MONASH University

MONASH BIOMEDICAL IMAGING AND LINKED LABORATORIES

ANNUAL REPORT 2021

Partners

MEMBERS

National Imaging Facility

Australian Research Council Centre of Excellence for Integrative Brain Function

VBIC

Monash MedTech

SUPPORTERS

Australian Government Department of Industry, Innovation and Science

VICTORIA State Government

NCRIS National Research Infrastructure for Australia An Australian Government Initiative

ARMI Australian Regenerative Medicine Institute

SCIENCE AND INDUSTRY ENDOWMENT FUND

COLLABORATORS

Australian Synchrotron

JÜLICH FORSCHUNGSZENTRUM

CSIRO

MonashHealth

HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

AlfredHealth

PARTNERS

SIEMENS Healthineers

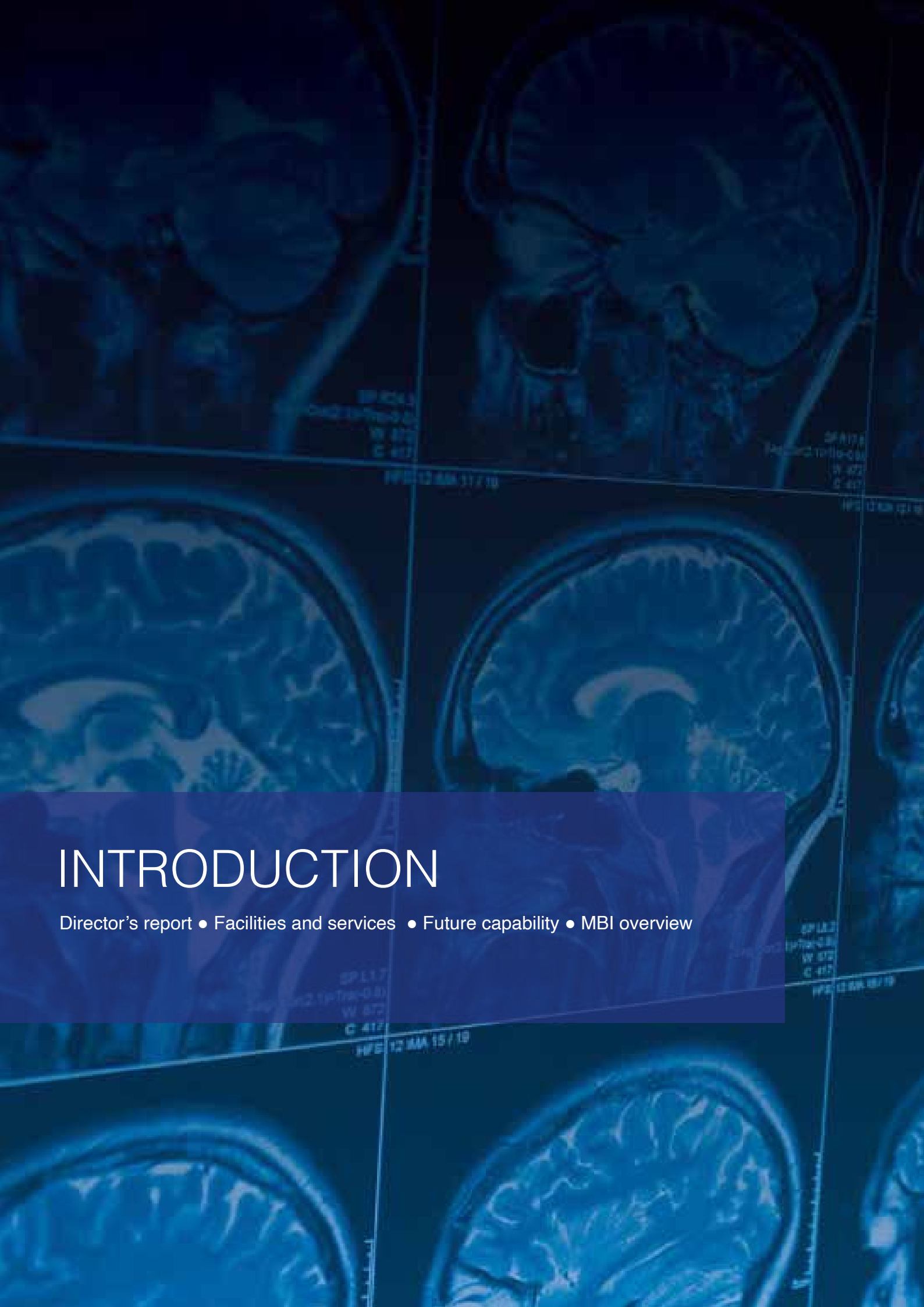
BRUKER

magnetic INSIGHT

Mediso

Contents

Cover image:
A Triceratops head with the brain case highlighted from CT images and laser scans. The Triceratops sample is from Melbourne Museum and scans performed at MBI.



INTRODUCTION

Director's report ● Facilities and services ● Future capability ● MBI overview

Director's report

The COVID-19 pandemic continued to significantly impact on the volume of work and imaging research services provided by MBI in 2021. Whilst clinical research activities were significantly impacted, particularly in the second half of the year, the preclinical research activities both at Clayton and ARA-MBI were largely unaffected. The outstanding work by the MBI administration team that led the COVID-19 response enabled essential research projects to safely continue during the difficult lock down periods of the pandemic. An important milestone was achieved during 2021 with the successful completion of the Imaging Research Identity System (IRIS) developed in-house at MBI. The system enables secure data linkage and remote reporting of images for data sharing and compliance matters and is now in routine use.

In spite of the continuing pandemic, 2021 was still a highly productive year with 57 scientific papers published by MBI and ARA-MBI staff and research users, as well as 39 publications by BrainPark staff and 87 papers by researchers based at the MBI Linked Labs. New research grants in 2021 included a total of $5.4 million funding to MBI staff, and $4.0 million funding to BrainPark and Linked Laboratory researchers. These included research awards and grants from the National Imaging Facility (NIF) for a national Mobile MR collaborative network, led by A/Prof Zhaolin Chen, and an MRI compatible focused ultrasound (FUS) equipment project, led by A/Prof David Wright. An Australian Research Council (ARC) Linkage Equipment grant was awarded for replacement of the ultrasound and photo-acoustic imaging scanner located at MBI. In April, the international collaboration in partnership with the Helmholtz Zentrum Dresden Rossendorf (HZDR), Germany to develop next generation of radio-immuno-theranostic agents was officially announced by the German Government.

The $26M Monash Cyclotron Facility that includes funding commitments by the Federal Government (NCRIS) and the Victorian State government was given final approved by the Vice Chancellor's Group. Work commenced on the planning and detailed design of the vault to house the medium-high energy cyclotron and the laboratories for the production of diagnostic and therapeutic radioisotopes for research purposes. The facility will provide Good Manufacturing Practice (GMP) production of PET radiotracers and radiometal (copper-64, zirconium-89, gallium-68) labelled radiopharmaceuticals that currently have limited availability in Australia. Plans to expand the existing radiochemistry laboratory were also approved and the laboratory design was commenced.

The Magnetic Particle Imaging (MPI) scanner funded by the ARC and located at ARA-MBI was officially opened in mid 2021 during a virtual event. MPI is a non-invasive imaging technique that detects superparamagnetic iron oxide nanoparticle tracers in vivo. Installation and commissioning of the world first multi-modal MPI-CT scanner was completed in early 2021, after an extensive delay due to COVID-19. The MPI facility was funded by a successful joint grant application to the ARC by Monash and RMIT Universities.

During 2021 the first studies using the Focused Ultrasound (FUS) instrument in collaboration with CSIRO scientists was conducted to study rodent brain tumor models. The FUS was used to transiently open the blood brain barrier (BBB) to investigate the efficacy of new drug delivery technologies into the brain. In conjunction, a new tissue culture laboratory was established to support the joint research program into treatment strategies for brain tumor models.

Professor Jack Jazieniak commenced at Pro-Vice Chancellor (Research Infrastructure) in late 2021. I congratulate Jack on his leadership role of the Monash Technology Research Platforms and for his support and advice during the latter part of 2021. Prof Rebekah Brown's leadership as Deputy Vice-Chancellor (Research) has been inspiring and all MBI staff are working to ensure that MBI continues to play a major role in the Monash University 2030 Strategic Plan.

My sincere thanks to all staff at MBI for their dedicated and excellent work during 2021. Again, I would particularly like to thank Kyle Reid who commenced her appointment as General Manager as COVID-19 struck, and has continued to do an outstanding job managing MBI throughout the difficult lockdown periods. All of the MBI staff including from the management and administration, clinical research imaging, imaging methods & analysis, and the preclinical imaging teams at MBI, Clayton and ARA-MBI continued to undertake their responsibilities throughout 2021 under difficult circumstances. My particular thanks to Dr Robert Brkljaca for his excellent management of the ARA-MBI facility and his support of MR projects at ARA-MBI.

In closing, I would like to sincerely thank all MBI staff for their invaluable contributions throughout 2021 and for their continued commitment to excellence in supporting biomedical imaging research at Monash University.

Professor Gary Egan

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

Facilities & services

MBI provides imaging expertise and technological capabilities to support preclinical and clinical research, including radiochemistry and image analysis services. It is a node of the Australian National Imaging Facility (NIF) and offers researchers internal and external to the University (including government and industry) a full suite of multimodal and simultaneous imaging equipment alongside human testing facilities.

The Monash Clayton campus houses the most extensive range of imaging equipment, and is located within the Monash Technology Precinct, opposite the Victorian Heart Hospital and adjacent to the Australian Synchrotron. MBI also operates preclinical facilities at the Alfred Research Alliance – Monash Biomedical Imaging (ARA-MBI) site in Prahran and at the Monash Institute of Pharmaceutical Sciences (MIPS) in Parkville.

MBI offers access to the following instrumentation, including on-site technical support and training, consultation on research projects:

HUMAN IMAGING FACILITIES

Human research studies can be performed with the following MBI human imaging and testing facilities at our main site in Clayton:

> 3T Magnetic Resonance Imaging (MRI)
> Simultaneous 3T MR-PET
> Electroencephalography (EEG)
> Oculomotor/eye tracking
> Transcranial magnetic stimulation (TMS)
> Neurocognitive testing and interview rooms

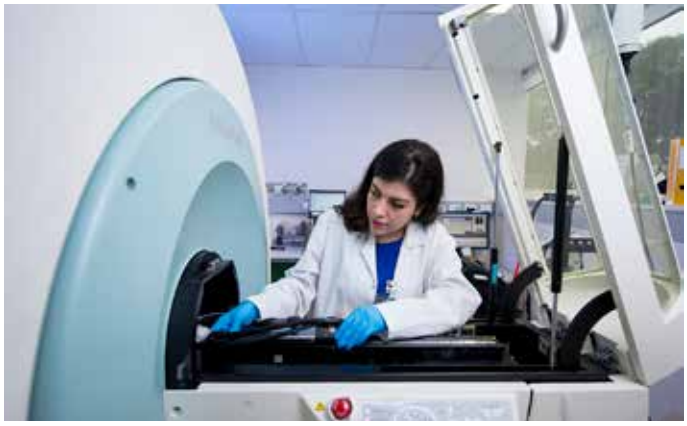
PRECLINICAL IMAGING FACILITIES

Preclinical research can be undertaken using the following equipment:

> Clayton site (Monash Biomedical Imaging)
  - 9.4T MRI small animal scanner
  - 3T MRI large animal scanner
  - Simultaneous 3T MR-PET scanner
  - PET-CT small animal scanner
  - Vevo 2100 Ultrasound
  - MRI guided focussed ultrasound
  - Cardiovascular profiling
  - CT large animal scanner

> Prahran site (Alfred Research Alliance - Monash Biomedical Imaging)
  - Magnetic Particle Imaging system
  - 9.4T MRI small animal imaging system
  - PET-CT small animal imaging system

> Parkville site (Monash Institute of Pharmaceutical Sciences)
  - FLECT-CT small animal imaging system



BRAINPARK

BrainPark houses the following equipment at MBI in Clayton:

> Gym
> Spin (cycle) room
> Exercise physiology
> Virtual reality studio
> Meditation/Yoga studio
> Meditation garden
> Brain training pods and clinical assessment rooms

Clinical research support

The clinical support team provides training and assistance to researchers who use Monash Biomedical Imaging equipment to conduct imaging or behavioural experiments, including MRI, MR-PET, EEG, TMS and multimodal experiments. Their wealth of experience in establishing and conducting human physiological, neuroimaging and behavioural experiments ensures research outcomes are enhanced. The team supports researchers during the early and ongoing stages of their studies to ensure they maximise their use of Monash Biomedical Imaging technologies and the data produced.

To gain optimal images from the MRI and simultaneous MR-PET scanners, researchers are supported by the Clinical Imaging Team, which consists of highly-trained radiographers and nuclear medicine technologists who regularly rotate through Monash Health imaging departments. The Clinical Imaging Team works with researchers to develop and provide advice on the MRI sequences and techniques required to address research questions. This highly individualised support for researchers ensures scanner use is efficient, cost-effective and delivers the best quality images possible.

Radiochemistry services

The radiochemistry facilities support radiochemistry development and preclinical studies. The preclinical capability includes small animal PET and SPECT imaging at our sites in Clayton and Prahran, and large animal simultaneous MR-PET research. The radiochemistry facilities include:

- a hot cell with a 68Ge/68Ga generator
- radio-analytical instruments including radio-HPLC, radio-TLC and an automatic gamma counter
- access to 99mTc, 64Cu, 177Lu and 89Zr radionuclides as well as commercially available radiotracers
- radiolabelling of small molecules, peptides, proteins and antibodies with radiometals
- advice in the design of radiotracers for imaging and radiotherapy
- animal holding areas for recovery experiments using radiotracers/radionuclides

For clinical research imaging using the simultaneous 3T MR-PET scanner, the radiopharmacy facilities include:

- dose calibration of a large range of radiopharmaceuticals for both bolus and infusion administration methods
- the expertise to take venous blood samples before, during and after radiopharmaceutical administration

Expansion of MBI's capabilities, with the establishment of the Australian Precision Medicine Enterprise will enable the production of diagnostic and therapeutic radiopharmaceuticals for application in clinical and developmental research.

Future capability

AUSTRALIAN PRECISION MEDICINE ENTERPRISE

Accelerating precision medicine research

A precision medicine manufacturing, research and innovation centre to advance diagnoses and treatments for cancer, cardiovascular, and neurological diseases is being developed at the Monash Biomedical Imaging site.

The facility will secure Australia's supply of advanced radiopharmaceuticals for diagnosis and therapy. Theranostics is precision medicine at the molecular level, combining imaging diagnostics with therapeutic drugs to detect and treat cancer and other diseases.

To meet domestic and global demand, the Australian Precision Medicine Enterprise will combine theranostics research and development, clinical trials and manufacturing in one world-class facility.

Locally produced radiopharmaceuticals

The facility as a whole will provide access to a range of PET and SPECT radionuclides. The research-dedicated production part of the facility will initially produce radiometal labelled radiopharmaceuticals (copper-64, zirconium-89, gallium-68) using Good Manufacturing Practice (GMP) standards. Currently, there is no domestic GMP production capability for these radiopharmaceuticals for late-stage clinical research studies.

Through a staged approach the access to PET radioisotopes will eventually be expanded to include the following radionuclides: Carbon-11, Nitrogen-13, Fluorine-18, Iodine-124, Gallium-68, Zirconium-89 and Copper-64.

The local supply of GMP compliant radiopharmaceuticals will establish a sovereign capability for researchers, pharmaceutical companies, and the healthcare sector to accelerate the development, translation and availability of novel nuclear medicines for the diagnosis and eventually treatment of cancer, cardiovascular, neurological and other diseases in Australia.

Industry partners

The Australian Precision Medicine Enterprise is a collaboration between Monash University, Global Medical Solutions Australia and Telix Pharmaceuticals, which has been awarded $23 million in Federal Government funding under the Manufacturing Collaboration Stream of the Modern Manufacturing Initiative (MMI). Global Medical Solutions Australia will be operating the commercial manufacturing part of the facility.

MONASH INNOVATION CLUSTER

In addition to the Australian Precision Medicine Enterprise, the Victorian Health Innovation Centre will also be developed by Monash University on the Monash Biomedical Imaging site.

Both the Australian Precision Medicine Enterprise and the Victorian Health Innovation Centre (VHIC) will be part of the infrastructure critical to realising the opportunities in the Monash Innovation Cluster create the conditions for a precinct that generates globally significant research outputs, new commercial opportunities, high value jobs and attractive investment opportunities for global players. The VHIC will be co-located with MBI.

HEARTLABS

The VHIC will be known as 'HeartLabs' and complements two current projects:

> Victorian Heart Hospital

> Monash Victorian Heart Institute

HeartLabs will be a unique, flagship cardiovascular disease-focused research accelerator to translate and commercialise clinical research, cardiac technology, models of care, drug discovery and biomedical engineering.

HeartLabs will house business development/ commercialisation groups and strategic industry commercial partners as anchor tenant/s. VHIC will accelerate new health and clinical innovations, create high-value jobs, intellectual property, start-ups, and attract significant global investment to Victoria.

"We are creating a global research precinct with new commercial opportunities, high value jobs and attractive investment opportunities.

Statistics

GRANTS

MBI

$3,264,631.00	National Competitive Grants
$2,430,000.00	International Grants
$2,787,508.00	Industry/ Philanthropic/ Other
$ 36,922,055.00	Government

LINKED LABS

$21,116,852.00	National Competitive Grants
$7,580,484.00	International Grants
$5,019,417.00	Industry/ Philanthropic/ Other
$160,000.00	Government

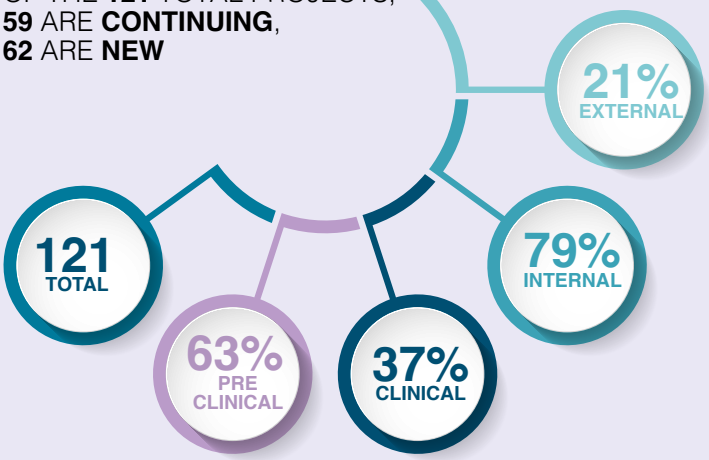
PUBLICATIONS

47 MBI

135 LINKED LABS

PROJECTS

OF THE **121** TOTAL PROJECTS,
59 ARE **CONTINUING**,
62 ARE **NEW**



EQUIPMENT USAGE

4412 HOURS

2318 RESERVATIONS

PERSONNEL

MBI and ARA-MBI personnel ● BrainPark personnel

MBI and ARA-MBI Personnel

DIRECTOR

Professor Gary Egan
Director MBI and CIBF; Distinguished Professorial Fellow, Turner Institute for Brain and Mental Health

MANAGEMENT AND ADMINISTRATION

Ms Kylie Reid
General Manager, MBI

Ms Janelle Redding
Senior Administrative Officer

Mr James Morrow
Senior Administrative Officer (parental leave position)

Ms Louise Mitchell
Senior Research Coordinator

Ms Gabi Di Camillo
Receptionist

Ms Merrin Morrison
Communications Officer

Ms Kate Fortune
Administrative Officer

PRECLINICAL RESEARCH IMAGING (ARA-MBI)

Assoc Professor David Wright
Director of Preclinical Imaging

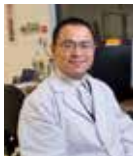
Dr Robert Brkljaca
ARA-MBI Facility Manager and Support Scientist

Dr Bianca Jupp
ARA-MBI Lead PET/CT Scientist

PRECLINICAL RESEARCH IMAGING (CLAYTON)

Dr Michael de Veer
Head of Preclinical Imaging

Dr Ekaterina Salimova
Research Fellow



Dr Gang Zheng
MRI Physicist

Ms Tara Sepehrizadeh
MR Imaging Scientist

Mr Alexander McDonald
CT Scanner Operator

CLINICAL RESEARCH IMAGING

Mr Richard McIntyre
Clinical Head and Supervising Radiographer

Ms Lauren Hudswell
Supervising Nuclear Medicine Technologist

MRI Radiographers dually appointed with Monash Health
Ms Arlene Hobson
Ms Patricia Heidmann
Ms Fiona Gould
Mr Van Vu
Mr Cuong Tran
Mr Scott Stewart
Mr Raj Badwal

Mr Nemat Nadir, *Nuclear Medicine Technologist*

RADIOCHEMISTRY

Dr Brett Paterson
Head of Radiochemistry

Students
Mr Cormac Kelderman
Mr Patrick Davey
Ms Melyssa Grieve
Ms Rachel MacLean

IMAGING ANALYSIS

Dr Zhaolin Chen
Head of Imaging Analysis

Dr Kamlesh Pawar
Research Fellow (Imaging Scientist)

Dr Shenjun Zhong
Research Fellow and Informatics Officer

Students
Mr Viswanath P Sudarshan
Mr Anjan Bhattarai
Ms Himashi Peiris
Mr Cameron Pain
Mr Mevan Ekanayake

CLINICAL RESEARCH SUPPORT

Dr Sharna Jamadar
Head of Clinical Research Support

Ms Parisa Zakavi
Technical Officer

Ms Christina Van Heer
Technical Assistant

BrainPark Personnel

Prof Murat Yücel
Director

Dr Rebecca Segrave
Deputy Director, David W Turner, Senior Research Fellow and Head of Behaviour Group

Prof Leonardo Fontonelle
Head of Clinical Group

A/Prof Kris Rotaru
Visiting Researcher

Dr Chao Suo
Head of Technology Group

Dr Rico Lee
Head of Assessment

Dr Lucy Albertella
Deputy Head of Assessment

Dr Karyn Richardson
Wilson Foundation-BrainPark Research Fellow

Dr Yann Chye
Research Fellow

Ms Amy Allen
Senior Operations Coordinator

Mr James Morrow
Implementation Coordinator

Mr Sam Hughes
Senior Exercise Physiologist (Standards and Compliance)

Mr Edouard Kayayan
Exercise Physiologist (Partnership and Program Development)

Ms Amelia Lowe
Wilson Foundation-BrainPark Research and Administration Officer

RESEARCH ASSISTANTS

Rebecca Kirkham, *Research Officer*
Joseph Pitt, *Research Officer*

PHD CANDIDATES

Erynn Christensen
Craig Harper
Campbell Ince
Chang Liu
Suzan Maleki
Dan Myles
Kavya Raj
Teresa Wulandari

CLINICAL PHD STUDENTS

Mary-Ellen Brierley
Catherine Brown
Olivia Chung
Louise Destree
Sakshi Dhir
Emma Thompson

CLINICAL NEUROPSYCHOLOGY PHD STUDENTS

Maja Brydevall
Lara Piccoli

HONOURS STUDENTS

Amanga Amarasena
Alysha Caroline
Tia van Heurck
Daniel Koay
Marko Milicevic
Emma Moon
James Rajadurai
Sian Rossjohn
Shaheen Samnani
Cindy Tran

RESEARCH AND DISCOVERY

MBI image analysis

MBI preclinical imaging

ARA-MBI preclinical imaging

Wright lab

BrainPark

Neural systems and behaviour lab

Monash neuroscience of consciousness Lab

Cognitive neuroimaging lab

Computational and systems neuroscience lab

Mechanisms of neurodegeneration lab

Neuroscience and society group

Clinical psychedelic research lab

MBI image analysis

Dr Chen leads the development of a national network of ultra-low field point of care MR (PoCeMR) scanners to bring accessible MR imaging to remote Australians. The partnership includes the Australian National Imaging Facility, Monash University, University of Queensland, South Australian Health and Medical Research Institute, Alfred Hospital, Royal Perth Hospital, and industry partner Hyperfine.

The Imaging Analysis team continues to develop novel imaging methods, publishing in top ranked medical imaging journals including Medical Image Analysis, European Journal of Nuclear Medicine and Molecular Imaging, and NeuroImage.

The team collaborates broadly within Monash University including Turner Institute for Brain and Mental Health, Monash Data Future Institutes, Faculties of IT and Engineering, Alfred Health and Monash Health on artificial intelligence based medical imaging. The team also collaborates with industry partners to enable rapid deployment and large-scale testing. Internationally, the team continues collaboration with the Juelich research centre in Germany for the development of next generation MRI-PET technology.

2021 highlights and achievements

- Team placed 2nd in the 2021 Federated Tumor Segmentation Challenge (MICCAI 2021)
- Team placed 3rd in the Brain MRI reconstruction challenge with realistic noise (MICCAI 2021)
- Dr Sudarshan received the prestigious 'Naik and Rastogi Award for Excellence in PhD Research' for the years 2019-2021 from the Indian Institute of Technology Bombay
- Dr Pawar received Magna Cum Laude Merit Award at the annual meeting of the International Society for Magnetic Resonance in Medicine (ISMRM)

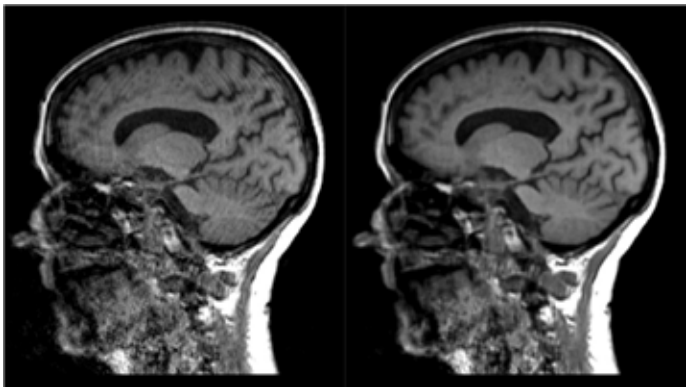
CASE STUDY

Patient motion during the magnetic resonance imaging (MRI) scanning process causes degradation of image quality and is a challenging issue in the clinical setting and research applications. Patient motion frequently occurs in 10-30% of clinical MR images and repeated scans are needed in around 20% of the patients that result in additional scanner time for patients, additional technologist scanning time and a financial loss of at least $115,000 per scanner per year.

Motion artifacts are more common for inpatients, emergency departments, paediatric, elderly, dementia, brain injury and claustrophobic patients. Sedation may be required in such uncooperative patients, which can have an adverse effect, particularly in paediatric patients.

Motion artifacts appear as ringing, ghosting, blurring and signal loss/gain in the MR images, which results in poor image quality, inaccurate diagnosis and poor performance of automated image analysis algorithms.

Our work aims to evaluate the clinical utility and limitations of a deep learning-based motion correction technique in the clinical setting using unseen patient MRI datasets. We hypothesise that the radiological assessment of neuroanatomical structures in the deep learning motion corrected images would be significantly improved compared to the motion degraded images.



Deep Learning based Motion Correction. (left) Motion corrupted image, and (right) Motion corrected image.

TEAM

Dr Zhaolin Chen, *Head of Imaging Analysis*

Staff

Dr Shenjun Zhong, *Informatics Fellow*; Dr Kamlesh Pawar, *Research Fellow*; Dr Anjan Bhattarai, *PhD candidate and Research Fellow*

Students

Mr Cameron Pain, *PhD candidate*; Mr Mevan Ekanayake, *PhD candidate*; Ms Himashi Peiris, *PhD candidate*

MBI preclinical imaging

During 2021 the MBI preclinical team continued to develop expertise and capabilities.

The MRI-guided Focused Ultrasound (MRgFUS) system (LP-100, FUS Instruments) performed its first project aimed to determine expression changes in brain tumours following FUS in mice. Drs Ekaterina Salimova and Gang Zheng teamed up to perform the studies, and the samples were sent to The University of Queensland for sequencing and analysis in early 2022.

The 9.4T MRI supported Alex Pei's PhD studies into how different diets can modulate stroke severity in mice. The study is lead by Dr Bradley Broughton at Monash University. Professor John Bertram's group at Monash University and Professor Kevin Bennet at Washington University project to use MRI-imaging of cationic ferritin to track progression in kidney disease made significant progress over the year. Professor Chrishan Samuel's work using MRI to detect cardiac fibrosis showed great promise and the work is being prepared for publication.

Projects using the computer tomography scanners at MBI (Somatom and Inveon, Siemens) were extensive in 2021. A highlight was the work of Tim Ziegler and Hazel Richards imaging the skull and neck bones of the The Melbourne Museum's latest fossil, the now famous Horridus (see the case study below). The MRT studies with the Synchrotron received a boost with Dr Elette Engels joining MBI with a fractional appointment to coordinate studies between MBI and the ANSTO-IMBL beamline.

The Vevo2100 (FUJIFILM/VisualSonics) ultrasound continued to operate and build capacity throughout 2021. MBI pre-clinical team member Dr Ekaterina Salimova continued to support a range of studies on the instrument, including a fascinating project with Professor Christoph Hagemeyer where echocardiography showed that orally consumed high oxygen water increased the ability of the recovering heart to pump blood after four weeks.

The molecular imaging capabilities at MBI were utilised by PhD student Sanjeevini Babu Reddiar's studies into the biodistribution of Kv1.3 inhibitors. These peptide molecules were labelled with Ga-68 and Cu-64 with the help from the MBI radiochemistry team. The MBI radiochemistry facility enables researchers to label molecules with radioisotopes. The facility consists of a hot cell, analytical equipment (HPLC and TLC) and a gamma counter.

The MBI pre-clinical and clinical teams conducted a pre-clinical biodistribution trial for AdAlta, a local biotechnology company developing novel therapies for lung-inflammatory diseases. We worked with colleagues from the Olivia Newton John Cancer Centre and the Monash Animal Research Platform. The zirconium-89 PET imaging study results were extremely valuable for the company, they are now focused on delivering the therapy via an inhaled device, directly to the lungs.

A consortium of researchers from Monash, RMIT, and The University of Wollongong were successful with an ARC-LEIF grant to develop the first near-infrared photoacoustic imaging facility in Victoria. The imaging instrument will be housed and operated by the MBI Pre-Clinical team, the preferred scanner will be chosen via an active tender process in 2022.

2021 highlights and achievements

- Imaging of Horridus
- Successful in obtaining an ARC LEIF for photoacoustic instrument
- Collaborative AdAlta biodistribution study

TEAM

Dr Michael de Veer, *Head, Preclinical Imaging*

Staff:
Dr Ekaterina Salimova, *Research Fellow*
Dr Gang Zheng, *MRI Physicist*
Ms Tara Sepehrizadeh, *MR Imaging Scientist*
Mr Alexander McDonald, *CT Scanner Operator*

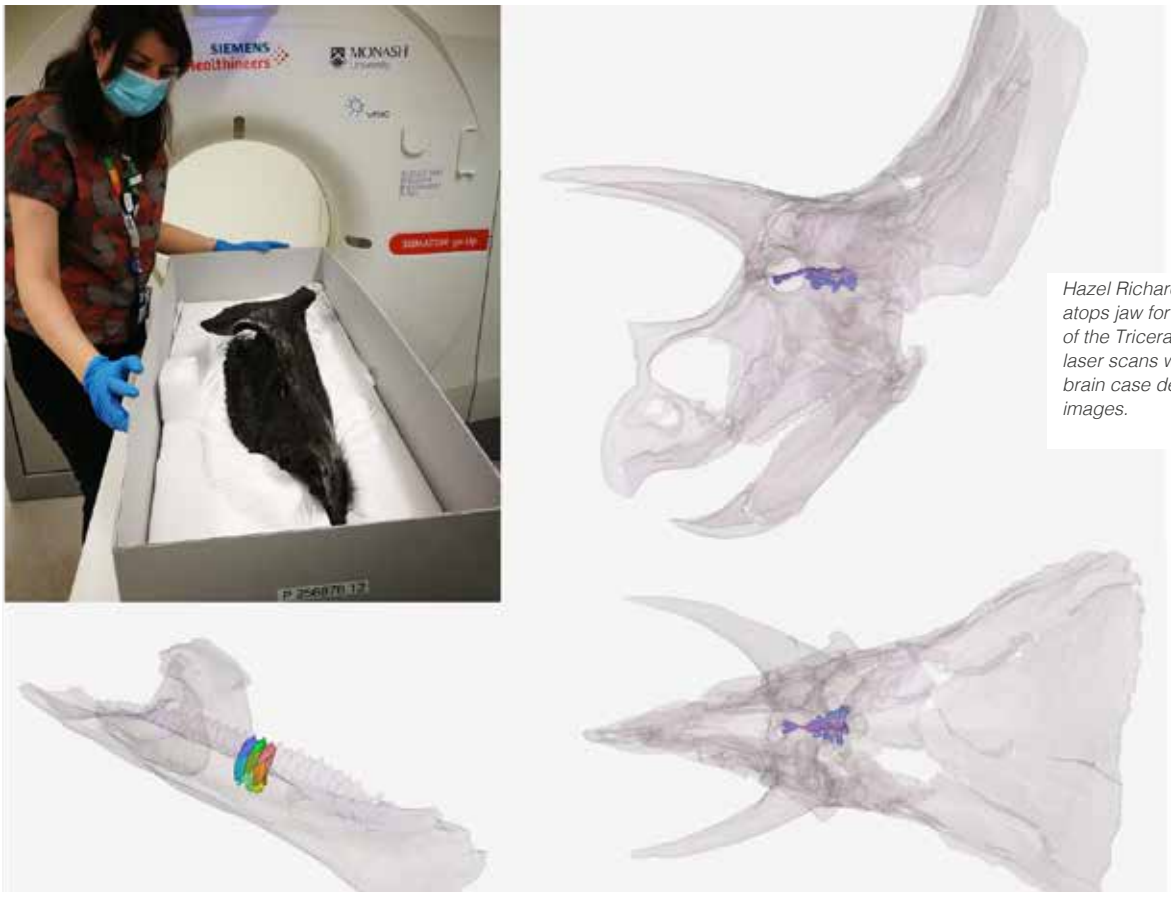
CASE STUDY: TRICERATOPS IMAGING

The Melbourne Museum recently acquired the world's most complete and finely preserved Triceratops (Triceratops horridis) fossil. This important fossil will go on display at the museum in early 2022, the first time in 67 million years. The MBI pre-clinical team worked with Tim Zeigler and Hazel Richards from The Melbourne Museum to collect a series of CT scans of the head, neck and selected vertebrae. There are longstanding research collaborations between the Melbourne Museum palaeontology team and researchers at Monash University, with MBI facilitating imaging of many important fossil specimens for collaborative scientific study, teaching and outreach. Horridus was scanned in MBI's large bore Siemens CT scanner before it was assembled for display, to enable further study of the Triceratops by the global scientific community.

The CT scans combined with the external surface scan images, create a complete 3D model of the Triceratops bones that facilitates research into a range of exciting biological and evolutionary questions. The scans will also be used to create resin casts and animated projections to enhance the Museums display and help people visualize and learn about Triceratops. This information can be used to communicate deeper stories within the display, including Triceratops evolution, behaviour and how they sensed their Cretaceous world. The data will also be used to create a digital record of these important structures for future scientists to study and learn from.

The data of the upper and lower jaws revealed that Horridus had more than 800 teeth. These CT scans will contribute to investigations of feeding biomechanics and diet in Triceratops and other highly specialised herbivorous dinosaurs.

Scans of the dinosaur's well-preserved braincase provided 3D models of the internal cranial cavity, allowing the team to examine the size and shape of regions of the brain and inner ear (see figure below). These provide important data for research reconstructing what sorts of sounds Triceratops was adapted to hear, and the relative importance of vision, smell and hearing in the daily lives of these long-extinct beasts.



Hazel Richards setting up the Triceratops jaw for scanning and renders of the Triceratops head from CT and laser scans with highlighted teeth or brain case derived from the CT scan images.

ARA-MBI preclinical imaging

Alfred Research Alliance-Monash Biomedical Imaging (ARA-MBI) in Prahran operates the world's first Magnetic Particle Imaging (MPI) instrument that is paired with a localised hyperthermia system (HYPER module) and CT scanner, and the only system in Victoria. The MPI system at ARA-MBI features the world's highest sensitivity and resolution of MPI images. This system was delivered in early 2020, but the capability was officially launched in June 2021, with over 120 attendees from more than 20 institutions globally.

The 9.4T MRI was upgraded to the latest Neo hardware and Paravision 360 software, with new equipment racks delivered in mid-June 2021.This upgrade has made scanning even more intuitive, and maintained full flexibility of the system, including access to an enlarged MRI sequence portfolio.

A business case was approved by the National Imaging Facility (NIF) for new MRI guided focussed ultrasound (FUS) Equipment along with funding for a MRI/FUS capability fellow. This FUS equipment will be the first of its kind in Australia and is expected to be operational in 2022.

CASE STUDY

The laboratory of Dr. Steven Petratos utilises the experimental autoimmune encephalomyelitis (EAE) mouse model of MS, that exhibits ascending spinal cord neuroinflammation and degeneration. Following transplantation of haemopoietic stem cells (HSCT) transduced with a therapeutic NgR(310)ecto-Fc plasmid, the lumbosacral spinal cord of these recipient mice was visualised and examined by DTI. During this recovery stage, significant increase in spinal cord white matter axial diffusivity (AD) was demonstrated in the NgR(310) ecto-Fc HSCT mice. Moreover, tractography images in mice with more severe EAE at clinical score 3 displayed disorientated fibre tracts with an anteroposterior orientation (red) at lesion sites.

2021 highlights and achievements

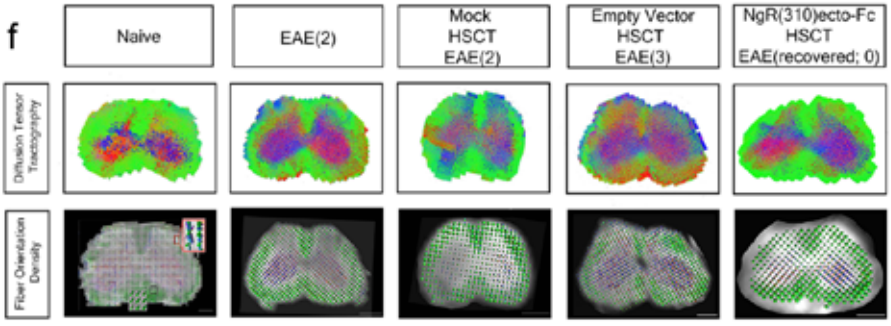
- Launched the world's first Magnetic Particle Imaging (MPI) instrument with localised hyperthermia system and CT scanner which was profiled by various media and news outlets, including COSMOS magazine, with videos posted on the MBI YouTube page attracting over 1.2k views.
- In collaboration with pharmaceutical company Eisai, researchers from the Department of Neuroscience and ARA-MBI's Lead PET/CT scientist Dr Bianca Jupp, established the suitability of [18F]-Flumazenil PET to identify biomarkers of treatment response of a novel epilepsy therapeutic.
- Four ARA-MBI researchers received grants contributing to scanner costs to assist in pilot data collection as part of the MBI User Access Scheme.
- The 2021 MBI image competition celebrated outstanding scanner images obtained at MBI and ARA-MBI, providing our users with a platform to showcase their research. Winning images taken on ARA-MBI equipment included Magnetic Particle Imaging of Xenograft Mouse by Jurie Tashkandi, [18F]-flumazenil uptake in the rat brain by Bianca Jupp, and Computed Tomography of a mouse lung by Karen Alt, each receiving $1,000 worth of scanner time.

TEAM

Dr Robert Brkljača, *ARA-MBI Facility Manager and Support Scientist*

Staff

Dr Bianca Jupp, *ARA-MBI Lead PET/CT Scientist*



Tractography indicated the diffusion of lateral fibres (blue), anteroposterior fibres (red) and rostral-caudal fibres (green) in the spinal cord sections, while fibre orientation density (FOD) estimated the orientation of fibres shown as voxel unit with gradients according to x (red), y (green) and z (blue) direction. The presence of single voxel was indicated in a red box in FOD image of naïve mice. Scale bar = 500 µm.

Wright lab

Led by Associate Professor David Wright, the Wright lab uses cutting-edge anatomical and molecular MR methods to improve our understanding of disease pathophysiology.

With a strong focus on neurodegeneration, using experimental models of motor neuron disease, traumatic brain injury (TBI), stroke, Alzheimer's disease and epilepsy, and validation of our imaging results with a wide array of physiological and histological measures. Employing a bench-to-bedside-to-bench approach, once validated these biomarkers are translated to the clinical setting to improve patient outcomes.

TEAM

A/Prof David Wright, *Head, Preclinical Imaging Alfred Research Alliance*

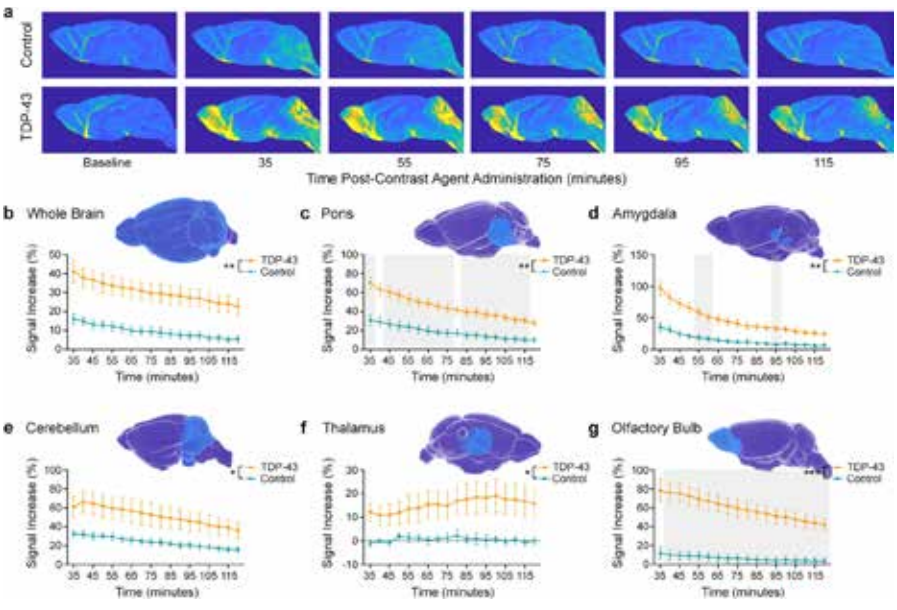
Staff Dr Akram Zamani, *Post-Doctoral Researcher*
Students Emma Thomas, *MBSC candidate*

2021 highlights and achievements

- Honours student Raysha Farah graduated, receiving the Dean's award as the highest achieving student in the BMedSc (Hons) program
- A/Prof David Wright was awarded a FightMND IMPACT grant 2021-2023
- Concussion research from the Wright Lab generated a national conversation around the time needed to adequately recover from sports related concussion, with articles printed in The Herald Sun, stories covered on the evening news of Channels 2, 7, 9 and 10, as well as radio stations ABC, MMM and FOX.

CASE STUDY: THE GLYMPHATIC SYSTEM IN MOTOR NEURONE DISEASE

Akram Zamani, Adam Walker, Ben Rollo, Katie Ayers, Raysha Farah, Terence O'Brien, David Wright



Dynamic contrast-enhanced MRI (DCE-MRI) revealed impaired glymphatic clearance in mice models of ALS. a Representative DCE-MRI images of control (top row) and ALS models (bottom row) mice over time after contrast agent administration. b–g Percent signal increase from baseline in the whole brain, pons, amygdala, cerebellum, thalamus and olfactory bulb.

The glymphatic system is a network of vessels designed to clear waste from the brain and central nervous system, working while you sleep to get rid of the toxic waste proteins that build up during the day. It has been suggested that this system may be suppressed in various diseases and that failure of glymphatic function in turn might contribute to pathology in neurodegenerative disorders such as amyotrophic lateral sclerosis (ALS).

Thanks to recent advances in MRI, the Wright Lab have been able to investigate the glymphatic system in preclinical models of motor neurone disease. In this study they used dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) following the injection of an MR contrast agent, to view the network of vessels in the brain of mice models for ALS (referred to as TDP-43).

The results demonstrate that the TDP-43 mice exhibited significantly disrupted glymphatic function, progressive neurodegeneration, deteriorating motor symptoms, significant weight loss, and shortened telomere length when compared to controls, very early in the disease course.

Whilst there is still more to learn of the relationship between ALS and glymphatic system function, this study provides initial evidence to suggest that the glymphatic system might be a potential therapeutic target in the treatment of ALS.

BrainPark

Using Neuroscience to create healthy habits and communities

As experts in the science of brain plasticity, behaviour, cognition, and mental health, the BrainPark team investigates how everyday lifestyle activities and digital tools can be used to both track and to improve brain and mental health.

To see other aspects of our work, please view our website: www.brainpark.com

CASE STUDY

BrainPark is increasingly being utilised by external research groups who are attracted to its radically different approach to lifestyle medicine and therapeutic technologies research. We now host 10 external studies focusing on diverse research fields (including OCD, GAD, PTSD, ADHD, autism, concussion, stroke, Parkinson's disease, OSA), all adopting BrainPark-developed approaches (e.g., digital/cognitive phenotyping, therapeutic virtual reality, and lifestyle interventions). Furthermore, The BrainPark research group is now supporting several rigorous programs of research investigating psychedelic medicines for mental illness that seek to evaluate their therapeutic effects and neurobiological mechanisms. These include some of the largest psychedelic studies in the world. There is exciting potential to combine psychedelics with lifestyle and technology interventions to accelerate recovery for those suffering from refractory mental illness, and to reduce the need for long-term medications.

TEAM

Prof Murat Yücel, *Director*
Dr Rebecca Segrave, Deputy Director, David W Turner *Senior Research Fellow and Head of Behaviour Group*
Prof Leonardo Fontonelle, *Head of Clinical Group*
A/Prof Kris Rotaru, *Visiting Researcher*
Dr Chao Suo, *Head of Technology Group*
Dr Rico Lee, *Head of Assessment*
Dr Lucy Albertella, *Deputy Head of Assessment*
Dr Karyn Richardson, *Wilson Foundation-BrainPark Research Fellow*
Dr Yann Chye, *Research Fellow*
Ms Amy Allen, *Senior Operations Coordinator*
Mr James Morrow, *Implementation Coordinator*
Mr Sam Hughes, *Senior Exercise Physiologist (Standards and Compliance)*
Mr Edouard Kayayan, *Exercise Physiologist (Partnership and Program Development)*
Ms Amelia Lowe, *Wilson Foundation-BrainPark Research and Administration Officer*

Research Assistants
Rebecca Kirkham, *Research Officer*
Joseph Pitt, *Research Officer*

PhD Candidates
Erynn Christensen
Craig Harper
Campbell Ince
Chang Liu
Suzan Maleki
Dan Myles
Kavya Raj
Teresa Wulandari

Clinical PhD Students
Mary-Ellen Brierley
Catherine Brown
Olivia Chung
Louise Destree
Sakshi Dhir
Emma Thompson

Clinical Neuropsychology PhD Students
Maja Brydevall
Lara Piccoli

Honours Students
Amanga Amarasena
Alysha Caroline
Tia van Heurck
Daniel Koay
Marko Milicevic
Emma Moon
James Rajadurai
Sian Rossjohn
Shaheen Samnani
Cindy Tran

2021 highlights and achievements

BrainPark COVID-19, Lifestyle and Mental Health Study / Wilson Foundation

This study has produced important outcomes, including: (i) that lifestyle factors (diet and physical activity) predicted compulsive behaviours throughout the COVID-19 pandemic; and (ii) a better understanding of the mechanisms driving different features of excessive internet use. Both findings make important contributions to informing novel mechanism-targeted interventions, including lifestyle and stress management, to reduce risk across multiple compulsive behaviours.

MAGNET – Mental Health Australia General Clinical Trials Network (NHMRC)

BrainPark is part of Australia's first ever mental health clinical trial network, MAGNET (led by Prof Michael Berk, Deakin University). MAGNET is a new national collaboration transforming the way mental health treatment is developed and tested. Within this effort, HARMON-E is the largest trial to date to compare the impact of a lifestyle therapy program versus a psychotherapy program for adults with a mood disorder.

Brain Exercise and Addiction Trial (NHMRC)

This study is investigating whether high intensity interval training can reverse brain harms caused by chronic cannabis use. Close to 1700 exercise doses have now been delivered to 59 research participants who have continued to have high attendance rates and positive outcomes. The study is due for completion in 2022, and world-first results will follow, informing the global community on the therapeutic potential of lifestyle behaviours on brain health and cognitive fitness.

Conquering Compulsions / Headspace app

Data collection for Conquering Compulsions concluded in September 2021. In this landmark trial, we partnered with the Headspace app to investigate how regular physical exercise and mindfulness meditation practice can modulate aspects of brain functioning and thinking skills associated with compulsivity.

BrainPAC – BrainPark Assessment of Cognition (NHMRC)

The BrainPark Assessment of Cognition (BrainPAC) app represents a paradigm shift in neurocognitive assessment. It fast-tracks the translation of a consensus-derived neurocognitive framework for mental health into a neuroscience-informed, accessible, engaging and purpose-built tool to assess neurocognitive functions key to human motivation and decision-making. This tool has now been adopted by many leading researchers and organisations worldwide and the Australian Defence Force to develop an assessment toolkit that indexes key cognitive drivers of high performance under pressure.

Therapeutic Virtual Reality (VR)

Partnering with The Melbourne Clinic, we systematically investigated potential barriers and enablers to the clinical implementation of therapeutic VR from the perspective of clinical stakeholders. With this knowledge, we can now inform practical recommendations for strategies to promote broad uptake of therapeutic VR. For example, the Melbourne Clinic are now embedding BrainPark's Therapeutic VR for OCD into their clinical programs. BrainPark's therapeutic VR software has also been licensed to industry leaders (e.g., Incannex Health) to drive world-first trials of psychedelic- and VR-assisted psychotherapy in mental health care.

Neural systems and behaviour lab

The human brain is arguably the most complex network that we know of, consisting of billions of nerve cells interconnected by trillions of axonal fibres.

Interactions unfolding within this intricate web of connectivity form the basis of all our thoughts, emotions and behaviour, and their derailment can lead to mental illnesses such as schizophrenia, depression, and obsessive-compulsive disorder.

To unravel this extraordinary complexity, our research combines human neuroimaging with techniques from neuroscience, genetics, psychology, psychiatry, physics, and mathematics. We use these approaches to map and model the connectivity of the brain in order to understand the biological basis of behaviour in health and disease. Our ultimate goal is to understand how different parts of the brain communicate with each other, how brain function supports adaptive behaviour, and how disruptions of brain function influence risk for mental illness.

2021 highlights and achievements

- Stuart Oldham, Kristina Sabaroedin, and Sid Chopra had their PhDs conferred
- Alex Fornito named Clarivte Analytics Highly Cited Researcher
- Sid Chopra and Mana Biabani received Australasian Cognitive Neuroscience Society (ACNS) Early Career Researcher Awards
- Sid Chopra awarded OHBM Open Science Fellowship
- Sid Chopra received Best Abstract award from Biological Psychiatry Australia
- Jeggan Tiego received Turner Institute Research Excellence Award
- High impact publications in Nature Communications (x2), JAMA Psychiatry, and Science Advances

TEAM

Prof Alex Fornito, *Head, Neural Systems and Behaviour Lab*

Staff

Dr James Pang, *Research Fellow*
Dr Trang Cao, *Research Fellow*
Dr Kevin Aquino, R*esearch Fellow*
Dr Jeggan Tiego, *Research Fellow*
Dr Chao Suo, *Research Fellow*
Dr Tribikram Thapa, *Research Fellow*
Mr Sam Brown, *Research Officer*

Students

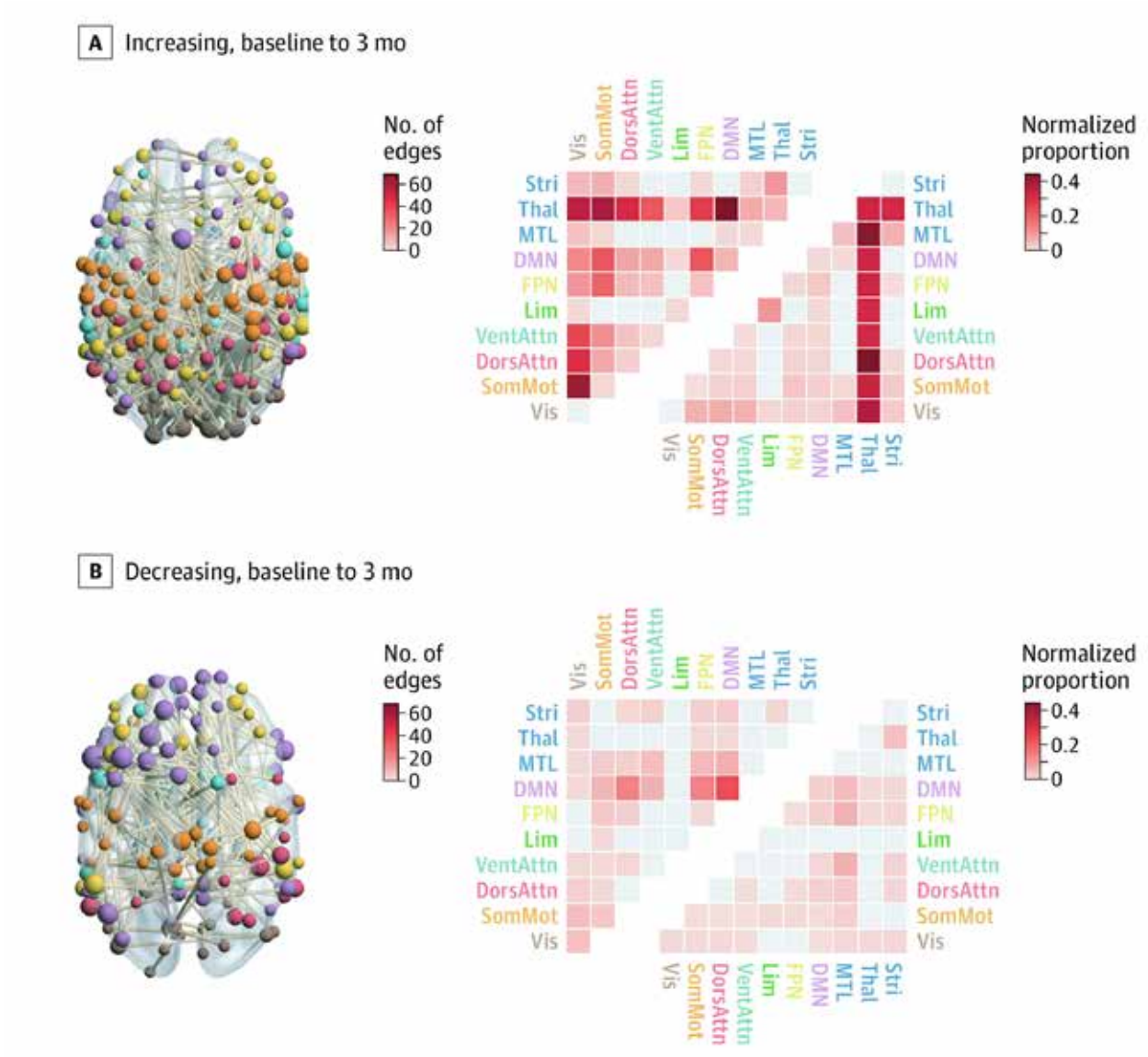
Ms Michelle Lamblin, *PhD Candidate*
Ms Kristina Sabaroedin, *PhD Candidate*
Mr Stuart Oldham, *PhD Candidate*
Ms Ashlea Segal, *PhD Candidate*
Mr Sid Chopra, *PhD Candidate*
Mr Yu-Chi Chen, *PhD Candidate*
Mr Alex Holmes, *PhD Candidate*
Ms Sian Virtue-Griffiths, *DPsych Candidate*

CASE STUDY

Brain changes in people with psychosis have been documented extensively, but disentangling the effects of illness from medication on the brain has been challenging. Such effects can only be understood using placebo-controlled clinical trials, which have proven difficult due to ethical and safety concerns associated with withholding medication.

Working closely with our clinical partners at the ORYGEN Centre for Youth Mental Health, we conducted the first such trial in young people experiencing their first episode psychosis, using magnetic resonance imaging to map changes in brain structure and function in medicated and unmedicated patients through their first year of illness.

Our findings identify some potentially protective effects of antipsychotics on the brain, and identify illness-related brain changes that cannot be attributed to medication. These results shed new light on the origins of brain changes in psychosis and help us understand how antipsychotic medications exert their therapeutic effects.



Longitudinal functional connectivity changes due to antipsychotic treatment

Monash neuroscience of consciousness lab

The Monash Neuroscience of Consciousness (MoNoC) Research Laboratory primarily aims to understand the neural basis of consciousness. Commencing in 2020, a research project we called Qualia Structure has been funded by the Japan Society for Promotion of Science. The project aims 1) to reveal the structure of conscious experience through novel psychological experiments, utilising online massive samples and other technologies, combined with big data analysis, 2) to study the structures of information that are extracted from the brain, and 3) to understand the relationships between the structures of qualia and information. The goals include better understanding of the neural substrates of consciousness, improving the accuracy of measures of consciousness (funded by NHMRC), and improving the quality of human-machine interaction through understanding of the principle of conscious experience in humans and its implications in AI research.

2021 highlights and achievements

- Previous lab member, Dr Thomas Andrillon was employed as Principal Investigator at ICM Paris Brain Institute.
- MoNoC paper authored by Thomas Andrillon was published in Nature Communications, and selected as one of the top 25 articles in Social Sciences and Human Behaviour Articles in 2021.
- The same research was featured in a piece for The Conversation
- *MoNoC Head* A/Prof Nao Tsuchiya released a book on consciousness in Japanese

CASE STUDY: SLEEP-LIKE SLOW WAVES DURING ATTENTION LAPSES

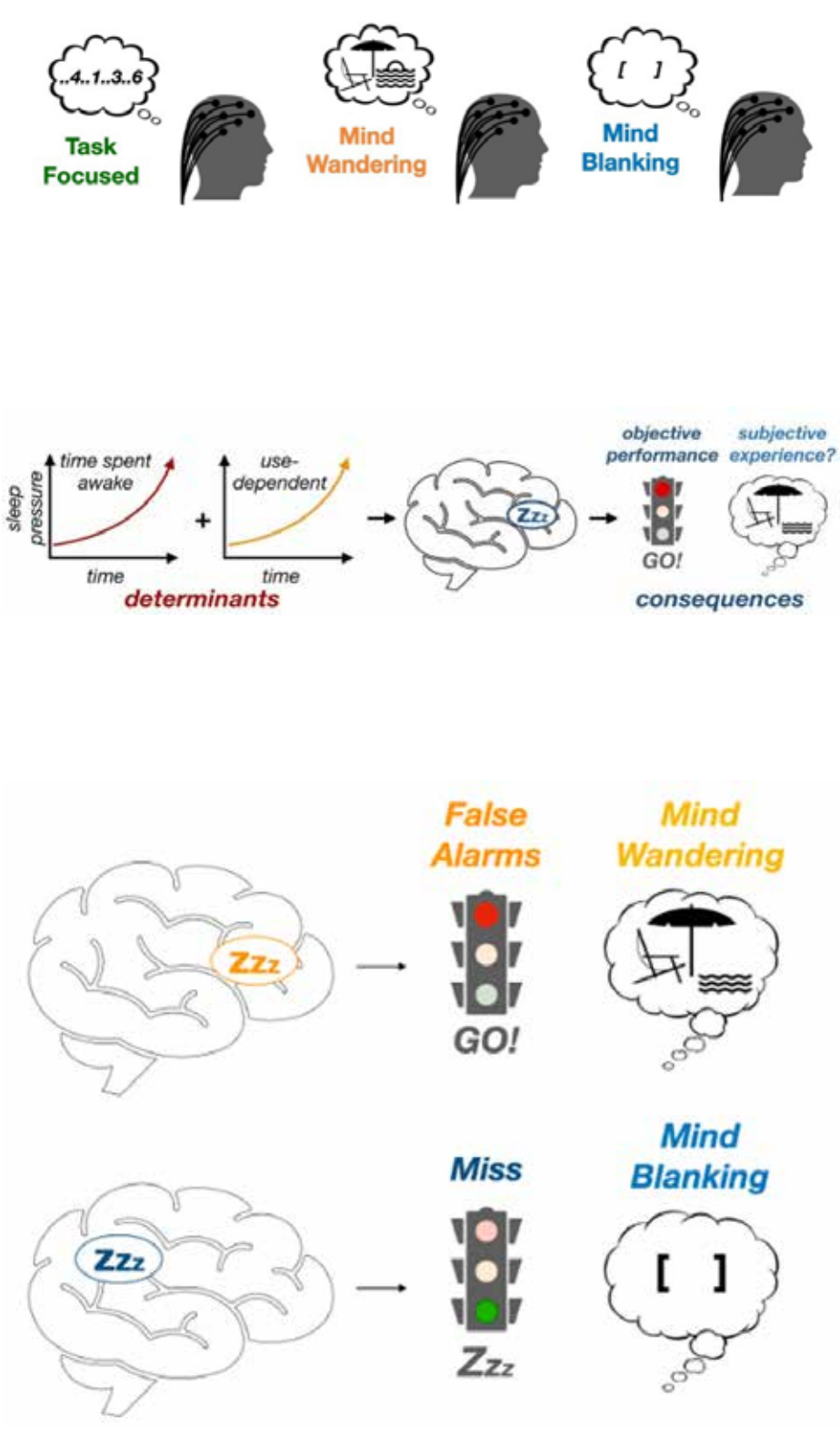
Thomas Andrillon, Angus Burns, Teigane Mackay, Jennifer Windt, Nao Tsuchiya

The onset of 'slow waves', a pattern of neural activity commonly associated with the transition to sleep, could predict whether someone is about to daydream or mind blank, and how they will respond to the environment. The study, published in Nature Communications, suggests this neural activity may be important in understanding different conscious states.

Lapses of attention occur half the time we are awake and are associated with mind wandering (daydreaming) or mind blanking, where the stream of consciousness halts. As these attentional lapses occur more often when people are tired, they could be linked to a neural phenomenon called 'local sleep', where certain brain regions show signs of being in deep sleep (slow waves) while the rest of the brain is alert. This association has been shown in rodents but has not been demonstrated in humans.

Thomas Andrillon and colleagues recorded whole brain electrical activity with electroencephalography in 26 well-rested adults while they performed a sustained attention task focusing on images of faces or numbers for an average of 1.7 hours. They were instructed to press a button in response to certain facial expressions or digits to maintain their focus. The participants were interrupted at random moments every 30 to 70 seconds, and were asked to indicate their mental state as task-focused, mind-wandering or mind-blanking, and level of sleepiness. This was measured alongside pupil size and task responsiveness. The authors found that slow waves in frontal brain areas preceded daydreaming and impulsive behaviour, whereas when they occurred in regions further back in the brain such as the parietal lobe, it was followed by mind blanking and slow responsiveness. The authors suggest that distinct neural signatures precede different conscious states.

Although the slow waves they identified here very closely resemble those encountered during sleep, the authors note that other techniques such as intracranial recording will be needed to verify the findings.



Lapses of attention where different brain regions show signs of being in deep sleep (slow waves) while the rest of the brain is alert, associated with mind wandering (daydreaming) or mind blanking, where the stream of consciousness halts.

TEAM

Prof Nao Tsuchiya, *Head Monash Neuroscience of Consciousness Lab*

Staff

Dr Regan Gallagher, *Postdoctoral Fellow*
Dr Elise Rowe, *Postdoctoral Fellow*
Dr William Wong, *Postdoctoral Fellow*
Dr Ariel Zeleznikow-Johnston, *Postdoctoral Fellow*
Mr Yota Kawashima, *Research Assistant*
Mr Chuyin Zhang, *Research Assistant*

Students

Mr Angus Leung, *PhD Candidate*
Mr Sharon Daniel, *PhD Candidate*
Mr Robert Munoz, *PhD Candidate*
Ms Aniko Kuztor, *PhD Candidate*
Ms Beth Fisher, *PhD Candidate*
Ms Qianchen Liang, PhD Candidate
Mr Matthew Lu, *Honours student*
Mr Vinay Nigram, *Honours student*
Mr Dominik Kirsten-Parsch, *Honours student*

Cognitive neuroimaging lab

The cognitive neuroimaging group investigates how our life experiences change our brains. The group brings together experts in cognitive neuroscience, neuroimaging methods, psychology and philosophy to understand brain function in healthy individuals. The group have core interests in examining resilience to the ageing process, and the neuroscience of parenthood across the lifespan.

In 2021, we continued to develop our simultaneous MRI-PET approach to measuring brain connectivity. The paper in Cerebral Cortex (Jamadar et al., 2021) established the human metabolic connectome for the first time. We continued to make our data publicly available, with the publication of two additional MRI-PET datasets on the OpenNeuro platform, the Monash vis-fPET-fMRI and Monash DaCRA fPET-fMRI. These datasets were accompanied by two technical papers published in Nature Scientific Data and Gigascience, respectively. Together with our Monash rest fPET-fMRI dataset published in 2020, our three datasets have become the most downloaded PET datasets on the OpenNeuro platform, with over 304 collective downloads to date, and at least 3 papers published by independent researchers using our data.

This year also saw expansion of the neuroscience of parenthood research stream. Winnie Orchard published the first outcomes from her NAPPY project (neural adaptations to post partum year), reporting that while there were no objective differences in mothers and non-mothers in cognition, mothers reported poorer subjective cognition relative to non-mothers (Orchard et al., in press, J Women's Health). Furthermore, in her study of late life parents, we found that the patterns of functional connectivity in older women indicates that motherhood is neuroprotective against age-related change in brain function (Orchard et al., 2021, Cerebral Cortex).

2021 highlights and achievements

- Winnie Orchard submitted her thesis for her PhD, The Cognitive Neuroscience of Parenthood.
- Kelsey Perrykkad submitted her PhD thesis, The Self in Autism: a Predictive Perspective; and her degree was conferred
- Kelsey Perrykkad and Winnie Orchard received Postdoctoral Publication Awards; all four Honours students graduated with H1 degrees
- The team received numerous accolades at the Australasian Cognitive Neuroscience Society, including Best Oral Presentation (Katharina Voigt, Winnie Orchard, Hamish Deery), Best Poster (Kelsey Perrykkad) and Best Rapid Fire Talk (Taylah Williams)
- Hamish Deery received the Monash Biomedical Imaging Outstanding Student Award
- Sharna Jamadar was elected for a third term as Secretary of the Australasian Cognitive Neuroscience Society, and continued on as Chair of the Gender, Equity & Diversity Committee of the Brain Function CoE, and as a member of the Australian Academy of Science Equity & Diversity reference group
- Sharna Jamadar organised, chaired, and presented at a symposium at the international Organisation for Human Brain Mapping conference, 'Simultaneous MRI-PET imaging: recent developments and future directions'.

TEAM

Dr Sharna Jamadar, *Head Cognitive Neuroimaging Lab, Senior Research Fellow & NHMRC Emerging Leader Fellow*

Staff

Dr Katharina Voigt, *Research Fellow*
Dr Kelsey Perrykkad, *Research Fellow*
Dr Phillip Ward, *Research Associate*
Ms Emma Liang, *Research Associate*
Ms Ashlea Segal, *Research Assistant*
Mr Gerard Murray, *Research Assistant*
Mr Navyaan Siddiqui, *Research Assistant*

Students

Ms Winnie Orchard, *PhD candidate*
Mr Robert Di Paolo, *PhD candidate*
Ms Nabita Singh, *PhD candidate*
Dr Hamish Deery, *MPhil candidate*
Ms Taylah Williams, *Honours student*
Mr Dylan Burrowes, *Honours student*
Ms Chloe Stevens, *Honours student*
Ms Yashaveene Jayachandran, *Honours student*

CASE STUDY: NEUROPROTECTIVE EFFECTS OF MOTHERHOOD ON BRAIN FUNCTION IN LATE LIFE

Winnie Orchard, Phillip Ward, Sidhant Chopra, Elsdon Storey, Gary Egan, Sharna Jamadar

The maternal brain undergoes widespread functional and structural changes during pregnancy and the postpartum period. However, little is known about the permanence of these effects, and whether they persist throughout the lifespan. In a previous study (Orchard et al., 2020), it was found that cortical thickness differs between mothers and non-mothers in late life (mean age 73 years).

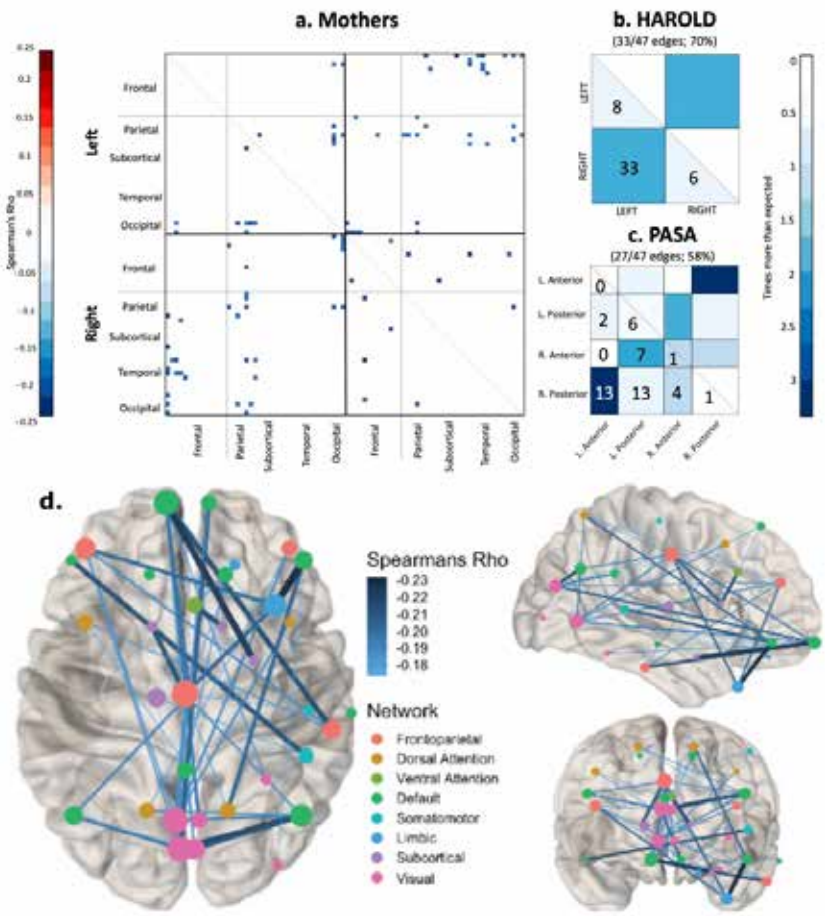
This study examined whether resting state connectivity differs between mothers and non-mothers in older age.

Patterns of resting-state connectivity were compared to three models of age-related functional change, to assess whether motherhood may be functionally neuroprotective for the ageing brain.

Widespread decreasing functional connectivity was found throughout the brain with increasing number of children parented.

As the number of children a woman parented increased, resting-state connectivity decreased between hemispheres, and decreased between anterior and posterior brain regions. In addition, network measures of brain connectivity showed increased segregation between networks with increasing number of children parented.

These three patterns of results are in the opposite direction to that expected during ageing, suggesting that motherhood may be beneficial for brain function in later life.



Caption: a. Resting-state functional connectivity for mothers was negatively correlated with number of children parented; thus as number of children parented increased, functional connectivity decreased. Examining the pattern of negative connections revealed that: b. negative connections were more likely to be obtained for left-right and right-left connections, than left-left or right-right connections; this is in the opposite direction to that predicted by the hemispheric asymmetry in older age (HAROLD) model; c. the negative connections were more likely to be obtained for posterior than anterior regions, in the opposite direction to that predicted by the posterior to anterior shift in ageing (PASA) model.

Computational and systems neuroscience lab

The Computational and Systems Neuroscience Lab's research vision is to perform cross-disciplinary research combining engineering, physics, and machine-learning approaches to answer questions that are motivated by and grounded in neurobiology. This will enable research to go beyond the traditional boundaries in order to understand how the brain implements cognition.

Our research program's priority areas include:

> development of multi-modal (e.g., functional MRI, diffusion MRI, EEG) and multi-scale Bayesian methods to characterise brain network dynamics and how these dynamics reorganise with different brain pathologies;

> development of neuroscience-inspired artificial intelligence schemes to understand how brain performs reasoning, learning and planning; use of classical psychedelics (e.g. LSD and Psilocybin) in combination with computational modelling to understand neural mechanisms underlying altered states of consciousness.

2021 highlights and achievements

> Dr. Razi was promoted to Associate Professor.

> A/Prof Razi was selected as CIFAR Azrieli Global Scholar, 2021-2024 in the Brain, Mind & Consciousness program (co-directors: Anil Seth and Adrian Owen) and interacting with Learning in Machines and Brains program (co-directors: Yoshua Bengio and Yann LeCun).

> A/Prof Razi was invited to the 2021 World Laureates Forum to participate as a young scientist, 30th Oct - 3rd Nov 2021 where he presented his research and and took part in a panel discussion alongside May-Britt Moser (Nobel Prize, 2014), John Hardy (Breakthrough Prize, 2016), and Jean-Pierre Changeux (Wolf Prize, 1982) among others.

> The third edition of the "Maths in the Brain" workshop was Victoria-wide with more than 90 participants joining for an in-person meeting.

TEAM

A/Prof Adeel Razi, *Head, Computational and Systems Neuroscience Lab*

Staff

Dr Leonardo Novelli, *Postdoctoral Research Fellow*
Dr Martin Williams, *Postdoctoral Research Fellow*
Dr Sadia Shakil, *Adjunct Research Fellow*
Ms Garance Delagneau, *Research Assistant*
Mr Sid Chopra, *Research Assistant*
Ms Tamrin Barta, *Research Assistant*
Mr Matthew Greaves, *Research Assistant*

Students

Mr Devon Stoliker, *PhD Candidate*
Mr Lingbin Bian, *PhD Candidate*
Mr Aswin Paul, *PhD Candidate*
Mr Mohsen Ghofrani-Jahromi, *PhD Candidate*
Ms Salma Mansour *PhD Candidate*
Ms Siti Raisya Audrea, *Honours Student*
Ms Hoang Anh Mai, *Honours Student*

CASE STUDY

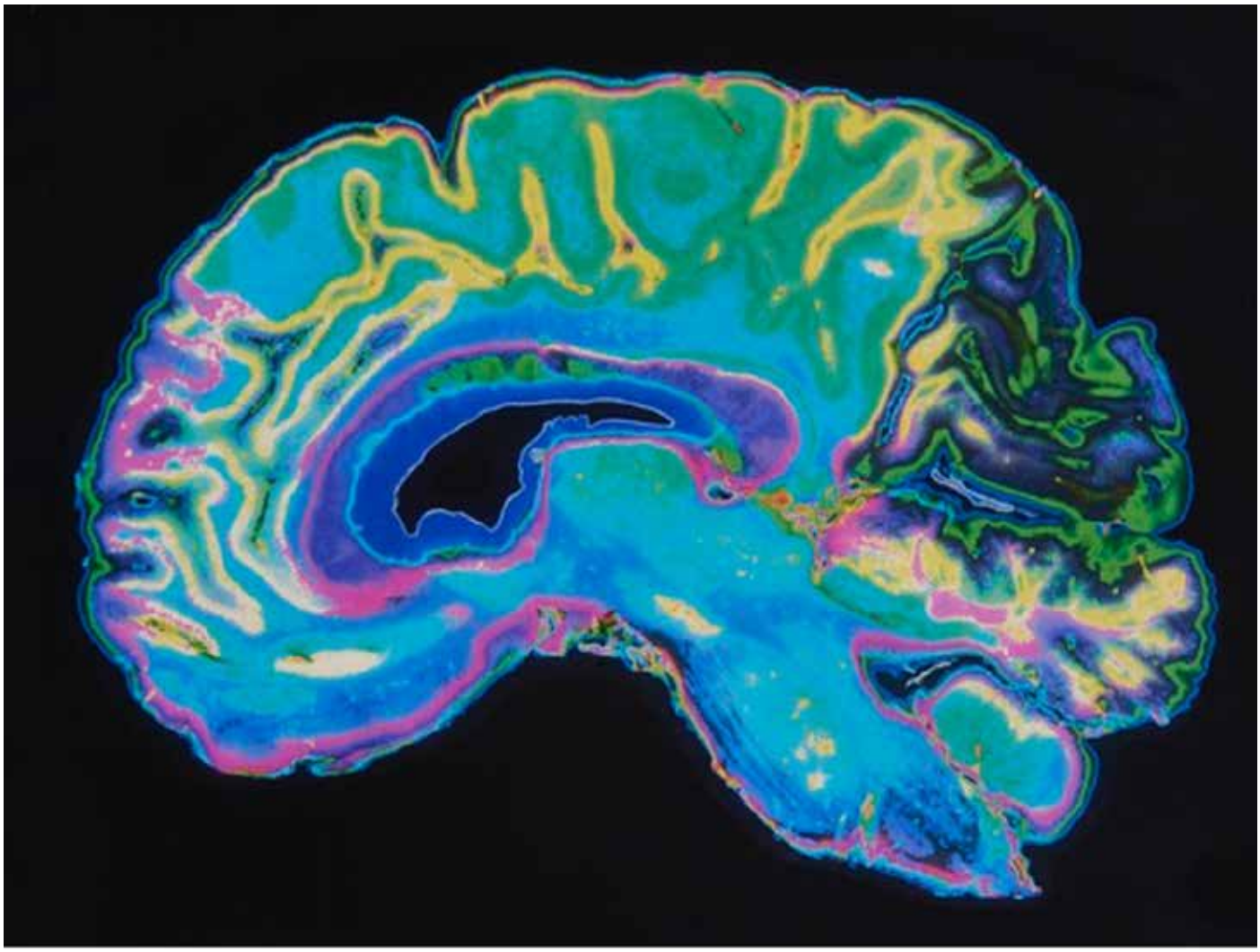
PsiConnect is Australia's first psychedelic trial in healthy humans, recently approved by the Monash University Human Research Ethics Committee (MUHREC), in which healthy participants are given Psilocybin. It is well known that ingesting psilocybin (magic mushrooms) will induce profound changes in consciousness and perception. However, their impact on the brain is unknown and the focus of PsiConnect which is sponsored by the Turner Institute for Brain and Mental Health at Monash University.

Delving into how our consciousness is altered involves researchers combining functional Magnetic Resonance Imaging (MRI) and Electroencephalography (EEG) scans from healthy adult brains before and after a dose of psilocybin. The impact of contextual factors like music and meditation are also being assessed.

The PSIConnect trial incorporates 60 healthy adults split into two equal groups, with one group completing eight weeks of online group meditation prior to their scans and the other group with no meditation at all, helping researchers determine what effects meditation may have on the brain and if the psychedelic experiences differ between the two groups as a result.

Psilocybin's effects last around 4-6 hours, with peak effects occurring around on hour after ingestion. These effects include sensory enhancement, a sense of time changing shifts in visual perception with objects appear to move (flowing patterns and shapes), vivid closed eye imagery, unusual thoughts and speech, personal insight and reflection, and excited mood.

This trial is being conducted at the Monash Biomedical Imaging and BrainPark facilities at the university's Clayton campus. International partners include USONA Institute, Rochester, USA and University of Zurich, Switzerland.



Psychedelics induces acute effects through the brain. These effects include sensory enhancement, a sense of time changing shifts, personal insight and reflection, and excited mood.

Mechanisms of neurodegeneration lab

The Mechanisms of Neurodegeneration research group uses magnetic resonance imaging (MRI), positron emission tomography (PET), blood biomarkers, and digital technologies to investigate and track brain and behavioural changes in people with neurodegenerative diseases. This work principally focuses on individuals with neurogenic diseases, including Friedreich ataxia, Spinocerebellar ataxias, and Huntington's disease. Additional work in other neurodegenerative disorders and in preclinical animal models is also being undertaken with our collaborators.

The broad aims of our research include describing changes in brain structure and function, and developing mechanistic insights, including cellular/molecular-level measurements of inflammation, oxidative stress, and metabolic dysfunction. Our studies seek to provide more comprehensive disease descriptions and to identify measures relevant to tracking disease progression or treatment efficacy.

2021 highlights and achievements

- Launch of the "SCARemote" study, using web-based platforms to measure and monitor movement, cognition, speech, and affect in people with spinocerebellar ataxias throughout Australia
- Expansion of the ENIGMA-Ataxia consortium, led by our team, through new projects launched by collaborators in Brazil and Italy
- Initiation of the "Statin Treatment for COVID-19 to Optimise Neurological Recovery" (STRONGER) clinical trial

TEAM

Dr Ian Harding, *Head, Mechanisms of Neurodegeneration Lab*

Staff

Dr Rebecca Kerestes, *Research Fellow*
Dr Louisa Selvadurai, *Research Fellow*
Mr James Morgan, *Research Assistant*
Ms Hannah Cummins, *Research Assistant*

Students

Ms Jo Wrigglesworth, *PhD candidate*
Ms Hiba Bilal, *PhD candidate*
Ms Kira-Elise Wilson, *PhD candidate*
Ms Sheryl Gullia, *Honours student*

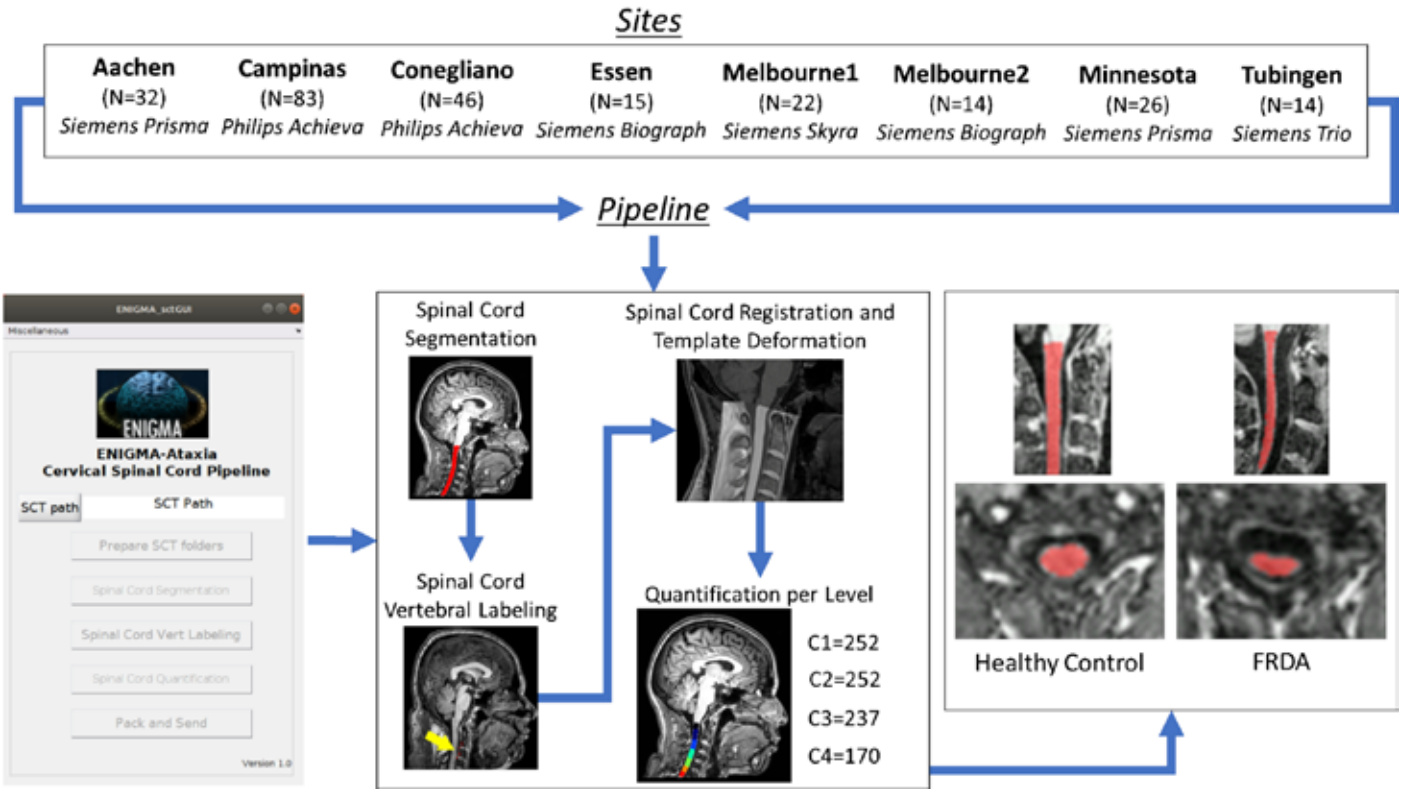
CASE STUDY: PROGRESSIVE SPINAL CORD DEGENERATION IN FRIEDREICH'S ATAXIA - RESULTS FROM THE ENIGMA-ATAXIA CONSORTIUM

Progressive spinal cord degeneration in Friedreich's ataxia: Results from the ENIGMA-Ataxia Consortium

The spinal cord is a key site of Friedreich's ataxia (FRDA) pathology, but spinal cord thinning is widely considered to be the consequence of developmental hypoplasia and not ongoing degeneration. As such, the spinal cord has not been viewed as a viable treatment target or biomarker candidate.

However, the *in vivo* measurement of spinal cord morphometry using MRI in a large multisite cohort definitively debunks this long-held conception. Our work presents the results of a harmonised international analysis of spinal cord morphometry from 8 sites, encompassing 256 patients and 223 controls. We report very strong evidence that spinal cord thinning is *progressive throughout the full course of the illness*, while changes in spinal cord shape (i.e., eccentricity) are early but stable. This supports two dissociable pathological processes – one likely of developmental origin, and the other degenerative. This is a critical shift in the conceptualisation of the expression and progression of FRDA.

This work was led as a collaboration primarily between our team and the University of Campinas (Sao Paulo, Brazil), in conjunction with data contributions from other sites in Europe and North America.



Study design and imaging processing pipeline.

Neuroscience and society group

The Neuroscience and society group is a collection of interdisciplinary researchers and practitioners examining the impact of neuroscience research and technology on society. The group includes expertise from neuroscience, psychology, social science, philosophy, ethics and public health. Our principal aim is to ensure the responsible research, innovation and use of emerging neurotechnologies, including brain computer interfaces, deep brain stimulation, direct-to-consumer brain recording and stimulating devices, psychedelic drugs, and digital psychiatry and remote sensors.

Neuroscience research and the new technologies that it produces can have unexpected and harmful effects on end-users that slows the effective translation of these technologies into society. Our researchers engage with a range of communities and stakeholders involved in the development and use of neurotechnologies to ensure that they meet the needs of all end-users, yielding optimal benefit, while meeting societal norms and values.

Community engagement is also key to foster public support for the use of technologies that can raise ethical concerns, including privacy, discrimination, impacts on agency, autonomy and identity, coercion, surveillance and fairness. We also work with stakeholders to ensure the effective governance and regulation of emerging technologies in a way that supports and guides innovation while reflecting public values.

The Neuroscience and society group has productive collaborations with scientists, engineers and developers, and clinical and legal practitioners across Monash, including those at Monash Biomedical Imaging, BrainPark, Monash Institute for Medical Engineering, Monash Vision Group, Monash Data Futures Institute, the National Centre for Healthy Ageing, the Monash Clinical Psychedelic Research Lab, as well as leading groups across the country and globally.

2021 highlights and achievements

- A/Prof Adrian Carter was made Director of Community Engagement and Neuroethics at the Turner Institute for Brain and Mental Health
- A/Prof Adrian Carter was selected as a finalist in the *Vice Chancellor's Excellence Award in Occupational Health and Safety* (Physical and psychological risks in a virtual world), Monash University
- A/Prof Adrian Carter was also selected as a member of the *National Committee for the History and Philosophy of Science*, Australian Academy of Science
- PhD Candidate Nathan Higgins won best Academic Essay in the International Neuroethics Society Essay Contest ('Continued access to invasive neural devices: lessons from the AIDS epidemic').
- Clinical PhD candidate Sarah Haines presented at the APSAP Scientific Alcohol and Drug Conference ('Prescription opioid supply and the role of prescription drug monitoring programs: an overview of research from the Victorian implantation')
- PhD candidate Daniel Myles provided consultation on a gambling harm-reduction feature which has been implemented in the online banking apps of the major 'big four' Australian banks.

CASE STUDY: CONSUMER EXPERIENCE OF PRESCRIPTION DRUG MONITORING PROGRAMS (PDMP) IN VICTORIA - PERSPECTIVES FROM PEOPLE WHO USE OPIOIDS TO MANAGE CHRONIC PAIN.

In 2020 Victoria implemented a new, real-time Prescription Drug Monitoring Program (PDMP) to help identity 'high risk' use of addictive medications. This study aimed to better understand the impacts of PDMP on people who use prescription opioid medications to manage pain. This included: What these medications afford them; Their understanding of opioids; Their concerns in the context of PDMP implementation; and What they would like their healthcare to look like.

We conducted a suite of studies, involving qualitative interviews with people who use prescription opioids to manage chronic pain and health care providers as well analyses of phone calls made to a SafeScript helpline by people who were affected the program. Our analysis identified six key themes that illustrated the impact the program had on patient care.

1. Quality of life: Prescription opioids afforded engagement with meaningful activities.
2. Mental health: Participants reported that their medication reduced feelings of helplessness associated with their pain condition.
3. Increased empathy: Participants expressed a desire for more empathy and understanding from their healthcare provider
4. Desire for shared care: Participants reported feeling left out of decisions relating to their own healthcare.
5. Stigma: Those identified as 'at risk' of opioid related harm experienced stigma from their healthcare provider
6. Informed use: Participants were well-informed about the risk of prolonged prescription opioid use

Findings from this study suggest that healthcare providers should be aware that opioids may be playing an important role in quality of life for people living with chronic pain, offer alternative supports and include them in decisions about their care.

TEAM

A/Prof Adrian Carter, *Head, Neuroscience and Society Group*

Students

Mr Daniel Myles, *PhD Candidate*
Mr Nathan Higgins, *PhD Candidate*
Ms Steph Slack, *PhD Candidate*
Mr Phillip Mosley, *PhD Candidate*
Mr Patrick Haylock, *Clinical PhD Candidate*
Ms Michaela Barber, *Clinical PhD Candidate*
Ms Sarah Haines, *Clinical PhD Candidate*
Ms Isobel Butorac, *Clinical PhD Candidate*
Ms Victoria Gentile, *Clinical PhD Candidate*
Ms Theoni Whyman, *Clinical PhD Candidate*
Ms Cassandra Thomson, *Clinical PhD Candidate*
Ms Alison Cullen, *Clinical PhD Candidate*
Ms Rachel Ham, *Clinical PhD Candidate*

Clinical psychedelic research lab

Established in late 2020, the lab is the first clinical psychedelic lab in Australia. Standing on the shoulders of giants overseas, and alongside a small handful of local researchers and clinicians, we are helping to establish the field of clinical psychedelics in Australia. The lab is focused on developing a rigorous program of research in psychedelic medicine at Monash University that seeks to evaluate therapeutic effects, innovate on treatment design, mitigate known risks, explore potential drawbacks, and understand therapeutic mechanisms.

We develop and conduct psychedelic clinical trials and other studies, therapist training programs, and public education. The Clinical Psychedelic Research Lab is uniquely positioned to implement leading-edge psychedelic treatment combined with evidence-based psychotherapeutic and behavioural interventions within a seamless, patient-focused, and highly conducive environment.

We are expanding psychedelic research and treatment into new indications, exploring synergies between psychedelics and various psychotherapeutic and behavioural interventions, improving treatment and training outcomes, developing pragmatic and affordable treatment models, investigating therapeutic mechanisms, predicting patient response, and assessing cost effectiveness.

2021 highlights and achievements

- Finalised protocol, received ethics approval, and commenced the largest psilocybin-assisted psychotherapy trial in Australia to date, and a world-first in the treatment of GAD.
- Developed and delivered the first applied psilocybin-assisted therapist training in Australia, involving leading international clinical psychedelic research experts
- Hosted Australia's first applied therapist training program for MDMA-assisted psychotherapy, in partnership with the Multidisciplinary Associated for Psychedelic Studies (MAPS).
- Commenced a world-first training module for research therapists to receive psilocybin under supportive conditions as part of their training.
- Completed recruitment and data collection for an international survey study on acute psychedelic experience, including the validation of novel scales.
- Commenced three new Clinical Psychology PhD students
- Executed a large technology licencing agreement with an industry funder for use as part of a novel intervention within a forthcoming psychedelic trial.

CASE STUDY: PSILOCYBIN-ASSISTED PSYCHOTHERAPY FOR GENERALISED ANXIETY DISORDER AND THERAPIST SUBSTUDY

Generalised Anxiety Disorder (GAD) is a chronic, relapsing, and relatively common disorder (about 4-6% lifetime prevalence in Australia), characterised by excessive anxiety and worry. Within recent trials, psilocybin-assisted psychotherapy led to reductions in anxiety symptoms associated with terminal cancer diagnoses. The Psi-GAD-1 clinical trial is a world first testing psilocybin-assisted therapy in the treatment of a primary anxiety disorder. With 72 participants, this investigator-initiated trial - sponsored by Monash University and funded by Incannex - is the largest psychedelic trial in Australia to date. The trial attempts to address a number of methodological shortcomings in the field (e.g., adequate statistical power, improved active placebo, reduced participant selection bias) that includes a range of treatment innovations and the development of a specialised therapist training program.

Psychedelic drugs can induce states of consciousness that are often reported to be remarkable, moving, beneficial, and difficult to describe. Clinical participants also report very challenging experiences that, when well supported, are felt to be highly valuable by the participant. It is essential that participants are supported by skilled and empathic therapists with specialist training. The Psi-GAD-1 therapist training program incorporated a world-first option for trial therapists to receive psilocybin under supportive conditions. Previous research suggests that psychedelic therapist training can be substantially enhanced if therapists have the opportunity for psychedelic self-experience, enhancing their ability to accompany clinical participants through profoundly unfamiliar terrain, and thereby improving treatment outcomes. The impact of this aspect of training is being scientifically investigated from the perspectives of both therapists and clinical participants.

TEAM

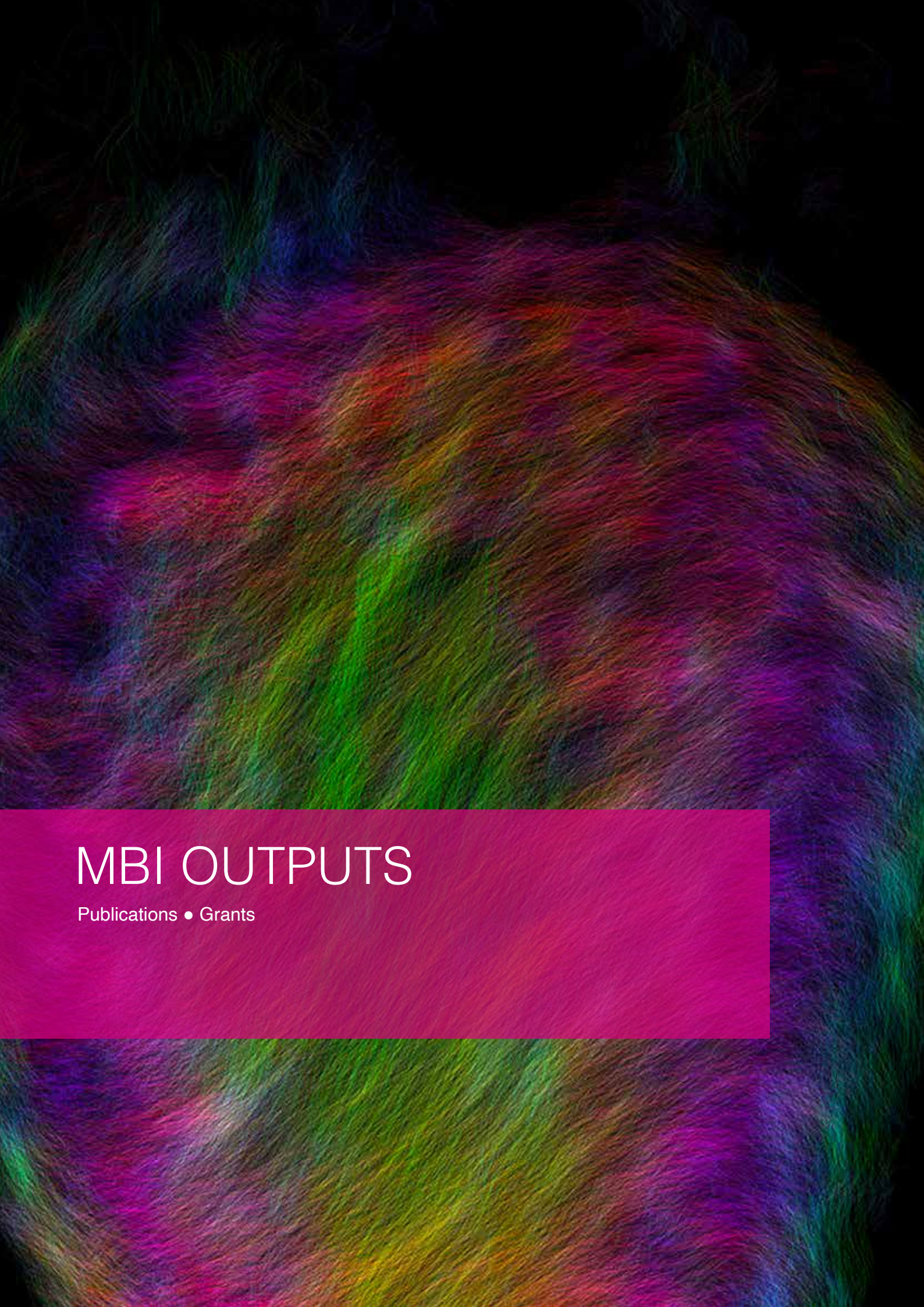
Dr Paul Liknaitzky, *Head, Clinical Psychedelic Research Lab*

Staff

Ms Hannah Bushell, *Senior Research Officer*
Mr Sean O'Carroll, *Lead Trial Therapist and Trainer*
Ms Sabrina Adams, *Clinical Psychologist, Trial Therapist*
Dr Simon Amar, *Psychiatrist, Trial Therapist*
Dr Esme Dark, *Clinical Psychologist, Trial Therapist*
Dr Surabhi Hiwale, *Psychiatrist, Trial Therapist*
Dr Phil Jaksa, *Psychiatrist, Trial Therapist*
Ms Shanti Monteiro, *Clinical Psychologist, Trial Therapist*
Ms Sarah Pant, *Trial Therapist*
Ms Marg Ryan, *Psychotherapist, Trial Therapist*
Dr David Spektor, *Clinical Psychologist, Trial Therapist*
Mr Campbell Townsend, *Clinical Psychologist, Trial Therapist*
Dr James Tranter, *Psychiatrist, Trial Therapist*
Dr Christopher Walsh, *Psychiatrist, Trial Therapist*

Students

Ms Georgia Ioakimidis-MacDougall, *PhD Candidate (Clinical Psychology) and Research Officer*
Ms Rachel Ham, *PhD Candidate (Clinical Psychology) and Research Officer*
Mr Joshua Kugel, *PhD Candidate (Clinical Psychology) and Research Officer*



MBI OUTPUTS

Publications • Grants

2021 PUBLICATIONS

MBI publications

Abrams, M.B., Bjaalie, J.G., Das, S., et al. (2021). Correction to: A Standards Organization for Open and FAIR Neuroscience: the International Neuroinformatics Coordinating Facility. *Neuroinformatics*. doi: 10.1007/s12021-021-09522-x.

Abrams, M.B., Bjaalie, J.G., Das, S., et al. (2021). A Standards Organization for Open and FAIR Neuroscience: the International Neuroinformatics Coordinating Facility. *Neuroinformatics*. doi: 10.1007/s12021-020-09509-0.

Abubakar, A.B., Bautista, T.G., Dimmock, M.R., et al. (2021). Behavioral and Regional Brain Responses to Inhalation of Capsaicin Modified by Painful Conditioning in Humans. *Chest*, 159(3): 1136-1146. doi: 10.1016/j.chest.2020.08.2105.

Babiloni, C., Arakaki, X., Azami, H., et al. (2021). Measures of resting state EEG rhythms for clinical trials in Alzheimer's disease: Recommendations of an expert panel. *Alzheimer's and Dementia*, 17(9): 1528-1553. doi: 10.1002/alz.12311.

Babiloni, C., Arakaki, X., Bonanni, L., et al. (2021). EEG measures for clinical research in major vascular cognitive impairment: recommendations by an expert panel. *Neurobiology of Aging*, 103: 78-97. doi: 10.1016/j.neurobiolaging.2021.03.003.

Behrens, R., McGovern, A.E., Farrell, M.J., et al. (2021). Mini Review: Central Organization of Airway Afferent Nerve Circuits. *Neuroscience Letters*, 744. doi: 10.1016/j.neulet.2020.135604.

Beltran Diaz, S., H'ng, C.H., Qu, X., et al. (2021). A New Pipeline to Automatically Segment and Semi-Automatically Measure Bone Length on 3D Models Obtained by Computed Tomography. *Frontiers in Cell and Developmental Biology*, 9. doi: 10.3389/fcell.2021.736574.

Chen, Z., Sforazzini, F., Baran, J., et al. (2021). MR-PET head motion correction based on co-registration of multicontrast MR images. *Human Brain Mapping*, 42(13): 4081-4091. doi: 10.1002/hbm.24497.

Ghaffari, M., Pawar, K., Oliver, R. (2021). Brain MRI motion artifact reduction using 3D conditional generative adversarial networks on simulated motion. DICTA 2021 - 2021 *International Conference on Digital Image Computing: Techniques and Applications.*

Gilchrist, C.P., Thompson, D.K., Alexander, B., et al. (2021). Growth of prefrontal and limbic brain regions and anxiety disorders in children born very preterm. *Psychological Medicine*. doi: 10.1017/S0033291721002105.

Grieve, M.L., Davey, P.R.W.J., Forsyth, C.M., et al. (2021). The synthesis of a bis(Thiosemicarbazone) macrocyclic ligand and the Mn(II), Co(II), Zn(II) and 68Ga(III) complexes. *Molecules*, 26(12). doi: 10.3390/molecules26123646.

Jamadar, S.D., Zhong, S., Carey, A., et al. (2021). Task-evoked simultaneous FDG-PET and fMRI data for measurement of neural metabolism in the human visual cortex. *Scientific Data*, 8(1). doi: 10.1038/s41597-021-01042-2.

Kirch, C., Gollo, L.L. (2021). Single-neuron dynamical effects of dendritic pruning implicated in aging and neurodegeneration: towards a measure of neuronal reserve. *Scientific Reports*, 11(1). doi: 10.1038/s41598-020-78815-z.

Le, B., Ferreira, P., Merchant, S., et al. (2021). Microarchitecture of the hearts in term and former-preterm lambs using diffusion tensor imaging. *Anatomical Record*, 304(4): 803-817. doi: 10.1002/ar.24516.

Lee, W.T., Zheng, G., Talbot, C.L., et al. (2021). Hyperpolarised gas filling station for medical imaging using polarised 129Xe and 3He. *Magnetic Resonance Imaging*, 79: 112-120. doi: 10.1016/j.mri.2021.02.010.

Lever, J., Brkljača, R., Rix, C., et al. (2021). Application of networking approaches to assess the chemical diversity, biogeography, and pharmaceutical potential of verongiida natural products. *Marine Drugs*, 19(10). doi: 10.3390/md19100582.

Levitis, E., Van Praag, C.D.G., Gau, R., et al. (2021). Centering inclusivity in the design of online conferences - An OHBM-Open Science perspective. *GigaScience*, 10(8). doi: 10.1093/gigascience/giab051.

Li, S., Jamadar, S.D., Ward, P.G.D., et al. (2021). Estimation of simultaneous BOLD and dynamic FDG metabolic brain activations using a multimodality concatenated ICA (mcICA) method. *NeuroImage*, 226. doi: 10.1016/j.neuroimage.2020.117603.

Martherus, T., Croughan, M.K., Crossley, K.J., et al. (2021). Higher CPAP levels improve functional residual capacity at birth in preterm rabbits. *Pediatric Research*. doi: 10.1038/s41390-021-01647-8.

McMahon, J.H., Zerbato, J.M., Lau, J.S.Y., et al. (2021). A clinical trial of non-invasive imaging with an anti-HIV antibody labelled with copper-64 in people living with HIV and uninfected controls. *EBioMedicine*, 65. doi: 10.1016/j.ebiom.2021.103252.

Nguyen, B.N., Kolbe, S.C., Verghese, A., et al. (2021). Visual search efficiency and functional visual cortical size in children with and without dyslexia. *Neuropsychologia*, 155. doi: 10.1016/j.neuropsychologia.2021.107819.

Norman, E.O., Hombsch, S., Lever, J., et al. (2021). Phytochemical Profiling and Biological Testing of the Constituents of the Australian Plant Haemodorum brevisepalum. *Journal of Natural Products*, 84(11): 2832-2844. doi: 10.1021/acs.jnatprod.1c00509.

Norman, E.O., Tuohey, H., Pizzi, D., et al. (2021). Phytochemical Profiling and Biological Activity of the Australian Carnivorous Plant,Drosera magna. *Journal of Natural Products,* 84(4): 964-971. doi: 10.1021/acs.jnatprod.0c00869.

Paino, J., Barnes, M., Engels, E., et al. (2021). Incorporating clinical imaging into the delivery of microbeam radiation therapy. Applied Sciences *(Switzerland),* 11(19). doi: 10.3390/app11199101.

Pang, J.C., Gollo, L.L., Roberts, J.A. (2021). Stochastic synchronization of dynamics on the human connectome. *NeuroImage*, 229. doi: 10.1016/j.neuroimage.2021.117738.

Pawar, K., Egan, G.F., Chen, Z. (2021). Domain knowledge augmentation of parallel MR image reconstruction using deep learning. *Computerized Medical Imaging and Graphics*, 92. doi: 10.1016/j.compmedimag.2021.101968.

Pearson, J.T., Thambyah, H.P., Waddingham, M.T., et al. (2021). β-blockade prevents coronary macro- And microvascular dysfunction induced by a high salt diet and insulin resistance in the Goto–Kakizaki rat. *Clinical Science*, 135(2): 327-346. doi: 10.1042/CS20201441.

Peiris, H., Chen, Z., Egan, G., et al., (2021). Duo-SegNet: Adversarial Dual-Views for Semi-supervised Medical Image Segmentation, in *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*: 428-438.

Pozaruk, A., Pawar, K., Li, S., et al. (2021). Augmented deep learning model for improved quantitative accuracy of MR-based PET attenuation correction in PSMA PET-MRI prostate imaging. *European Journal of Nuclear Medicine and Molecular Imaging*, 48(1): 9-20. doi: 10.1007/s00259-020-04816-9.

Rajkumar, R., Farrher, E., Mauler, J., et al. (2021). Comparison of EEG microstates with resting state fMRI and FDG-PET measures in the default mode network via simultaneously recorded trimodal (PET/MR/EEG) data. *Human Brain Mapping*, 42(13): 4122-4133. doi: 10.1002/hbm.24429.

Ross, M.M., Cherkerzian, S., Mikulis, N.D., et al. (2021). A randomized controlled trial investigating the impact of maternal dietary supplementation with pomegranate juice on brain injury in infants with IUGR. *Scientific Reports,* 11(1). doi: 10.1038/s41598-021-82144-0.

Saxena, J., Adhikari, B., Brkljaca, R., et al. (2021). Effect of compositional variation on physico-chemical and structural changes in infant formula during storage. *International Dairy Journal,* 116. doi: 10.1016/j.idairyj.2020.104957.

Saxena, J., Adhikari, B., Brkljaca, R., et al. (2021). Influence of lactose pre-crystallization on the storage stability of infant formula powder containing lactose and maltodextrin. *Food Hydrocolloids*, 111. doi: 10.1016/j.foodhyd.2020.106385.

Saxena, J., Adhikari, B., Brkljaca, R., et al. (2021). Influence of Lactose on the Physicochemical Properties and Stability of Infant Formula Powders: A Review. *Food Reviews International*. doi: 10.1080/87559129.2021.1928182.

Sepehrizadeh, T., Jong, I., DeVeer, M., et al. (2021). PET/MRI in paediatric disease. *European Journal of Radiology,* 144. doi: 10.1016/j.ejrad.2021.109987.

Shah, N.J., da Silva, N.A., Yun, S.D. (2021). Perfusion weighted imaging using combined gradient/spin echo EPIK: Brain tumour applications in hybrid MR-PET. *Human Brain Mapping*, 42(13): 4144-4154. doi: 10.1002/hbm.24537.

Shishegar, R., Pizzagalli, F., Georgiou-Karistianis, N., et al. (2021). A gyrification analysis approach based on Laplace Beltrami eigenfunction level sets. *NeuroImage,* 229. doi: 10.1016/j.neuroimage.2021.117751.

Sorrentino, P., Rucco, R., Baselice, F., et al. (2021). Flexible brain dynamics underpins complex behaviours as observed in Parkinson's disease. *Scientific Reports,* 11(1). doi: 10.1038/s41598-021-83425-4.

Sudarshan, V.P., Li, S., Jamadar, S.D., et al. (2021). Incorporation of anatomical MRI knowledge for enhanced mapping of brain metabolism using functional PET. *NeuroImage*, 233. doi: 10.1016/j.neuroimage.2021.117928.

Sudarshan, V.P., Upadhyay, U., Egan, G.F., et al. (2021). Towards lower-dose PET using physics-based uncertainty-aware multimodal learning with robustness to out-of-distribution data. *Medical Image Analysis*, 73. doi: 10.1016/j.media.2021.102187.

Tahmasebi Yamchelou, M., Law, D., Brkljača, R., et al. (2021). Geopolymer synthesis using low-grade clays. *Construction and Building Materials*, 268. doi: 10.1016/j.conbuildmat.2020.121066.

Tahmasebi Yamchelou, M., Law, D., Brkljača, R., et al. (2021). The effect of pre-treatment and curing temperature on the strength development of alkali-activated clay. *Construction and Building Materials*, 287. doi: 10.1016/j.conbuildmat.2021.123000.

Trappetti, V., Fernandez-Palomo, C., Smyth, L., et al. (2021). Synchrotron Microbeam Radiation Therapy for the Treatment of Lung Carcinoma: A Preclinical Study. *International Journal of Radiation Oncology Biology Physics*, 111(5): 1276-1288. doi: 10.1016/j.ijrobp.2021.07.1717.

Wang, H.X., Chen, Y., Haque, Z., et al. (2021). Sialylated milk oligosaccharides alter neurotransmitters and brain metabolites in piglets: an In vivo magnetic resonance spectroscopic (MRS) study. *Nutritional Neuroscience,* 24(11): 885-895. doi: 10.1080/1028415X.2019.1691856.

Wrigglesworth, J., Ward, P., Harding, I.H., et al. (2021). Factors associated with brain ageing - a systematic review. *BMC Neurology*, 21(1). doi: 10.1186/s12883-021-02331-4.

Xirouchaki, C.E., Jia, Y., McGrath, M.J., et al. (2021). Skeletal muscle NOX4 is required for adaptive responses that prevent insulin resistance. *Science Advances*, 7(51). doi: 10.1126/sciadv.abl4988.

Yamchelou, M.T., Law, D., Brkljača, R., et al. (2021). Pre-treatment impact on the disposition of water in clay-based geopolymer. *Open Ceramics*, 5. doi: 10.1016/j.oceram.2020.100053.

Wright lab publications

Baker, T.L., Agoston, D.V., Brady, R.D., et al. (2021). Targeting the Cerebrovascular System: Next-Generation Biomarkers and Treatment for Mild Traumatic Brain Injury. *Neuroscientist*. doi: 10.1177/10738584211012264.

Brait, V.H., Wright, D.K., Nategh, M., et al. (2021). Longitudinal hippocampal volumetric changes in mice following brain infarction. *Scientific Reports*, 11(1). doi: 10.1038/s41598-021-88284-7.

Major, B., Symons, G.F., Sinclair, B., et al. (2021). White and Gray Matter Abnormalities in Australian Footballers with a History of Sports-Related Concussion: An MRI Study. *Cerebral Cortex*, 31(12): 5331-5338. doi: 10.1093/cercor/bhab161.

Nicolo, J.P., Chen, Z., Moffat, B., et al. (2021). Study protocol for a phase II randomised, double-blind, placebo-controlled trial of perampanel as an antiepileptogenic treatment following acute stroke. *BMJ Open,* 11(5). doi: 10.1136/bmjopen-2020-043488.

Nicolo, J.P., Moffat, B., Wright, D.K., et al. (2021). 7t magnetic resonance imaging quantification of brain glutamate in acute ischaemic stroke. *Journal of Stroke*, 23(2): 281-284. doi: 10.5853/jos.2020.04784.

Pham, L., Wright, D.K., O'Brien, W.T., et al. (2021). Behavioral, axonal, and proteomic alterations following repeated mild traumatic brain injury: Novel insights using a clinically relevant rat model. *Neurobiology of Disease*, 148. doi: 10.1016/j.nbd.2020.105151.

Wright, D.K., Gardner, A.J., Wojtowicz, M., et al. (2021). White Matter Abnormalities in Retired Professional Rugby League Players with a History of Concussion. *Journal of Neurotrauma*, 38(8): 983-988. doi: 10.1089/neu.2019.6886.

Wright, D.K., Symons, G.F., O'Brien, W.T., et al. (2021). Diffusion Imaging Reveals Sex Differences in the White Matter following Sports-Related Concussion. *Cerebral Cortex,* 31(10): 4411-4419. doi: 10.1093/cercor/bhab095.

Yaghmaie, N., Syeda, W.T., Wu, C., et al. (2021). QSMART: Quantitative susceptibility mapping artifact reduction technique. *NeuroImage*, 231. doi: 10.1016/j.neuroimage.2020.117701.

Zamani, A., O'Brien, T.J., Kershaw, J., et al. (2021). White matter changes following experimental pediatric traumatic brain injury: an advanced diffusion-weighted imaging investigation. *Brain Imaging and Behavior*, 15(6): 2766-2774. doi: 10.1007/s11682-020-00433-0.

BrainPark publications

Albertella, L., Rotaru, K., Christensen, E., et al. (2021). The Influence of Trait Compulsivity and Impulsivity on Addictive and Compulsive Behaviors During COVID-19. *Frontiers in Psychiatry*, 12. doi: 10.3389/fpsyt.2021.634583.

Brierley, M.E.E., Albertella, L., Rotaru, K., et al. (2021). The role of psychological distress in the relationship between lifestyle and compulsivity: An analysis of independent, bi-national samples. *CNS Spectrums*. doi: 10.1017/S1092852921001048.

Cao, Z., Ottino-Gonzalez, J., Cupertino, R.B., et al. (2021). Mapping cortical and subcortical asymmetries in substance dependence: Findings from the ENIGMA Addiction Working Group. *Addiction Biology*, 26(5). doi: 10.1111/adb.13010.

Castro-Calvo, J., King, D.L., Stein, D.J., et al. (2021). Expert appraisal of criteria for assessing gaming disorder: an international Delphi study. *Addiction*, 116(9): 2463-2475. doi: 10.1111/add.15411.

Chye, Y., Kirkham, R., Lorenzetti, V., et al. (2021). Cannabis, Cannabinoids, and Brain Morphology: A Review of the Evidence. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, 6(6): 627-635. doi: 10.1016/j.bpsc.2020.07.009.

Chye, Y., Suo, C., Romero-Garcia, R., et al. (2021). Examining the relationship between altered brain functional connectome and disinhibition across 33 impulsive and compulsive behaviours. *Br J Psychiatry*, 220(2): 1-3. doi: 10.1192/bjp.2021.49.

Cullen, A.J., Dowling, N.L., Segrave, R., et al. (2021). Exposure therapy in a virtual environment: Validation in obsessive compulsive disorder. *Journal of Anxiety Disorders*, 80. doi: 10.1016/j.janxdis.2021.102404.

Cullen, A.J., Dowling, N.L., Segrave, R., et al. (2021). Considerations and practical protocols for using virtual reality in psychological research and practice, as evidenced through exposure-based therapy. *Behavior Research Methods*, 53(6): 2725-2742. doi: 10.3758/s13428-021-01543-3.

Debenham, J., Birrell, L., Champion, K., et al. (2021). Neuropsychological and neurophysiological predictors and consequences of cannabis and illicit substance use during neurodevelopment: a systematic review of longitudinal studies. *The Lancet Child and Adolescent Health*, 5(8): 589-604. doi: 10.1016/S2352-4642(21)00051-1.

Destrée, L., Brierley, M.E.E., Albertella, L., et al. (2021). The effect of childhood trauma on the severity of obsessive-compulsive symptoms: A systematic review. *Journal of Psychiatric Research*, 142: 345-360. doi: 10.1016/j.jpsychires.2021.08.017.

Dhir, S., Teo, W.P., Chamberlain, S.R., et al. (2021). The Effects of Combined Physical and Cognitive Training on Inhibitory Control: A Systematic Review and Meta-Analysis. *Neuroscience and Biobehavioral Reviews*, 128: 735-748. doi: 10.1016/j.neubiorev.2021.07.008.

Enticott, P.G., Barlow, K., Guastella, A.J., et al. (2021). Repetitive transcranial magnetic stimulation (rTMS) in autism spectrum disorder: Protocol for a multicentre randomised controlled clinical trial. *BMJ Open*, 11(7). doi: 10.1136/bmjopen-2020-046830.

Ferreira, G.M., Lee, R.S.C., Piquet-Pessôa, M., et al. (2021). Habitual versus affective motivations in obsessive-compulsive disorder and alcohol use disorder. *CNS Spectrums*, 26(3): 243-250. doi: 10.1017/S1092852919001706.

Fontenelle, L.F., Albertella, L., Brierley, M.E., et al. (2021). Correlates of obsessive-compulsive and related disorders symptom severity during the COVID-19 pandemic. *Journal of Psychiatric Research*, 143: 471-480. doi: 10.1016/j.jpsychires.2021.03.046.

Fontenelle, L.F., Destrée, L., Brierley, M.E., et al. (2021). Are different stressful or traumatic life events related to types of obsessive-compulsive and related disorders? An online study. *Journal of Affective Disorders Reports*, 5. doi: 10.1016/j.jadr.2021.100170.

Fontenelle, L.F., Destrée, L., Brierley, M.E., et al. (2021). The place of obsessive-compulsive and related disorders in the compulsive-impulsive spectrum: A cluster-analytic study. *CNS Spectrums*. doi: 10.1017/S109285292100033X.

Ganbold, O., Matsui, Y., Rotaru, K. (2021). Effect of information technology-enabled supply chain integration on firm's operational performance. *Journal of Enterprise Information Management*, 34(3): 948-989. doi: 10.1108/JEIM-10-2019-0332.

Grace, S., Rossetti, M.G., Allen, N., et al. (2021). Sex differences in the neuroanatomy of alcohol dependence: hippocampus and amygdala subregions in a sample of 966 people from the ENIGMA Addiction Working Group. *Translational Psychiatry*, 11(1). doi: 10.1038/s41398-021-01204-1.

Hartmann, J.A., McGorry, P.D., Destree, L., et al. (2021). Pluripotential Risk and Clinical Staging: Theoretical Considerations and Preliminary Data From a Transdiagnostic Risk Identification Approach. *Frontiers in Psychiatry*, 11. doi: 10.3389/fpsyt.2020.553578.

Hendrikse, J., Thompson, S., Suo, C., et al. (2021). The effects of multi-day rTMS and cardiorespiratory fitness on working memory and local GABA concentration. *Neuroimage: Reports*, 1(4): 100049. doi: https://doi.org/10.1016/j.ynirp.2021.100049.

Hook, R.W., Grant, J.E., Ioannidis, K., et al. (2021). Trans-diagnostic measurement of impulsivity and compulsivity: A review of self-report tools. *Neuroscience and Biobehavioral Reviews*, 120: 455-469. doi: 10.1016/j.neubiorev.2020.10.007.

Ince, C., Yücel, M., Albertella, L., et al. (2021). Exploring the clinical profile of problematic pornography use. *CNS Spectrums*, 26(6): 648-657. doi: 10.1017/S1092852920001686.

Liu, C., Rotaru, K., Lee, R.S.C., et al. (2021). Distress-driven impulsivity interacts with cognitive inflexibility to determine addiction-like eating. *J Behav Addict*, 10(3): 534-9. doi: 10.1556/2006.2021.00027.

Liu, C., Yücel, M., Suo, C., et al. (2021). Reward-Related Attentional Capture Moderates the Association between Fear-Driven Motives and Heavy Drinking. *European Addiction Research*, 27(5): 351-361. doi: 10.1159/000513470.

Lorenzetti, V., Takagi, M., van Dalen, Y., et al. (2021). Investigating the Residual Effects of Chronic Cannabis Use and Abstinence on Verbal and Visuospatial Learning. *Frontiers in Psychiatry*, 12. doi: 10.3389/fpsyt.2021.663701.

Ottino-González, J., Garavan, H., Albaugh, M.D., et al. (2021). Brain structural covariance network differences in adults with alcohol dependence and heavy-drinking adolescents. *Addiction*. doi: 10.1111/add.15772.

Rakesh, D., Lv, J., Zalesky, A., et al. (2021). Altered resting functional connectivity patterns associated with problematic substance use and substance use disorders during adolescence. *Journal of Affective Disorders*, 279: 599-608. doi: 10.1016/j.jad.2020.10.051.

Romero-Garcia, R., Hook, R.W., Tiego, J., et al. (2021). Brain micro-architecture and disinhibition: a latent phenotyping study across 33 impulsive and compulsive behaviours. *Neuropsychopharmacology*, 46(2): 423-431. doi: 10.1038/s41386-020-00848-9.

Rossetti, M.G., Mackey, S., Patalay, P., et al. (2021). Sex and dependence related neuroanatomical differences in regular cannabis users: findings from the ENIGMA Addiction Working Group. *Translational Psychiatry*, 11(1). doi: 10.1038/s41398-021-01382-y.

Rossetti, M.G., Patalay, P., Mackey, S., et al. (2021). Gender-related neuroanatomical differences in alcohol dependence: findings from the ENIGMA Addiction Working Group. *NeuroImage: Clinical*, 30. doi: 10.1016/j.nicl.2021.102636.

Rotaru, K., Kalev, P.S., Yadav, N., et al. (2021). Transferring cognitive talent across domains to reduce the disposition effect in investment. *Scientific Reports,* 11(1). doi: 10.1038/s41598-021-02596-2.

Sghirripa, S., Graetz, L., Merkin, A., et al. (2021). The Role of Alpha Power in the Suppression of Anticipated Distractors During Verbal Working Memory. *Brain Topography*, 34(1): 102-109. doi: 10.1007/s10548-020-00810-4.

Sghirripa, S., Graetz, L., Merkin, A., et al. (2021). Load-dependent modulation of alpha oscillations during working memory encoding and retention in young and older adults. *Psychophysiology*, 58(2). doi: 10.1111/psyp.13719.

Tiego, J., Lochner, C., Ioannidis, K., et al. (2021). Measurement of the problematic usage of the Internet unidimensional quasitrait continuum with item response theory. *Psychological Assessment*, 33(7): 652-671. doi: 10.1037/pas0000870.

Verveer, I., Hill, A.T., Franken, I.H.A., et al. (2021). Modulation of control: Can HD-tDCS targeting the dACC reduce impulsivity? *Brain Research*, 1756. doi: 10.1016/j.brainres.2021.147282.

Wilson, M.T., Moezzi, B., Rogasch, N.C. (2021). Modeling motor-evoked potentials from neural field simulations of transcranial magnetic stimulation. *Clinical Neurophysiology*, 132(2): 412-428. doi: 10.1016/j.clinph.2020.10.032.

Yücel, M., Lee, R.S.C., Fontenelle, L.F. (2021). A New Consensus Framework for Phenotyping and Treatment Selecting in Addiction and Obsessive-Compulsive-Related Disorders. *JAMA Psychiatry*, 78(7): 699-700. doi: 10.1001/jamapsychiatry.2021.0243.

Zhang, X., Chye, Y., Braganza, L., et al. (2021). Severity related neuroanatomical alteration across symptom dimensions in obsessive-compulsive disorder. *Journal of Affective Disorders Reports*, 4. doi: 10.1016/j.jadr.2021.100129.

Neural systems and behaviour lab publications

Arenella, M., Cadby, G., De Witte, W., et al. (2021). Potential role for immune-related genes in autism spectrum disorders: Evidence from genome-wide association meta-analysis of autistic traits. *Autism*, In press. doi: 10.1177/13623613211019547.

Arnatkeviciute, A., Fulcher, B.D., Bellgrove, M.A., et al. (2021). Where the genome meets the connectome: Understanding how genes shape human brain connectivity. *NeuroImage,* 244. doi: 10.1016/j.neuroimage.2021.118570.

Arnatkeviciute, A., Fulcher, B.D., Bellgrove, M.A., et al. (2021). Imaging Transcriptomics of Brain Disorders. *Biological Psychiatry Global Open Science*. doi: https://doi.org/10.1016/j.bpsgos.2021.10.002.

Arnatkeviciute, A., Fulcher, B.D., Oldham, S., et al. (2021). Genetic influences on hub connectivity of the human connectome. *Nature Communications*, 12(1). doi: 10.1038/s41467-021-24306-2.

Biabani, M., Fornito, A., Coxon, J.P., et al. (2021). The correspondence between EMG and EEG measures of changes in cortical excitability following transcranial magnetic stimulation. *Journal of Physiology,* 599(11): 2907-2932. doi: 10.1113/JP280966.

Chopra, S., Fornito, A., Francey, S.M., et al. (2021). Differentiating the effect of antipsychotic medication and illness on brain volume reductions in first-episode psychosis: A Longitudinal, Randomised, Triple-blind, Placebo-controlled MRI Study. *Neuropsychopharmacology*, 46(8): 1494-1501. doi: 10.1038/s41386-021-00980-0.

Chopra, S., Francey, S.M., O'Donoghue, B., et al. (2021). Functional Connectivity in Antipsychotic-Treated and Antipsychotic-Naive Patients with First-Episode Psychosis and Low Risk of Self-harm or Aggression: A Secondary Analysis of a Randomized Clinical Trial. *JAMA Psychiatry*, 78(9): 994-1004. doi: 10.1001/jamapsychiatry.2021.1422.

Conway, C.C., Forbes, M.K., South, S.C. (2021). A Hierarchical Taxonomy of Psychopathology (HiTOP) Primer for Mental Health Researchers. *Clin Psychol Sci*, In press. doi: 10.1177/21677026211017834.

Deco, G., Kringelbach, M.L., Arnatkeviciute, A., et al. (2021). Dynamical consequences of regional heterogeneity in the brain's transcriptional landscape. *Science Advances*, 7(29). doi: 10.1126/sciadv.abf4752.

Fulcher, B.D., Arnatkeviciute, A., Fornito, A. (2021). Overcoming false-positive gene-category enrichment in the analysis of spatially resolved transcriptomic brain atlas data. *Nature Communications*, 12(1). doi: 10.1038/s41467-021-22862-1.

Kirschner, M., Hodzic-Santor, B., Antoniades, M., et al. (2021). Cortical and subcortical neuroanatomical signatures of schizotypy in 3004 individuals assessed in a worldwide ENIGMA study. *Molecular Psychiatry*, In press. doi: 10.1038/s41380-021-01359-9.

Klauser, P., Cropley, V.L., Baumann, P.S., et al. (2021). White Matter Alterations between Brain Network Hubs Underlie Processing Speed Impairment in Patients with Schizophrenia. *Schizophrenia Bulletin Open*, 2(1). doi: 10.1093/schizbullopen/sgab033.

Knott, R., Johnson, B.P., Tiego, J., et al. (2021). The Monash Autism-ADHD genetics and neurodevelopment (MAGNET) project design and methodologies: a dimensional approach to understanding neurobiological and genetic aetiology. *Molecular Autism*, 12(1). doi: 10.1186/s13229-021-00457-3.

Lau, H.Y.G., Fornito, A., Fulcher, B.D. (2021). Scaling of gene transcriptional gradients with brain size across mouse development. *NeuroImage*, 224. doi: 10.1016/j.neuroimage.2020.117395.

Markello, R.D., Arnatkevičiūtė, A., Poline, J.B., et al. (2021). Standardizing workflows in imaging transcriptomics with the Abagen toolbox. *eLife*, 10. doi: 10.7554/eLife.72129.

Oldham, S., Ball, G., Fornito, A. (2021). Early and late development of hub connectivity in the human brain. *Current Opinion in Psychology*, In press. doi: 10.1016/j.copsyc.2021.10.010.

Pani, S.M., Sabaroedin, K., Tiego, J., et al. (2021). A multivariate analysis of the association between corticostriatal functional connectivity and psychosis-like experiences in the general community. *Psychiatry Research - Neuroimaging*, 307. doi: 10.1016/j.pscychresns.2020.111202.

Tan, B., Shishegar, R., Poudel, G.R., et al. (2021). Cortical morphometry and neural dysfunction in Huntington's disease: a review. *European Journal of Neurology*, 28(4): 1406-1419. doi: 10.1111/ene.14648.

Than, S., Moran, C., Beare, R., et al. (2021). Interactions between Age, Sex, Menopause, and Brain Structure at Midlife: A UK Biobank Study. *Journal of Clinical Endocrinology and Metabolism*, 106(2): 410-420. doi: 10.1210/clinem/dgaa847.

Thapa, T., Hendrikse, J., Thompson, S., et al. (2021). No evidence for changes in GABA concentration, functional connectivity, or working memory following continuous theta burst stimulation over dorsolateral prefrontal cortex. *Neuroimage: Reports*, 1(4): 100061. doi: https://doi.org/10.1016/j.ynirp.2021.100061.

Whitson, S., O'Donoghue, B., Hester, R., et al. (2021). Cognitive ability and metabolic physical health in first-episode psychosis. *Schizophrenia Research: Cognition*, 24. doi: 10.1016/j.scog.2021.100194.

Yüncü, Z., Cakmak Celik, Z., Colak, C., et al. (2021). Resting state functional connectivity in adolescent synthetic cannabinoid users with and without attention-deficit/hyperactivity disorder. *Human Psychopharmacology*, 36(5). doi: 10.1002/hup.2781.

Monash neuroscience of consciousness lab publications

Andrillon, T., Burns, A., Mackay, T., et al. (2021). Predicting lapses of attention with sleep-like slow waves. *Nature Communications*, 12(1). doi: 10.1038/s41467-021-23890-7.

Daniel, S., Andrillon, T., Tsuchiya, N., et al. (2021). Divided attention in the tactile modality. *Attention, Perception, and Psychophysics*, In press. doi: 10.3758/s13414-021-02352-8.

Haun, A., Tsuchiya, N. (2021). Reasonable criteria for functionalists; scarce criteria from phenomenological perspective. *Cognitive Neuroscience*, 12(2): 95-96. doi: 10.1080/17588928.2020.1838473.

Ishizu, K., Shiramatsu, T.I., Hitsuyu, R., et al. (2021). Information flow in the rat thalamo-cortical system: spontaneous vs. stimulus-evoked activities. *Scientific Reports*, 11(1). doi: 10.1038/s41598-021-98660-y.

Kawashima, Y., Li, R., Chen, S.C.Y., et al. (2021). Steady state evoked potential (SSEP) responses in the primary and secondary somatosensory cortices of anesthetized cats: Nonlinearity characterized by harmonic and intermodulation frequencies. *PLoS ONE*, 16(3 March). doi: 10.1371/journal.pone.0240147.

Leung, A., Cohen, D., Van Swinderen, B., et al. (2021). Integrated information structure collapses with anesthetic loss of conscious arousal in Drosophila melanogaster. *PLoS Computational Biology*, 17(2). doi: 10.1371/JOURNAL.PCBI.1008722.

Maier, A., Tsuchiya, N. (2021). Growing evidence for separate neural mechanisms for attention and consciousness. *Attention, Perception, and Psychophysics*, 83(2): 558-576. doi: 10.3758/s13414-020-02146-4.

Quettier, T., Gambarota, F., Tsuchiya, N., et al. (2021). Blocking facial mimicry during binocular rivalry modulates visual awareness of faces with a neutral expression. *Scientific Reports*, 11(1). doi: 10.1038/s41598-021-89355-5.

Shehata, M., Cheng, M., Leung, A., et al. (2021). Team flow is a unique brain state associated with enhanced information integration and interbrain synchrony. *eNeuro,* 8(5). doi: 10.1523/ENEURO.0133-21.2021.

Tsuchiya, N., Saigo, H. (2021). A relational approach to consciousness: Categories of level and contents of consciousness. *Neuroscience of Consciousness*, 2021(2). doi: 10.1093/nc/niab034.

Cognitive neuroimaging lab publications

Christensen, E.L., Harding, I.H., Voigt, K., et al. (2021). Neural underpinnings of food choice and consumption in obesity. *International Journal of Obesity*, 46(1): 194-201. doi: 10.1038/s41366-021-00974-4.

Harper-Hill, K., Wilson, W., Armstrong, R., et al. (2021). Sound amplification in school contexts: Implications for inclusive practice, in *Supporting Students on the Autism Spectrum in Inclusive Schools: A Practical Guide to Implementing Evidence-Based Approaches*, S. Carrington., B. Saggers., K. Harper-Hill., M Whelan (Eds), London: Taylor and Francis p. 88-103.

Jamadar, S.D., Ward, P.G.D., Liang, E.X., et al. (2021). Corrigendum to: Metabolic and Hemodynamic Resting-State Connectivity of the Human Brain: A High-Temporal Resolution Simultaneous BOLD-fMRI and FDG-fPET Multimodality Study. *Cerebral cortex* (New York, N.Y. : 1991), 31(8): 3973. doi: 10.1093/cercor/bhab170.

Jamadar, S.D., Ward, P.G.D., Liang, E.X., et al. (2021). Metabolic and Hemodynamic Resting-State Connectivity of the Human Brain: A High-Temporal Resolution Simultaneous BOLD-fMRI and FDG-fPET Multimodality Study. *Cerebral cortex* (New York, N.Y. : 1991), 31(6): 2855-2867. doi: 10.1093/cercor/bhaa393.

Maron, D.N., Bowe, S.J., Spencer-Smith, M., et al. (2021). Oculomotor deficits in attention deficit hyperactivity disorder (ADHD): A systematic review and comprehensive meta-analysis. *Neuroscience and Biobehavioral Reviews*, 131: 1198-1213. doi: 10.1016/j.neubiorev.2021.10.012.

McGlashan, E.M., Poudel, G.R., Jamadar, S.D., et al. (2021). Afraid of the dark: Light acutely suppresses activity in the human amygdala. *PLoS ONE*, 16(6 June 2021). doi: 10.1371/journal.pone.0252350.

Orchard, E.R., Ward, P.G.D., Chopra, S., et al. (2021). Neuroprotective Effects of Motherhood on Brain Function in Late Life: A Resting-State fMRI Study. *Cerebral Cortex*, 31(2): 1270-1283. doi: 10.1093/cercor/bhaa293.

Perrykkad, K., Lawson, R.P., Jamadar, S., et al. (2021). The effect of uncertainty on prediction error in the action perception loop. *Cognition*, 210. doi: 10.1016/j.cognition.2021.104598.

Pietzuch, M., Bindoff, A., Jamadar, S., et al. (2021). Interactive effects of the APOE and BDNF polymorphisms on functional brain connectivity: the Tasmanian Healthy Brain Project. *Scientific Reports*, 11(1). doi: 10.1038/s41598-021-93610-0.

Sasan, D., Ward, P.G.D., Nash, M., et al. (2021). "phantom Kicks": Women's Subjective Experience of Fetal Kicks after the Postpartum Period. *Journal of Women's Health*, 30(1): 36-44. doi: 10.1089/jwh.2019.8191.

Verdejo-Garcia, A., Tiego, J., Kakoschke, N., et al. (2021). A unified online test battery for cognitive impulsivity reveals relationships with real-world impulsive behaviours. *Nature Human Behaviour*, 5(11): 1562-1577. doi: 10.1038/s41562-021-01127-3.

Voigt, K., Giddens, E., Stark, R., et al. (2021). The hunger games: Homeostatic state-dependent fluctuations in disinhibition measured with a novel gamified test battery. *Nutrients*, 13(6). doi: 10.3390/nu13062001.

Wilson, W.J., Harper-Hill, K., Armstrong, R., et al. (2021). A preliminary investigation of sound-field amplification as an inclusive classroom adjustment for children with and without Autism Spectrum Disorder. *Journal of Communication Disorders*, 93. doi: 10.1016/j.jcomdis.2021.106142.

Computational and systems neuroscience lab publications

Abeyasinghe, P.M., Long, J.D., Razi, A., et al. (2021). Tracking Huntington's Disease Progression Using Motor, Functional, Cognitive, and Imaging Markers. *Movement Disorders*, 36(10): 2282-2292. doi: 10.1002/mds.28650.

Bajaj, S., Raikes, A.C., Razi, A., et al. (2021). Blue-Light Therapy Strengthens Resting-State Effective Connectivity within Default-Mode Network after Mild TBI. *J Cent Nerv Syst Dis*, 13: 11795735211015076. doi: 10.1177/11795735211015076.

Bian, L., Cui, T., Thomas Yeo, B.T., et al. (2021). Identification of community structure-based brain states and transitions using functional MRI. *NeuroImage*, 244. doi: 10.1016/j.neuroimage.2021.118635.

Friston, K.J., Fagerholm, E.D., Zarghami, T.S., et al. (2021). Parcels and particles: Markov blankets in the brain. *Netw Neurosci*, 5(1): 211-251. doi: 10.1162/netn_a_00175.

Friston, K.J., Parr, T., Zeidman, P., et al. (2021). Second waves, social distancing, and the spread of COVID-19 across the USA. *Wellcome Open Research*, 5. doi: 10.12688/wellcomeopenres.15986.3.

Hidalgo-Lopez, E., Zeidman, P., Harris, T.A., et al. (2021). Spectral dynamic causal modelling in healthy women reveals brain connectivity changes along the menstrual cycle. *Communications Biology*, 4(1). doi: 10.1038/s42003-021-02447-w.

Krylova, M., Skouras, S., Razi, A., et al. (2021). Progressive modulation of resting-state brain activity during neurofeedback of positive-social emotion regulation networks. *Scientific Reports*, 11(1). doi: 10.1038/s41598-021-02079-4.

Paul, A., Sajid, N., Gopalkrishnan, M., et al., (2021). Active Inference for Stochastic Control, in *Communications in Computer and Information Science*. p. 669-680.

Rasheed, K., Qadir, J., O'Brien, T.J., et al. (2021). A Generative Model to Synthesize EEG Data for Epileptic Seizure Prediction. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 29: 2322-2332. doi: 10.1109/TNSRE.2021.3125023.

Rasheed, K., Qayyum, A., Qadir, J., et al. (2021). Machine Learning for Predicting Epileptic Seizures Using EEG Signals: A Review. *IEEE Reviews in Biomedical Engineering*, 14: 139-155. doi: 10.1109/RBME.2020.3008792.

Voigt, K., Razi, A., Harding, I.H., et al. (2021). Neural network modelling reveals changes in directional connectivity between cortical and hypothalamic regions with increased BMI. *International Journal of Obesity*, 45(11): 2447-2454. doi: 10.1038/s41366-021-00918-y.

Mechanisms of neurodegeneration lab publications

Glikmann-Johnston, Y., Mercieca, E.C., Carmichael, A.M., et al. (2021). Hippocampal and striatal volumes correlate with spatial memory impairment in Huntington's disease. *Journal of Neuroscience Research*, 99(11): 2948-2963. doi: 10.1002/jnr.24966.

Harding, I.H., Chopra, S., Arrigoni, F., et al. (2021). Brain Structure and Degeneration Staging in Friedreich Ataxia: Magnetic Resonance Imaging Volumetrics from the ENIGMA-Ataxia Working Group. *Annals of Neurology*, 90(4): 570-583. doi: 10.1002/ana.26200.

Hernandez-Castillo, C.R., Diaz, R., Rezende, T.J.R., et al. (2021). Cervical spinal cord degeneration in spinocerebellar ataxia type 7. *American Journal of Neuroradiology*, 42(9): 1735-1739. doi: 10.3174/ajnr.A7202.

Selvadurai, L.P., Georgiou-Karistianis, N., Shishegar, R., et al. (2021). Longitudinal structural brain changes in Friedreich ataxia depend on disease severity: the IMAGE-FRDA study. *Journal of Neurology*, 268(11): 4178-4189. doi: 10.1007/s00415-021-10512-x.

Vivash, L., Bertram, K.L., Malpas, C.B., et al. (2021). Sodium selenate as a disease-modifying treatment for progressive supranuclear palsy: Protocol for a phase 2, randomised, double-blind, placebo-controlled trial. *BMJ Open*, 11(12). doi: 10.1136/bmjopen-2021-055019.

Neuroscience and society group publications

Barnett, A., Savic, M., Pienaar, K., et al. (2021). Enacting 'more-than-human' care: Clients' and counsellors' views on the multiple affordances of chatbots in alcohol and other drug counselling. *International Journal of Drug Policy*, 94. doi: 10.1016/j.drugpo.2020.102910.

Butorac, I., Carter, A. (2021). The Coercive Potential of Digital Mental Health. *American Journal of Bioethics*, 21(7): 28-30. doi: 10.1080/15265161.2021.1926582.

Haines, S., Savic, M., Nielsen, S., et al. (2021). Key considerations for the implementation of clinically focused Prescription Drug Monitoring Programs to avoid unintended consequences. *International Journal of Drug Policy*, In press. doi: 10.1016/j.drugpo.2021.103549.

Hall, W., Carter, A. (2021). Drug Legalization is Not a Masterstroke for Addressing Racial Inequality. *American Journal of Bioethics*, 21(4): 44-46. doi: 10.1080/15265161.2021.1892867.

Higgins, N., Gardner, J., Carter, A. (2021). Recognizing a Plurality of Industry Perspectives in the Responsible Innovation of Neurotechnologies. *AJOB Neuroscience*, In press. doi: 10.1080/21507740.2021.2001084.

Moreira-de-Oliveira, M.E., de Menezes, G.B., dos Santos-Ribeiro, S., et al. (2021). Are mental disorders related to disbelief in free will? *A systematic review. Systematic Reviews*, 10(1). doi: 10.1186/s13643-021-01621-9.

Morphett, K., Puljević, C., Borland, R., et al. (2021). Attitudes towards a hypothetical 'clean nicotine' product and harm reduction among smokers. *International Journal of Drug Policy*, 88. doi: 10.1016/j.drugpo.2020.103020.

Mosley, P.E., Robinson, K., Coyne, T., et al. (2021). 'Woe Betides Anybody Who Tries to Turn me Down.' A Qualitative Analysis of Neuropsychiatric Symptoms Following Subthalamic Deep Brain Stimulation for Parkinson's Disease. *Neuroethics*, 14: 47-63. doi: 10.1007/s12152-019-09410-x.

Picco, L., Lam, T., Haines, S., et al. (2021). How prescription drug monitoring programs influence clinical decision-making: A mixed methods systematic review and meta-analysis. *Drug Alcohol Depend*, 228: 109090. doi: 10.1016/j.drugalcdep.2021.109090.

Santiago, V.A., Cassin, S.E., Sockalingam, S., et al. (2021). Food Addiction and Policy, in Handbook of Substance Misuse and Addictions: From *Biology to Public Health*, V.B. Patel., V.R. Preedy (Eds). Cham: Springer International Publishing. p. 1-23.

Slack, S.K. (2021). Is Health-Related Digital Autonomy Setting the Autonomy Bar Too High? *Am J Bioeth*, 21(7): 40-42. doi: 10.1080/15265161.2021.1926584.

Thomson, C.J., Segrave, R.A., Carter, A. (2021). Changes in Personality Associated with Deep Brain Stimulation: a Qualitative Evaluation of Clinician Perspectives. *Neuroethics*, 14: 109-124. doi: 10.1007/s12152-019-09419-2.

Thomson, C.J., Segrave, R.A., Carter, A. (2021). Informed Consent and Voluntariness: Balancing Ethical Demands During Trial Recruitment. *AJOB Neuroscience*, 12(1): 83-85. doi: 10.1080/21507740.2020.1867667.

Thomson, C.J., Segrave, R.A., Fitzgerald, P.B., et al. (2021). "Nothing to Lose, Absolutely Everything to Gain": Patient and Caregiver Expectations and Subjective Outcomes of Deep Brain Stimulation for Treatment-Resistant Depression. *Frontiers in Human Neuroscience*, 15. doi: 10.3389/fnhum.2021.755276.

Vandenberg, B., Livingstone, C., Carter, A., et al. (2021). Gambling and homelessness in older adults: a qualitative investigation. *Addiction*, In press. doi: 10.1111/add.15756.

Vandenberg, B., Livingstone, C., Carter, A., et al. (2021). Gambling and homelessness: A systematic review and meta-analysis of prevalence. *Addictive Behaviors*, In press. doi: 10.1016/j.addbeh.2021.107151.

Whatnall, M., Skinner, J., Verdejo-Garcia, A., et al. (2021). Symptoms of addictive eating: What do different health professions think? *Behavioral Sciences*, 11(5). doi: 10.3390/bs11050060.

Whyman, T., Adams, K., Carter, A., et al. (2021). Lateral violence in Indigenous peoples. *Australian Psychologist*, 56(1): 1-14. doi: 10.1080/00050067.2021.1893595.

Whyman, T., Murrup-Stewart, C., Young, M., et al. (2021). 'Lateral violence stems from the colonial system': settler-colonialism and lateral violence in Aboriginal Australians. *Postcolonial Studies*. doi: 10.1080/13688790.2021.2009213.

Clinical psychedelic research lab publications

Coomber, K., Mayshak, R., Liknaitzky, P., et al. (2021). The Role of Illicit Drug Use in Family and Domestic Violence in Australia. *Journal of Interpersonal Violence*, 36(15-16): NP8247-NP8267. doi: 10.1177/0886260519843288.

Payne, J.E., Chambers, R., Liknaitzky, P. (2021). Combining Psychedelic and Mindfulness Interventions: Synergies to Inform Clinical Practice. *ACS Pharmacology and Translational Science*, 4(2): 416-423. doi: 10.1021/acsptsci.1c00034.

Perkins, D., Sarris, J., Rossell, S., et al. (2021). Medicinal psychedelics for mental health and addiction: Advancing research of an emerging paradigm. *Australian and New Zealand Journal of Psychiatry*, 55(12): 1127-1133. doi: 10.1177/0004867421998785.

Polito, V., Liknaitzky, P. (2021). The emerging science of microdosing: A systematic review of research on low dose psychedelics (1955–2021) and recommendations for the field. *Neuroscience and Biobehavioral Reviews*, In press. doi: 10.1016/j.neubiorev.2022.104706.

Sharman, S.J., Coomber, K., Mayshak, R., et al. (2021). Situational Characteristics Uniquely Associated With Children's Exposure to Intimate Partner Violence. *Journal of Interpersonal Violence*, 36(19-20): NP11087-NP11105. doi: 10.1177/0886260519881006.

Staiger, P.K., Liknaitzky, P. (2021). An alternative goal-setting technique for addictive behaviour interventions: The Chronos Approach. *Clinical Psychologist*, 25(2): 124-130. doi: 10.1080/13284207.2021.1923129.

Williams, M.L., Korevaar, D., Harvey, R., et al. (2021). Translating Psychedelic Therapies From Clinical Trials to Community Clinics: Building Bridges and Addressing Potential Challenges Ahead. *Frontiers in Psychiatry*, 12. doi: 10.3389/fpsyt.2021.737738.

2021 GRANTS

MBI grants

Bachmann, M., Egan, G.F., Kopka, K., et al. (2021-2025). MHELTHERA - Monash Helmholtz Theranostics Joint International Laboratory. Helmholtz Association (Germany), $2,430,000.

Bourne, J., Leopold, D., Egan, G.F. (2018-2021). The pulvinar drives visual cortical development and plasticity in early life. NHMRC Project Grant, $1,230,780.

Chen, Z., Egan, G.E., Law, M., et al. (2021-2024). Biophysics informed deep learning framework for magnetic resonance imaging. ARC Discovery Project, $518,700.

Chen, Z., Egan, G.E., Bath, M., et al. (2022-2024). National Mobile MR network using Federated Learning. National Imaging Facility 2018RIIP fund, $1,575,099.

Coxon, J., Egan, G. F., Bellgrove, M., et al. (2022). NeuroFUS: transcranial focused ultrasound neuromodulation system. NHMRC Equipment Grant, $142,000.

Egan, G.F., Bansal, V., Wood, B., et al. (2022). Near Infrared fluorescence and photoacoustic imaging facility. ARC Large Equipment Grant, $699,691.

Egan, G.F., de Veer, M., Puttick, S., et al. (2020-2022). Developing more effective targeted therapy for high grade glioma with MR guided focussed ultrasound. CSRIO, $254,550.

Egan, G.E., Jamadar, S.D., Chen, Z., et al. (2018-2022). Simultaneous to synergistic MR-PET: integrative brain imaging technologies. ARC Linkage Project, $673,460.

Egan, G. F., Johnston, L., Jackson, G., et al. (2021-2022). Victorian biomedical imaging capability. Victorian Government (VHESIF), $5,197,500.

Galloway, G., Egan, G. F., et al. (2019-2022). Capital expenditure for the National Imaging Facility. National Collaborative Research Infrastructure Scheme (NCRIS), $5,197,500.

Galloway, G., Egan, G. F., et al. (2019-2023). Operational expenditure for the National Imaging Facility. National Collaborative Research Infrastructure Scheme (NCRIS), $1,627,055.

Hdalik, W., Egan, G.F., Cade, D. (2022-2024). Australian Precision Medicine Enterprise. Modern Manufacturing Initiative (Federal Government), $23,000,000.

Hdalik, W., Egan, G.F., Cade, D. (2022-2024). Australian Precision Medicine Enterprise. Modern Manufacturing Initiative (Victorian Government), $1,900,000.

Holloway, L., Chen, Z. (2021-2023). Australian Cancer Data Network: distributed learning from clinical data. Australian Research Data Commons, $957,859.

BrainPark grants

Lee, R. (2021-2025). To utilise a purpose-built mhealth tool to understand drivers of addiction and to improve treatment engagement and outcomes. Medical Research Future Fund, $645,205.

Myles, D., Yücel, M., & Carter, A. (2020-2022). Do “losses disguised as wins” in Australian pokies cause harm? NSW Responsible Gambling Foundation, $44,000.

Rotaru, K., Sohal, A., Yücel, M., & Albertella, L. (2021). Psychological flexibility and workplace resilience in the Australian aged care workforce. Monash Business School Seed Funding Scheme, $15,000.

Yücel, M., Solowij, N., Coxon, J., Lubman, D., Suo, C., Lee, R. & Segrave, R. (2018-2022). Efficacy of a 3-month aerobic exercise regime for restoring ‘brain health’ in heavy cannabis users. NHMRC Project Grant, $1,209,221.

Yücel, M., Solowij, N., Martin, J. H., & Galettis, P. (2018-2022). Cannabidiol may protect the brain against the harmful effects of marijuana. NHMRC Project Grant, $984,586.

Yücel, M. (2017-2022). Enhancing and integrating addiction neuroscience knowledge with clinical practice, by transforming the approach to assessment and classification of protocols and improving outcomes by using neurocognitive phenotypes for tailored treatments. NHMRC Project Grant, $838,845.

Yücel, M., Albertella, L., Lee, R., Kirkham, R., & Aidman, E. (2020). Cognitive measurement Delphi study. Australian Defence Force, $160,000.

Neural systems and behaviour lab grants

Bellgrove, M., Thiele, A., Chong, T., et al. (2022-2026). Neuropharmacology of decision-making: causal brain network modelling across species. NHMRC Ideas Grant, $2,100,000.

Fornito, A. (2020-2025). A network approach to mapping and modifying brain changes in psychosis. NHMRC Investigator Grant, $2,163,244.

Fornito, A. (2020-2025). Maps, models and modifiers of brain changes in psychosis. NHMRC Fellowship, $715,210

Fornito, A., Deco, G., Aquino, K. M. (2020-2023). A Comprehensive Framework for Modelling the Human Connectome. ARC Discovery Project, $560,517.

Monash neuroscience of consciousness lab grants

Andrillon, T. (2020-2024). Fathoming sleep depth: a novel approach to the understanding and assessing of sleepstate misperception in insomnia. NHMRC Early Career Fellowship, $327,000.

Garrido, M., Tsuchiya, N., Ueli, R., et al. (2018-2021). Multimodal testing for a fast subcortical route for salient visual stimuli. ARC Discovery Project, $414, 792.

Koizumi, A., Tsuchiya, N. (2018-2021). Discovery of the neuronal mechanisms within sensory cortical areas that supports fear memory. Japan Society for the Promotion of Science, 3,510,000 JPY.

Pennartz, C., Olcese, U., Muckli, L., et al. (2021). Pilot studies for the adversarial testing of predictive processing and integrated information theories of consciousness. Templeton World Charity Foundation, $321,845.

Tsuchiya, N. (2021). Online research on consciousness. Sony Computer Science Laboratory, $11,000.

Tsuchiya, N., Fulcher, B., Carter, A., et al. (2020-2024). Integrating theory-guided and data-driven approaches for measuring consciousness. NHMRC Ideas Grant, $1,042,607.

Tsuchiya, N., Oizumi, M., Kawasaki, H., et al. (2020-2021). Neural origins of conscious perception in no-report paradigms. ARC Discovery Project, $314, 286.

Tsuchiya, N., Phillips, Saigo, H. (2020-2022). Consciousness in the physical world. FQXi Foundational Questions Institute, $75,900 USD

Tsuchiya, N., Yamada, Oizumi, M. (2020-2023). Understanding the relationship between the structure of qualia and information. Japan Society for the Promotion of Science, 69,440,000 JPY.

Cognitive neuroimaging lab grants

Jamadar, S.D. (2020-2024). Neural metabolic connectivity in ageing and neurodegeneration. NHMRC Emerging Leader Fellowship, $625,480.

Karayanidis, F., Fabiani, M., Gratton, G., et al. (2020-2022). Linking arterial, brain and cognitive integrity in healthy older adults. ARC Discovery Project, $539,000.

Ward, P. (2020-2024). A connectomic approach to understanding cerebrovascular disease in the elderly. NHMRC Emerging Leader Fellowship, $639,750.

Computational and systems neuroscience lab grants

Murayama, K., Razi, A., Moeller, J., et al (2021-2023). Series of workshops on longitudinal data analysis across disciplines. Joint CIFAR-Jacobs Foundation grant, CAD$50,000.

Razi, A. (2021-2025). Understanding early-stage neurodegeneration using computational modelling. NHMRC Investigator Grant, $624,000.

Razi, A. (2022-2024). CIFAR Azrieli Global Scholars Program, CAD$100,000.

Razi, A., Seth, A., Richards, B., et al. (2022-2024). Towards mechanistic understanding of artificial and biological neural computation of conscious learning. CIFAR Catalyst grant, $106,222

Razi, A., Verdejo-Garcia, A. (2020-2021). Treating obesity with brain stimulation. Monash University Strategic Support Funds, $40,000.

Razi, A., Zalesky, A., Friston, K. (2020-2023). Multiscale and multimodal modelling of brain dynamics. ARC Discovery Project, $525,000.

Mechanisms on neurodegeneration lab

Anderson, C., Zoungas, S., Naismith, S., et al. (2021-2023). Statin Treatment for COVID-19 to Optimise Neurological Recovery (STRONGER) Trial. Medical Research Future Fund COVID19 $2,375,779.

Diciotti, S., Mascalchi, M., Harding, I.H. (2020-2021). Artificial Intelligence for individual profiling and prediction: probing the FractaL dimension of brain MRI in FriEdreich ataXia and SCAs using the ENIGMA-Ataxia international meta-dataset (FLEX-AI). Italian Association for Ataxia, $82,000.

Georgiou-Karistianis, N., Corben, L., Harding, I.H., et al. (2021-2025). A natural history study to TRACK brain and spinal changes in individuals with Friedreich ataxia (TRACK-FA). Friedreich Ataxia Research Alliance and Pharmaceutical Partners $1,972,898.

Harding, I.H. (2020-2021). Investigator-Initiated Collaborative Research, ENIGMA-Ataxia Research Consortium. Takeda Pharmaceuticals (USA), $85,000.

Harding, I.H. (2021). Senior Postdoctoral Fellowship. Monash University, $70,000.

Harding, I.H., Corben, L.A., Delatycki, M.B., et al. (2019- 2021). Neuroinflammation in Friedreich Ataxia: Mechanism, Biomarker, and Therapeutic Target. Friedreich Ataxia Research Alliance (USA), $283,665.

Harding, I.H., Storey, E., Klockgether, T., et al. (2020-2023). Neurodegeneration in Spinocerebellar Ataxias: Biomarkers, Mechanisms, and Variability. NHMRC Ideas Grant, $1,165,360.

Verdejo-Garcia, A., Andrews, Z., Lockie, S., et al. (2019-2022). The Neurocircuitry of Food Choice in Obesity. NHMRC Project Grant, $765,000.

Zoungas, S., McNeil, J., Storey, E., et al. (2019-2023). Prevention of Stroke in Older Australians. The Heart Foundation, $2,768,702.

Zoungas, S., Law, M., Anderson, C., et al. (2021-2026). Clinical trial to determine the effects of statins on cognition: STAREE-Mind. NHMRC Clinical Trial, $2,796,000.

Neuroscience and society group grants

Carter, A. (2017-2021). Translating neuroscience into treatments and public health policies for addictive behaviours. NHMRC Career Development Fellowship, $425,048.

Carter, A. (2020-2021). Do “losses disguised as wins” in Australian pokies cause harm? New South Wales Office of Responsible Gambling, Gambling Capacity Grant and PhD Scholarship, $44,000.

Wright lab grants

Ali, I., Jones, N., O’Brien, T., et al. (2021). Measuring inflammation in brain and blood for predicting risk of post-traumatic epilepsy. US DoD Epilepsy Research Program, $677,949.

Kwan, P., O’Brien, T., Jones, N., et al. (2021). Stratasys Objet30 Pro 3D. NHMRC Equipment Grant, $50,000.

O’Brien, T., Kwan, P., Ali, I., et al. (2020-2021). Testing of the effect of E2730 treatment on multimodality in-vivo biomarkers of GABAergic function in healthy rats and preclinical chronic epilepsy models. Eisai Inc (United States), $1,260,000.

O’Brien, T., Ali, I., Wright, D. (2021). EPIBIOSRX – Project 2 – Preclinical model for antiepileptogenic therapy screening in post-traumatic epilepsy. NIH-NINDS Research Program, $1,738,208

Wright, D., Walker, A., Zamani, A. (2021). The glymphatic system: novel biomarker of disease severity and therapeutic target. FightMND IMPACT Grant, $249,502.

Clinical psychedelic research lab grants

Liknaitzky, P., Sundram, S., Yücel, M. (2020-2023). A Phase 2A randomised double-blind active-placebo-controlled trial to assess the safety and efficacy of psilocybin-assisted psychotherapy for Generalised Anxiety Disorder (Psi-GAD-1). Incannex Healthcare Ltd., $1,577,213.

Liknaitzky, P., Sundram, S., Yücel, M. (2020-2023). MMP-1: An open-label safety and efficacy trial of MDMA-assisted psychotherapy for severe PTSD. Multidisciplinary Association for Psychedelic Studies, $200,000.

COLLABORATIONS & PARTNERSHIPS

Collaborations

VICTORIAN BIOMEDICAL IMAGING CAPABILITY

The Victorian Biomedical Imaging Capability (VBIC) is the peak body for the biomedical research imaging community in Victoria. Current VBIC members include Monash University, The Florey Institute of Neuroscience and Mental Health, the University of Melbourne, Swinburne University, and the Olivia Newton John Cancer Wellness and Research Centre. The business development and management activities of VBIC are undertaken by Neurosciences Victoria. During 2021 VBIC was again prominent in the promotion of biomedical imaging research within Victoria with the VBIC Annual Network meeting held virtually in November with over 150 attendees. The meeting focused on major research programs in medical imaging including stroke and epilepsy, an innovation in imaging research session with presentations from VBIC member organisations, and an industry and commercialisation panel with national and international industry partners.

NATIONAL IMAGING FACILITY

The National Imaging Facility (NIF) was established in 2007 with funding from the National Collaborative Research Infrastructure Scheme (NCRIS) and is the peak imaging research infrastructure network across Australia. Monash University is one of the 13 nodes of the Facility and as a member of NIF provides access to the MBI and ARA-MBI biomedical imaging facilities to researchers across Australia. NCRIS funding was received by the National Imaging Facility for the period 2018-23 to expand and strengthen the national imaging research infrastructure. During 2021 Monash received funding to establish the national low field mobile MR network, incorporate focused ultrasound into the technical capabilities of the ultra-high field small animal MR scanner at ARA-MBI, and further expand the radiochemistry facilities at MBI.

MONASH HEALTH

Clinical imaging staffing arrangements at MBI are undertaken in partnership with Monash Health. During 2021 Monash Health provided radiographers and nuclear medicine technologists to operate the clinical MRI and MR-PET scanners at MBI. Monash Health staff also provide research support to users from industry in addition to users from tertiary and research institutions.

ALFRED HEALTH

The clinical neurosciences research imaging collaboration between MBI and the Departments of Medical Imaging and Clinical Neurosciences at the Alfred Hospital have continued during 2021. The partnership includes the University of Southern California, Los Angeles and the ARC Centre of Excellence for Integrative Brain Function. The objectives of the partnership are to facilitate the exchange for research utilisation of medical images between campuses of Monash University, to advance the use of artificial intelligence technologies for the reconstruction and analysis of biomedical images, and to establish a platform for the integration of medical imaging across the University.

JULICH FORSCHUNGSZENTRUM, GERMANY

MBI has a long-standing collaboration with Jülich Forschungszentrum (FZJ), Germany in the field of hybrid MR-PET imaging. FZJ leads a Helmholtz innovation Fund project to develop a next generation BrainPET scanner for ultrahigh field 7 Tesla MR-PET imaging of the human brain. The Helmholtz Validation Fund project progressed through the final assembly and testing stages, with the first images demonstrating that the scanner will achieve PET images with sub-2mm spatial resolution. Scientists and engineers from the MBI Image Analysis team had responsibility for the PET attenuation and motion correction algorithms required for the integrated system. The project was successfully completed at the end of 2021 with the first human brain scans planned for 2023.

HELMHOLTZ ZENTRUM DRESDEN ROSENDORF (HZDR)

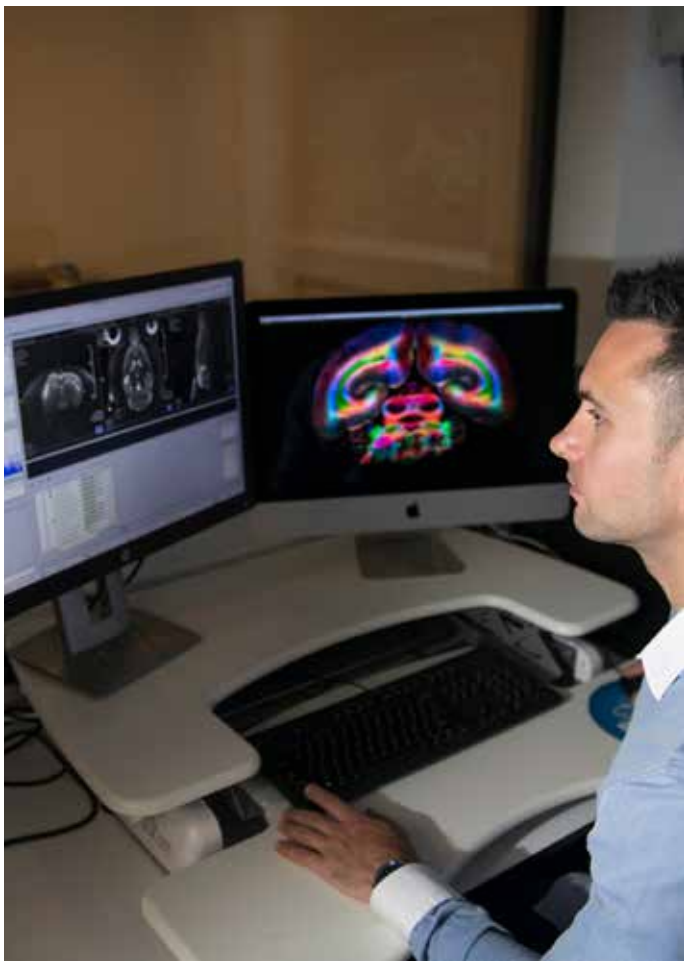
Monash University and the Helmholtz Zentrum Dresden Rosendorf (HZDR) have collaborated in chemistry research over the past 15 years. The two institutions have a long standing and successful collaborative research in the development of radiopharmaceuticals. A Joint international laboratory was established between Monash and HZDR in 2021 to undertake research into ultrasmall nanomaterials for imaging, immunotherapeutics based on antibodies, recombinant derivatives thereof, and cellular therapies based on immune effector cells. The current research focus includes the development and clinical translation of switchable cellular radio-immuno-theranostics for imaging and treatment of tumours and future applications in cardiovascular disease.

CSIRO

The collaborative research between MBI and CSIRO researchers continued during 2021. The MR guided focused ultrasound instrument provided by CSIRO has enabled focused ultrasound pulses in animal models of brain cancer to be used in conjunction with the preclinical MR scanner at Clayton. The technology has been demonstrated to open the blood brain barrier for the delivery of blood borne therapeutic drugs into the brain in experimental models. The state of the art MR imaging and guided focused ultrasound capability is now available to researchers on request.

ARC CENTRE OF EXCELLENCE FOR INTEGRATIVE BRAIN FUNCTION

Led by Monash University, the aim of the Australian Research Council Centre of Excellence for Integrative Brain Function (Brain Function CoE) was to understand one of the greatest scientific challenges of our time - understanding the link between brain activity and human behavior. Centre researchers undertook fundamental investigations into the principles of brain structure and function that underlie attention, prediction and decision-making, and other complex brain functions. The world class research imaging facilities at MBI provided the opportunity for MBI-based researchers to collaborate with Centre researchers in a unique program investigating how the brain interacts with the world.



Partnerships

SIEMENS

Monash University and Siemens Healthcare established a research collaboration agreement in 2010 to support the establishment of biomedical imaging research infrastructure at Monash. The agreement enables Monash scientists to access pre-commercial MR, PET and CT imaging technologies that provide opportunities for Monash researchers to undertake innovative studies using novel advanced techniques. An ARC Linkage Project grant to develop software technologies for joint MR-PET image reconstruction and modelling was funded to commence in 2019 and has resulted in more than ten joint publications and presentations at international conferences.

BRUKER

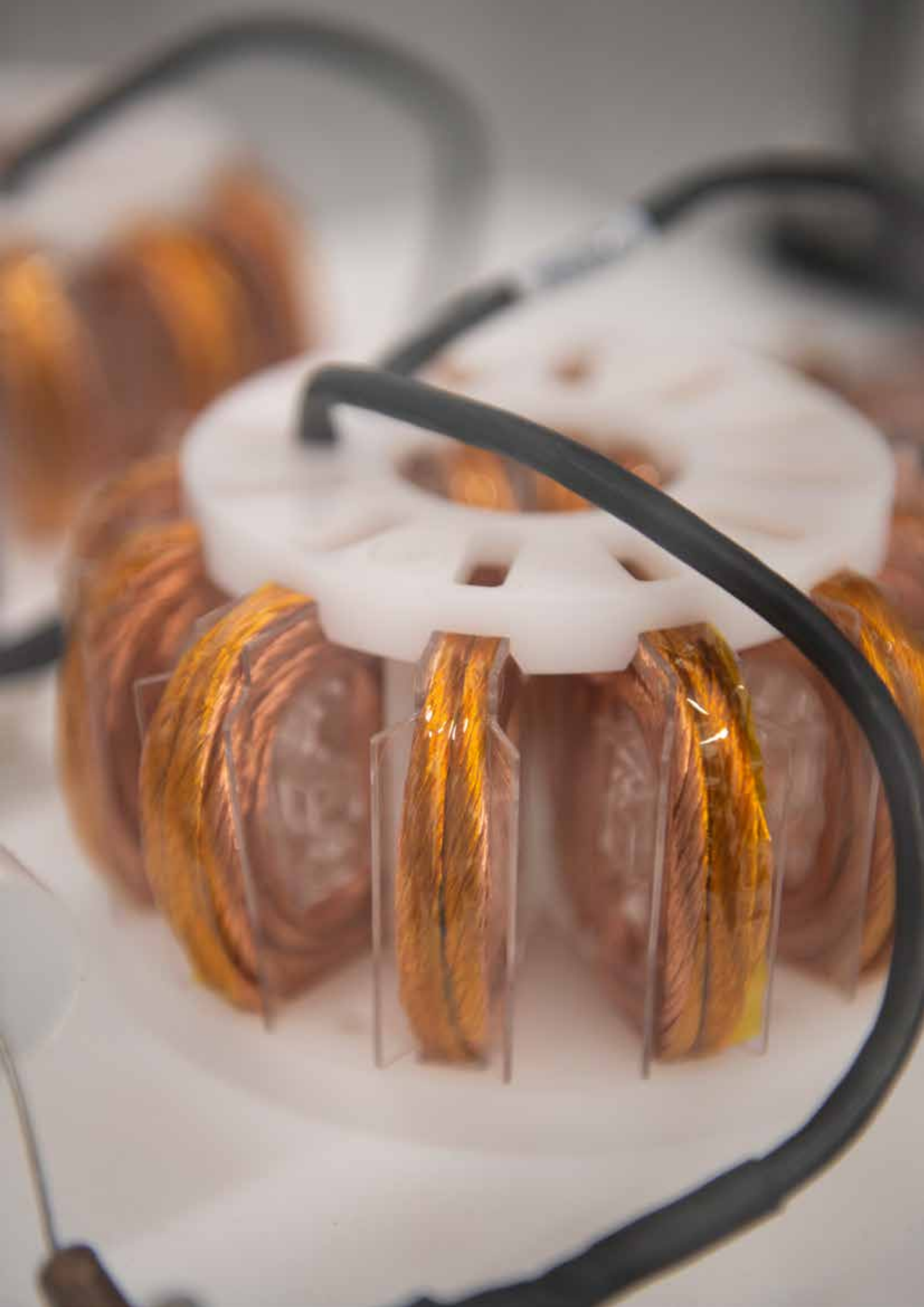
The Bruker 9.4T small animal MRI scanners at the ARA-MBI and Clayton nodes were fully operational during 2021. Importantly, Bruker has reaffirmed their commitment to the provision of comprehensive local and international support to ensure optimal utilisation of the advanced preclinical MR imaging technologies, including cryocoil technology that provides significant signal to noise improvement for ultrahigh high contrast imaging applications

MEDISO

The preclinical PET-CT scanner at the ARA-MBI node provides high-sensitivity, high-resolution PET-CT imaging to support applications in neuroscience, cardiovascular, oncology and infectious disease research applications. The PET-CT scanner was supplied by Mediso Medical Imaging Systems, Hungary and installed with a universal animal handling platform for large axial field of-view imaging to allow rapid scanning and reconstruction of up to four mice concurrently. Plans are underway to procure a second Mediso preclinical PET-CT scanner for the Clayton node, and concurrently establish a collaboration agreement in molecular imaging between Mediso and Monash University.

MAGNETIC INSIGHT

The first Magnetic Particle Imaging (MPI) Facility in Victoria was opened at the ARA-MBI node in mid 2021 following a successful grant application to the Australian Research Council in 2019. MPI is a breakthrough technology with applications in the fields of cell tracking, material science and biotechnology. The MPI scanner was provided by Magnetic Insight, USA and promises to contribute to the generation of new knowledge in the nanotechnology, molecular imaging and industrial biosciences research sectors.



GROUP OF EIGHT AUSTRALIA

MONASH BIOMEDICAL IMAGING

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