Monash's long-term collaborative approach with its partners, particularly CSIRO, and has poised MBI for significant development and growth of industry linkages in 2016.

I would like to thank Professor Ian Smith for his continued support during 2015. I would also like to thank Ms Sue Renkin, Chair of the MBI Advisory Board, who provides invaluable support for myself and other senior staff at MBI. The MBI Advisory Board members provide invaluable guidance and advice regarding the operations and development of the MBI research platform, and I would like to acknowledge and thank them for their contributions. My thanks also to Dr Lisa Hutton for her continued oversight of the day-to-day operations of the MBI facilities throughout 2015 whilst concurrently managing the CIBF. During 2015, Dr Charles Hardy was responsible for both the MBI Research and Operations activities and the development of the BMTF MR-PET scanner facility and I would like to thank him for his contribution throughout the year.

The MBI team leaders, Dr James Pearson, Associate Professor Nicholas Ferris, Dr Zhaolin Chen, and Associate Professor Jeroen van Boxtel successfully led their teams' research and imaging research support activities throughout the year. The teams' hard work has ensured the successful provision of high quality imaging research services at MBI and I sincerely thank all staff for their invaluable contributions. The end of 2015 marked the end of the first five years of the strategic plan to establish and develop the MBI research platform. The 2016-20 MBI strategic plan is now under development with the objective of ensuring the international competitiveness of the Monash Biomedical Imaging research facilities through to the end of the decade.

Gary Egan
Director MBI and CIBF; Distinguished Professorial Fellow, School of Psychological Sciences.

Overview

Facilities

MBI is one of the world's pre-eminent sites for biomedical imaging and cognitive and systems neurosciences research. MBI facilities are located primarily at the Monash University Clayton Campus, and include high-resolution clinical and preclinical magnetic resonance imaging (MRI) scanners, and preclinical X-Ray computed tomography (CT), Positron Emission Tomography (PET), and Single Photon Emission CT (SPECT). We manage access to offsite preclinical scanners including a PET-CT scanner (Mediso) at the Alfred Medical Research and Education Precinct (AMREP, Prahran) and (Fluorescent Emission Computed Tomography) FLECT and CT scanners (TriFoil and Mediso) at the Monash Institute of Pharmaceutical Sciences (MIPS) located at the Parkville campus. We also manage access to a suite of clinical testing facilities at the Clayton campus, including Electroencephalogram (EEG), Transcranial Magnetic Stimulation (TMS), and ocularmotor testing equipment.

Throughout 2015 building works were underway to significantly enhance the MBI facilities through the installation of a scanner capable of performing simultaneous MRI and PET scans (MR-PET) in humans and large animals. The MR-PET scanner, the first in Victoria, allows us to combine the benefits of PET molecular imaging with the exquisite structural detail provided by MRI, and will facilitate research in biomedical materials and device development and industry collaboration, in addition to basic molecular imaging research. To complement the MR-PET facility we have also installed a 'hot lab' for the development and dispensing of PET radiopharmaceuticals ('tracers') as well as a dedicated large animal surgery.

The expertise and technological capabilities at MBI support a wide range of preclinical and clinical research projects undertaken by researchers and clinicians from Monash University and collaborating organisations throughout Victoria. These facilities are colocated with the Australian Synchrotron Imaging and Medical Beam Line, providing capability for ultra-high resolution imaging of soft tissues in living animals. MBI scientists collaborate with global experts in medicine, science and engineering, as well as industry and government to create innovative solutions to clinical health challenges.

Governance

MBI has an Advisory Board with an independent chairperson that meets three times per year. The functions of the Board are to:

- assist the Director with strategic planning including advice in alignment with government policy on research infrastructure and industry trends;
- monitor the utilisation of MBI facilities;
- help define appropriate metrics (key performance indicators) for the platform;
- provide representation for stakeholders; and
- make recommendations on strategies for the further development of MBI facilities and operations.

MBI Advisory Board

Chair

Ms Sue Renkin
Director, Intuitively Focused; Distinguished Alumnus, Monash University

Deputy Chair

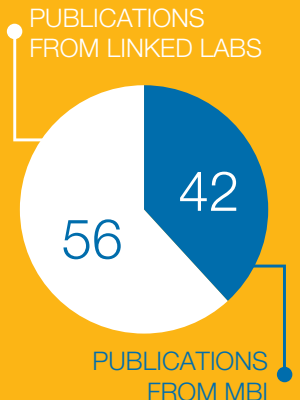
Professor Ian Smith
Vice-Provost, Research and Research Infrastructure, Monash University

Members

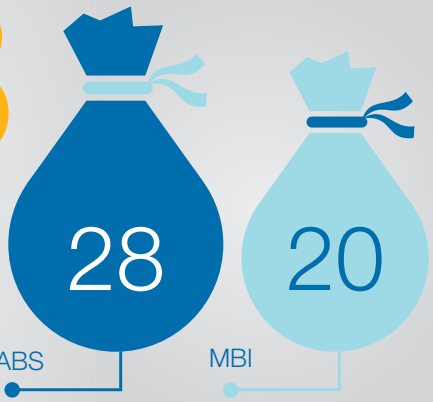
- **Professor Paul Bonnington**
  Director, Monash e-Research Centre
- **Professor Ross Coppel**
  Deputy Dean (Research), Faculty of Medicine, Nursing and Health Sciences, Monash University
- **Professor Gary Egan**
  Director, Monash Biomedical Imaging, Monash University
- **A/Professor Nicholas Ferris**
  Clinical Head, Monash Biomedical Imaging, Monash University
- **Professor Matthew Gillespie**
  (Standing in for Ross Coppell) Associate Dean (Research Strategy), Faculty of Medicine, Nursing & Health Sciences
- **Dr Lisa Hutton**
  General Manager, Monash Biomedical Imagng, Monash University
- **Dr Michael James**
  Head of Science, Australian Synchrotron
- **Dr Gareth Moorhead**
  Research Program Leader, Materials Science and Engineering, CSIRO
- **Professor Andrew Peele**
  Director, Australian Synchrotron
- **Professor Stephen Stuckey**
  Director Diagnostic Imaging, Monash Health (formerly Southern Health)
- **Professor Murat Yücel**
  Director, Monash Brain and Mental Health, Monash Institute of Cognitive and Clinical Neurosciences, Faculty of Medicine, Nursing & Health Sciences

MBI 2015 Snapshot

98 PUBLICATIONS



48 GRANTS



03 SITES

CLAYTON
PARKVILLE
PRAHRAN

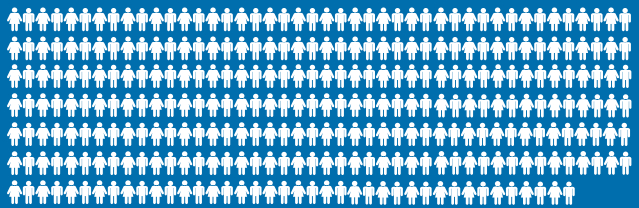
12 MAJOR PIECES OF EQUIPMENT

1551 TOTAL RESERVATIONS
Leading to 3573 scanning hours

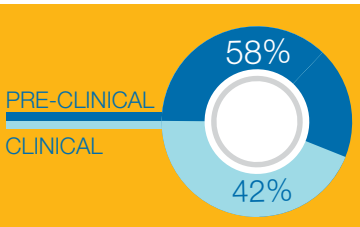
03 LINKED LABS

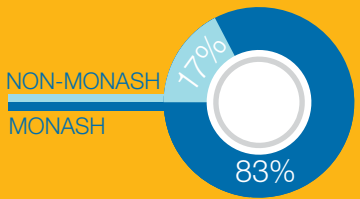
304 RESEARCHERS INVOLVED IN RESEARCH PROJECTS

Organisations across Australia 14 | International 2



47 NEW RESEARCH PROJECTS IN 2015





MBI Personnel

Director

Professor Gary Egan
Director, MBI and CIBF; Distinguished Professorial Fellow, School of Psychological Sciences.

Associate Directors

Professor Michael Farrell
Associate Director (Academic)

Professor Jon Shah
Director, Monash Institute for Medical Engineering & Associate Director, MBI

Management & Administration

Dr Lisa Hutton
General Manager, MBI & Centre Manager, CIBF

Dr Charles Hardy
Research and Operations Manager

Ms Janelle Giling
Administrative Assistant

Ms Nichola Thompson
Resources Coordinator

Ms Louise Mitchell
Research Administrartive Officer

Ms Jessica Despard
Project Officer

Students

- ***Phil Ward***
  PhD Candidate
- ***Shenjun Zhong***
  PhD Candidate
- ***Saman Kashuk***
  PhD Candidate
- ***Sulaiman Al Hasani***
  PhD Candidate (co-supervision)
- ***Jakub Baran***
  Trainee
- ***Magdalena Kolodziej***
  Trainee

Preclinical Imaging

Dr James Pearson
Head; Senior Research Fellow, NIF Facility Fellow, MBI Staff Scientist, Imaging and Medical Beamline, Australian Synchrotron

Dr Ruth Vreys
MRI Imaging Scientist, NIF Facility Fellow

Dr Qi-Zhu Wu
Research Fellow, MR Physicist, NIF Facility Fellow, MBI Research Scientist, CMSE, CSIRO

Mr Aldo Besmer
Preclinical Imaging Scientist

Imaging Analysis

Dr Zhaolin Chen
Head

Dr Thomas Close
Senior Informatics Officer, NIF Informatics Fellow

Mr Francesco Sforazzini
Research Assistant

Dr Michael Eager
Computational Biomedical Imaging Scientist

Dr Parnesh Raniga
Medical Imaging Scientist, MBI Research Scientist, ICT Centre CSIRO

Clinical Research Imaging

A/Prof Nicholas Ferris
Head, Clinical MRI, MBI and Clinical Radiologist, Monash Health

Mr Richard McIntyre
Radiographer, Monash Health & MBI

- ***Patricia Heidmann***
  Radiographer, Monash Health & MBI
- ***Jeff Chen***
  Radiographer, Monash Health & MBI
- ***Arlene Hobson***
  Radiographer, Monash Health & MBI
- ***Fiona Gould***
  Radiographer, Monash Health & MBI

Cognitive Neuroimaging Research

A/Prof Jeroen van Boxtel
Head, Senior Research Fellow, School of Psychological Sciences and MBI

Dr Sharna Jamadar
Research Fellow, School of Psychological Sciences and MBI

Ms Parisa Zakavi
Technical Assistant

Dr Bryan Paton
Research Fellow, School of Psychological Sciences and MBI

Ms Katharina Voigt
Technical Assistant

Research at MBI is conducted across four broad areas: Clinical Research Imaging; Cognitive Neuroimaging; Imaging Methods and Analysis; and Preclinical Imaging. Each teams' leader is responsible for supporting the MBI research users, developing the research methods in each discipline, as well as ensuring there is co-operation across the MBI teams. Selected highlights from 2015 are presented below together with links to the MBI website where more details are available, including the research publications and opportunities to participate in research.

Clinical Research Imaging

In 2015, the Clinical Research Imaging Team continued its focus on research with potential clinical implications or applications. The ASPREE NEURO sub--study of the larger ASPREE study (low--dose aspirin versus placebo in the healthy elderly), continued to be a major focus of activity, with the one-year follow-up brain MRI studies being conducted throughout the year. The third and final round of brain imaging will be done in 2017. Comparison of the one-year studies with those at baseline will yield important insights into the frequency of subtle injuries such as silent strokes and cerebral microbleeds (see below). Other studies are looking at mapping the brain's network of veins without the need to inject a contrast agent (or 'tracer') to highlight the blood vessels, and measurement of the distribution of iron in brain tissues. Outside the brain, the Clinical Research Imaging Team is assisting in developing techniques for non-invasive measurement of body fat composition. The group was also active in contributing to the design of the clinical facilities for the new MR-PET scanner facility.

Read more about the Clinical Research Imaging Team's work, including progress on the microbleeds in the eldery study.

Microbleeds in the healthy elderly

Gary Egan, Nicholas Ferris, Richard McIntyre, Elsdon Storey, Parnesh Raniga, John McNeil, Robyn Woods, Stephanie Ward

An advanced MRI technique known as Susceptibility-Weighted Imaging (SWI) has shown that many healthy older people have had very small amounts of bleeding (microbleeds) within their brain tissue, without apparent ill-effect. These are often seen in diagnostic scans performed for other reasons, but their significance is not well understood. As part of the ASPREE trial of low-dose aspirin versus placebo in the healthy elderly, MBI is running the ASPREE NEURO sub-study. This study is focused on the proportion of elderly people who have had microbleeds by the time of their first scan, how many more microbleeds occur during the four years of the study, and whether the occurrence of new microbleeds correlates with either cognitive performance, or exposure to low-dose aspirin. By using a high-strength MRI magnetic field, and a specially designed version of the SWI pulse sequence, we have made the scans highly sensitive to these very small abnormalities, thereby increased our ability to obtain optimal information concerning the microbleeds. At least one microbleed was seen in a substantial minority of subjects in the baseline scans, and a number of new microbleeds have been seen in the one-year followup studies (shown in image below).

SWI used to detect microbleeds (black spots, indicated by red arrows) in the elderly. Typical scans are shown above. Baseline scan is on the left. One year follow-up is on the right, with the appearance of a new microbleed highlighted.

Baseline - right occipital microbleed

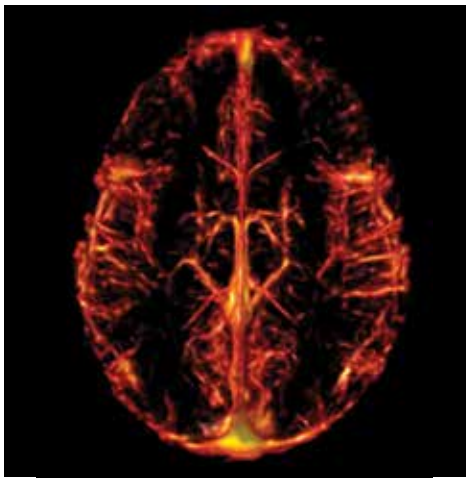
One Year follow up - new right occipital microbleed

Magnetic resonance mapping of brain veins without contrast

Phillip Ward, Parnesh Raniga, David Barnes, David Dowe, Amanda Ng, Gary Egan, Nick Ferris, John McNeil, Robyn Woods, Elsdon Storey, Stephanie Ward

Clinical imaging of the veins in and around the brain usually requires the injection of an intravenous contrast agent, to improve the visibility of the veins. Although these agents are very safe, they are relatively expensive, and there is a small risk of side-effects. It would be desirable to be able to demonstrate the veins without the need for such an injection, particularly in population health studies such as the ASPREE NEURO trial. The new MRI technique of SWI takes advantage of the high magnetic susceptibility of de-oxygenated haemoglobin, found mainly in venous blood, to highlight the veins against other tissues. Some parts of the brain have minimal MRI signal, which is also highlighted in susceptibility-weighted images. To avoid confusion of low-signal regions with veins, a related technique, Quantitative Susceptibility Mapping (QSM) is used to specifically highlight the veins.

A segmentation program is being developed to combine the information from SWI and QSM with mathematical filters to automatically generate three-dimensional maps of the cerebral veins, without the need for a contrast injection (see image below).



3D render of the combined SWI and QSM data to show cerebral veins without the need for contrast agents.

Cognitive Neuroimaging

The Cognitive Neuroimaging Team provides support for all human research studies at MBI (e.g. electroencephaology (EEG), transcranial magnetic stimulation (TMS), and oculomotor measurements). In the last year the team updated a lot of the equipment, and installed new equipment as well. The new EEG setup is now fully operational, and a new exercise bike has been installed for research into the influence of activity on brain plasticity. We also continued the development of combined MRI and TMS.

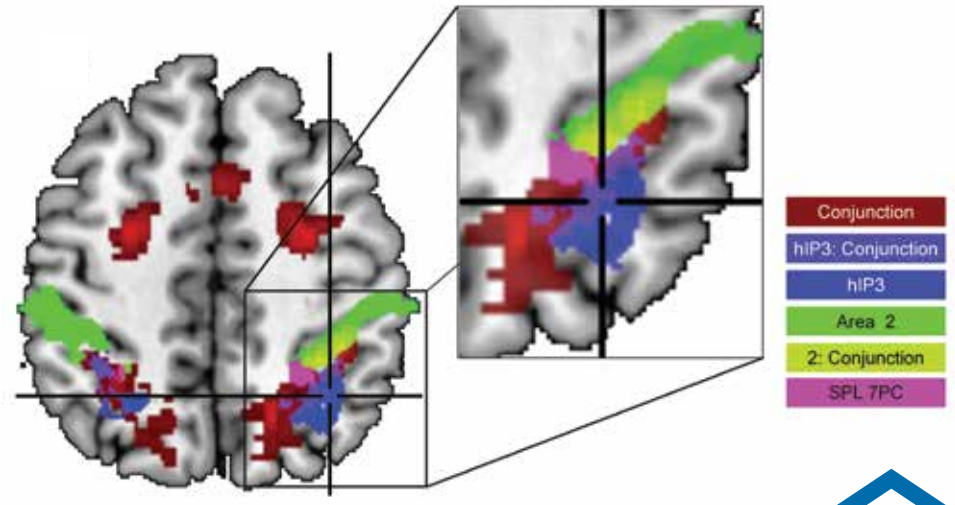
Functional sub-divisions in the human intraparietal sulcus are involved in object-based visuospatial transformation in a non-context dependent manner

Alexandra Papadopoulos, Francesco Sforazzini, Gary Egan, Sharna Jamadar

The intraparietal sulcus (IPS) plays a pivotal role in organising visuospatial attention. A wide range of processes activate the IPS, with neurons encoding information such as spatial coordinates of objects, the position of body parts in space, eye movement data or geometrical properties of objects such as shape, size and orientation. A potential commonality between these processes is that all require some form of visuospatial transformation within an object-based reference frame. Two object-based transformation tasks that consistently activate the IPS are mental rotation (e.g. imagining the rotation of a visual stimulus) and antisaccade tasks (inhibiting an automatic response to look at a stimulus and instead look in the opposite direction). Despite clear differences in task parameters – e.g. imagined vs. overt movement and category-response rule transformations – in both tasks, the visuospatial transformation has been mapped to neurons within the IPS. This leads to the hypothesis that the IPS may play a general purpose role in object-based spatial transformations.

Conjunction fMRI analysis showed overlapping activity between two tasks in sub-regions of the IPS. Using a Gaussian Bayes Classification algorithm with probabilistic cytoarchitectonic maps, we demonstrated that one subregion of the IPS (hIP3), is likely to play a ***general purpose*** role in object-based visuospatial transformation. This finding is consistent with experimental psychology that visuospatial transformations draw on a number of general purpose spatial processing resources and a small number of transformation-specific resources.

Read more about the Cognitive Neuroimaging Team's work, including progress on the IPS study



fMRI data showing areas of activity during each of the tasks and the consistently activited hIP3 region.

Imaging Methods and Analysis

In 2015, the Imaging Methods and Analysis Team made progress in the development of novel MRI acquisition and analysis methods. A method that calculates the oxygen extraction fraction ratio from quantitative susceptibility maps has been developed. Non-fourier encoded MRI methods have been introduced to accelerate the image acquisition.

Through collaboration with Forschungszentrum Jülich in Germany, the team has also established novel quantitative imaging methods. Water content mapping is a method that quantifies water percentage in local tissues of the brain. These newly established methods will be used for cohort studies in the clinical research and neuroscience projects. The team is also leading the image analysis effort for the ASPREE NEURO study.

Another major theme in 2015 was the installation of the new MR-PET scanner. The imaging analysis team provided expert input to the tender for the scanner selection and asssisted with preparations for the operation of the new scanner.

Read more about the Imaging Methods and Analysis Team's work, including using dMRI images

Enhancing our capacity to use dMRI images

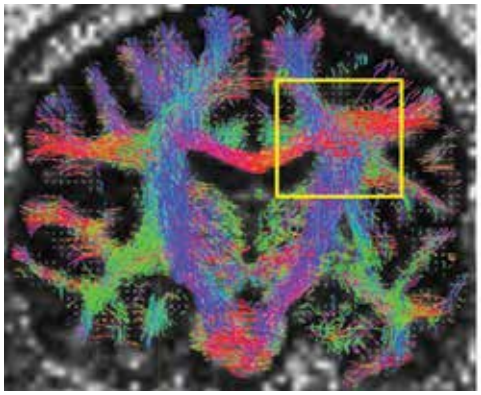
Tom Close, Francesco Sforazzinni, Sharna Jamadar, Gary Egan

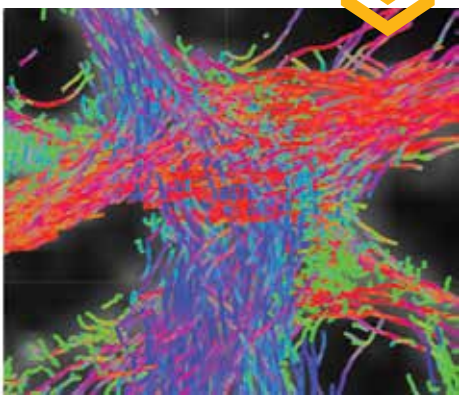
Diffusion magnetic resonance imaging (dMRI) is used to investigate the structure and integrity of long range, white matter, connections between brain regions. A bit like electric wires or internet cables connecting various parts of a building and its computing and warehousing spaces.

By sampling the rate of self-diffusion of intra/extracellular water along many orientations (directions), the presence of microstructural barriers to the movement of water can be inferred. For the most part these barriers are the walls of cells and their myelin sheaths (the equivalent of insulation or the plastic around an electric or data cable). In white matter, the myelinated walls of neighbouring cells typically run in parallel as part of large nerve bundles conveying information between distinct brain regions, which allows the integrity and orientation of a nerve bundle to be estimated from the aggregate rates of diffusion within an image voxel (3D pixel). The nerve bundles are then tracked or traced through the white matter by moving along the estimated bundle orientations to produce structural connectivity maps of the long range connections within the subject's brain. These diagrams are colour coded based on the direction the fibres travel in.

As part of the ASPREE NEURO project, we have generated structural connectivity maps for healthy elderly subjects in order to understand the relationship between structural connectivity and cognitive performance as we age. A typical image and zoom is shown below.

An example of a structural connectivity map generated for the ASPREE NEURO project, with a zoomed in portion of the left image shown on the right. Code: relative to the page, red is used to denote left-right; blue for up-down; and green for in-out of the page. Combination and strength of colour indicate where fibres travel diagonally.





Preclinical Imaging

The MBI Preclinical Imaging Team had a highly productive 2015, with a number of new projects initiated as well as advances in existing collaborations. The following preclinical imaging projects highlight the diversity of studies that are undertaken and supported by the preclinical imaging team.

The 3 Tesla (3T) MRI was used to image sheep with intervertebral spinal damage. In a collaboration with biologists and engineers at Deakin University, the team measured antibody targeted iron nanoparticle binding at the sites of fat accumulation in the arteries of rats with heart disease. In a parallel study researchers at the Monash Clayton campus and at the Baker IDI Institute used copper-64 labeled antibodies and the PET-CT scanner located at AMREP to image plaques in mice with heart disease.

The team regularly combines their expertise in MRI, PET and CT with that of the imaging scientists at the Australian Synchrotron to undertake world leading imaging science. In a study to investigate renal oxygenation the 9.4 Tesla (9.4T) small animal MRI and the X-ray source and micro-CT at the synchrotron Imaging and Medical Beam Line (IMBL) were used to anatomically map small renal arteries and veins in a rodent model. Researchers from Grenoble in France, used the 9.4T MRI to measure tumour volumes and recovery following irradiation with the synchrotron medical X-ray Beamline. The small animal PET-SPECT-CT was also used to measure murine femurs and quantify lung tumor sizes in a mouse model. Throughout 2015 the Preclinical Imaging Team provided support to complete development of the MBI gas hyperpolariser system. The system successfully produced xenon-129 and helium-3 gas for use as contrast agents for lung MRI and the team is looking forward to seeing the first projects commence in early 2016.

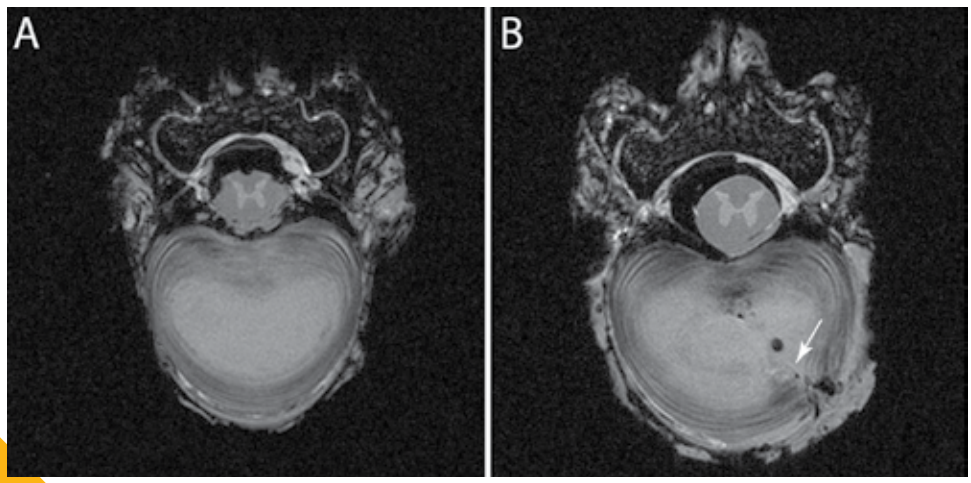
Read more about the Preclinical Imaging Team's work, including using stem cells to support spinal disc repair

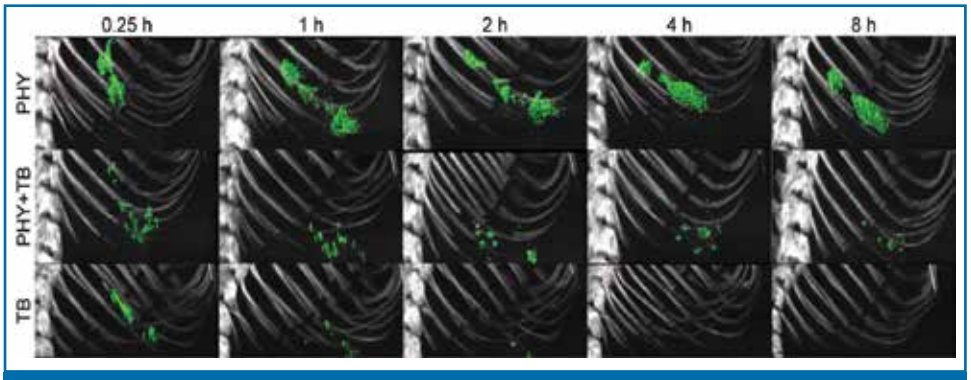
Stem cells to cure disc degeneration

Chris Daly, Peter Ghosh, David Oehme (Hudson Institute of Medical Research), Anne Gibbon, Graham Shillito (Monash Animal Research Platform), Ruth Vreys, QiZhu Wu and James Pearson (MBI), Graham Jenkin, Tony Goldschlager (Hudson Institute of Medical Research)

Microdiscectomy is the surgical removal of a small piece of degenerated intervertebral disc to relieve pain due to nerve compression. However, removal of the offending portion of the disc fails to address the underlying disc degeneration. Progress in tissue engineering and stem cell research has given researchers the ability to engineer cellular constructs for replacement of damaged tissues. Dr Daly and his team are testing Mesenchymal Precursor Cells (MPCs) (a type of adult stem cell found in many tissues throughout the body), to treat, and potentially initiate a reparative process. For this project, they use sheep, the preferred model for spinal research due to its many similarities with the human spine. As such, the same criteria, (i.e. the Pfirrmann MRI disc degeneration score, used in human patients to measure disc damage) can be applied. Having developed a suitable model (see image), the researchers can now focus on clinical trials investigating MPCs for the treatment of back pain and disc degeneration, as well as investigating the mechanisms by which the cells produce tissue regeneration.

9.4T MRI of experimentally injured sheep intervertebral disc prior to stem cell therapy. (A) control disc, and (B) injured disc (white arrow shows site of injury).





CT images obtained from the CT scanner show the presence of formulation in the stomach (green) over time for phytantriol (PHY, a non-digestible lipid; top panel), tributyrin (TB, a digestible lipid; bottom panel), and a mixture of the two (PHY+TB; middle panel).

Tracking the position of lipid formulations in the gastrointestinal tract

Anna Pham, TriHung Nguyen, Linda Hong, Oliver Montagnat, Cameron Nowell, Bim Graham, Ben Boyd

The use of lipid (fat) based formulations for the delivery of poorly water soluble drugs has held promise for decades. However, only a few products have made it to the market because the behaviour of these systems *in vivo* (whole animals or people) is not understood. With some lipid systems, it was thought that as fats take longer to breakdown in our stomach then drugs dissolved in fat also take longer to be absorbed. In order to better understand this behaviour, the CT scanner was used to track the position of gold nanoparticles resuspended in different lipid formulations within the gastrointestinal tract of rats. The imaging of the gastric compartment confirmed that gastric retention was lower with digestible lipids, and higher with non-digestible lipids. Pharmacokinetics showed drugs within digestible lipids are absorbed rapidly while those in non-digestible lipids can reside in the stomach for over 24 hour, slowing absorption but increasing bioavailability.

The Brain and Mental Health Laboratory (BMH)

The Brain and Mental Health Laboratory aims to understand the principles and mechanisms of human brain function in order to uncover causes and treatments of mental illness.

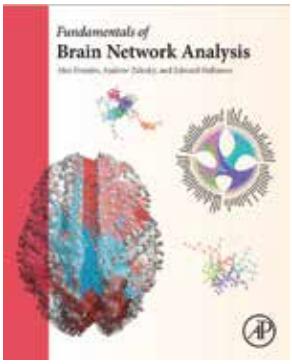
BMH research activities primarily use brain imaging and other tools from cognitive neuroscience to understand human brain structure and function in health and disease. We use advanced technologies to personalise and fast-track the translation of new scientific knowledge into simple, effective, safe and accessible interventions.

The BMH team has a diverse range of expertise, with particular strengths in structural, functional, diffusion and spectroscopic MRI, EEG, TMS, PET, graph theory and network science, and clinical neuropsychology, as well as translational research. Here, we present some of the highlights of our work across a range of areas. You can see other aspects of our work, including recent research outcomes on our website. Note that prior to 2015, BMH was called Monash Clinical and Imaging Neuroscience (MCIN) Laboratory.

Read more about the work of the Brain and Mental Health Laboratory

Brain Systems

By modeling the brain as a complex, interconnected system, we can uncover key principles of neural organization in health and disease. We do this using techniques that include non-invasive structural, functional and molecular brain imaging (MRI and PET), statistical genetics, graph theory and complex network science. An example of our work is the recently published book “Fundamentals of Brain Network Analysis” which provides a comprehensive introduction to neural connectomics.

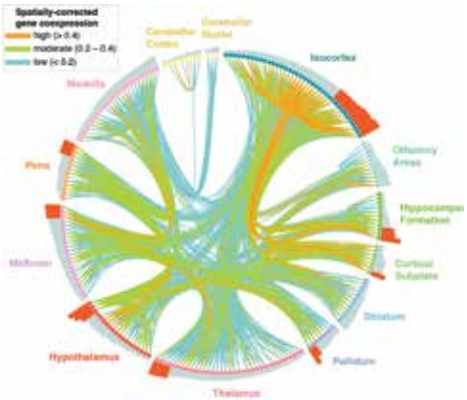


You can obtain a copy of the book from the Elsevier Store via this QR Code.

Download the journal article (open access)

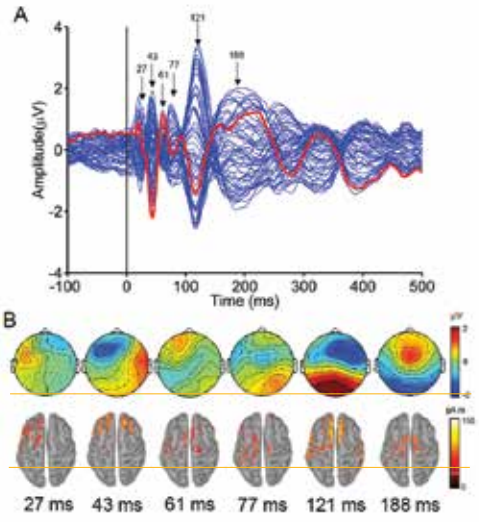
Computational modelling

Large, complex datasets are commonly measured in neuroscience, be it comprehensive gene expression datasets (of tens of thousands of genes), or data on interconnectivity between hundreds of different brain regions. To uncover the subtle patterns in these data, we require sophisticated statistical methods for data processing, and mathematical methods for analysis and modelling. BMH are developing state-of-the art quantitative techniques for computational modeling and simulation of brain connectivity and dynamics. An example is our recent paper showing that the most highly connected brain regions have the most similar gene expression patterns, providing genetic markers of long-range communication in the brain.



Brain Stimulation

We are combining non-invasive brain stimulation with neuroimaging to develop methods for probing and manipulating brain function, and to identify novel treatment approaches for mental illness. This includes utilising rapidly sampled neurophysiological recordings (EEG and Magnetoencephalography, MEG), as well as cognitive models and measures of memory. For example, we have recently combined brain stimulation and EEG to show that a brain mechanism called cortical inhibition in the frontal cortex is related to short term memory performance.

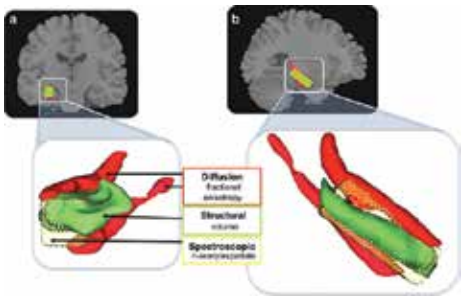


The response to single pulses of brain stimulation over the frontal cortex measured using EEG.

You can access the article via the Science Direct website.

Substance and behavioural addictions

We work within the principles of neuroplasticity to understand the mechanisms of the human brain in light of the 'addiction processes' and how lifestyle and psychological factors can alter these processes. We recently assessed 74 long-term cannabis users and 37 non-user control participants and found that two distinct psychoactive compounds within commonly smoked cannabis appear to have differing effects. While ongoing cannabis use is associated with harms to brain health, our findings also show that cannabis-related brain harms can be recovered with extended periods of abstinence. Interestingly, our findings also indicate that Δ(9)-tetrahydrocannabinol (THC) exacerbates, whereas cannabidiol (CBD) protects from, these harmful neuroanatomic alterations.

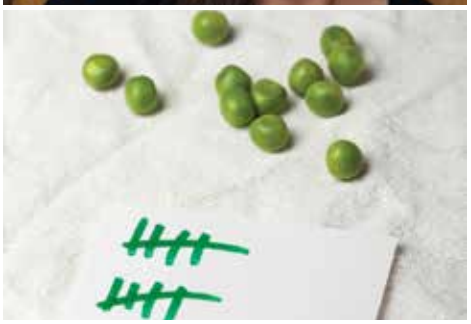


Multi-modal assay of the medial temporal grey matter and white matter, and biochemistry.

Read the full article via this QR Code (open access)

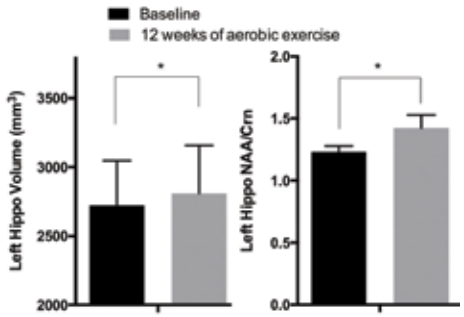
Compulsive disorders

Supported by a long-term philanthropic partnership (the David Winston Turner Endowment Fund), BMH is leading ground-breaking research into compulsive disorders, including obsessive-compulsive disorder (OCD) and addiction. Building upon significant strategic commitments by Monash University, we aim to translate our research outcomes into personalized, cost-effective treatments for the hundreds of thousands of people in the community affected by compulsive disorders.



Lifestyle and psychological treatments

BMH fosters the pathway from discovery to practice by conducting research that positively impacts care (e.g. diagnosis, treatment, prevention). We do this by developing tailored lifestyle, psychological, and technology-based interventions that are safe and accessible. This includes exploring physical exercise, mindfulness, neurofeedback, virtual reality, brain stimulation and smart phone technologies incorporated into therapeutic interventions. One of our recent studies demonstrated that a 12-week exercise training program has a positive influence on the region of the brain involved in learning and memory. Preliminary results of another study showed that individuals who practiced mindfulness showed better control over their brain activity during tasks that required them to direct their attention. These findings support the use of exercise and mindfulness as treatment interventions to improve brain health.



Increase in the size (3.5% increase; left) and neuronal integrity (16.3% increase; right) in the hippocampus after a 12-week exercise program.

Neuroethics and policy

We use our developing knowledge of the complex factors that contribute to addiction and OCD, including neuroscience, to create positive social and policy change. This includes guidelines for treatment professionals and policy-makers on the use of emerging neurobiological treatments of addiction and OCD, as well as public engagement events, patient advocacy and community outreach initiatives. Recently, we critically assessed the evidence supporting the growing view of addiction as a brain disease. We found that the model is not supported by animal and neuroimaging evidence to the extent its advocates suggest. Use of this model (addiction as a brain disease) has not helped to deliver more effective treatments of addiction and its effect on public policies toward drugs and people with addiction has been modest. It may have a negative impact on the treatment of addiction for some individuals.

BMH Personnel

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- ***Ellen Stavrinos,*** Volunteer Student
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Read the full article in The Lancet

Monash Neuroscience of Consciousness (MoNoC)

The Monash Neuroscience of Consciousness (MoNoC) Research Laboratory aims to understand the neural basis of consciousness. Our approaches focus on three areas:

1. Consciousness itself - Developing the theory of consciousness and empirically testing it, revealing the boundary condition of conscious and non-conscious processing.
2. Attention - The relationship between consciousness and attention.
3. Biological motion processing - How does the perception of social motion stimuli depend on attention, and individual differences.

To learn more about their research, visit the MoNoC Research Lab website

No-report paradigms: extracting the true neuronal correlates of consciousness

Naotsugu Tsuchiya, Melanie Wilke (University Medicine, Goettingen), Stefan Frassle (University of Marburg), Victor Lamme (University of Amsterdam)

The goal of consciousness research is to reveal the neural basis of phenomenal experience – to understand how signals in the brain generate what we consciously experience. In order to do this, researchers have tended to ask their research subjects to provide a report (written, verbal, and other forms of perceptual reports including manual button presses) on what they experience. In this article in *Trends in Cognitive Sciences*, we argue that asking for subjects to provide reports has biased the search for the neural correlates of consciousness over the past decades. In some cases, these reports have misled the researchers to take the neural correlates of reports with the neural correlates of consciousness.

Research is now at a point where we are trying to disconnect the brain activity that gives rise to consciousness from the brain activity that enables the reporting. Moreover, we are now conducting experiments where subjects are not asked to provide reports – so called no-report paradigms – in order to study conscious experience in the complete absence of any report. The emerging no-report paradigms are bringing us closer to understanding the true neural basis of consciousness.

Use this QR code to read the full article online.

Using category theory to assess the relationship between consciousness and integrated information theory

Naotsugu Tsuchiya, Shigeru Taguchi (Hokkaido University, Japan), Hayato Saigo (Nagahama Institute of BioScience, Japan)

One of the most mysterious phenomena in science is the nature of conscious experience. Due to its subjective nature, it seems difficult or nearly impossible to derive the laws of consciousness, which explains how the neural activity in the brain gives rise to conscious thoughts and feelings, as rigorous as the laws of physics explaining how the outer physical world works. A recently developed theoretical framework, called integrated information theory (IIT) of consciousness, however, boldly aims to achieve this ambitious goal. In particular, IIT proposes that a maximally irreducible conceptual structure (MICS) is identical to conscious experience (essentially a specific type of interactions among neurons corresponds to a specific type of conscious experience). However, there has been no way to assess whether the proposed relationship is true or false. In this study we proposed a mathematical formalism, called category theory, to assess the identity.

In order to test the identity we first ascertain if there is a translation between the domain of conscious experience and that of the MICS. If the translation exists, it may be possible for questions in one domain to be answered in another domain. For example, very difficult questions in the domain of consciousness could be resolved in the domain of mathematics. Our work proposes a joint use of neuroscientific and computational approaches to empirically test if such a translation exists. Our general, principled and empirical framework allows researchers to assess the relationship between the domain of consciousness and the domain of mathematical structures, including those suggested by IIT.

Joints and their relations as critical features in action discrimination: Evidence from a classification image method

Jeroen J.A. van Boxtel, Hongjing Lu (UCLA, USA)

Determining whether someone or something is walking or running is an important task. It helps us predict and respond to danger and informs us on how we, ourselves, should move. Unless you are a scrutineer of Olympic walking, the seeming ease with which we classify whether someone is walking or running belies the complex (and unconscious) perceptual and decision processes that underlie these classifications. Indeed, it is difficult to determine which features the brain uses to perform this task. This is especially true for hypothesis-driven research, because of the number of factors involved – more than a dozen joints (feet, knees, hips, hands, elbows, shoulders and head) moving simultaneously in three dimensions; this creates 66 joint relationships that need to be tested.

A hypothesis free approach has been developed based on a classification image method using experimental data from relatively few trials (~1000 trials per subject). Employing ambiguous actions morphed between a walker and a runner, we identified three types of features that play important roles in discriminating bipedal locomotion (walking on two legs) when presented in a side view:

1. **Critical joint features** were supported by the finding that the similarity of the movements of feet and wrists to prototypical movements of these joints were most reliably used across all participants;
2. **Structural features**, indicated by contributions from almost all other joints, potentially through a form-based analysis; and
3. **Relational features**, revealed by statistical correlations between joint contributions, specifically between the two feet, and between the wrists/elbow and the hips.

When the actions were turned upside-down so they were walking or running on the ceiling, participants relied heavily on the *critical joint features* to decide if the figure was walking or running. When actions were presented with continuous depth rotation, *critical joint features* and *relational features* associated strongly with the assessment of walking or running. Using a double-pass paradigm (participants viewed 20% of the images twice) we estimated that the internal noise (the variation in decision-making caused by our brain) is about twice as large as the external noise (the variation researchers added to the stimuli participants were asked to assess), and is consistent with previous findings.

Overall, our novel design revealed a rich set of critical features that are used to assess walking versus running and that the number of visual cues relied upon can vary depending on the viewing conditions.

High-level action adaptation is reduced in autism spectrum disorders

Jeroen van Boxtel, Steven Thurman (UCLA USA), Mirella Dapretto (UCLA USA), Martin Monti (UCLA USA), Jeffrey Chiang (UCLA USA), Hongjing Lu (UCLA US)

Biological motion research has shown that prolonged exposure to one action gives rise to an after-effect that biases perception of a subsequently displayed action. For example, after viewing an actor walking to the left for a while, a subsequently presented actor with an ambiguous walking direction will be perceived to move to the right. Here we investigated such action adaptation for a particularly relevant group – children with autism spectrum disorders (ASD). Recognising and adapting to biological movement is particularly important for (human) social development and we know that people with ASD have impaired social development. Using a computer-based assessment, we set out to determine the extent of perception bias in children with ASD, compared to "age-matched" counterparts.

We found decreased location-invariant adaptation in children with ASD – that is children with ASD do not show the same extent of perception bias as their age-matched counterparts. We then investigated the regions of the brain that might be responsible for these observed differences in typically developing adults. We found significant correlations between neural adaption in the superior temporal sulcus (STS) and behavioural adaptation measures. The STS has been heavily implicated in other studies of ASD, particularly as it relates to other social functions such as speech understanding, and face perception. We found that adaptation correlated with the level of autistic traits in our sample, consistent with our findings in ASD.

Taken together our findings show that people with ASD have reduced global adaptation to biological motion, and this is likely due to a reduced sensitivity in a region of their brain called the superior temporal sulcus.

Principal component analysis (PCA) of an action discrimination task (walking vs running). The joints are colour/size coded to show the loadings of the first component of the PCA analysis. Larger size means larger loadings, red is positive, blue is negative. The left figure is the data for an upright figure seen from the side, the middle figure are the data for an inverted figure from the side, and right figure is the data for an upright and rotating figure. Data from van Boxtel JJA & Lu H, Journal of Vision 15(20):2015.

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MBI Operations

Early in 2015 planning and design activities commenced in earnest for the installation of a new scanner capable of performing simultaneous MRI and PET imaging (MR-PET). Included in the scope of the project were volunteer procedure rooms, a radiation 'hot lab', and a large animal surgery. This activity required a significant contribution of time and effort from a large number of staff across MBI, and took place on top of the normal operational activities (see separate BMTF project report, opposite). The established facilities at MBI saw strong usage, with a 42% increase in the number of projects commencing during the year relative to 2014, 1551 total reservations, and 3573 hours of facility time booked.

Staffing changes

Late in the year saw the departure of two long-standing MBI staff Drs Bryan Paton and Parnesh Raniga, who played key roles in the development of novel research protocols and image analysis methodology. We welcomed Dr Tom Close as Senior Informatics Officer (who recently returned to Australia from post-doctoral studies in Okinawa, Japan). We also welcomed Francesco Sforrazini as a Research Assistant in the Imaging Methods and Analysis Team, and Parisa Zakavi as a Technical Officer to bolster our technical and developmental capabilities.

Facility utilisation and equipment

After a period of validation and testing, online bookings for both preclinical and clinical facilities were transferred to the Australian Research Infrastructure Network (ARIN) booking system in early 2015. The ARIN booking system allows us to track facility utilisation by individual project and/or user, and according to category of use such as assisted, unassisted, maintenance or development.

Researchers utilising MBI facilities commenced 47 new projects (42% preclinical, 58% clinical), of which 83% were Monash researchers and the remainder external investigators. There was continued strong use of the established facilities at MBI throughout the year, with the Siemens Skyra 3T MRI scanner being the most heavily utilised, typically in the range of 100-130 hours/month, or approximately 70-90% of available time. Other clinical testing facilities, including EEG, TMS and ocular motor, had solid usage, frequently in the range of 40-80 hours/week during peak periods. The Agilent 9.4T MRI was the most heavily used of the preclinical facilities, typically in the range of 40-80 hours/month, or approximately 55% of available time.

Research groups from the Monash Institute of Cognitive and Clinical Neurosciences (MICCN) are key users of MBI facilities, and a number of MICCN research groups are physically colocated as MBI Linked Laboratories to facilitate this interaction. This contributes to a lively research environment with extensive exchange of information, and development of novel research capabilities and techniques jointly by MBI and MICCN personnel. In 2015 the group formerly known as Monash Clinical and Imaging Neuroscience Laboratory (MCIN) became the Brain and Mental Health Laboratory (BMH).

As evidence of the strong relationship between MBI and MICCN, in 2015 the Faculty of Medicine, Nursing and Health Sciences allocated awarded Platform Access Grants, including 11 to researchers using the MBI facilities. The projects ranged from studies into the neural control of sleep in humans to cognitive compensation in the elderly. Further details of the MICCN research activities can be seen in the Linked Laboratories Reports.

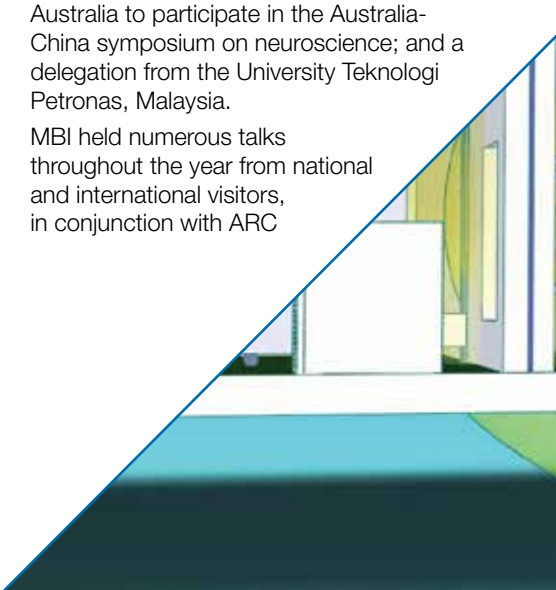
Training courses, media, tours and seminars

As has been the practice in previous years, MBI hosted a two-day course in conjunction with the ARC Centre of Excellence for Integrative Brain Function, on the application of Matlab for researchers in psychology, psychophysics, cognitive neuroscience, neuroscience and related fields.

Several news stories from researchers utilising MBI Facilities appeared in *The Age*, including an article about development of the visual pathway in the brain by Associate Professor James Bourne from the Australian Regenerative Medicine Institute, Monash University, and an article by Monash University neuroscientist Professor Murat Yücel on research into the use of virtual reality technology to treat addictive behaviours such as problem gambling.

MBI hosted a number of tours for visiting dignitaries and scientists interested in our Facilities and Operations. These included Dr. Simon Corrie, Australian Institute for Bioengineering and Nanotechnology, The University of Queensland; Mr Dan Sinai Associate Vice-President (Research) from Western University, Canada; Professor Ned Pankhurst and Professor Huijun Zhao from Griffith University; a delegation from the Translational Research Institute, Queensland; Dr Ryan Yuen, Hospital for Sick Children, Canada; delegates from the Chinese Academy of Sciences in Australia to participate in the Australia-China symposium on neuroscience; and a delegation from the University Teknologi Petronas, Malaysia.

MBI held numerous talks throughout the year from national and international visitors, in conjunction with ARC



Centre of Excellence for Integrative Brain Function and the School of Psychological Sciences, including:

- Dr Christoph Mathys, Welcome Trust Centre for Neuroimaging, University College London. ***The uncertainty, precision, prediction errors and their relevance to computational Psychiatry***
- Dr Christopher Witte, LeibnizInstitut für Molekulare Pharmakologie, Berlin. ***Inert but Alert: Development of MRI biosensors using hyperpolarised xenon.***
- Professor Peter Robinson, University of Sydney. ***Modelling brain dynamics and connectivity using neural fields: theory, experiment and prospects.***
- Dr Pulin Gong, The University of Sydney. ***Cortical spatiotemporal patterns and their computational roles.***
- Dr Barry Richmond, National Institute of Mental Health, NIH. ***Transforming visual stimuli into meaning: learning reward values and ranking them.***
- Associate Professor Alex Holcombe, University of Sydney. ***Sampling from the page or from your visual buffer?***
- Dr Paul Dux, School of Psychology, The University of Queensland. ***Neuro-cognitive mechanisms of cognitive control training.***
- Dr Marta Garrido, Centre for Advanced Imaging, The University of Queensland. ***Predictive and efficient coding in sensory learning.***

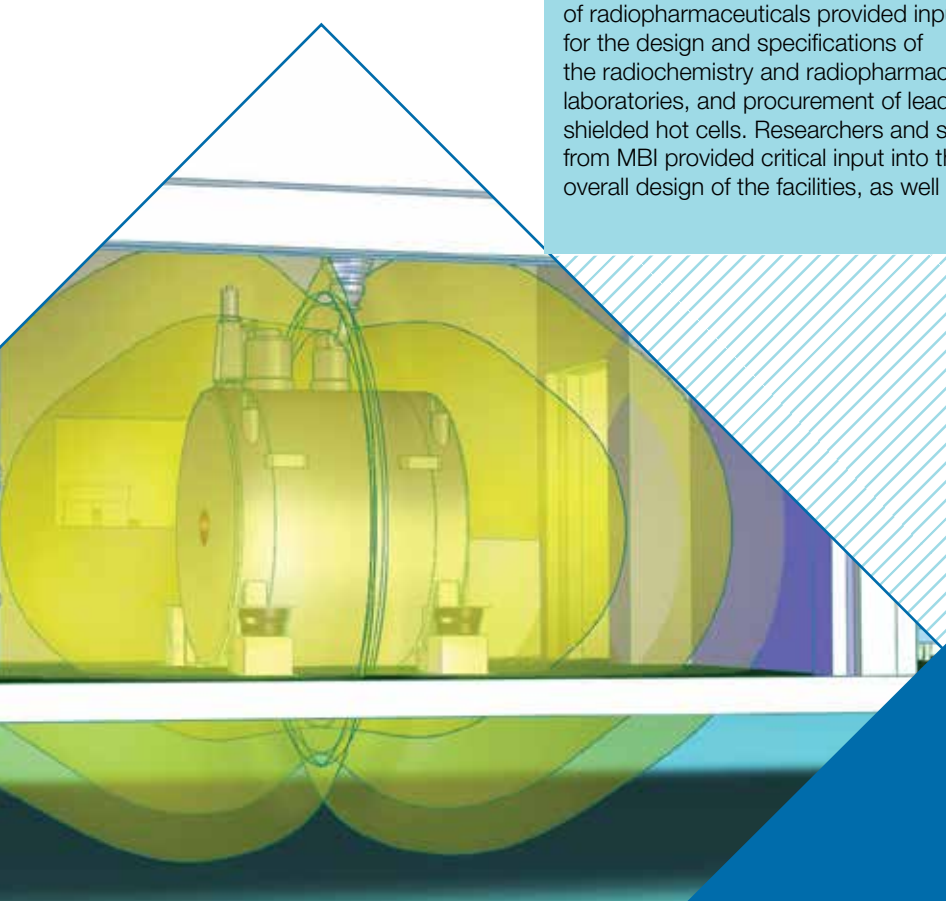
Biomedical Materials Translational Research Facilities building project

Monash University and the CSIRO received funding in late 2014 from the Science and Industry Endowment Fund to establish the Biomedical Materials Translational Facility (BMTF). One of the aims of the BMTF was to provide a facility capable of realtime non-invasive imaging in large animal preclinical studies. An integral step in the achievement of this goal was the installation of an MR-PET scanner at MBI. MR-PET scanner technology provides the unique capabilities of simultaneously acquiring high quality non-invasive images, particularly in soft tissues, together with dynamic molecular imaging data, in preclinical and human imaging research studies. To facilitate routine PET scanning in human participants and large animal research models, the plans included construction of dedicated laboratory spaces for the production, testing, and dispensing of radiopharmaceuticals, as well as a large animal surgery.

The project commenced in early 2015, with an ambitious timeline requiring scanner installation and completion of the first scans by December 2015. An intensive design phase gathered critical design parameters from numerous experts including those in the fields of human and large animal research to guide construction of the large animal surgery and BMTF. Experts in the production and utilisation of radiopharmaceuticals provided input for the design and specifications of the radiochemistry and radiopharmacy laboratories, and procurement of lead-shielded hot cells. Researchers and staff from MBI provided critical input into the overall design of the facilities, as well as specifications for the room housing the MR-PET scanner.

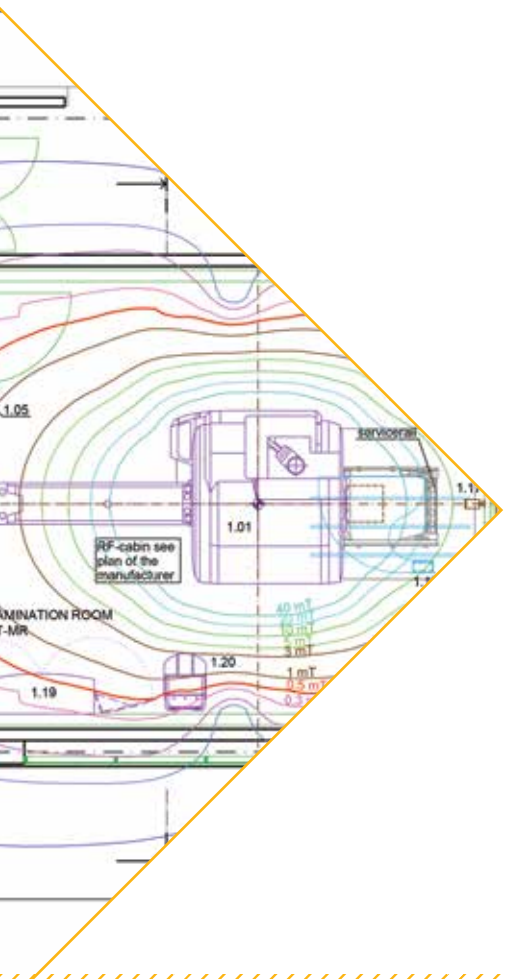
In parallel with the design phase, a tender was initiated for the procurement of the MR-PET scanner, involving representations from the potential suppliers, site visits to Europe and North America to assess technical capabilities, and rigorous assessment and ranking of the tender submissions. The decision to procure the Siemens Biograph mMR scanner was made in July together with the commencement of the facility construction, and delivery and installation of the MR-PET scanner occurred in early December. The scanner installation and acceptance tests were completed in late January 2016.

Construction of the BMTF MR-PET Scanner facilities at MBI was a highly technical and challenging project that was completed only one month behind schedule. The first successful MR-PET scan involving injection of radiopharmaceutical into a human volunteer was completed in February 2016, and a largescale clinical research project into neuropsychiatric disorders has recently commenced. The timely and successful completion of the project was made possible by the clear vision and support of Monash Executive and Research leadership, a strong effort from the entire team of MBI staff, together with a skilled and hard-working team of architects, engineers, builders and trades. The result is a unique worldclass facility that will provide opportunities for large animal scientists, as well as clinical researchers, to undertake cutting-edge research into neurosciences, as well as translational research into testing and development of biomaterials and medical devices. It is hoped that the facility will allow the scientific research community to engage strongly with industry, to further invest in technology and innovation in Australia.



MBI Collaborations

MBI is focused on collaborative research efforts for both the development of biomedical imaging research techniques as well as their use in research projects. Throughout 2015 we continued to develop and maintain relationships with key research organisations and partners.



VBIC

The partnership established through the formation of the Victorian Biomedical Imaging Capability (VBIC) has been led from MBI for almost five years. In that time VBIC has supported major initiatives across the biomedical imaging community. It has also supported the development and release of imaging research guidelines covering the Management of Incidental Findings, and a separate document on Quality Control within 3T MRI Research Facilities. MBI was also a feature of the August edition of the VBIC newsletter *Topics*.

The efforts of VBIC since 2010 have seen Victoria establish itself as a major imaging hub in Australia. This reputation and associated expertise was the foundation for MBI, Siemens and several other clinical imaging partners in developing a joint bid for the establishment of a Brain Injury Cooperative Research Centre (outcomes to be announced in 2016).

MASSIVE

MASSIVE is a national imaging and visualisation facility, which provides MBI researchers and users with access to data processing, advanced analysis and visualisation resources. MASSIVE provides integration of neuroinformatics tools and neuroimaging databases, workflow analyses and data management to MBI. MASSIVE underpins the neuroscience research by:

- providing access to data processing, advanced analysis and visualisation resources;
- supporting and enhancing the publication of MBI tools and data; and
- building partnerships with international neuroinformatics infrastructure initiatives.

In 2016 MASSIVE will launch the next stage of works (MASSIVE3) to ensure future requirements can be met.

CSIRO

The collaboration formed with CSIRO in 2011 has been strengthened in 2015, with the successful procurement and installation of a MR-PET scanner, to be located at MBI. The scanner was purchased as a result of a successful joint bid between CSIRO and Monash University, to establish a Biomedical Materials Translational Facility, under the Science and Industry Endowment fund. The scanner, which will be fully operational in early 2016, will enable new collaborative opportunities between CSIRO, Monash University and other industry partners.

National Imaging Facility

MBI continued to participate in the NIF network, through the provision of access to scanners and infrastructure. NIF continued to provide salary support for Facility Fellows, throughout 2015, enabling researchers to utilise state of the art imaging facilities.

incf
National Node of Victoria, Australia

The International Neuroinformatics Coordinating Facility (INCF) was established in 2006 by the Organisation for Economic Co-operation and Development. Seventeen countries have INCF nodes including the USA, UK, Germany, Sweden, and Japan. The INCF develops and maintains databases and computational infrastructure for brain researchers. Software tools and standards for the international neuroinformatics community are being developed through the INCF Programs, which address infrastructure issues of high importance to the neuroscience research community.

The INCF Victorian Node was established in 2012 through a collaboration between Monash University and The University of Melbourne and head-quartered at MBI. During 2015 the node was expanded to include the six collaborating institutions of the ARC Centre of Excellence for Integrative Brain Function (see below). During 2015 the Australian node hosted the INCF International Congress in conjunction with the International Society for Neurochemistry scientific meeting held in Cairns. A one day symposium within the Congress highlighted the INCF Australian node neuroinformatics research activities in neuroimaging, advanced neuroscience visualisation, and neuroatlases (see http://neuroinformatics2015.org).

Australian Research Council
Centre of Excellence for
Integrative Brain Function

Led by Monash University, the Centre of Excellence for Integrative Brain Function (CIBF) aims to understand how the brain interacts with the world. The Centre is a collaboration between Monash University, the University of Queensland, the University of Melbourne, the University of Sydney, the Australian National University, the University of New South Wales, and twelve international partner institutions from Europe, North America and Asia. Several CIBF researchers are based at MBI and extensively use the imaging research facilities located at MBI. The Centre's researchers are actively pursuing multidisciplinary approaches to investigate integrative brain functions including attention, predictive coding and decision-making. CIBF provides the opportunity for MBI-based researchers to participate in one of Australia's leading neuroscience research centres.

CIBF 2015 Annual Report

CIBF website

MBI recognises the importance of forming strategic alliances with key partners for the development of imaging infrastructure and research capabilities.

SIEMENS

Since the opening of MBI, Siemens and MBI have continued to work collaboratively on a number of research projects including: (i) application of Siemens MEGAPRESS sequence for GABA spectroscopy to investigate inhibitory mechanisms in the brain, (ii) development of quantitative susceptibility imaging methods to examine brain iron content, and (iii) applications to high resolution imaging in kidney and brain using Siemens ZOOMIT multi-channel transmit technology. The installation of the MR-PET scanner will further strengthen this partnership and expand the breadth of projects from MR to include molecular imaging. The initial simultaneous MR-PET technology development projects include MR guided improvements to PET image reconstruction and PET attenuation correction estimation.

Helmholtz Association

In 2015, a Letter of Intent was signed between Monash University and Helmholtz Forschungszentrum Jülich to collaborate in the field of hybrid MR-PET and ultra high field (human) functional MRI. The partners have commenced discussion towards the formation of a German-Australia Centre for Advanced Bioimaging in the area of simultaneous MR-PET and intend to exchange staff in order to promote knowledge exchange and develop a training site for PhD students and new simultaneous MR-PET applications. Professor Jon Shah has taken a dual appointment across the two institutions and was recently awarded a three year Helmholtz Innovation Fund grant to develop a next generation Brain PET scanner. The technology development project includes Siemens AG (Germany) and Monash University as an international partner, and is scheduled to commence in 2016.

MBI, BMH and MoNoC Research Outputs

Publications

MBI Clinical Research Imaging

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81. Valenzuela, M. J., A. J. Turner, N. A. Kochan, W. Wen, C. Suo, H. Hallock, R. A. McIntosh, P. Sachdev and M. Breakspear (2015). "Posterior compensatory network in cognitively intact elders with hippocampal atrophy." Hippocampus 25(5): 581-593.
82. Vijayakumar, N., S. Whittle, M. Yücel, M. L. Byrne, O. Schwartz, J. G. Simmons and N. B. Allen (2015). "Impaired Maturation of Cognitive Control in Adolescents Who Develop Major Depressive Disorder." J Clin Child Adolesc Psychol: 1-13.
83. Yücel, M., A. Kandola and A. Carter (2015). "Remind me again, how does cannabis affect the brain?" The Conversation epub May 28.
84. Yücel, M., S. Whittle, G. J. Youssef, H. Kashyap, J. G. Simmons, O. Schwartz, D. I. Lubman and N. B. Allen (2015). "The influence of sex, temperament, risk taking behavior and mental health on gambling behavior: a longitudinal study of youth." International Gambling Studies 15(1): 1-16.

MBI, BMH and MoNoC Research Outputs

MoNoC

85. Van Boxtel, J. J. and H. Lu "Understanding Biological Motion." Emerging Trends in the Social and Behavioral Sciences: An Interdisciplinary, Searchable, and Linkable Resource.
86. Koenig-Robert, R., R. VanRullen and N. Tsuchiya (2015). "Semantic Wavelet-Induced Frequency-Tagging (SWIFT) Periodically Activates Category Selective Areas While Steadily Activating Early Visual Areas." PLoS One 10(12): e0144858.
87. Oizumi, M., S.-i. Amari, T. Yanagawa, N. Fujii and N. Tsuchiya (2016). "Measuring Integrated Information from the Decoding Perspective." PLoS Comput Biol 12(1): e1004654.
88. Takaura, K., N. Tsuchiya and N. Fujii (2016). "Frequency-dependent spatiotemporal profiles of visual responses recorded with subdural ECoG electrodes in awake monkeys: Differences between high- and low-frequency activity." NeuroImage 124, Part A: 557-572.
89. Tsuchiya, N., S. Frässle, M. Wilke and V. Lamme (2016). "No-Report and Report-Based Paradigms Jointly Unravel the NCC: Response to Overgaard and Fazekas." Trends in Cognitive Sciences.
90. Tsuchiya, N., A. Haun, D. Cohen and M. Oizumi (2016). Empirical tests of integrated information theory of consciousness. Return of Consciousness. A. Haag. Sweden, Axon Foundation.
91. Tsuchiya, N. and C. Koch (2015). The relationship between consciousness and top-down attention. The Neurology of Consciousness S. Laureys, G. Tononi and O. Gosseries, Academic Press: 69-89.
92. Tsuchiya, N., S. Taguchi and H. Saigo (2016). "Using category theory to assess the relationship between consciousness and integrated information theory." Neuroscience Research.
93. Tsuchiya, N., M. Wilke, S. Frässle and V. A. Lamme (2015). "No-Report Paradigms: Extracting the True Neural Correlates of Consciousness." Trends in Cognitive Sciences 19(12): 757-770.
94. Van Boxtel, J. and N. Tsuchiya (2015). "De-confounding the neural constitution of phenomenal consciousness from attention, report and memory." The Constitution of Phenomenal Consciousness: 81-103.
95. van Boxtel, J. J., M. Dapretto and H. Lu (2016). "Intact recognition, but attenuated adaptation, for biological motion in youth with autism spectrum disorder." Autism Research.
96. van Boxtel, J. J. and H. Lu (2015). "Joints and their relations as critical features in action discrimination: Evidence from a classification image method." Journal of vision 15(1): 20-20.e
97. Elizabeth Z., H.H. Yu, E. Rowe, M. Rosa, and N. Price "Rapid adaptation induces persistent biases in population codes for visual motion The Journal of Neuroscience, 20 April 2016, 36(16): 4579-4590

Current Grants

MBI Clinical Research Imaging

1. NHMRC Principal Research Fellowship Grant APP1102725: "Simultaneous MR-PET metabolic and functional Imaging for neuroscience and dementia research", (2016) Chief Investigator: G.F. Egan
2. National Collaborative Research Infrastructure Scheme (NCRIS) "Support for the National Imaging Facility", (2015-17) Co-Principal Investigators –G. Galloway, G.F. Egan, et al.
3. ARC Centre of Excellence CE140100007: "ARC Centre of Excellence for Integrative Brain Function", (2014-20) CIs: G.F. Egan, M. Rosa, J. Mattingley, P. Robinson, P. Sah, G. Stuart, M. Ibbotson, A. Lowery, E. Arabzadeh, G. Paxinos, P. Martin, S. Petrou, U. Grunert, E. Skafidis, M. Garrido; PIs - M. Breakspear, P. Mitra, J. Victor, T. Margrie, M. Diamond, G. Johnson, D. Leopold, J. Movshon, H. Markram, S. Hill.
4. ARC Discovery Project DP140103045, 2014-2016. "The comparative physiology of oxygen delivery to the kidney". D.W. Smith, R.G. Evans, B.S. Gardiner, J.T. Pearson, M.M. Kett.
5. NHMRC Principal Research Fellowship Grant #1003993: "Development of ultrahigh resolution brain imaging for investigating neurological and neurodegenerative diseases", (2011-15) Chief Investigator: G.F. Egan
6. NHMRC Project Grant APP1042528, 'Activity in central cough networks in patients with cough hypersensitivity' (2013-2015) Chief Investigators: S. Mazzone, M. Farrell, G.F. Egan
7. NHMRC Project Grant APP1042893: 'A role for the pulvinar nucleus in visual cortical development and plasticity' (2013-15) Chief Investigators: J. Bourne, D. Leopold, G.F. Egan
8. NHMRC Project Grant APP1046037: 'A longitudinal neuroimaging study investigating reorganisation of cerebellar-cerebral networks in Friedreich ataxia', (2013-2016) Chief Investigators: N Georgiou-Karistianis, G.F. Egan, M. Delatycki, A. Churchyard, L. Corben
9. NHMRC Project Grant APP1061291: "Development of folding in the fetal cerebral cortex", (2014-16) Chief Investigators: DW Walker, J Britto, L Johnston, M Tolcos, G.F. Egan

MBI Cognitive NeuroImaging

10. fMRI of Cognitive Compensation in the Oldest Old. Monash University (Jamadar, S)
11. Jamadar. Research Assistance to Advance Women's Research Success, Monash University (Jamadar, S).
12. Cognitive Compensation in Ageing. Australian Research Council Discovery Early Career Researcher Award (DECRA) (Jamadar, S)

MBI Imaging Methods and Analysis

13. NHMRC Project Grant APP1086188, "ASPREE NEURO Study: Cerebral micro-haemorrhages and aspirin in the elderly: cognitive and clinical consequences. A prospective randomised controlled trial" (2015-2018) Chief Investigators: J. McNeil, G.F. Egan, A. Brodtmann, S. Ward, N. Ferris, M. Bailey

MBI Preclinical Imaging

14. ARC Discovery Project DP140103045, 2014-16, DW Smith, RG Evans, BS Gardiner, JT Pearson, MM Kett The comparative physiology of oxygen delivery to the kidney
15. NHMRC Project Grant APP1064973, 2014-16, SB Hooper, MJ Kitchen, M Siew JT Pearson Facilitating the pulmonary increase in blood flow at birth
16. Project Grant APP1083744, 2015-17, National Health and Medical Research Council R Lim, E Wallace, D Chambers, JT Pearson Bronchopulmonary Dysplasia – A Regenerative Medicine Approach
17. Development Grant APP1093319, 2015-17, National Health and Medical Research Council MJ Kitchen, JMC Brown, DM Paganin, SB Hooper, JT Pearson Single shot X-ray tomography for real-time functional X-ray imaging
18. Project Grant APP1101552, 2016-18, National Health and Medical Research Council KM Denton, C Samuel, R Widdop, T Hewitson, JT Pearson Understanding the cardioprotective action of the AT2R in females: shifting gears between AT1 and AT2 receptor balance of function with relaxin
19. NHMRC Equipment Grant GNT9000320, 2015, Monash University JA Bourne, C Marcelle, JT Pearson, J Bertram, IS Harper, Confocal and multifocal imaging system for intravital physiology, anatomy and developmental biology.
20. NHMRC Project APP1050672, 2013-15. "The pathophysiology of septic acute kidney injury". Chief Investigators: C. May, R.G. Evans, J.T. Pearson.

BMH

21. The David Winston Turner Endowment Fund (2015-21). "Addiction and obsessive-compulsive disorder project: Integrating neuroscience into the clinic". Yücel, Fontenelle, Cornish
22. NHMRC Early Career Fellowship (2015-18). "From brain maps to mechanisms: Modelling the pathophysiology of schizophrenia." Fulcher
23. NHMRC Peter Doherty Fellowship (2014-17). "Characterising and modulating corticostriatal connectivity in schizophrenia." Rogasch
24. ARC Future Fellowship (2013-17). "Mapping, understanding and manipulating the human brain connectome with MRI." Fornito
25. Central Research Grants Scheme (2014-15). "An investigation of decision-making and self-regulation during pregnancy and its association with gestational weight gain". Hayden, Fuller-Tyszkiewicz, Kremer, Yücel, Verdejo-Garcia, Boyle, Nagle, Skouteris
26. Psychology Research Grant Initiative (Monash University, Monash Institute of Cognitive and Clinical Neurosciences) (2015-16). "A robust and versatile database infrastructure to support the Research Clinics of MICCN". Bei, Drummond, Kazantzis, Mansfield, Norton, Rajaratnam, Verdejo-Garcia, Willmott, Yücel
27. Psychology Research Grant Initiative (Monash University, Monash Institute of Cognitive and Clinical Neurosciences) (2015-16). "Overcoming trauma: a real-time fMRI neurofeedback intervention using virtual reality." Molenberghs, Jobson, Lorenzetti, Yücel, Suo, Dominguez
28. Psychology Research Grant Initiative (Monash University, Monash Institute of Cognitive and Clinical Neurosciences) (2015-16). "An innovative app-based platform for real-world health and behaviour monitoring." Yücel, Fornito, Fulcher, Carter, Youssef
29. Platform Access Grant (Monash University) (2015-16). "Acute aftereffects of high-intensity exercise on primary motor cortex inhibition and motor learning." Coxon, Yücel, Suo
30. Platform Access Grant (Monash University) (2015-16). "Cognitive training effects on network connectivity in children." Spencer-Smith, Fornito, Rogasch
31. Faculty Strategic Grants (Monash University, Faculty of Medicine, Nursing and Health Sciences) (2015-16). "A platform for sharing and visualizing the human connectome." Fornito, Dwyer
32. Faculty Strategic Grants (Monash University, Faculty of Medicine, Nursing and Health Sciences) (2015-16). "Cognitive training effects on network connectivity in children." Spencer-Smith, Fornito, Rogasch
33. Faculty Strategic Grants (Monash University, Faculty of Medicine, Nursing and Health Sciences) (2015-16). "Interaction between physical fitness and brain network plasticity induced by rTMS." Coxon, Rogasch, da Costa, Watt, Yücel

34. Faculty Strategic Grants (Monash University, Faculty of Medicine, Nursing and Health Sciences) (2014-15). "The neurobiology of overeating: ethical, clinical and policy implications of "food addiction." Carter, Yücel, Verdejo-Garcia, Loxton and Hall
35. Faculty Strategic Grants (Monash University, Faculty of Medicine, Nursing and Health Sciences) (2014-15). "Brain mapping of nutrient sensing during food choice in obesity." Verdejo-Garcia, Andrews, Yücel, Truby, Stice
36. Faculty Research Development Grant (Deakin University) (2015). "Understanding the social brain through functional neuroimaging and brain stimulation." Kirkovski, Enticott, Berk, Fitzgerald, Fornito, Rogasch, Fulcher.
37. NHMRC Project Grant ID (APP1064704) (2014-18). "Antipsychotic medication in first-episode psychosis: An RCT to assess the risk-benefit ratio." McGorry, Nelson, Francey, Fornito, Allott, Alvarez-Jimenez, Harrigan
38. NHMRC Project Grant ID (APP1066779) (2014-18). "A combined PET-fMRI study of frontostriatal dysfunction in first episode psychosis." Fornito, Cropley, Thomas, Harrison, Pantelis, Francey
39. NHMRC Project Grant ID (APP1064643) (2014-17). "Predicting treatment response in youth depression with brain imaging." Harrison Davey, Yücel, Whittle, Fornito, Pujol
40. NHMRC Project Grant ID (APP1067040) (2014-17). "Erythrocyte membrane fatty acid concentrations and myelin integrity in young people at ultra-high risk of psychosis." Amminger, Pantelis, Whitford, Whittle, Fornito, Hermens
41. NHMRC Equipment Grant ID (GNT9000248) (2014-15). "Brain Stimulation Equipment Suite." Hoy, Fitzgerald, Segrave, Fitzgibbon, Maller, Rogasch, Fornito, Yücel
42. NHMRC Equipment Grant ID (GNT9000248) (2014-15). "Portable Sleep and Respiratory Phenotyping System." Rajaratnam, Lubman, Ogeil, Cain, Edwards, Anderson, Yücel, Wang, Cornish, Hamilton, Ponsford

MoNoC

43. ARC Discovery Project, 2013-2015 "The neuronal basis of visual consciousness: how brain rhythms control the doors of perception" (PIs: Tsuchiya, Maller, Foster, Takaura)
44. Silvership sponsorship grant from the ARC Center for Integrative Brain Functions, 2015, (Tsuchiya, Egan, Price, Fornito, van Boxtel)
45. ARC Future Fellowship, 2013-2016 " The neuronal bases of consciousness and attention" (Tsuchiya, FT120100619)
46. ARC Discovery Project, 2013-2015 "The neuronal basis of visual consciousness: how brain rhythms control the doors of perception" (Tsuchiya, Maller, Foster, Takaura, DP130100194)
47. JST (Japan Science and Technology) CREST (Core Research for Evolutionary Science and Technology), Construction of artificial consciousness based the axiomatic computational theories in neuroscience and its engineering application into real life" 2015-2020, (Kanai, Co-PI: Kawanabe, Maekawa, Co-Is: Tsuchiya, Oizumi, Miyanishi, Morales, Watanabe, Kanemura)
48. National Computational Merit Allocation Scheme 2015 (200,000 CPU-core hours)

Selected Presentations/Outreach

MBI Clinical Research Imaging

1. Ferris, NJ, "Prostate Cancer : The View from Down Under", Course in 'Global Cancer Imaging – Insights from Overseas', Radiological Society of North America, Chicago, November 2015
2. P.G. D. Ward, A. Ng, N.J. Ferris, D.L. Dowe, D.G. Barnes, P. Raniga, G.F. Egan, "Sensitivity of vascular metrics on MR venography", International Society for Magnetic Resonance in Medicine (Toronto, May 2015).
3. P.G.D. Ward, N.J. Ferris, A.C. L. Ng, D.G. Barnes, D.L. Dowe, G.F. Egan, P. Raniga, "Venous segmentation using Gaussian mixture models and Markov random fields", International Society for Magnetic Resonance in Medicine (Toronto, May 2015).
4. S. Al-Hasani, G.F. Egan, J. Zhang, "Optimal spread spectrum for enhanced multi-receive compressed sensing MRI", accepted International Society for Magnetic Resonance in Medicine (Toronto, May 2015).
5. Q. Duché, P. Raniga, G.F. Egan, O. Acosta, O. Salvado, H. Saint-Jalmes, "Cortical thickness measurements with MPRAGE and MP2RAGE at 3T", International Society for Magnetic Resonance in Medicine (Toronto, May 2015).
6. I. Harding, L. Corben, M. Stagnitti, G. Poudel, E. Storey, G.F. Egan, M. Delatycki, N. Georgiou-Karistianis, "Abnormal brain function and connectivity in cerebello-cerebral circuits underlying cognitive function in Friedreich Ataxia: the IMAGE-FRDA study", International Ataxia Research Conference (London, Mar 2015)
7. I. Harding, L. Corben, M. Stagnitti, G. Poudel, E. Storey, G.F. Egan, M. Delatycki, N. Georgiou-Karistianis, "Cerebello-cerebral dysfunction and disconnectivity underlying cognition in Friedreich Ataxia", Human Brain Mapping Conference (Honolulu, June 2015)
8. K. Pitchaimuthu, Q-Z. Wu, G.F. Egan, O. Carter, B.N. Nguyen, A. M McKendrick, "In vivo Gamma Aminobutyric Acid (GABA) concentration assessed using 1H Magnetic Resonance Spectroscopy (MRS) and its relationship with contrast suppression, motion suppression and binocular rivalry in young adults", Experimental Psychology Conference (Melbourne, April 2015).
9. Z. Abaryan, et al. (incl G.F. Egan), "Regional striatal morphometry in pre- and symptomatic Huntington's disease: A high-resolution shape analysis of IMAGE-HD data", Soc for Neuroscience (Chicago, Oct 2015).
10. Invited Keynote & Plenary Lectureships
11. CAG Triplet Repeat Disorders Gordon Research Conference (Barga, Italy), "Using neuroimaging to investigate the mechanisms of Friedreich's ataxia" (May, 2015).
12. Invited International Presentations
13. Invited Chairperson and Moderator, Special Session on International Funding Trends in Neuroimaging, OHBM 2015, Honolulu (18 June, 2015)
14. National & Institutional Presentations
15. Imaging Technologies National Symposium, University of Queensland (7 May, 2015) – "Deciphering brain function using next generation brain imaging technologies"
16. University of Melbourne (16 December, 2015) – "Brain biomarkers in healthy ageing: first results from the ASPREE NEURO study".
17. Orygen Research Institute, Melbourne (13 November, 2015) – "Prospects for deciphering brain disorders using next generation brain imaging"
18. School of Psychology, University of Queensland (6 November, 2015) – "Monash Biomedical Imaging- collaborative research opportunities"
19. School of Psychological Sciences, Monash University (1 May, 2015) – "ARC Centre of Excellence for Integrative Brain Function: scientific research and collaborations, knowledge sharing activities and industry partnership opportunities"

MBI Cognitive NeuroImaging

20. Papadopoulos, Egan, Fielding, Jamadar (2015). Functional subdivisions within the human intraparietal sulcus are involved in spatial transformation in a non-context dependent manner. Australian Cognitive Neuroscience Society, Auckland NZ.
21. Kolbe S, Gajamange S, Jamadar S, Johnson B, Egan G and Fielding J (2015). Inter-individual differences in intrinsic connectivity of the ocular motor network predict anti-saccade spatial accuracy. Front. Hum. Neurosci. Conference Abstract: XII International Conference on Cognitive Neuroscience (ICON-XII). doi: 10.3389/conf.fnhum.2015.217.00299

MBI Imaging Methods and Analysis

22. Chen, Z. G., Guillaume; and Fuderer, Miha (2015). Improved contrast in multi-echo susceptibility-weighted imaging by using a non-linear echo combination. ISMRM 2015 Annual Meeting. Toronto: 2109.
23. Hasani, S. A. A. C., Zhaolin; Egan, Gary F ; and Zhang, Jingxin (2016). Accelerated 3D Acquisition for Susceptibility Weighted Imaging Using Spread Spectrum Encoding and Compressive Sensing. ISMRM 2016 Annual Meeting. Singapore: 3967.
24. Ward, P. G. D., A. P. Fan, P. Raniga, D. G. Barnes, D. L. Dowe and G. F. Egan (2016). Partial volume correction of quantitative susceptibility maps for oxygen extraction fraction measurements. ISMRM.
25. Ward, P. G. D., N. J. Ferris, A. C. L. Ng, D. G. Barnes, D. L. Dowe, G. F. Egan and P. Raniga (2015). Venous segmentation using Gaussian mixture models and Markov random fields. ISMRM.
26. Ward, P. G. D., P. Raniga, N. J. Ferris, A. C. L. Ng, D. G. Barnes, D. L. Dowe, E. Storey, R. L. Woods and G. F. Egan (2015). Consistency of commonly applied vessel segmentation methods for magnetic resonance venography.
27. Egan. G., University of Melbourne (16 December,2015) –"Brainbio markers in healthy ageing: first results from the ASPREE NEURO study".
28. Chen, Z. Monash Institute of Medical Engineering, Monash University - "overview of methods development in Monash Biomedical Imaging"
29. Chen, Z. Monash PET image reconstruction and analysis workshop, 22 April, 2015 (Monash University)

MBI Preclinical Imaging

30. Pearson, J.T. In vivo microvascular imaging capability at the Australian Synchrotron. Australian Society of Molecular Meeting Annual Meeting December 8-9 2015, Baker IDI.
31. Pearson, J.T. Demonstrating the benefits of beta-blockers in hypertensive diabetic heart disease with synchrotron microangiography. Medical Applications of Synchrotron Radiation 2015, Oct 2015, Villard de Lans, France.
32. Fujii, Y., M. Shirai, J. Pearson, Y. Takewa, E. Tatsumi. (2015) Changes in inflammatory response during and after cardiopulmonary bypass using a rat extracorporeal circulation model. 37th Annual Int. Conf. of the IEEE Eng Med Biol Soc.
33. Pearson JT. A.J. Edgley, Y-C. Chen, H. Thambyah, H. Tsuchimochi, T. Inagaki, M. Waddingham, D.J. Kelly, K.Umetani, M. Shirai (2015). Demonstrating the benefits of beta-blockers in hypertensive diabetic heart disease with synchrotron microangiography .
34. Medical Applications in Synchrotron Radiation 2015 Conference, ESRF Grenoble, France, October 5-9, 2015.
35. Y-C. Chen, T. Inagaki,Y. Fujii, D.O. Schwenke, A.J. Edgley, K. Umetani, Y. Zhang, D.J. Kelly, M. Yoshimoto, H. Tsuchimochi, H. Nagai, I. Kuwahira, R.G. Evans, M. Shirai, J.T. Pearson. Chronic intermittent hypoxia accelerates coronary microcirculatory dysfunction in young insulin resistant Goto-Kakizaki rats. Medical Applications in Synchrotron Radiation 2015 Conference, ESRF Grenoble, France, October 5-9, 2015

MBI, BMH and MoNoC Research Outputs

36. Pearson JT, Shirai M. (2015). In Vivo Microvascular Imaging Capability at the Australian Synchrotron. Australian Society of Molecular Imaging Annual Meeting, Baker-IDI, Melbourne. December.
37. Fujii, Y., M. Shirai, J. Pearson, Y. Takewa, E. Tatsumi. (2015) Changes in inflammatory response during and after cardiopulmonary bypass using a rat extracorporeal circulation model. 37th Annual International Conference of the IEEE Eng Med Biol Soc., August 25-29, 2014, Milano, Italy.
38. Lang JA, Pearson JT, te Pas AB, Wallace MJ, Siew ML, Kitchen MJ, Fouras A, Polglase GR, & Hooper SB (2015) Pulmonary blood flow increases at birth regardless of local aeration or pO2. Journal of Paediatrics and Child Health, 50(1), p18. Pediatric Academic Societies Annual Meeting, San Diego, USA. April 25-28.

BMH

39. Yücel, M. European College of Neuropsychopharmacology, Amsterdam. (August, 2015). "How a stick becomes a reward to reinforce compulsivity in OCD: Implications for addiction"
40. Yücel, M. National Cannabis Prevention and Information Centre, Melbourne. (October, 2015). "Marijuana-linked hippocampal injury, protection and recovery"
41. Yücel, M. Centre for Drug Research Symposium on Addiction and Neurodegeneration, Malaysia. (November, 2015). "Repairing and preventing cannabis related brain harms: Hazy dream or a reality?"
42. Carter, A. Neuroethics Network, Paris. (June, 2015). "Neuromedicine: Who's to Blame? A legal case of drug-induced compulsive behaviour."
43. Carter, A. Obesity and Addiction in Policy and History, Sydney (June, 2015). "Public and patient views on 'Food Addiction'."
44. Carter, A. International Medicine in Addiction Conference, Melbourne. (March, 2015). "Anticipating possible clinical and policy uses of addiction neuroscience research."
45. Rogasch, N. C. International Brain Stimulation Conference, Singapore. (March, 2015). "Gamma-band connectivity is reduced in schizophrenia following prefrontal TMS and during working memory"
46. Our research featured in a "Sunday Age" newspaper article on pioneering ideas for neuroscience and clinical research using virtual reality technology (25 October, 2015).
47. Brain stimulation demonstration at ARC Centre of Excellence for Integrative Brain Function Public Event Oct 2015 (Rogasch, N)

MoNoC

48. van Boxtel J., Thomas V.. Motion-induced blindness caused by contraction and expanding motion: dependence on speed and visual field. Australasian Cognitive Neuroscience Society Meeting - Auckland (2015).
49. Thurman S; van Boxtel J; Monti M.; Lu, H.. Neural correlates of action aftereffects triggered by adaptation to biological motion. Vision Science Society 2015
50. Thomas V., Davidson, M., Zakavi, P., Tsuchiya N., van Boxtel J., 'Motion Induced Blindness occurs in natural viewing conditions' Integrative Brain Function Workshop: Multi-modal approaches to understand brain function
51. Davidson, M. (2016, March). What makes us Conscious? The Conversation
52. van Boxtel, J.A.. Contextual biological motion processing and the link to autism traits, and autism diagnosis. (University of Leuven and University of Melbourne)
53. Tsuchiya, Frassle, Wilke, Lamme (2015) "The no-report paradigm: a promising avenue for consciousness research?" a symposium for Association for the Scientific Study of Consciousness, 19th annual meeting. Paris, France
54. Tsuchiya , N."On the unique characteristics of human mind" Japanese Psychological Association (2015), Nagoya Japan
55. Tsuchiya , N. "Conscious and non-conscious thinking" Japanese Psychological Association (2015), Nagoya Japan
56. Tsuchiya , N."The Return of Consciousness – A New Science on Ancient Questions" The Axel and Margaret Ax:son Johnson Foundation (2015), Sweden
57. Tsuchiya , N. Workshop on the Mechanism of Brain and Mind (2015), Rusutsu, Japan
58. Oizumi M. (Invited as a speaker) (in collaboration with Tsuchiya, Shun-ichi Amari) "A unified framework for information integration based on information geometry" , 2nd Monash Brain Function Workshop (2015)
59. Gordon N., R. Koenig, N. Tsuchiya, J.van Boxtel, J. Hohwy "Neural markers of perceptual inference and prediction error" Experimental Psychology Conference, Melbourne (2016)
60. Thomas V., M. Davidson, P. Zakavi, N. Tsuchiya, J. van Boxtel "Motion Induced Blindness occurs in natural viewing conditions" Experimental Psychology Conference, Melbourne (2016)
61. Cohen D., O.H. Zalucki , B. van Swinderen, N. Tsuchiya "Isoflurane anesthesia reduces coherence in the central fly brain, SCINDU, Brisbane (2015)
62. Cohen D., O.H. Zalucki , B. van Swinderen, N. Tsuchiya "Isoflurane anesthesia reduces coherence in the central fly brain", 2nd Monash Brain Function Workshop (2015)
63. Corneille V., J. Matthews, J. van Boxtel, N. Tsuchiya "Sustained conscious memory for upright-faces in RSVP", 2nd Monash Brain Function Workshop (2015)
64. Matthews J., P. Schroeder, J. van Boxtel, N. Tsuchiya "Necessity tamed: Metacognition without attention" , 2nd Monash Brain Function Workshop (2015)
65. Tsuchiya N., H. Saigo, S. Taguchi "Using category theory to assess the relationship between consciousness and integrated information theory", 2nd Monash Brain Function Workshop (2015)
66. Fujiwara M., C. Ding, J. Stout, D. Thyagarajan, N. Tsuchiya, "Parkinson's Disease patients retain intact involuntary eye movement (optokinetic nystagmus, OKN), 2nd Monash Brain Function Workshop (2015)
67. Chen B., N. Tsuchiya, M. Mundy "Perceptual Learning improves Metacognitive Accuracy of low- but not high-level Face Properties" ACNC 2015

Professional Contributions

MBI

Memberships and Registrations

1. Royal Australian and New Zealand College of Radiologists (Ferris, N)
2. Australian and New Zealand Society for Neuroradiology (Ferris, N)
3. Society for Imaging Informatics in Medicine (Ferris, N)
4. Australian Medical Association (Ferris, N)
5. Radiological Society of North America (Ferris, N)
6. European Society for Radiology (Ferris, N)
7. International Society for Magnetic Resonance in Medicine (Ferris, N; Egan GF, Chen, Z)
8. American Board of MRI Safety (Ferris, N)

Assessorships

9. National Health & Medical Research Council Project Grants (Ferris, N; Jamadar, S)
10. Computerized Medical Imaging and Graphics (Chen, Z)
11. Australian Research Council (Chen, Z; Jamadar, S)

Editorships

12. Co-Editor-in-Chief, Human Brain Mapping (Egan, GF)
13. International Journal of Imaging Systems and Technology (Egan, GF)
14. Frontiers in Neuroscience, Frontiers Research Foundation, (Egan, GF)
15. American Journal Physiological Regulatory, Integrative Computational Physiology (Pearson, JT)
16. Frontiers in Psychology Cognition, Associate Editor (Jamadar, S)

Committees

17. International Neuroinformatics Co-ordinating Facility, Governing Board Member, (Egan GF)
18. ISMRM Annual Meeting & Exhibition, Local Organising Committee (LOC), (Egan, GF)
19. Human Brain Project, International Expert Review Panel (Egan, GF)
20. Herston Imaging Research Facility, Scientific Advisory Board Member (Egan, GF)
21. Australian Academy of Science Brain Implementation Committee (Egan, GF)
22. Club Melbourne, Member & Ambassador, State Government of Victoria (Egan, GF)
23. Australian Cognitive Neuroscience Society Early Career Research Committee Member, (Jamadar, S)
24. ARC Centre of Excellence for Integrative Brain Function Early Career Researcher Committee (Jamadar, S)

BMH

Memberships and Registrations

25. APS College of Clinical Neuropsychologists (Yücel, M)
26. APHRA endorsement in the clinical practise area of Clinical Neuropsychology (Yücel, M)
27. Australian Health Practitioner Registration Agency (Yücel, M)
28. Australian Psychological Society (Yücel, M)
29. Member, International Drug Abuse Research Society (Yücel, M)
30. Member, Asia-Pacific Society for Alcohol and Addiction Research (Yücel, M)
31. Member, Biological Psychiatry Australia (Yücel, M)
32. Member, Australian Neuroscience Society (Yücel, M)
33. Member, International College of Obsessive Compulsive Spectrum Disorders (Yücel, M)
34. Member, International College of Problems of Drug Dependence (Yücel, M)
35. Member, International Society for Magnetic Resonance in Medicine (Yücel, M)
36. Member, New York Academy of Sciences (Yücel, M)
37. Member, Australasian Society for Psychiatric Research (Yücel, M)
38. Member of Australian Academy of Science's National Committee on Brain and Mind Science (Fornito, A)
39. Psychiatry Australia (Fornito, A)

Committees

40. Program Leader, 'Addiction Studies', Monash Institute of Cognitive and Clinical Neurosciences, Monash University (Yücel, M)
41. Director, Brain and Mental Health Laboratory, Monash University (Yücel, M)
42. Ambassador, Victorian Tall Poppy Campaign, Australian Institute of Policy and Science (Yücel, M)
43. Listed on 2015 Thompson Reuters Highly Cited Researchers List (top 1% internationally) (Yücel, M.)
44. Executive Council Member, Biological Psychiatry Australia (Fornito, A)

Editorships

45. Editorial Board Member, Neuroscience Biobehaviour Review (Yücel, M)
46. Psychiatry Research and Neuroimag (Yücel, M)
47. Revista Brasileira Psiquiatria (Yücel, M)
48. The Open NeuroImaging Journal (Yücel, M)
49. Editorial Board, Journal of Neuroscience (Fornito, A)
50. Editorial Board, Biological Psychiatry (Fornito, A)
51. Editorial board, Biological Psychiatry: Cognitive Neuroscience and Neuroimaging (Fornito, A)

Assessorships

52. National Health & Medical Research Council of Australia (Yücel, M)
53. Australian Research Council (Yücel, M)
54. National Institute of Health, (USA) (Yücel, M)
55. Medical Research Council, (UK) (Yücel, M)
56. ZonMW (NETH) (Yücel, M)

MoNoC

Memberships

57. Association for the Scientific Study of Consciousness (van Boxtel, J)
58. Vision Sciences Society (van Boxtel, J)
59. Australasian Cognitive Neuroscience Society (van Boxtel, J)
60. Australasian Society for Cognitive Science (van Boxtel, J)
61. International Conference Board Member

Committees

62. Association for Scientific Studies of Consciousness (2014-) (Tsuchiya, N)
63. Initiative for Synthetic Study of Awareness (Summer School, 2015-) (Tsuchiya, N)

Editorships

64. Neuroscience of Consciousness (Tsuchiya, N)

Assessorships

65. Israel Science Foundation (van Boxtel, J)

Abbreviations

3T/9.4T	3 Tesla / 9.4 Tesla
AMREP	Alfred Medical Research and Education Precinct
ANSTO	Australian Nuclear Science and Technology Organisation
AMREP	Alfred Medical Research and Education Precinct
ASD	Autism Spectrum Disorder
ARC	Australian Research Council
ARIN	Australian Research Infrastructure Network
ASPREE	Aspirin Reducing Events in the Elderly
BMH	Brain and Mental Health (research laboratory)
BMTF	Biomedical Materials Translational Facility
CIBF	Australian Research Council Centre of Excellence for Integrative Brain Function
CSIRO	Commonwealth Scientific Industrial Research Organisation
CT	Computed Tomography
EEG	Electroencephalogram
FLECT	Fluorescence Emission Computed Tomography
fMRI	Functional Magnetic Resonance Imaging
IIT	Integrated Information Theory
INCF	International Neuroinformatics Coordinating Facility
IMBL	Imaging and Medical Beam Line
MASSIVE	Multimodal Australian Sciences Visualisation Environment
MBI	Monash Biomedical Imaging
MEG	Magnetoencephalography
MICS	Maximally Irreducible Conceptual Structure
MIPS	Monash Institute of Pharmaceutical Sciences
MoNoC	Monash Neuroscience of Consciousness (research laboratory)
MRI	Magnetic Resonance Imaging
MR-PET	Magnetic Resonance - Positron Emission Tomography
NHMRC	National Health and Medical Research Council
NIF	National Imaging Facility
NIH	National Institutes of Health
OCD	Obsessive Compulsive Disorder
PET	Positron Emission Tomography
QSM	Quantitative Susceptibility Mapping
SIEF	Science and Industry Endowment Fund
SPECT	Single Photon Emission Computed Tomography
MICCN	Monash Institute of Cognitive and Clinical Neurosciences
SWI	Susceptibility Weighted Imaging
TMS	Transcranial Magnetic Stimulation
VBIC	Victorian Biomedical Imaging Capability
VPTN	Victorian Platform Technology Network

MONASH University

Biomedical Imaging

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