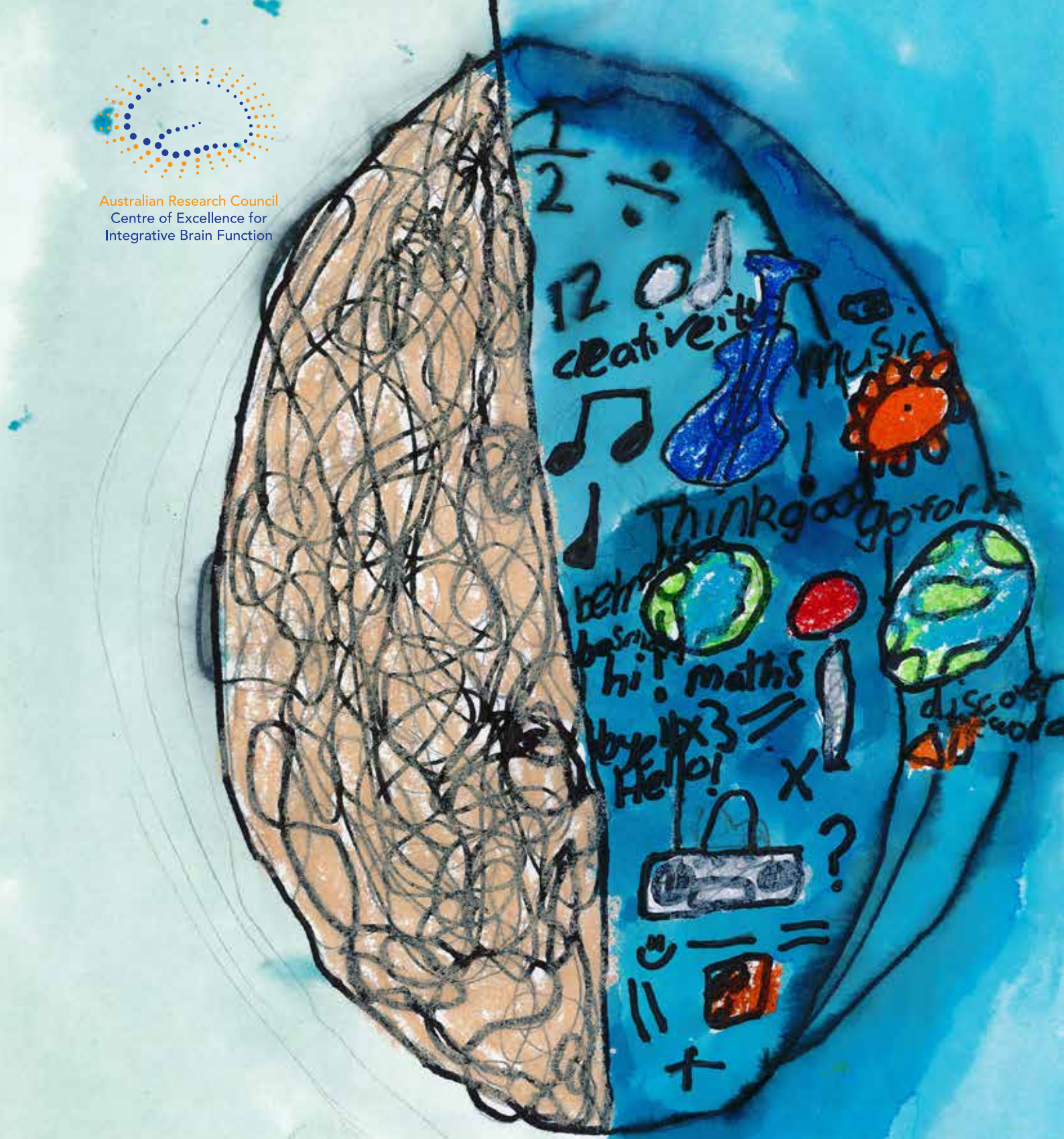
Australian Research Council
Centre of Excellence for
Integrative Brain Function



ANNUAL REPORT 2017

ARC CENTRE OF EXCELLENCE FOR INTEGRATIVE BRAIN FUNCTION

Cover image: Art Competition Category 2, 3rd place by Gabby, age 7

COLLABORATING, PARTNER AND AFFILIATE ORGANISATIONS

Collaborating organisations

Partner organisations

Affiliate organisations

The ARC Centre of Excellence for Integrative Brain Function

Annual Report 2017

Contents

INTRODUCTION

About the Centre

Understanding how the brain interacts with the world is one of the greatest challenges of the 21st century. To address this challenge, brain researchers from around the country, with expertise across multiple disciplines have joined forces to establish the ARC Centre of Excellence for Integrative Brain Function (Brain Function CoE). The Centre has developed an integrated research program aimed at studying the brain across a multitude of spatial and temporal scales. By integrating research across scales and disciplines, the outcomes of the Centre will provide a more comprehensive understanding of how the brain functions as a whole.

The Centre's research has focused on understanding how the brain integrates information at multiple scales, from nerve cell electrical and biochemical activity through patterns of activity in large scale circuit networks to yield complex behaviour in the three key daily-life functions of attention, prediction, and decision behaviour. In parallel, Centre researchers are developing powerful predictive models of processes at each of the different scales to feed into the development of novel neural technologies for patentable devices and software.

Beyond research outcomes, the Centre has a commitment to maximise its influence, by disseminating research achievements and fostering discussion of emerging issues with stakeholders, both within academia and across the broader public sphere. In addition, the Centre is fostering a community of scholars by mentoring future research leaders skilled in this multi-disciplinary approach that will meld neuroscience, physics, and engineering.

Through this process the Centre strives to maintain topicality and remain at the forefront of international research by engaging with international neuroscience initiatives, to ensure Australian neuroscientists provide an influential voice in the ethical, social and economic impact of brain research to the wider community.

Read more about the Centre

brainfunction.edu.au

Vision and mission

Awarded in 2014 as part of the Australian Research Council (ARC) Centres of Excellence Scheme, the Brain Function CoE is a seven-year research program funded by the ARC with contributions from six universities across Australia.

Led by Monash University (Administering Organisation), the Centre brings together researchers from the University of Queensland, the University of Melbourne, the University of Sydney, Australian National University, and the University of New South Wales (Collaborating Organisations), alongside QIMR Berghofer, and 11 international partnering institutions across Europe, Japan and the USA (Partner Organisations).

Vision

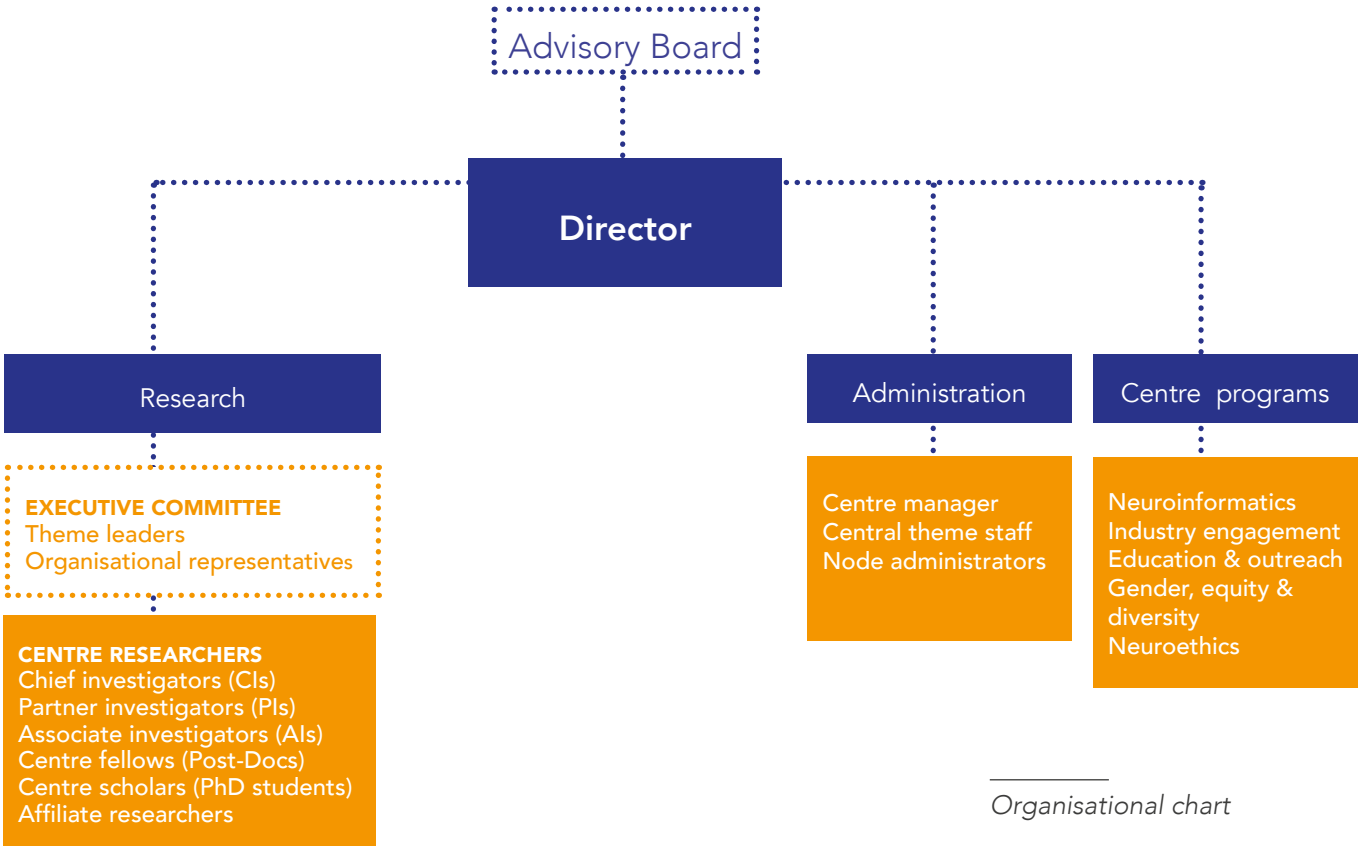
To understand how the brain interacts with the world.

Mission

By focusing on the complex brain functions that underlie attention, prediction and decision-making, Centre for Integrative Brain Function researchers are undertaking fundamental investigations into the principles of brain structure and function. The Centre is studying the relationship between brain activity and behaviour at multiple spatial and temporal scales, to build an integrated model of how attention, prediction and decision-making occurs. This is being accomplished by a research program based on four interconnected themes: Cells and Synapses, Neural Circuits, Brain Systems, and Models and Technologies.

Strategic objectives

1. Reveal how the brain integrates information in large-scale networks to yield complex behaviour.
2. Develop neural technologies and translate them into patentable devices and software; Ensure that Australians benefit from the rapid advances being made in neurotechnologies.
3. Maximise dissemination and exploitation of research findings across the education, medical and government sectors, into industry, and across the broader community, to facilitate social change and progress.
4. Mentor a new generation of future leaders at the interfaces between neuroscience, physics, and engineering, to create an international competitive culture of combined theoretical and experimental neuroscience.
5. Position Australia amongst the world leaders in the international drive to expand the understanding of the brain. Serve as an Australian focal point for interactions with leading international neuroscience initiatives, including the Human Brain Project and the BRAIN initiative.



Organisational chart

Governance

Advisory Board

The Advisory Board provides strategic direction and advice regarding all aspects of the Centre's activities to the Director. The Board meets a minimum of twice per year – both in person and virtually, and are invited to partake in annual scientific meetings.

Members have significant experience in collaborations involving multiple large organisations, as well as international neuroscience activities, industry, and government engagement. In 2017, the Advisory Board welcomed the appointment of two additional members, Dr Jeanette Pritchard and Dr Stella Clark, who will provide guidance on industry linkages and mentorship opportunities for Centre members.

Advisory Board members

- Prof Lyn Beazley, Chair, Past Chief Scientist of Western Australia, Perth, Australia
- Dr Amanda Caples, Lead Scientist, Victorian State Government, Melbourne, Australia
- Prof John Funder, Senior Fellow, Hudson Institute of Medical Research, Melbourne, Australia
- Prof David van Essen, Director, Human Connectome Project, St Louis, USA
- Prof Ulf Eysel, Principal Investigator, Department of Neurophysiology, Ruhr University, Bochum, Germany
- Dr Allan Jones, CEO, Allen Brain Institute, Seattle, USA
- Dr Jeanette Pritchard, Executive Officer, The Garnett Passe and Rodney Williams Memorial Foundation, Melbourne, Australia
- Dr Stella Clark, Executive Director, Stella Connect Pty Ltd, Melbourne, Australia

Senior leadership

Centre Director Prof Gary Egan oversees the Centre's research and operations while playing a key role in the development of industry engagement activities. Deputy Director, Prof Marcello Rosa, is instrumental in the development of international collaborations and partnerships. Associate Director Prof Jason Mattingley plays a critical role in the strategic development of key initiatives in the Education and Training Program and acts as an alternate for Professor Rosa.

Executive Committee

The Executive Committee oversees the Centre's operations and comprises representatives from each research theme, collaborating institution and senior Centre personnel. In 2017, the Executive Committee met monthly and comprised:

Executive Committee members

- Prof Gary Egan, Director, Brain Function CoE, Monash University
- Prof Marcello Rosa, Deputy Director, Brain Function CoE, Monash University
- Prof Jason Mattingley, Associate Director, Brain Function CoE, Brain Systems, University of Queensland
- Prof Pankaj Sah, Neural Circuits, University of Queensland
- Prof Greg Stuart, Cells and Synapses, Australian National University
- Prof Peter Robinson, Models and Technologies, University of Sydney
- Prof Michael Ibbotson, University of Melbourne
- Prof George Paxinos, University of New South Wales
- Dr Glenn Papworth, Centre Manager, Monash University

Message from the Director

"The essence of a Centre of Excellence – the whole truly being more than the sum of its individual parts – was evident in the Centre in 2017."

In 2017 the Centre for Integrative Brain Function passed the halfway mark in our seven-year funding period, and the process of preparing for our successful mid-term review (held in November) necessitated reflection on what we as a Centre of Excellence have achieved to this point and where we plan to go from here.

In 2017 we reached the midpoint of the Australian Research Council's funding period for the Centre for Integrative Brain Function. During the year we successfully prepared for the mid-term review that was held in November, we reflected on what the Centre has achieved during its first three years, and we continued to pursue the Centre's goals as well as actively plan the second half of the Centre's research activities.

The mid-term review and the continual refinement and refocusing of the research program reinforced to me yet again the breadth and quality of the multi-disciplinary and integrative research projects being undertaken. The research excellence and scientific passion of our researchers continued to shine through in 2017, not only the established Chief, Partner and Associate Investigators, but in particular the Early Career Researchers (ECRs) and younger Affiliate Researchers in the Centre. Significantly, the Centre was able to provide an expanded program of funding and scientific opportunities for research and for professional development for the early career researchers in 2017. The program was managed and self-driven by the ECR cohort under the impressive leadership of the ECR Executive Committee. Equally impressive was what the younger researchers contributed to the Centre's outputs in 2017 – driving numerous, truly integrative neuroscience research projects across multiple Centre nodes. This talented and exciting group of young researchers have enthusiastically grasped opportunities through the Centre to establish new collaborations and to create new ways of tackling challenging neuroscience research questions focused on the integrative functions of attention, prediction and decision.

The Centre's research program was highly ambitious as originally conceived. This ambition continued to be realised in 2017 with significant research outputs addressing the integrative nature of the attention, prediction and decision functions of the brain. Highlights were presented at the Centre's Annual all-Centre science meeting and at the AGM in Sydney in December under the theme of 'Paint a Bigger Picture'. An initiative to build the research translation and entrepreneurship skills of our ECRs was also held in Sydney, the first Centre 'Pitch' competition for innovative neuroscience experiments (NeuroX), and brain technologies (BrainteX). The event was entertaining, with a number of creative and scientifically intriguing ideas presented.

Broadly communicating Australia's capabilities in neuroscience research is one of our key remits as a Centre of Excellence. The Centre's education and outreach programs continued to thrive in 2017, with unprecedented turnout from the general public to community engagement events that were held across the country. We also experienced increased participation in our primary and secondary school neuroscience education initiatives. Similarly, the Centre's Neuroethics and Neuroinformatics programs were very active, and have led the way nationally in presenting topical and timely issues in neuroscience research and the responsible conduct of research nationally and internationally.

I would like to thank the Centre's Chief Investigators and Executive team in particular, for their continued hard work and support. We have ensured that in 2017 the wealth of neuroscience research talent in Australia has engaged in new opportunities for international collaboration to further our global reputation in brain research. I would also like to thank the staff of the Centre's central theme based at Monash University together with the node administrative staff around the country, for their continued hard work and dedication to the Centre's goals. They are ensuring that the Centre is a focal point for neuroscience awareness in the broader community, as well as their daily work behind the scenes in the Centre's operations. A particular thank you to Dr Lisa Hutton, who moved on in May 2017 from her role as Centre Manager which she held since the Centre's inception, and who was instrumental in making the Centre the success it is today.

The Centre continued to benefit from the considered and expert guidance of our Advisory Board, under the leadership of chairperson Prof Lyn Beazley, and I thank them all for their continued advice and support. The Advisory Board was expanded in late 2017 when Dr Stella Clarke and Dr Jeanette Pritchard accepted invitations to become members of the board. I look forward to continuing to receive the Board's advice and guidance during 2018-20.

The essence of a Centre of Excellence – the whole truly being more than the sum of its individual parts - was clearly evident in the Centre for Integrative Brain Function in 2017. We look forward in 2018 to continuing to make discoveries that will advance our understanding of how the brain interacts with the world.

Professor Gary Egan
Director, ARC CoE for Integrative Brain Function

Message from the Chair

"During 2017 we refined our Vision, Mission, and Strategic Plan, including specific Strategic Objectives, to take greater advantage of our achievements, capabilities, and human capacity."

The ARC Centre of Excellence for Integrative Brain Function has a big mission. We investigate the relationship between brain activity and behaviour at multiple spatial and temporal scales. Our goal is to understand how the integrative functions of attention, prediction and decision underpin the way in which the brain interacts with the world.

The Centre's research program integrates these three key functions, coordinated via the themes of Models and Technologies, Cells and Synapses, and Neural Circuits and Brain Systems.

Building on the capabilities of the Centre's personnel and state-of-the-art infrastructure, by the mid-point of the Centre's funding period in 2017 our researchers have attracted further funding of over $36M in competitive grants, have published over 100 papers that are co-authored by at least two Centre members, and been cited over 600 times.

In addition to discovering the mechanisms and circuits underpinning integrative brain function, the Centre's overarching goal is to leave a legacy of internationally competitive research outputs that have significantly advanced our understanding of key integrative brain functions. During 2017 we refined our Vision, Mission, and Strategic Plan, including specific Strategic Objectives, to take greater advantage of our achievements, capabilities, and human capacity.

We have adapted and consolidated our research program to initiate and accelerate projects that span across research themes and Centre nodes. We are ensuring that the national and international collaborative networks built by the Centre are being optimally utilised and that the recognition of the excellence of Australian neuroscience research is growing worldwide.

We are proud that in 2017 the Centre continued to make a significant contribution to the training and development of the next generation of neuroscience leaders in Australia. Whilst early career researchers receive extensive training in individual neuroscience disciplines, the cross-disciplinary nature of many Centre research projects has led to the recruitment of high-calibre brain researchers with backgrounds in, for example, mathematics, physics, electrical engineering, software engineering, as well as physiology, neuroanatomy, and neuropharmacology.

During the year the Board oversaw the direction and progress of the Centre's research program, ensuring that our researchers maintained their focus on significant multi-scale projects that would be difficult to pursue without the ARC Centre of Excellence framework. The Board also had significant input into promoting Equity and Diversity in such a large and geographically diverse centre.

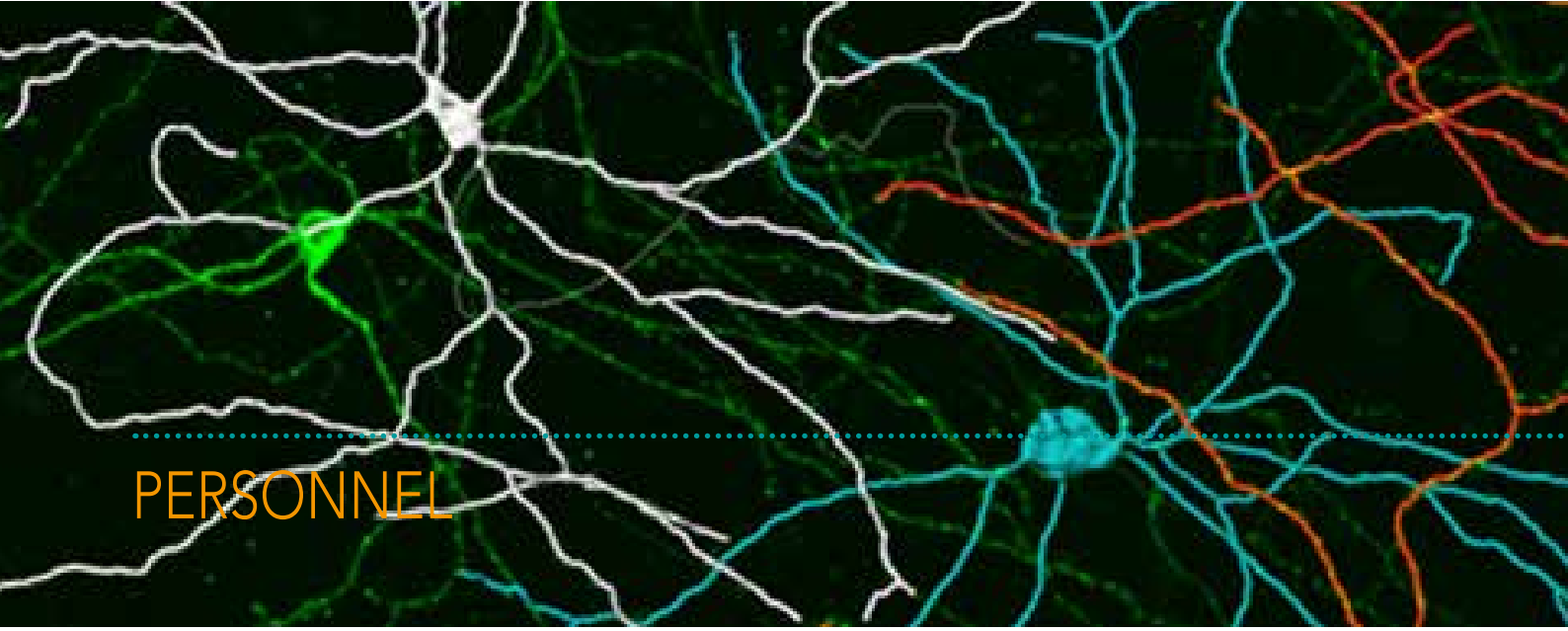
In 2017 we recognised the opportunity to further develop linkages with industry as the Centre enters the second half of its life and the research outputs mature. We are now expanding the Centre's breadth to include a focus on research translation and technology transfer, and the consequent economic and social legacy of the Centre for Australian society. Accordingly, two new Advisory Board appointments were made in 2017. I have pleasure in welcoming to the Advisory Board Dr Stella Clark and Dr Jeanette Pritchard who both bring significant expertise and experience in this area. Dr Clark's expertise covers policy and program development and communication and gender equity challenges, and she is deeply committed to the development of young future leaders of science. Dr Pritchard brings substantial expertise in strategic consulting with government, industry and investment groups who work in the biotechnology and nanotechnology space.

In 2017 the Centre's research program continued to attract PhD students and post-doctoral researchers from around the globe. The Centre is offering these early career researchers unique cross-disciplinary experience as well as extensive professional career development opportunities. The Centre currently supports around 75 Centre Scholars (PhD students) and 75 Centre Fellows (postdoctoral researchers) who have joined the Centre from Australia and many other countries, including Iran, Russia, Argentina, Brazil, New Zealand, China, Poland, India and the United States.

In 2017 the Board was pleased to appoint Prof Melinda Fitzgerald, Professor of Neurotrauma at the Perron Institute and Curtin University, as the new Chair of the Centre's Gender, Equity and Diversity Committee. The Board thanks Prof Sarah Dunlop from the Perron Institute and the University of Western Australia for her contribution to the Centre during her time coordinating the Centre's Equity program.

Thank you once again to my fellow Board members for their governance expertise, especially our international Board members who selflessly give up their time and energy after long intercontinental flights or via late night and early morning videoconferences. Their dedication and ongoing support is greatly appreciated. Overall I thank and congratulate the entire team of the staff, students and the Board on making the Centre a success and look forward to another high achieving year.

Professor Lyn Beazley AO
Chair, Advisory Board, ARC CoE for Integrative Brain Function



PERSONNEL

Chief Investigators

Gary Egan
Director
Monash University

Marcello Rosa
Deputy Director
Monash University

Jason Mattingley
Associate Director
Leader Brain Systems
University of Queensland

Ehsan Arabzadeh
Australian National University

Marta Garrido
University of Queensland

Ulrike Grünert
University of Sydney

Michael Ibbotson
University of Melbourne

Arthur Lowery
Monash University

Paul Martin
University of Sydney

George Paxinos
University of New South Wales

Steve Petrou
University of Melbourne

Peter Robinson
Leader Models and Technologies
University of Sydney

Pankaj Sah
Leader Neural Circuits
University of Queensland

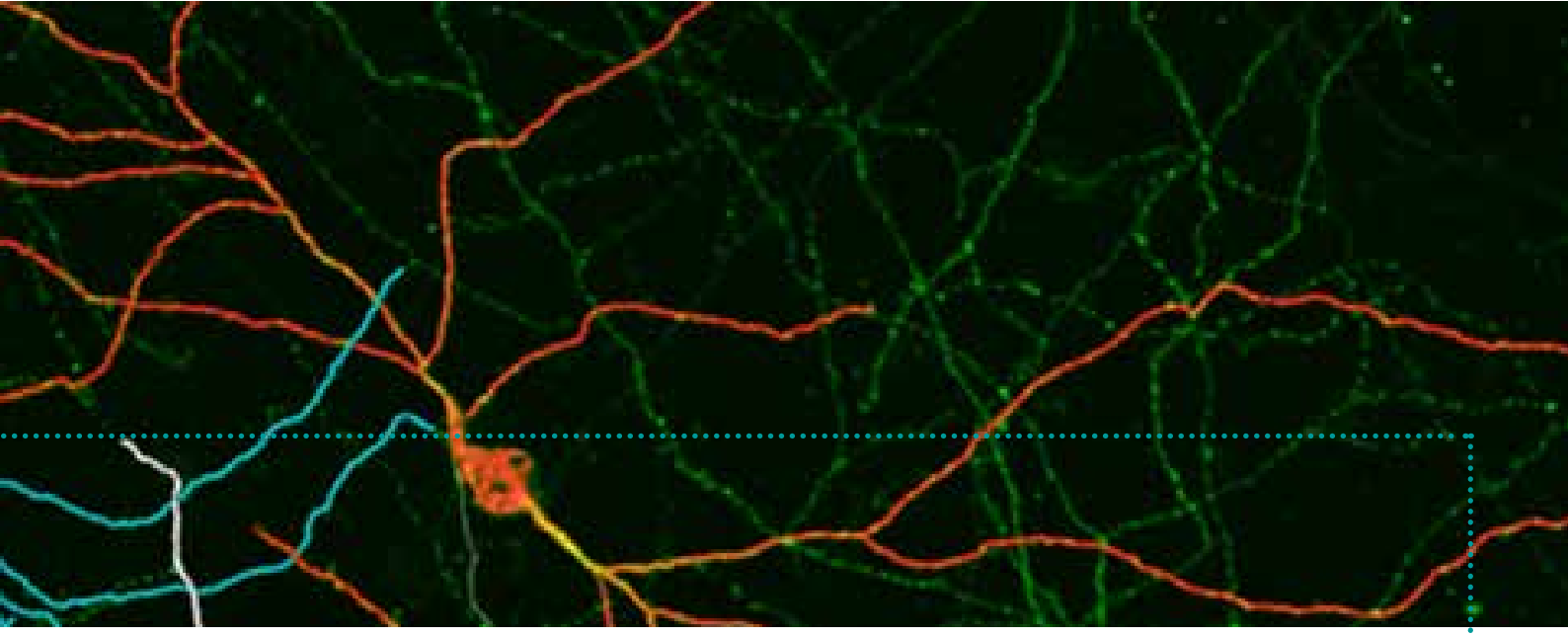
Stan Skafidas
University of Melbourne

Greg Stuart
Leader Cells and Synapses
Australian National University

Program Coordinators

In addition to scientific research, the Centre has developed non-research programs aimed at interacting with the end-user community. These programs are spearheaded by coordinators to address societal, ethical, educational, computational and industry issues raised by brain research.

- A/Prof Adrian Carter, Neuroethics Coordinator
- Prof Melinda Fitzgerald, Chair, Equity and Diversity Committee (from August 2017)
- Prof Sarah Dunlop, Gender Equity (to Aug 2017)
- Dr Pulin Gong, Computational Resources Coordinator
- Dr Wojtek Goscinski, Neuroinformatics Coordinator
- Prof Jakob Hohwy (from August 2017), Neurophilosophy Coordinator
- Dr Rachel Nowak, Director (to May 2017), The Brain Dialogue



Administrative Team - Management and Operations

The Administrative Team is comprised of administrative and management personnel providing support to the Director and Executive Committee in the conduct, communication and administration of research. Personnel are located at each of the collaborating organisations throughout Australia, and meet monthly to review, plan and conduct activities across the Centre.

- Glenn Papworth, Centre Manager, Monash University
- Lisa Hutton, Centre Manager (to April 2017), Monash University
- Maria del Mar Quiroga, Education and Outreach Officer, Monash University
- Merrin Morrison, Communications Officer, Monash University
- Hatice Sarac, Senior Administration Officer (maternity leave), Monash University
- Masha Perry, Senior Administration Officer (maternity leave replacement), Monash University
- Jessica Despard, Central Theme Project Officer, Monash University
- Silvia Pongracic, Central Theme Administrator (to October 2017), Monash University
- Trudi Gilmore, Central Theme Administrator (to February 2017), Monash University
- Teri Furlong, Node Administrator, University of New South Wales
- Cindy Guy, Node Administrator, University of Sydney
- Roxanne Jemison, Node Administrator, University of Queensland
- Tenille Ryan, Node Administrator, University of Melbourne
- Danielle Ursino, Node Administrator, Australian National University

Associate Professor Ulrike Grünert, Chief Investigator

Ulrike Grünert is a key contributor to the Centre's research that requires high-resolution anatomical analyses to address the neural computations involved in attention, prediction and decision-making. She is based at the Save Sight Institute, University of Sydney and is internationally recognised for her capacity to produce detailed reconstructions of neuronal pathways, including the synaptic connections of individual neurons.

Her work mapping the morphology of primate retinal ganglion cells has uncovered the existence of more than 20 different variations of these cells distributed throughout the retina, with their shape providing some indication of their specific functions.

In 2017 A/Prof Grünert was acknowledged for her contribution to the scientific community, and was awarded the Australasian Neuroscience Society's annual Nina Kondelos award - for outstanding contribution to basic or clinical neuroscience research by a female neuroscientist.

29 Centre Fellows

32 Research Scholars

9 Honours Students

36 Affiliate Scholars

Partner Investigators

- Michael Breakspear, QIMR Berghofer Medical Research Institute
- Matthew Diamond, International School for Advanced Studies, Italy
- Sean Hill, International Neuroinformatics Coordinating Facility (INCF), Sweden
- Viktor Jirsa, Aix-Marseille University, France
- G. Allan Johnson, Duke University, USA
- David Leopold, NIH: National Institute of Mental Health, USA
- Troy Margrie, The Francis Crick Institute, UK
- Henry Markram, Blue Brain Project, Switzerland
- Partha Mitra, Cold Spring Harbor Laboratory, USA
- Tony Movshon, New York University, USA
- Keiji Tanaka, Riken Brain Institute, Japan
- Jonathan Victor, Weill Cornell Medicine, USA

Associate Investigators

- Derek Arnold, University of Queensland
- Sofia Bakola, Monash University
- John Bekkers, Australian National University
- Anthony Burkitt, University of Melbourne
- Vincent Daria, Australian National University
- Paul Dux, University of Queensland
- Alex Fornito, Monash University
- Geoff Goodhill, University of Queensland
- Ted Maddess, Australian National University
- Farshad Mansouri, Monash University
- Nick Price, Monash University
- Fabio Ramos, University of Sydney
- Olaf Sporns, Indiana University, USA
- Nao Tsuchiya, Monash University
- Trichur Vidsyagar, University of Melbourne
- Charles Watson, Curtin University

Centre Fellows

- Massoud Aghili Yajadda, University of Sydney
- Tahereh Babaie, University of Sydney
- Bill Connelly, Australian National University
- Ilvana Dzafic, University of Queensland
- Calvin Eiber, University of Sydney
- Kristen Farrell, Australian National University
- Timothy Feleppa, Monash University
- Teri Furlong, University of New South Wales
- Demi Gao, University of Sydney
- Saba Gharaei, Australian National University
- Veronika Halasz, University of Queensland
- Joan Holgate, Australian National University
- Kaori Ikeda, Australian National University
- Sharna Jamadar, Monash University
- Tim Karle, University of Melbourne
- Ehsan Kheradpezhouh, Australian National University
- Stuart Knock, University of Sydney
- Melissa Larsen, University of Queensland
- Sammy Lee, University of Sydney
- Roger Marek, University of Queensland
- Hamish Meffin, University of Melbourne
- Anand Mohan, Monash University
- Babak Nasr, University of Melbourne
- Sander Pietersen, University of Sydney
- Guilherme Silva, Australian National University
- Matthew Tang, University of Queensland
- Phillip Ward, Monash University
- Dongping Yang, University of Sydney
- Natalie Zeater, University of Sydney

Dr James Roberts, Fellow

Based at QIMR Berghofer Medical Research Institute, James Roberts is an ECR working with Prof Breakspear in the Systems Neuroscience Group. His work predominantly focuses on human imaging, with a particular focus on functional connectivity.

His work resulted in six publications in 2017, two of which were published in high ranking neuroscience journal *NeuroImage*.

In addition to his publications, James was awarded an NHMRC New Investigator grant for $419,847 to fund his research project *Beyond the connectome: Modelling large-scale brain dynamics* over the next three years.

James' contribution to the Centre was recognised at the welcome dinner of our Annual General Meeting, where he was awarded the David van Essen Award for Outstanding Early Career Researcher.

Dr Phillip Ward, Fellow

Phillip Ward is a postdoctoral fellow working under the supervision of Prof Gary Egan at Monash University. His background in physics and computer science has led him to undertake a research focus in developing novel methods to process and analyse human neuroimaging data.

His latest work has resulted in the development of a new technique to automatically identify veins in MRI images, which allows for quantification of the oxygen content within those veins. This analysis technique has resulted in two publicly available tools (https://github.com/philgd/CVI-MRI and https://github.com/philgd/ShMRF), with the work also being recognised as a finalist in the Best Student Paper Prize at the IEEE International Symposium for Biomedical Imaging held in Melbourne in April.

In 2017, Phillip was a mentor in the BrainSTEM Innovation Challenge, a program offering high school students the opportunity to work in a research environment and participate in the journey of scientific discovery alongside their STEM mentor.

Phillip was also named as one of 12 recipients of the Victoria Fellowship, awarded by VESKI (Victorian Endowment for Science Knowledge and Innovation) in 2017. The Victorian Government has awarded Phillip a travel grant to undertake a short-term overseas study mission. Victoria Fellowship recipients help shape Victoria's future economy by driving new ideas and products and enhancing the state's reputation as a global centre for discoveries and technology.

Centre Scholars

- Ali Almasi, University of Melbourne
- Sahand Assadzadeh, University of Sydney
- Ashleigh Chandra, University of Sydney
- Guozhang Chen, University of Sydney
- Farah Deeba, University of Sydney
- Daniel Fehring, Monash University
- Mariya Ferdousi, University of Sydney
- Natasha Gabay, University of Sydney
- Saba Gharaei, Australian National University
- Yifan Gu, University of Sydney
- Suraj Honnuraiah, Australian National University
- Xian Iong, University of Sydney
- Adam Keane, University of Sydney
- Thomas Lacy, University of Sydney
- Conrad Lee, Australian National University
- You Liang, University of Melbourne
- Yuxi Liu, University of Sydney
- Xiaochen Liu, University of Sydney
- Dan Ma, University of Sydney
- Rania Masri, University of Sydney
- Jessica McFadyen, University of Queensland
- Kamrun Mukta, University of Sydney
- Eli Muller, University of Sydney
- Brandon Munn, University of Sydney
- Daniel Naomenko, University of Sydney
- James Pang, University of Sydney
- Yang Qi, University of Sydney
- Yadollah Ranjbar, Australian National University
- Nipa Roy, University of Sydney
- Rory Townsend, University of Sydney
- Cong Wang, University of Queensland
- Iris Zhu, Monash University

Kamrun Mukta, Scholar

PhD Scholar Kamrun Mukta was awarded a highly competitive 'University of Sydney International Scholarship' to complete her postgraduate studies as an international student at the University of Sydney. Enrolled under the supervision of Prof Peter Robinson, Kamrun's research focuses on studying eigenmode analysis of spherical brain activity.

2017 saw her first publication arising from her PhD research *Theory of corticothalamic brain activity in a spherical geometry: Spectra, coherence, and correlation*, as well as her first International conference presentation at BrainModes, 2017 Delhi, India.

Kamrun was also one of 48 women selected to attend the biennial Abdus Salam International Centre for Theoretical Physics (ICTP) Career Development Workshop for Women in Physics, in Trieste Italy. After a competitive application process, Kamrun was accepted into the program, and was awarded a travel grant to support her attendance to this workshop. This was a unique opportunity for Kamrun to take part in a variety of highly interactive exercises, talks, panel discussions, training sessions and other activities designed to help women in physics share their experiences, gain self-confidence and acquire extra skills they need to become successful in their professions.

Honours Students

- Elissa Belluccini, University of Sydney
- Shena Cooke, University of Queensland
- Lucy Ford, University of Queensland
- Jake Laycock, University of Queensland
- Lily Li, University of Sydney
- Max Slattery, University of Sydney
- Asem Wardak, University of Sydney
- Rebecca West, University of Queensland
- Megan Young, University of Melbourne

Professional Staff

- Arzu Demir, University of Sydney
- Hilary Knowles, University of Sydney
- Julie Pages, University of Sydney
- Afsah Zaheer, University of Sydney

Affiliate Academics

- Hassan Alinejad, University of Sydney
- Christine Guo, QIMR Berghofer Medical Research Institute
- Leo Lui, Monash University
- Sam Merlin, Western Sydney University
- Adam Morris, Monash University
- Stratton Peter, University of Queensland
- Svetlana Postnova, University of Sydney
- Margaretha Ridder, University of Queensland
- Mark Schira, University of Wollongong
- Fabrice Turpin, University of Queensland
- Francois Windels, University of Queensland
- Yan Wong, Monash University

Affiliate Fellows

- Ali Almasi, University of Melbourne
- Elenora Autuori, University of Queensland
- Oliver Baumann, University of Queensland
- Claire Bradley, University of Queensland
- Konstantinos Chatzidimitrakis, Monash University
- Shaun Cloherty, Monash University
- Giovanna D'Abaco, University of Melbourne
- Mirella Dottori, University of Melbourne
- Hannah Filmer, University of Queensland
- Ben Fulcher, University of Sydney
- Maureen Hagan, Monash University
- James Henderson, University of Sydney
- Helena Huang, Australian National University
- Sahama Ishani, University of Queensland
- Cliff Kerr, University of Sydney
- Marcin Kielar, University of Queensland
- Conrad Lee, Australian National University
- Delphine Levy-Bencheton, University of Queensland
- Andy Liang, University of New South Wales
- James MacLaurin, University of Sydney
- Snezana Maljevic, University of Melbourne
- Marilia Menezes de Oliveira, University of Sydney
- John Morris, University of Queensland
- Lena Oesreich, University of Queensland
- David Painter, University of Queensland

Affiliate Fellows, Cont.

- Madhusoothanan Perumal, University of Queensland
- Lei Qian, University of Queensland
- Dragan Rangelov, University of Queensland
- Kay Richards, University of Melbourne
- Paula Sanz-Leon, University of Sydney
- Somwrita Sarkar, University of Sydney
- Emma Schofield, University of New South Wales
- Robert Sullivan, University of Queensland
- Yajie Sun, University of Queensland
- Angelo Tedoldi, University of Queensland
- Tahereh Tekieh, University of Sydney
- Wei Tong, University of Melbourne
- Hsin-Hao Yu, Monash University
- Molis Yunzab, University of Melbourne
- Elizabeth Zavitz, Monash University

Dr Lena Oestreich, Affiliate Fellow

Lena is an affiliate fellow and ECR, working within the lab of Dr Marta Garrido at the University of Queensland. Her research uses computational neuroscience approaches to integrate functional and structural neuroimaging data in healthy individuals and schizophrenia patients, to explore potential biomarkers that could identify individuals at high-risk for developing psychosis.

In 2017 she recevied an Ian Potter Foundation Award to fund her travel to attend, and present her work at the Annual Meeting of the Organization for Human Brain Mapping in Vancouver, Canada.

She was also named as the Australasian Cognitive Neuroscience Society's (ACNS) Female Emerging Researcher of the Year, for her publication *Abnormal white matter microstructure and increased extracellular free-water in the cingulum bundle associated with delusions in chronic schizophrenia*. The ACNS Emerging Researcher Award is aimed at recognising outstanding researchers working in the field of cognitive neuroscience in the very early stages of their career.

Affiliate Scholars

- Ali Almasi, University of Melbourne
- Nicholas Bland, University of Queensland
- Alexander Bryson, University of Melbourne
- Tristan Chaplin, Monash University
- Yadeesha Deerasooriya, University of Melbourne
- Amu Faiz, University of Queensland
- Masoud Ghodrati, Monash University
- Michelle Hall, University of Queensland
- Anthony Harris, University of Queensland
- Basem Hassan, University of Melbourne
- Luke Hearne, University of Queensland
- Linghan Jia, University of Melbourne
- Young Jun (Jason) Jung, University of Melbourne
- Liliana Laskaris, University of Melbourne
- Ting Ting Lee, University of Melbourne
- James McFadyen, Monash University
- Morgan McIntyre, University of Queensland
- Dulini Mendis, University of Melbourne
- Shruthi Narayanan, Monash University
- Brian Oakley, Monash University
- Grishma Pandejee, University of Sydney
- Kirstie Petrie, University of Queensland
- Roshini Randeniya, University of Queensland
- Angela Renton, University of Queensland
- Katrina Richards, Monash University
- Naz Samra, University of Queensland
- Cooper Smout, University of Queensland
- Cooper Smout, University of Queensland
- Artemio Soto-Braceda, University of Melbourne
- Shi (Scott) Sun, University of Melbourne
- Borloo Tessa, University of Queensland
- Susan Travis, University of Queensland
- Chalini Wijetunge, University of Melbourne
- Lisa Wittenhagen, University of Queensland
- Shanzhi Yan, University of Queensland
- M S Zobaer, University of Sydney

Affiliate Professional Staff

- Jonathan Chan, Monash University
- Cecilia Cranfield, Monash University
- Janelle Gilling, Monash University
- Cill Gross, University of Melbourne
- Ianina Hutler-Wolkowicz, Monash University
- Oscar Jacoby, University of Queensland
- David Lloyd, University of Queensland
- Annette McLeod, University of Melbourne
- Petra Sedlak, University of Queensland
- Joyce Vromen, University of Queensland
- Kirsty Watkins, Monash University
- Katrina Worthy, Monash University
- Li Xu, University of Queensland

Collaboration network

NORTH AMERICA

CANADA
Rotman Research Institute, Toronto

USA
Boston Childrens Hospital, Boston
Boston University, Boston
Cold Spring Harbor Laboratory, New York
Columbia University, New York
Duke University, Durham
Emory Univeristy, Atlanta
Harvard University, Cambridge
Icahn School of Medicine, Mt Sinai, New York
Indiana University, Indiana
Johns Hopkins University, Baltimore
Massachusetts General Hospital, Boston
New York University, New York
NIH: National Institute of Mental Health, Bethesda
Oregon Health & Science University, Portland
Stanford University, Stanford
State University of New York, New York
Texas A&M University, Texas
University of California, Berkeley, Berkeley
University of California, Davis, Davis
University of California, San Diego, San Diego
University of Rochester, Rochester
University of Texas, Austin
Vanderbilt University, Nashville
Virginia Commonwealth University, Richmond
Virginia Tech, Blacksburg
Vollum Institute, Portland
Weill Cornell Medicine, New York

EUROPE

BELGIUM
University of Liege, Wallonia

DENMARK
Aarhus University, Aarhus

FINLAND
University of Helsinki, Helsinki

FRANCE
Ecole Normale Supérieure de Paris, Paris
Inria Sophia-Antipolis, Valbonne
Institut de Neurosciences des Systèmes, Marsielle
Institut National de la Santé et de la Recherche Médicale, Paris
Université de Rennes, Rennes
Universite Grenoble Alpes, Saint-Martin-d'Hères
Universite Paris-Saclay, Paris

GERMANY
Bielefeld University, Bielefeld
Forschungszentrum Jülich GmbH, Jülich
Frankfurt Institute of Advanced Studies, Frankfurt
Leibniz Institute of Neurobiology, Magdeburg
Max Planck Institute, Munich
University of Duesseldorf, Duesseldorf
University of Marburg, Marburg
University of Münster, Münster
University of Tuebingen, Tuebingen

HUNGARY
University of Pécs, Pécs

IRELAND
Trinity College, Dublin

ITALY
International School for Advanced Studies, Trieste
Univeristy of Bologna, Bologna
University of Pisa, Pisa

THE NETHERLANDS
University of Amsterdam, Amsterdam
University of Groningen, Groningen

POLAND
Nencki Institute, Warszawa

SPAIN
Univerity of Murcia, Murcia
Universidad Autonoma de Madrid, Madrid

SWEDEN
International Neuroinformatics Coordinating Facility (INCF), Stockholm
Karolinska University Hospital, Stockholm

SWITZERLAND
Blue Brain Project, Stockholm
Human Brain Project, Lausanne
Swiss Federal Institute of Technology, Zurich, Zurich

TURKEY
Ege University, Izmir

UK
City University London, London
Imperial College London, London
Newcastle University, Newcastle
The Francis Crick Institute, London
University College London, London
University of Birmingham, Birmingham
University of Cambridge, Cambridge
University of Nottingham, Nottingham
University of Oxford, Oxford
Wellcome Trust Centre for Neuroimaging, London

MIDDLE EAST, ASIA & PACIFIC

CHINA
Chinese Academy of Science, Beijing
New York University Shanghai, Shanghai

IRAN
Babol University of Technology, Babol
Kerman University, Kerman

ISRAEL
Weizmann Institute, Rehovot

JAPAN
Keio University School of Medicine, Tokyo
National Institute for Materials Science, Tsukuba
Riken Brain Institute, Tokyo

QATAR
Hamad Bin Khalifa University, Doha

SINGAPORE
Duke-NUS Medical School, Singapore
Singapore University of Technology and Design, Singapore

NEW ZEALAND
University of Otago, Otago
University of Waikato, Waikato

NATIONAL COLLABORATORS

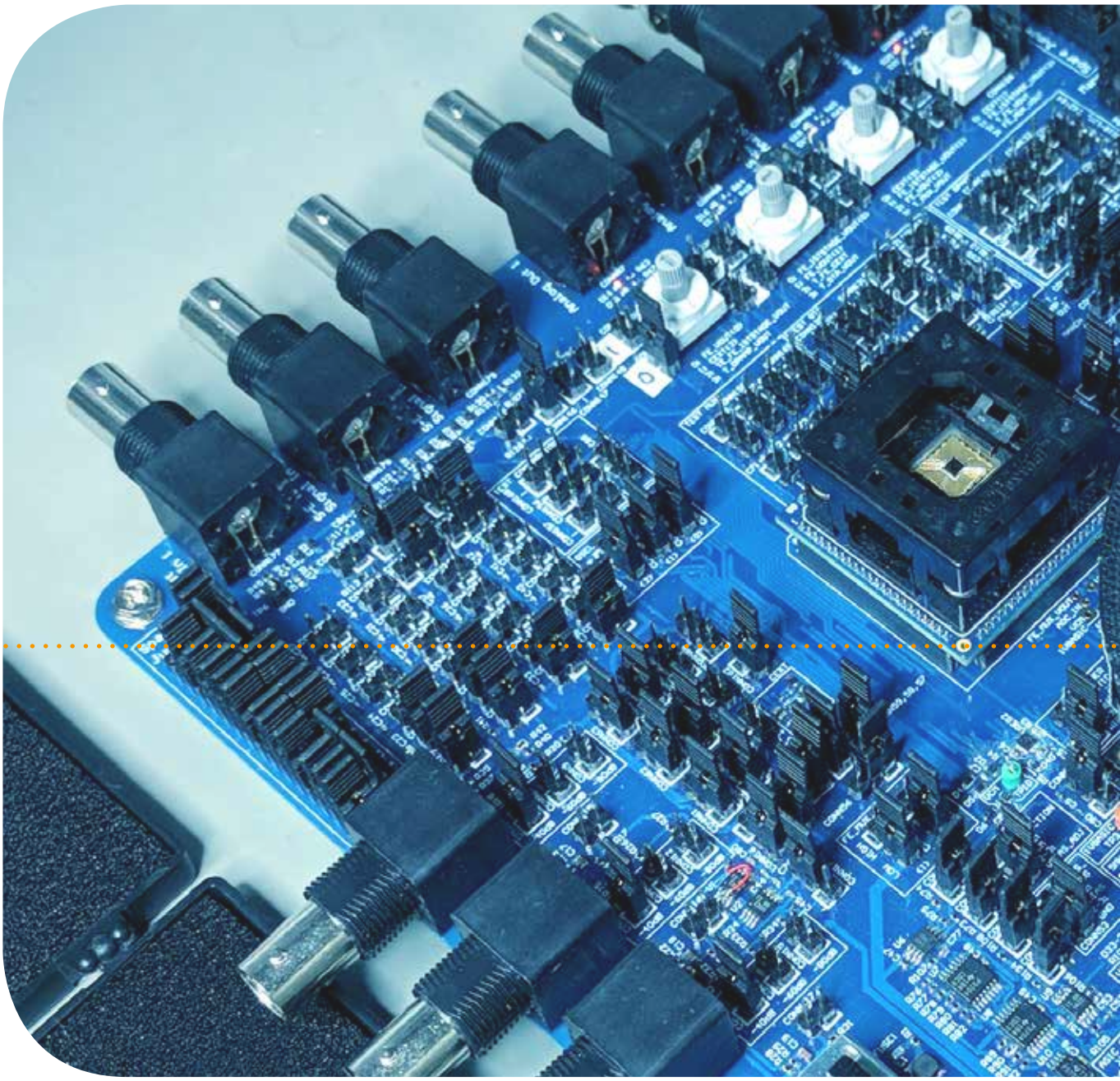
Alfred Health, Melbourne
Austin Health, Melbourne
Australian College of Optometry, Melbourne
Australian National University, Canberra
Charles Stuart University, Bathurst
Cooperative Research Centre (CRC) for Mental Health, Melbourne
CSIRO Australian eHealth Research Center, Brisbane
Curtin University, Perth
Deakin University, Melbourne
Flinders University, Adelaide
Florey Institute of Neuroscience and Mental Health, Melbourne
La Trobe University, Melbourne
Macquarie University, Sydney
Monash Health, Melbourne
Monash University, Melbourne
National Vision Research Insitute, Melbourne
Neuroscience Research Australia (NeuRA), Sydney
QIMR Berghofer Medical Research Institute, Brisbane
Queensland University of Technology, Brisbane
RMIT University, Melbourne
Royal Brisbane and Women's Hospital, Brisbane
Stem Cells Australia, Melbourne
Swinburne University of Technology, Melbourne
The Black Dog Institute, Sydney
University of Adelaide, Adelaide
University of Melbourne, Melbourne
University of New South Wales, Sydney
University of Newcastle, Newcastle
University of Queensland, Brisbane
University of South Australia, Adelaide
University of Sydney, Sydney
University of Wollongong, Sydney
Victorian Life Sciences Computation Initiative, Melbourne
Western Sydney University, Sydney

34 National collaborators

86 International collaborators from **24** countries

22 Visits to overseas laboratories

RESEARCH REPORT



69

Publications

162

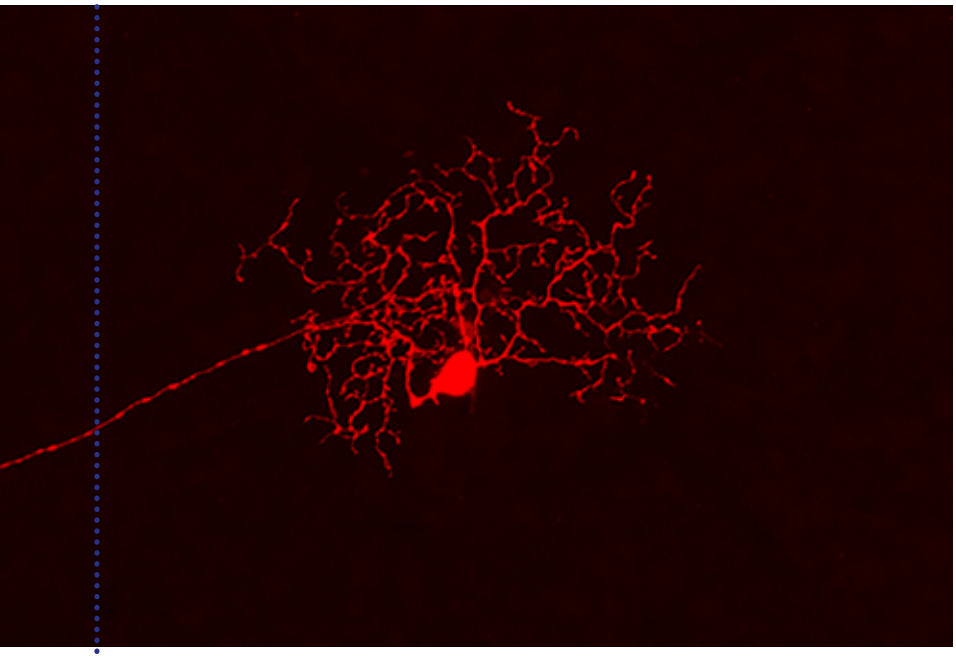
Conference presentations

1050

Citations

- Research
- Publications
- Presentations

Research themes



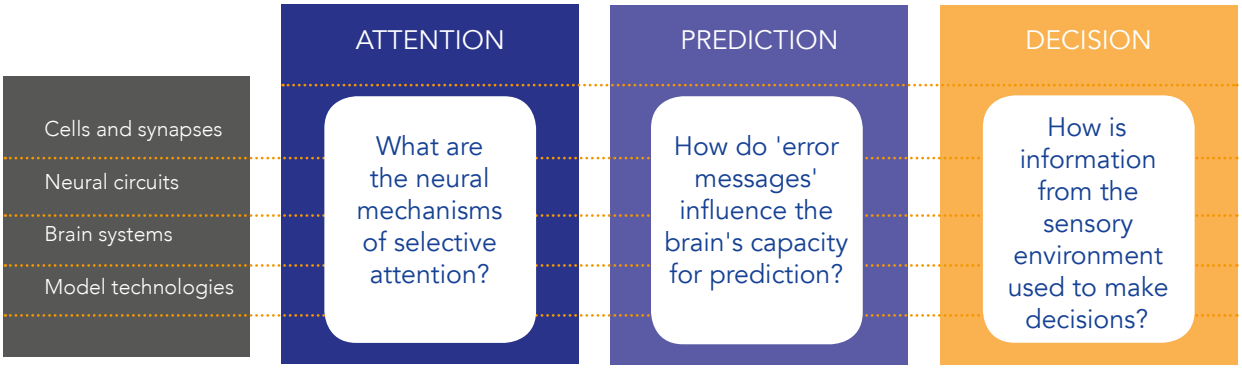
CELLS AND SYNAPSES Brain function relies on spiking activity under control of sensory inputs and stored brain states (memories). However, spiking activity also depends on the biophysical properties of neurons and their connections (synapses), as well as whole brain (behavioural and hormonal) states. Ultimately, the generation of spikes requires the movement of charged ions.

NEURAL CIRCUITS The mammalian brain is assembled from local neural circuits that are connected into networks, in which signals are encoded as brief voltage 'spikes'. This spiking activity is used to communicate information between neurons, and is the basis of the computations performed in the brain.

BRAIN SYSTEMS Historically, brain science has focused on how distinct brain regions carry out specialised functions such as sensation, motor control and cognition. This approach has led to a 'compartmentalised' map of the brain, whereby nerve cells (neurons) with shared morphology and function, located in the same area, correspond to discrete information processing modules.

MODELS AND TECHNOLOGIES Historically, data collection in neuroscience has outpaced developments in theory and computation. As a result the field lacks the simple concepts needed to unify results of huge numbers of experiments.

Research structure



The research program of the Centre for Integrative Brain Function spans different levels of analysis, organised into the themes of Cells and Synapses, Neural Circuits, Brain Systems, and Models and Technologies. Coordinated investigations are undertaken across the research themes at different spatial scales using theoretical, experimental, analytical, and modelling approaches.

The research program is structured to allow our researchers to work on unique, multi-scale approaches to address the three key integrative brain functions of Attention, Prediction and Decision. The research program is addressing the following critical cross-theme research questions:

Attention - What are the neural mechanisms of selective attention?

Prediction - How do 'error messages' influence the brain's capacity for prediction?

Decision - How is information from the sensory environment used to make decisions?

In 2017 this approach has led to the initiation of new opportunities for cross-theme collaborations between research groups at different Centre nodes. Previously distinct research projects have merged, with an increasing emphasis on the integration of results with physical and computational models in order to drive new experiments and generate new technologies.

In the following section is a summary of the progress and outcomes of the collaborative multi-scale research projects undertaken in 2017.

Sensory decision-making in rodents; *and* Understanding human attention, decision-making and prediction using psychophysics, brain imaging and neural stimulation.

Investigators: Ehsan Arabzadeh and Greg Stuart (ANU), Jason Mattingley and Matthew Tang (UQ)

Research outcomes achieved in 2017

» *Used new behaviour paradigms and simultaneous nerve cell recordings to show that rodents can prioritise sensory processing based on context.*

The Centre's research groups at the Australian National University and the University of Queensland have designed a novel spatial attention paradigm that is implemented in both humans and mice. The paradigm employs frequency tagging (a well-established method in extraction of electroencephalogram (EEG) data in human attention research) in head-fixed mice, where neuronal activity can be observed (and manipulated) at a higher temporal and spatial resolution. This line of research bridges the gap between cognitive neuroscience and cellular neurophysiology and allows a quantitative understanding of the human frequency-tagging data and its attentional modulation at the neuronal level.

Highlight

This work was presented by Centre Fellow Matthew Tang (UQ), and Scholar Guthrie Dyce (ANU) in two separate poster presentations at the 37th Annual Meeting of the Australasian Neuroscience Society in Sydney.

Rapid Information processing in subcortical amygdala pathways; *and* neural circuits that mediate fear learning and extinction.

Investigators: Marta Garrido, Jason Mattingley and Pankaj Sah (UQ), Greg Stuart (ANU)

Research outcomes achieved in 2017

» *Used functional imaging and behaviour measurements to show threatening stimuli use a primitive subcortical route to reach fear-control centres in the brain.*

Used chemogenetic and optogenetic tools to study circuits that drive top-down (attentional) components of fear learning and its extinction.

At the University of Queensland, Centre researchers have developed new methods to compare behavioural findings between rodents and humans. Here, manipulations are made using chemogenetics in animals, and the results were compared with those from imaging in humans. This research is uncovering how organisms quickly generate fear responses to a wide range of visual properties, highly relevant to future research on anxiety-prevention strategies.

The brain has a shortcut for quickly identifying threatening images

An alternative pathway carries detailed visual information about threats.

Responding promptly to imminent danger is crucial to our survival. An almond-shaped bundle of brain cells called the amygdala coordinates these fear and emotional responses.

However, it's not completely clear how quickly the amygdala receives information about the threats that we see, and whether it initially receives a coarse picture that's only refined later.

Brain Function CoE PhD scholar Jessica McFadyen and colleagues at the Queensland Brain Institute and Grenoble Alps University in France found evidence of a shortcut that allows detailed visual information to reach the amygdala quickly and efficiently.

The team used a mathematical method called dynamic causal modelling, which provides information about the direction in which information travels between different parts of the brain. Their findings add to existing anatomical evidence of this alternative pathway.

The experiments also show that the shortcut can send information about the threat in much more detail than previously thought. Detail is important, because knowing if the person who just jumped out in front of you is your best friend or the world's most wanted serial killer is essential for determining how to respond.

The role of predictive coding in receptive field formation in visual cortex; *and* Visual signal processing in thalamocortical loops; predictive coding in attentional circuits.

Investigators: Michael Ibbotson and Hamish Meffin (UMelb), Paul Martin and Pulin Gong (USyd)

Research outcomes achieved in 2017

» *Employed high-density recording techniques to measure simultaneous nerve cell activity in vivo from over 200 sites in multiple brain areas.*

Centre researchers from the Melbourne and Sydney nodes have employed new semiconductor-based electrode arrays and nonlinear signal analysis techniques, to allow the most detailed assessment yet of the visual properties of neurons in the visual system. Previous techniques allowed the measurement of linear visual properties, but the new techniques uncover nonlinear decoding strategies. Application of nonlinear turbulence physics has enabled novel analyses of complex patterns across nerve cell populations. The influence of attention and prediction on the visual system is highly nonlinear, making it essential to understand nonlinear processing at the neuronal level.

Brain research moving in the right direction

When we see something in motion, its direction of movement influences the movement of corresponding waves in brain activity.

Brain activity ebbs and flows like ocean waves during a tropical storm. The turbulent waves of activity form micro patterns even when we're sleeping or under anaesthesia, but how these patterns relate to what we're currently seeing and experiencing is not completely understood.

Brain Function CoE researchers Rory Townsend, Pulin Gong and Paul Martin, together with colleagues at the University of Sydney and University College London, wanted to see what these wave patterns look like in the visual areas of the brain while we're watching moving objects. The team showed marmosets a series of moving patterns on a computer screen. They rotated the patterns – either circular white dots or sets of parallel lines – by 90 degrees until the marmosets had seen them 100 times in all four cardinal directions.

Using methods for analysing turbulence patterns in gases and liquids, the team found that the direction in which the patterns moved across the screen altered the direction of the corresponding brain waves in areas of the brain that respond to visual information.

This discovery marks the first time that the movement direction of brain waves has been directly linked to movement in the environment. "These waves were not previously detected," explains Gong, "because we normally average brain activity across many repetitions of the experiment. This averaging process makes the responses easier to interpret, but we found that it also removes all of the interesting wave activity."

The team speculates that these moving waves have a specific role in information processing in the brain.

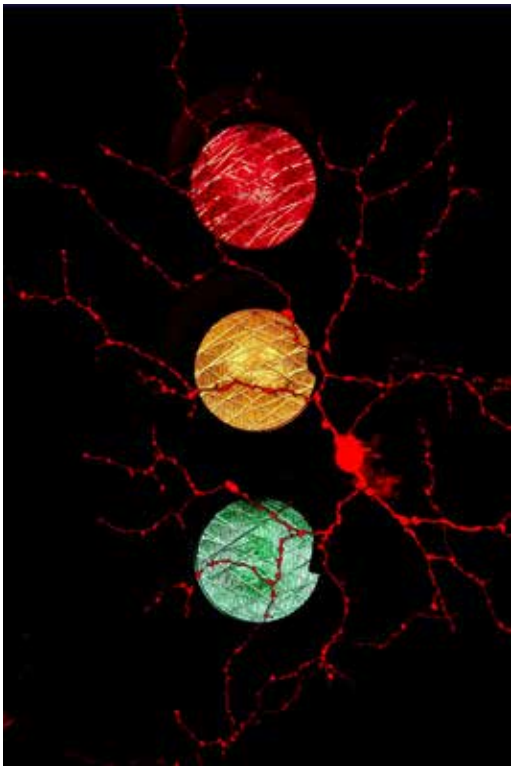
Neural signatures of decision making in the primate cortex; *and* Neural circuits that mediate fear learning and extinction.

Investigators: Ulrike Grünert and Paul Martin (USyd), Steve Petrou (UMelb), Marcello Rosa (Mon) and Pankaj Sah (UQ)

Research outcomes achieved in 2017

» *Employ particle-mediated gene transfer to discover that multiple pathways projecting from the eye to attention-regulating circuits in the primate brain.*

In a collaboration across three Centre nodes, researchers are applying new molecular techniques (viral vectors and RNA tagging) developed in mice, to analyse neural pathways from the eye to attention and fear-regulating brain centres in non-human primates. This research is uncovering high diversity in evolutionarily old (amygdala) and new (pulvinar and cortical) pathways for attention and fear regulation.



Transmission wires alert the brain to what the eyes see

A small subpopulation of brain cells in the eye sends alert signals to the brain in response to visual threats.

When we see something, our eyes send messages to our brain through the optic nerves. Each nerve contains around a million long 'wires', called axons, which carry information from ganglion cells in the retina to relevant parts of the brain. Although at least 20 ganglion cell types have been discovered in primate retinas, how each type contributes to visual processing is not clear.

Brain Function CoE investigators Ashleigh Chandra, Sammy Lee and Ulrike Grünert have taken a big step towards identifying which wires are responsible for sending alerting messages to the brain areas that regulate attention. The team used a biological marker to tag all the brain cells in the retina that contain a protein called calretinin. Closer inspection revealed that most of the tagged cells were thorny cells – named after their special thorn-like connections to other cells in the retina.

"We knew that thorny cells project to areas of the brain that help you adjust to new or threatening stimuli in the environment, for example the image of an approaching car when you start to cross the street," says Chandra. "What surprised us when we counted the thorny cells is that there are a lot more of them than we previously thought."

This discovery suggests that the eye and brain devote a lot of processing power to threat detection, which may reflect the importance of survival for our ancestors. "Of course, now we have traffic lights to help us avoid threats from cars, but our thorny cells are still there if we need them," Chandra says.

In addition to revealing an important role for this ganglion cell type, the researchers have confirmed that tagging calretinin is a useful method for studying these cells in the retina.

Unified neural models for attention, prediction, and decision.

Investigators: Peter Robinson, Pulin Gong and Paul Martin (USyd), Marta Garrido (UQ) and Michael Breakspear (QIMR).

Research outcomes achieved in 2017

» *Developed new physical and computational methods for understanding brain activity, imaging, structure, and function that underpin attention, prediction, and decision, and their measurement.*

Centre researchers at the University of Sydney have developed a new brain-based approach to analysing dynamics in the visual system, combining physiologically-based models and neural field theory. The results show that dynamics can be interpreted in a control systems framework. This lays the foundation for incorporating the inseparable stages of attention and prediction, and the later stages of decision and control in a single framework – an advance that cuts across and unifies the Centre's research strands. Experimental tests began in 2017 via collaboration with other Centre investigators.

Highlight

This work has resulted in the development and release of several publicly available analysis tools, including:

» NeuroPatt Toolbox - automatically detect, analyse and visualise spatiotemporal patterns in neural population activity (https://github.com/BrainDynamicsUSYD/NeuroPattToolbox)

» Spikegrid - simulate and analyse cortical microcircuits (https://github.com/BrainDynamicsUSYD/spikegrid)

» NFTstim - simulation of multiscale neural field dynamics (https://github.com/BrainDynamicsUSYD/nftsim)

» BrainPalimpsest Toolbox – deconvolve BOLD-fMRI data by producing the underlying spatiotemporal neural and hemodynamic activity (https://github.com/BrainDynamicsUSYD/BrainPalimpsest)

Real time analysis of network function using an all-optical interface; *and* neural circuits that mediate fear learning and extinction.

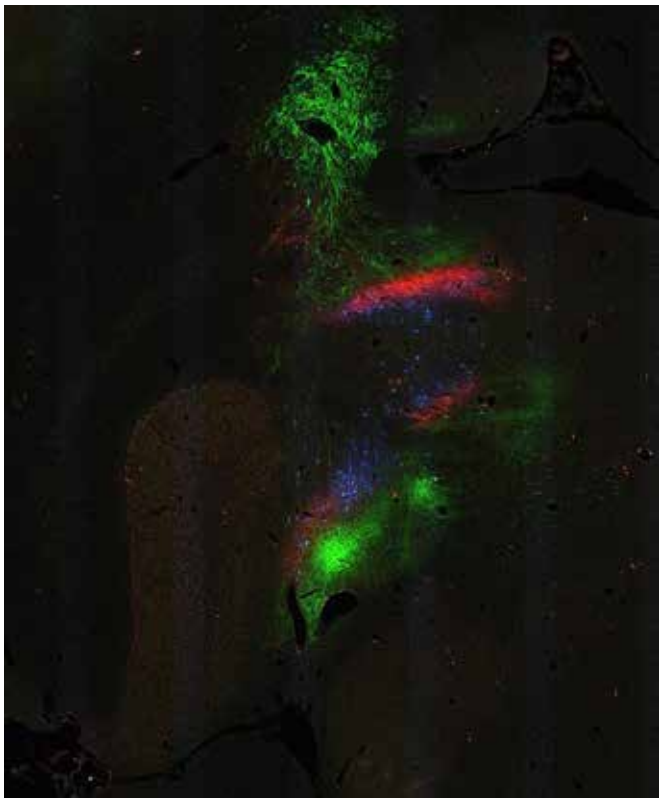
Investigators: Steve Petrou (UMelb), Greg Stuart (ANU) and Pankaj Sah (UQ)

Research outcomes achieved in 2017

» *Developed and deployed new high-speed microscopes for measuring activity across intact neural networks in the brain.*

» *Developed transgenic mouse lines for optogenetics and dendritic patch-clamp recording, to address how individual cells and circuits contribute to integrative brain function.*

Centre researchers are using optogenetics, in-house transgenic mouse lines, two-photon and high-speed imaging in conjunction with patch-clamp recording, to address how individual cells and circuits contribute to brain function. A microscope has been specifically built to allow for fast imaging (up to 2,000 samples per second) of both voltage and calcium signals that derive from changes in fluorescent intensity. Their results are fed into dynamic clamp computer-cell hybrids to predict the emergent behaviour of biophysically realistic models.



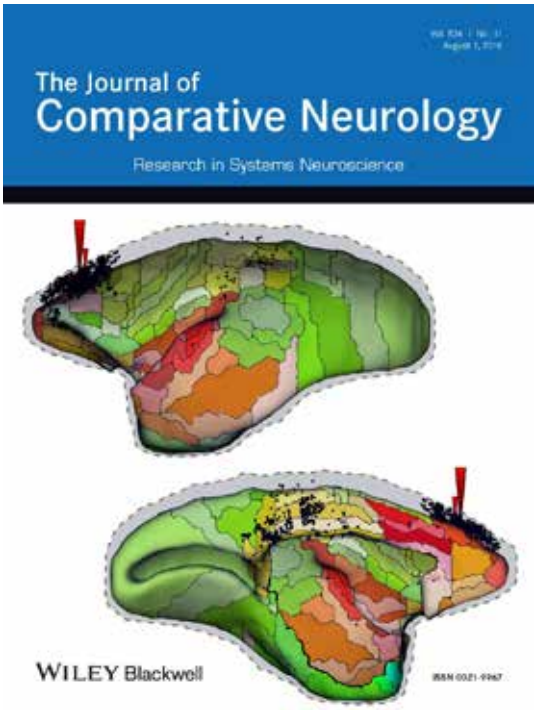
Stimulating connections: an effective connectivity brain map; DTI/MRI atlas of the rat brain; A digital atlas of connections in the marmoset brain; *and* A high-resolution 3D-MRI atlas of the human brain

Investigators: Gary Egan and Marcello Rosa (Mon), George Paxinos (UNSW)

Research outcomes achieved in 2017

» *Developed a publicly available database of the full pattern of cortical connections in non-human primate (marmoset) brains. Constructed and published brain atlases with resolutions greater than previously achieved.*

Centre researchers across two nodes in collaboration with international investigator Partha Mitra (Cold Spring Harbour) have developed brain connectivity maps using high-resolution imaging in humans and other primates. The imaging methods (Magnetic Resonance Imaging/ Diffusion Tensor Imaging, MRI/DTI) and brain tracer techniques have allowed them to construct connectivity atlases with resolutions 400x greater than previously achieved. Their results are giving completely new insights on the computational architecture of the primate brain and brain evolution, because they allow common principles of connectivity to be understood by direct measurement and cross-species comparison.



An automated way to combine and share brain data from world labs

Neuroscientists want detailed anatomical information about the average brain, and about how brains differ between individuals. This automated process brings the dream closer.

Neuroscientists dream of a brain atlas called a 'connectome' that not only shows how different regions connect to each other, brain cell by brain cell, but also lets them know how much brains differ from individual to individual.

For some animal species, a lot of neuroanatomical data has already been collected. Unfortunately, it is scattered across the world, in different laboratories, on different types of histology slides, and much of it unpublished.

Now that information can be collated using a series of high-throughput, automated image processing techniques and computational analyses, called the Marmoset Brain Architecture Project.

The procedures or 'toolbox' were developed by a team led by the Centre's Piotr Majka and Marcello Rosa, both of Monash University, in collaboration with partner investigator Partha Mitra of Cold Spring Harbor Laboratory.

The procedures capture, combine and share brain data from histological slides, both newly-generated and archived. In tests, the brain maps generated are almost as precise as those generated by expert neuroanatomists using the same slides. That's important, because it gives users an understanding of how much confidence they can place in their interpretations of the Project's data.

What's more, all data and computational tools are freely available to anyone through the Project website.

The Marmoset Brain Architecture Project will help reduce the number of animals needed to achieve a full-scale connectome of the marmoset brain cortex (in fact, of any primate), since a lot of the data already exists, says Rosa.

It could also be used in big-data brain research projects like the Human Brain Project.

Brain machine interface tiles; *and* Printable electronics for wide area neural recording

Investigators: Arthur Lowery (Mon), Stan Skafidis (UMelb)

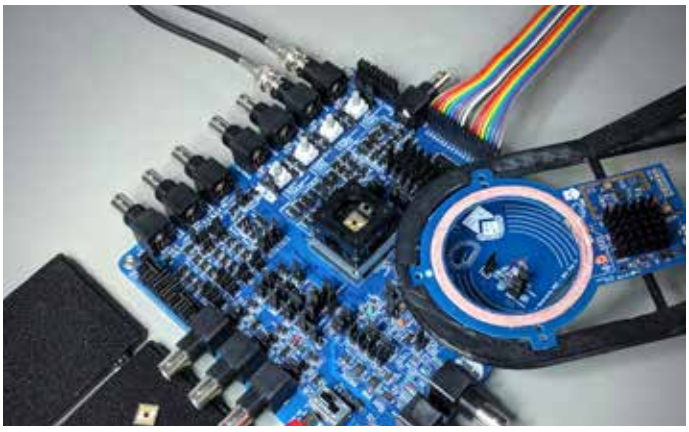
Research outcomes achieved in 2017

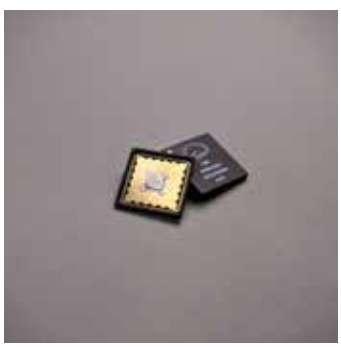
- *Developed a functional prototype of implantable wireless electronics for brain stimulation, recording, and data logging to study basis of attention and decision making in freely moving animals.*
- *Adapted ink-jet printer technology to prototype a completely printable, flexible and biocompatible neurotechnology prosthesis.*

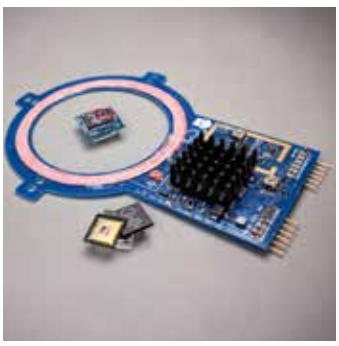
Centre researchers are developing completely new ways to record activity and activate nerve cell populations in the brain. They use inkjet technology to develop flexible and biocompatible neurotechnology prosthesis, and have achieved a functional bench prototype of an implantable wireless neural stimulating and recording system. The Centre is facilitating the training of the next generation of electrical engineers that are also trained in neuroscience and are able to produce the next generation of neural and biomedical prosthesis, an area of global strength for Australia.

Highlight

Prototypes of the wireless neural microchip have been developed and are currently in the testing phase.







Publications

2 Book chapters

3 Conference papers

60 Journal papers

4 Review papers

Book Chapters

Chaplin TA, Rosa MGP, Yu HH. *Scaling up the simian primate cortex: a conserved pattern of expansion across brain sizes*, in Evolution of Nervous Systems, J.H. Kaas, Editor. Academic Press: Massachusetts, USA; 2017. p. 99-111.

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Sforazzini F, Chen Z, Baran J, Bradley J, Carey A, Shah NJ, Egan GF. *MR-based attenuation map re-alignment and motion correction in simultaneous brain MR-PET imaging*. Proc IEEE Symp Biomed Imaging. 2017; 7950508: 231-234.

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Cornwell BR, Garrido MI, Overstreet C, Pine D, Grillon C. *The unpredictive brain under threat: A neurocomputational account of anxious hypervigilance*. Biol Psychiatry. 2017; 82(6): 447-454.

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Halupka KJ, Abbott CJ, Wong YT, Cloherty SL, Grayden DB, Burkitt AN, Sergeev EN, Luu CD, Brandli A, Allen PJ, Meffin H, Shivdasani MN. *Neural responses to multielectrode stimulation of healthy and degenerate retina*. Invest Ophthalmol Vis Sci. 2017; 58(9): 3770-3784.

Halupka KJ, Shivdasani MN, Cloherty SL, Grayden DB, Wong YT, Burkitt AN, Meffin H. *Prediction of cortical responses to simultaneous electrical stimulation of the retina*. J Neural Eng. 2017; 14(1): Art 016006.

Harris A, Dux P, Jones C, Mattingley J. *Distinct roles of theta and alpha oscillations in the voluntary capture of goal-directed attention*. NeuroImage. 2017; 152: 171-183.

Hatch RJ, Mendis DC, Kaila K, Reid CA, Petrou S. *Gap junctions link regular-spiking and fast-spiking interneurons in layer 5 somatosensory cortex*. Front Cell Neurosci. 2017; 11: Art 204.

Garcia JE, Hung YS, Greentree AD, Rosa MGP, Endler JA, Dyer AG. Improved color constancy in honey bees enabled by parallel visual projections from dorsal ocelli. Proc Natl Acad Sci USA. 2017; 114(9): 7713-7718.

A paper published by Centre researchers in the Proceedings of the National Academy of Science, presents a mathematical model to understand how pollinators, like the honey bee, perceive the same colours on visited flowers, despite continuous and rapid changes in ambient illumination and background colour? The model proposes that the observed spectral tuning of simple ocellar photoreceptors in the honey bee allows for the necessary input for an optimal color constancy solution to most natural light environments.

The model is fully supported by our detailed description of a neural pathway allowing for the integration of signals originating from the ocellar photoreceptors to the information processing regions in the bee brain. These findings reveal a neural implementation to the classic color constancy problem that can be easily translated into artificial color imaging systems.

The paper has since earned an Altemetric score of 211, within the top 5% of ALL research outputs scored by Altmetric.

Hearne L, Cocchi L, Zalesky A, Mattingley J. *Reconfiguration of brain network architectures between resting-state and complexity-dependent cognitive reasoning*. J Neurosci. 2017; 37(35): 8399-8411.

Hietanen MA, Price NSC, Cloherty SL, Hadjidimitrakis K, Ibbotson MR. *Long-term sensorimotor adaptation in the ocular following system of primates*. PloS One. 2017; 12(12): e0189030.

Ibbotson MR, Hung YS, Meffin H, Boeddeker N, Srinivasan MV. *Neural basis of forward flight control and landing in honeybees*. Sci Rep. 2017; 7(1): Art 14591.

Jones S, To MS, Stuart G. *Dendritic small conductance calcium-activated potassium channels activated by action potentials suppress EPSPs and gate spike-timing dependent synaptic plasticity*. eLife. 2017; 6: e30333.

Kheradpezhouh E, Adibi M, Arabzadeh E. *Response dynamics of rat barrel cortex neurons to repeated sensory stimulation*. Sci Rep. 2017; 7(1): Art 11445.

Kheradpezhouh E, Choy JM, Daria VR, Arabzadeh E. *TRPA1 expression and its functional activation in rodent cortex*. Open Biol. 2017; 7(4): Art 160314.

Kóbor P, Petykó Z, Telkes I, Martin PR, Buzás P. *Temporal properties of colour opponent receptive fields in the cat lateral geniculate nucleus*. Eur J Neurosci. 2017; 45(11): 1368-1378.

Publications

Mansouri FA, Acevedo N, Illipparampil R, Fehring DJ, Fitzgerald PB, Jaberzadeh S. *Interactive effects of music and prefrontal cortex stimulation in modulating response inhibition.* Sci Rep. 2017; 7(Art 18096).

Mansouri FA, Egner T, Buckley MJ. *Monitoring demands for executive control: Shared functions between human and nonhuman primates.* Trends Neurosci. 2017; 40(1): 15-27.

McFadyen J, Mermillod M, Mattingley JB, Halász V, Garrido MI. *A rapid subcortical amygdala route for faces irrespective of spatial frequency and emotion.* J Neurosci. 2017; 37(14): 3864-3874.

Mehta-Pandejee G, Robinson PA, Henderson JA, Aquino KM, Sarkar S. *Inference of direct and multistep effective connectivities from functional connectivity of the brain and of relationships to cortical geometry.* J Neurosci Meth. 2017; 283: 42-54.

Mukta KN, MacLaurin JN, Robinson PA. *Theory of corticothalamic brain activity in a spherical geometry: Spectra, coherence, and correlation.* Phys Rev E. 2017; 96(5): Art 052410.

Müller EJ, van Albada SJ, Kim JW, Robinson PA. *Unified neural field theory of brain dynamics underlying oscillations in Parkinson's disease and generalized epilepsies.* J Theor Biol. 2017; 428: 132-146.

Naughtin C, Mattingley J, Bender A, Dux P. *Decoding early and late cortical contributions to individuation of attended and unattended objects.* Cortex. 2017; 99: 45-54.

Nozari M, Suzuki T, Rosa MGP, Yamakawa K, Atapour N. *The impact of early environmental interventions on structural plasticity of the axon initial segment in neocortex.* Dev Psychobiol. 2017; 59(1): 39-47.

Palmer J, Keane A, Gong P. *Learning and executing goal-directed choices by internally generated sequences in spiking neural circuits.* PLoS Comput Biol. 2017; 13(7): Art e1005669.

Pang J, Robinson PA, Aquino KM, Vasan N. *Effects of astrocytic dynamics on spatiotemporal hemodynamics: Modeling and enhanced data analysis.* NeuroImage. 2017; 147: 994-1005.

Pietersen ANJ, Cheong SK, Munn B, Gong P, Martin PR, Solomon SG. *Relationship between cortical state and spiking activity in the lateral geniculate nucleus of marmosets.* J Physiol. 2017; 595(13): 4475-4492.

Ranjbar-Slamloo Y, Arabzadeh E. *High-velocity stimulation evokes "dense" population response in layer 2/3 vibrissal cortex.* J Neurophysiol. 2017; 117(3): 1218-1228.

Mansouri FA, Egner T, Buckley MJ. Monitoring demands for executive control: Shared functions between human and nonhuman primates. Trends Neurosci. 2017; 40(1): 15-27.

Centre researchers reviewed recent findngs regarding the role of the human dorsal anterior cingulate cortex (dACC) in detecting conflict and inducing adaptive control of behaviour.

Their research suggests that there are greater commonalities across species including equivalent behavioural consequences of conflict and similar neuronal signals in the dACC, but also a common failure of dACC lesions to reliably abolish conflict-driven behaviour.

Mansouri and his coauthors conclude that conflict might be one among many drivers of adjustments in executive control and that the ACC might be just one component of overlapping distributed systems involved in context-dependent learning and behavioural control.

This paper is a highly cited publication, within the top 1% of cited papers in the field of Neuroscience (WoS).

Mansouri FA, Koechlin E, Rosa MGP, Buckley MJ. Managing competing goals - a key role for the frontopolar cortex. Nat Rev Neurosci. 2017; 18(11): 645-657.

In this paper, published in the prestigious *Nature Reviews Neuroscience,* Mansouri et al. argue that many forms of uniquely human behaviour may benefit from the cognitive ability mediated by the frontopolar cortex.

Humans are set apart from other animals by many elements of advanced cognition and behaviour, including language, judgement and reasoning. What is special about the human brain that gives rise to these abilities? Could the foremost part of the prefrontal cortex (the frontopolar cortex), which has become considerably enlarged in humans during evolution compared with other animals, be important in this regard, especially as, in primates, it contains a unique cytoarchitectural field, area 10? The first studies of the function of the frontopolar cortex in monkeys have now provided critical new insights about its precise role in monitoring the significance of current and alternative goals. In human evolution, the frontopolar cortex may have acquired a further role in enabling the monitoring of the significance of multiple goals in parallel, as well as switching between them.

This research was publsihed in the number 1 ranked journal in the field of Neuroscience (WoS).

Publications

Reser DH, Majka P, Snell S, Chan JMH, Watkins K, Worthy K, Quiroga MDM, Rosa MGP. *Topography of claustrum and insula projections to medial prefrontal and anterior cingulate cortices of the common marmoset (Callithrix jacchus).* J Comp Neurol. 2017; 525(6): 1421-1441.

Roberts JA, Perry A, Roberts G, Mitchell PB, Breakspear M. *Consistency-based thresholding of the human connectome.* NeuroImage. 2017; 145: 118-129.

Robinson PA. *The balanced and introspective brain.* J R Soc Interface. 2017; 14(130): Art 20160994.

Roy N, Sanz-Leon P, Robinson PA. *Spectral signatures of activity-dependent neural feedback in the corticothalamic system.* Phys Rev E. 2017; 96(5): Art 052310.

Sale M, Nydam A, Mattingley J. *Stimulus uncertainty enhances long-term potentiation-like plasticity in human motor cortex.* Cortex. 2017; 88: 32-41.

Sanz-Leon P, Robinson PA. *Multistability in the corticothalamic system.* J Theor Biol. 2017; 432: 141-156.

Shevell SK, Martin PR. *Color opponency: Tutorial.* J Opt Soc Am A Opt Image Sci. 2017; 34(7): 1099-1108.

Simpson DA, Morrisroe E, McCoey JM, Lombard AH, Mendis DC, Treussart F, Petrou S, Hollenberg LCL. *Non-neurotoxic nanodiamond probes for intraneuronal temperature mapping.* ACS Nano. 2017; 11(12): 12077-12086.

Simpson DA, Ryan RG, Hall LT, Panchenko E, Drew SC, Petrou S, Donnelly PS, Mulvaney P, Hollenberg LCL. *Electron paramagnetic resonance microscopy using spins in diamong under ambient conditions.* Nat Commun. 2017; 8(1): Art 458.

Strobel C, Sullivan R, Stratton P, Sah P. *Calcium signalling in medial intercalated cell dendrites and spines.* J Physiol. 2017; 595(16): 5653-5669.

Taylor JA, Matthews N, Michie PT, Rosa MJ, Garrido MI. *Auditory prediction errors as individual biomarkers of schizophrenia.* Neuroimage Clin. 2017; 15: 264-273.

Townsend RG, Solomon SS, Martin PR, Solomon SG, Gong P. *Visual motion discrimination by propagating patterns in primate cerebral cortex.* J Neurosci. 2017; 37(42): 10074-10084.

Ward PGD, Fan AP, Raniga P, Barnes DG, Dowe DL, Ng ACL, Egan GF. *Improved quantification of cerebral vein oxygenation using partial volume correction.* Front Neurosci. 2017; 11: Art 89.

Ward SA, Raniga P, Ferris NJ, Woods RL, Storey E, Bailey MJ, Brodtmann A, Yates PA, Donnan GA, Trevaks RE, Wolfe R, Egan GF, McNeil JJ. *ASPREE-NEURO study protocol: A randomized controlled trial to determine the effect of low-dose aspirin on cerebral microbleeds, white matter hyperintensities, cognition, and stroke in the healthy elderly.* Int J Stroke. 2017; 12(1): 108-113.

Yang DP, Robinson PA. *Critical dynamics of Hopf bifurcations in the corticothalamic system: Transitions from normal arousal states to epileptic seizures.* Phys Rev E. 2017; 95(4): Art 042410.

Yong J, Hassan B, Liang Y, Ganesan K, Rajasekharan R, Evans R, Egan G, Kavehei O, Chana G, Nasr B, Skafidas E. *A silk ribbon fibroin Bio-Transient Solution Processable Memristor.* Sci Rep. 2017; 7(1): Art 14731.

Zhao X, Robinson PA. *Neural field model of seizure-like activity in isolated cortex.* J Comput Neurosci. 2017; 42(3): 307-321.

Zobaer MS, Anderson RM, Kerr CC, Robinson PA, Wong KKH, D'Rozario AL. *K-complexes, spindles, and ERPs as impulse responses: unification via neural field theory.* Biol Cybern. 2017; 111(2): 149-164.

Review Papers

Hagan MA, Rosa MGP, Lui LL. *Neural plasticity following lesions of the primate occipital lobe: The marmoset as an animal model for studies of blindsight.* Dev Neurobiol 2017; 77(3): 314-327.

Mansouri FA, Koechlin E, Rosa MGP, Buckley MJ. *Managing competing goals - a key role for the frontopolar cortex.* Nat Rev Neurosci. 2017; 18(11): 645-657.

Roberts JA, Friston KJ, Breakspear M. *Clinical applications of stochastic dynamic models of the brain, Part I: A primer.* Biol Psychiatry Cogn Neurosci Neuroimaging. 2017; 2(3): 216-224.

Roberts JA, Friston KJ, Breakspear M. *Clinical applications of stochastic dynamic models of the brain, Part II: A review.* Biol Psychiatry Cogn Neurosci Neuroimaging. 2017; 2(3): 225-234.

Presentations

International Presentations

Postnova S, Robinson PA. *Insight to shiftwork dynamics from neurophysical modelling of sleep and circadian rhythms.* 23rd International Symposium on Shiftwork and Working Time. 19-20 June 2017; Uluru, Australia.

Almasi A, Cloherty SL, Grayden DB, Wong YT, Ibbotson MR, Meffin H. *Are receptive fields in visual cortex quantitatively consistent with the theory of efficient coding?* 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Robinson PA, Zhao Z, Aquino K, Griffiths JD, Mehta-Pandejee G, Gabay N, MacLaurin J, Sarkar S. *Structure-function relationships via neural field theory.* 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Sah P. *The new science of learning.* 2nd International Conference on Educational Neuroscience. 5-6 March 2017; Abu Dhabi, United Arab Emirates.

Furlong TM. *Accelerated habitual behaviour resulting from L-dopa exposure is rescued by N-acetylcysteine.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Garrido MI. *Feedback loops in detecting (un) seen change.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Grünert U, Lee SCS, Kwan WC, Mundinano IC, Martin PR, Bourne JA. *Retinal ganglion cell types projecting to the pulvinar and superior colliculus in marmoset.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Hagan MA. *Mechanisms of feedforward processing in the visual system.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Hagan MA, Chaplin TA, Huxlin KR, Rosa MGP, Lui LL. *Fewer cells in the middle temporal area represent visual space inside the scotoma after chronic lesions of the primary visual cortex.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Kheradpezhouh E, Arabzadeh E. *TRPA1 modulation of information processing in mice somatosensory cortex.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Lee C, Clifford C, Arabzadeh E. *Neuronal correlates of sensory prioritization in rats.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Morris A, Krekelberg B. *A stable visual world in primate cortex during eye movements.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Price N, Zavitz E, Oakley, Rosa MGP. *Nonlinear temporal integration of visual motion.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Zavitz E, Price N. *How is motion information transformed between V1 and MT?* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 December 2017; Sydney, Australia.

Sah P. *Deep brain stimulation: From movement disorders to psychosurgery.* 6th Annual Neuropsychiatry and Behavioural Neurology Conference. 27-28 October 2017; Sydney, Australia.

Bland N. *Gamma coherence mediates interhemispheric transfer of visual information during multiple object tracking.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Affiliate scholar Nicholas Bland, from the University of Queensland, was awarded best talk at the Australasian Cognitive Neuroscience Society Conference.

Title of presentation: Gamma coherence mediates interhemispheric transfer of visual information during multiple object tracking.

Conference: 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Dzafic I. *Impaired regularity learning in healthy individuals with psychotic experiences is mediated by reduced top-down frontotemporal effective connectivity.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Filmer H. *Neurochemical inhibition in the prefrontal cortex predicts individuals' response to electrical stimulation.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Hall MG, Naughtin CK, Mattingley JB, Dux PE. *Distributed and opposing effects of incidental learning on visual processing in the human brain.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Jamadar SD, Chen Z, Li S, Sforazzini F, Baran J, Ward PGD, Egan GF. *Development of simultaneous functional MRI and functional PET imaging.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Rangelov D. *Bayesian inference as a model of complex decision making in humans.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Martin PR, Eiber C, Pietersen ANJ, Zeater N, Solomon SG. *Chromatic and achromatic response properties of blue-on cells in marmoset lateral geniculate nucleus.* Annual Meeting of the Association for Research in Vision and Ophthalmology. 7-11 May 2017; Baltimore, USA.

Zeater N. *Complex visual processing in subcortical visual pathways.* Asia Pacific Conference on Vision. 14-17 July 2017; Tainan, Taiwan.

Price N, Ghodrati M, Zavitz E, Rosa MGP. *Orientation tuning in V1 is contrast invariant on short, but not long, timescales.* Asia-Pacific Conference on Vision. 14-17 July 2017; Tainan, Taiwan.

Zavitz E, Hagan MA, Yu H-H, Rosa MGP, Lui L, Price, N. *Stimulus structure impacts population codes for motion within and between areas V1 and MT.* Asia-Pacific Conference on Vision. 14-17 July 2017; Tainan, Taiwan.

Hagan MA, Chaplin TA, Huxlin KR, Rosa MGP, Lui LL. *Motion selectivity of MT cells after V1 lesions.* Asian Pacific Conference for Vision 14-17 July 2017; Tianan, Taiwan

Grünert U, Nasir Ahmad S, Lee SC, Martin PR. *Melanopsin-expressing ganglion cells in human retina.* Association for Research in Vision and Ophthalmology (ARVO) Asia. 5-8 February 2017; Brisbane, Australia.

Paxinos G. *Know thyself.* Athens Science Festival. March 2017; Athens, Greece.

Mattingley JB. *The role of selective attention in conscious and unconscious vision: evidence from healthy and damaged brains.* Azrieli Program in Brain, Mind and Consciousness. Disorders in the Contents of Consciousness. 12 June 2017; Beijing, China.

Robinson PA. *Beyond connection matrices: Brain modes based analysis of Structure and Function.* BrainModes 2017. 11-14 December 2017; Delhi, India.

Sah P. *Neural circuits that mediate fear learning and extinction.* Brainnetome Lecture Series, Chinese Academy of Sciences. 15 March 2017; Beijing, China.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* Dementia Congress. November 2017; Athens, Greece.

Sarkar S, Robinson PA. *Zipf's Law for Australia: An outlier?* DPG-Frühjahrstagung (DPG Spring Meeting). 19-24 March 2017; Dresden, Germany.

Grünert U. *Anatomical analysis of the rod pathway in human retina.* Federation of European Neuroscience Societies. 20-23 September 2017; Pécs, Hungary.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* Fourth Symposium on Brainnetome Meets Genome. 16-17 October 2017; Beijing, China.

Stuart G. *SK channels in spines regulate STDP.* Gordon Research Conference on Dendrites. 26-31 March 2017; Lucca, Italy.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* Health Tourism Conference as a Lever for Development. March 2017; Athens, Greece.

Arabzadeh E. *Neural coding.* IBRO Neuroscience School. 1-5 August 2017; Kerman, Iran.

Sforazzini F, Chen Z, Baran J, Bradley J, Carey A, Shah NJ, Egan G. *MR-based attenuation map re-alignment and motion correction in simultaneous brain MR-PET imaging.* IEEE International Symposium on Biomedical Imaging. 18-21 April 2017; Melbourne, Australia.

Ward PGD, Ferris NJ, Raniga P, Ng ACL, Barnes DG, Dowe DL, Egan GF. *Vein segmentation using shape-based Markov Random Fields.* IEEE International Symposium on Biomedical Imaging. 18-21 April 2017; Melbourne, Australia.

Centre Fellow Phillip Ward, from Monash University, was awarded 3rd place in Best Student Paper Prize at the IEEE International Symposium on Biomedical Imaging.

Title of presentation: Vein segmentation using shape-based Markov Random Fields.

Conference: IEEE International Symposium on Biomedical Imaging. 18-21 April 2017; Melbourne, Australia.

Presentations

Mattingley JB. *Using frequency tagging to measure visual attention in real time.* International Neuropsychological Symposium. 20-24 June 2017; Sitia, Crete.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* International Symposium on Morphological Sciences Congress. 25-30 July 2017; Xi'an, China.

Paxinos G. *Opened conference.* Medical Society Corfu. November 2017; Corfu, Greece.

Robinson PA. *Physically based modeling and analysis of brain activity and function.* Opening Symposium of the ICCN and BCCN Berlin, and GRK Workshop From Neurons to Behavior - Computing across Scales. 12 October 2017; Berlin, Germany.

Stuart G. *Dendritic physiology.* SDC Neuroscience Symposium. 15-20 October 2017; Bejing, China.

Rosa MGP, Majka P, Takahashi Y, Worthy KH, Lin MK, Wolkowicz I, Tolpygo AS, Bai S, Huo B, Chan JM, Sasaki E, Reser DH, Okano H, Mitra PP. *Monosynaptic connections between auditory and visual areas in the marmoset monkey.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* Speech Therapy Conference. November 2018; Ioannina, Greece.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* Summer Symposium of Neurology of the Greek Academy of Neurosciences. May 2017; Athens, Greece.

Shivdasani MN, Halupka KJ, Spencer TC, Abbott CJ, Epp SB, Brandli A, Luu CD, Allen PJ, McGowan C, Nayagam DAX, Wong YT, Cloherty SL, Grayden DB, Burkitt AN, Sergeev EN, Fallon J.B., Meffin H. *Visual cortex responses to multichannel stimulation in retinal degeneration: Towards current focusing and steering.* The Eye and The Chip 24-26 September 2017; Detroit, USA.

Sah P. *Prefrontal inhibitory circuits and behavioral control.* Winter Conference on Neural Plasticity. 4-11 February 2017; St Georges, Grenada.

Paxinos G. *Brain or mind: Who is the puppet and who is the puppeteer?* World Federation of Neurosurgical Societies World Congress of Neurosurgery. 20-25 August 2017; Istanbul, Turkey.

National Presentations

Yang DP. *Moran process with network dynamics for the evolution of cooperation.* 2nd Australian Social Network Analysis Conference. 28-29 November 2017; Sydney, Australia.

Arabzadeh E. *Efficient sensory processing in rodent cortex.* Anderson Stuart Seminar Series. 23 October 2017; Sydney, Australia.

Garrido MI. *Digging deep with MEG.* ARC Centre of Excellence in Cognition and its Disorders, CCD-KIT Workshop. 5 December 2017; Sydney, Australia.

Arabzadeh E. *Neural coding.* Australian Course for Advanced Neuroscience (ACAN). 28 April 2017; Stradbroke Island, Australia.

Stuart G. *The electrical structure of neurons.* Australian Course for Advanced Neuroscience (ACAN). 27 April 2017; Stradbroke Island, Australia.

Garrido MI. *Modelling the interaction of attention and prediction errors.* Australian Mathematical Psychology Conference 2017. 14 February 2017; Brisbane, Australia.

Stuart G. *Neuronal computation.* BITS: Brain-Inspired Technologies and Systems symposium. 27 October 2017; Melbourne, Australia.

Garrido MI. *Brain connectivity modelling of prediction errors.* Brain-Inspired Technologies and Systems. 22 October 2017; Melbourne, Australia.

Stuart G. *How does MS influence electrical signalling in the brain.* Canberra MS symposium. 16 May 2017; Canberra, Australia.

Richards K. *Glass Brain: 3D whole brain imaging.* Imaging PhD course. April 2017; Melbourne, Australia.

Garrido MI. *Connectivity modelling of brain prediction errors.* MICCN Computational Neuroscience Symposium: The application and utility of computational neuroscience for understanding brain function. 2 February 2017; Melbourne, Australia.

Dzafic I. *Impaired regularity learning in healthy individuals with psychotic experiences is mediated by reduced top-down frontotemporal effective connectivity. Paint a bigger picture,* Science meeting of the ARC Centre of Excellence for Integrative Brain Function. 2 Decemebr 2017; Sydney, Australia.

Sanz-Leon P. *Multiscale neural field dynamics. Paint a bigger picture,* Science meeting of the ARC Centre of Excellence for Integrative Brain Function. 2 December 2017; Sydney, Australia.

Tang M. *How prediction affects sensory representation in humans and rodents. Paint a bigger picture,* Science meeting of the ARC Centre of Excellence for Integrative Brain Function. 12 December 2017; Sydney, Australia.

Presentations

Zeater N. *Binocular integration in the marmoset lateral geniculate nucleus. Paint a bigger picture*, Science meeting of the ARC Centre of Excellence for Integrative Brain Function. 2 December 2017; Sydney, Australia.

Sah P. *Anxiety and depression - the search for better therapeutics*. QBI Neuroscience Seminars. 11 October 2017; Brisbane, Australia.

Chandra A. *Calretinin immunolabelling in retina*. Save Sight Institute, Annual Higher Degree Research Student Symposium, Vision Science and Ophthalmology. 31 March 2017; Sydney, Australia.

Masri R. *Characterisation of ganglion cell populations in marmoset retina*. Save Sight Institute, Annual Higher Degree Research Student Symposium, Vision Science and Ophthalmology. 31 March 2017; Sydney, Australia.

Gu Y, Qi Y, Gong P. *Interrelating the structural connectivity and spatiotemporal dynamics of cortical microcircuits*. Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

McFadyen J, Heider B, Karkhanis AN, Muñoz F, Ramalingam N, Siegel RM, Morris AP. *Population coding of gaze direction in parietal cortex during reaching and changing visual scenes*. Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Pang JC, Robinson PA, Aquino KM, Lacy TC, Schira MM. *Deconvolving a palimpsest of brain activity and hemodynamics from fMRI*. Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Zavitz E, Hagan M, Yu H-H, Rosa PGP, Lui L, Price N. *Population codes in V1 and MT are opimized for the structure of natural images*. Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Garrido MI. *Connectivity underpinnings of statistical learning in healthy people with psychotic experiences*. Systems & Computational Neuroscience Down Under 2017 (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Sah P. *Hippocampus and amygdala,* Systems & Computational Neuroscience Down Under 2017 (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Sanz-Leon P. *Large scale brain dynamics*. University of Western Sydney, Seminar Series. 14 March 2017; Sydney, Australia.

Postnova S. *Physiologically based modelling of sleep and alertness*. WIMSIG 2017: Women in Australian Mathematical Sciences. 24-26 September 2017; Adelaide, Australia.

Poster Presentations

Filmer HL, Lyons M, Mattingley JB, Dux PE. *Anodal tDCS applied during multitasking training leads to transferable performance gains*. 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

McFadyen J, Mattingley J, Garrido M. *Fibre density of the subcortical route to the amygdala enhances fearful face perception: a tractgraphy and DCM analysis of the HCP dataset*. 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

Painter D, Renton A, Kim J, Mattingley J. *Are two brains better than one? Evidence for neural synchrony across co-actors in a visually guided movement task*. 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

Rangelov D, Mattingley J. *Maintaining multiple attentional sets decreases the specificity of cognitive control,* 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

Renton A, Painter D, Mattingley J. *Differential mobilization of visual selective attention during dynamic approach and avoidance behaviour.* 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

Smout C, Garrido M, Tang M, Mattingley J. *Expectation effects pre-stimulus neural activity.* 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

Wittenhagen L, Mattingley J. *Role of spatial attention in modulation of neural representations of illusory shapes,* 13th International Conference for Cognitive Neuroscience. 5-8 August 2017; Amsterdam, Netherlands.

Ferdousi M, Babaie T, Robinson PA. *Nonlinear harmonic generation and wave-wave interactions in the brain*. 2017 Annual Meeting of the Organization for Human Brain Mapping. 25-29 June 2017; Vancouver, Canada.

Griffiths JD, Aquino K, Robinson PA, McIntosh AR. *The spherical harmonic structure of MEG functional connectivity networks*. 2017 Annual Meeting of the Organization for Human Brain Mapping. 25-29 June 2017; Vancouver, Canada.

MacLaurin J, Robinson PA. *Inference of structural connectivity from functional connectivity of brain networks*. 2017 Annual Meeting of the Organization for Human Brain Mapping. 25-29 June 2017; Vancouver, Canada.

Presentations

Roy N, Sanz-Leon P, Robinson PA. *Signatures of neural feedback effectsin power spectra of large-scale brain activity*. 2017 Annual Meeting of the Organization for Human Brain Mapping. 25-29 June 2017; Vancouver, Canada.

Almasi A, Cloherty SL, Grayden DB, Wong YT, Ibbotson MR, Meffin H. *Are receptive fields in visual cortex quantitatively consistent with the theory of efficient coding?* 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Assadzadeh S, Robinson PA. *Necessity of sleep and wake for synaptic homeostasis*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Babaie T, Robinson PA. *Neural field theory of corticothalamic prediction and attention*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Deeba F, Sanz-Leon P, Robinson PA. *Dependence of absence seizure dynamics on physiological parameters*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Gu Y, Gong P. *Sharp wave ripples as propagating patterns emerging from spatially extended neural circuits*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Henderson J, Gong P. *Self-organised balanced spiking neural networks to encode natural stimuli*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Li LW, Lizier J, Sanz-Leon P, Kerr CC. *Network analysis of task-oriented neuroimaging data via multivariate information-theoretic measures*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Qin W, Hadjinicolaou A, Meffin H, Burkitt A, Grayden D, Ibbotson MR, Kameneva T. *Single-compartment models of retinal granglion cells with different morphologies*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Sanz-Leon P, Knock SA. *Spreading of nonlinear dynamics in a nonuniform neural field model*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Sanz-Leon P, Robinson PA. *Low-and high-mode waking states in the cortiocothalamic system*. 26th Annual Computational Neuroscience Meeting. 15-20 July 2017; Antwerp, Belgium.

Mitchell B, Tang M, Mattingley J, Arabzadeh E. *Single-cell expectation suppression and expectation enhancement in the vibrissal cortex of anaesthetised mice*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Chandra AJ, Lee SCS, Masri RA, Grünert U. *Identification of calbindin positive cells in the human retina*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Chaplin TA, Hagan MA, Allitt BJ, Rosa MGP, Lui LL. *Effects of spike count correlations on population decoding of motion embedded in noise in the middle temporal area*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Eiber CD, Pietersen ANJ, Zeater N, Townsend R, Solomon SG, Martin PR. *Single unit and beta-band local field potential responses to visual stimulus in primate lateral geniculate nucleus (LGN)*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Gabay N, Babaie T, Robinson PA. *Spatiotemporal properties of eigenmodes of brain activity: a neural field analysis*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Dyce G, Tang M, Mattingley J, Arabzadeh E. *Frequency tagging in the mouse vibrissal cortex*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Meffin H, Almasi A, Sun S, Wong YT, Cloherty SL, Yunzab M, Ibbotson MR. *Revisiting feature invariance of complex cells in primary visual cortex*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Lee SCS, Martin PR, Rosa MGP, Grünert U. *Subpopulations of wide-field ganglion cells express the transcription factor FoxP2 in marmoset retina*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Yunzab M, Choi V, Meffin H, Cloherty SL, Scholl B, Priebe NJ, Ibbotson MR. *Contrast-dependent phase-sensitivity in mouse primary visual cortex: an intracellular study*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Marek R, Xu L, Sah P. *Parvalbumin interneurons shape hippocampus-driven prefrontal activity in fear extinction*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Masri RA, Purushothuman S, Lee SCS, Martin PR, Grünert U. *Distribution of three types of cone bipolar neurons in the inner nuclear layer of the human retina*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Meffin H, Almasi A, Sun S, Cloherty SL, Wong YT, Yunzab M, Ibbotson MR. *Revisiting feature invariance of complex cells in primary visual cortex*. 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Presentations

Pietersen ANJ, Eiber CD, Zeater N, Solomon SG, Martin PR. *Split identity of blue-off and suppresssed-by-contrast cells in lateral geniculate nucleus of anaesthetised marmosets.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Cloherty SL, Yates JL, DeAngelis GC, Mitchell JF. *Motion perception in the common marmoset.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Singh T, Lee C, Fenlon L, Suarez R, Richards L, Arabzadeh E. *A controlled behavioural paradigm for bilateral integration of information in the whisker sensory system.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Wang C, Marek R, Stratton P, Sah P. *State-specific neural activity in the medial prefrontal cortex and hippocampus that encodes fear learning and extinction behaviour.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Yunzab M, Choi V, Meffin H, Cloherty SL, Scholl B, Priebe NJ, Ibbotson MR. *Contrast-dependent phase sensitivity in mouse primary visual cortex: An intracelluar study.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Zeater N, Cheong SK, Pietersen ANJ, Dreher B, Solomon SG, Martin PR. *Interocular matching of receptive field properties in binocular cells of the marmoset LGN.* 37th Annual Meeting of the Australasian Neuroscience Society. 3-6 Dember 2017; Sydney, Australia.

Hearne L. *Anomalous functional network integration in response to cognitive control demands in human callosal dysgenesis.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Affiliate scholar Luke Hearne, from the University of Queensland, was awarded best Poster at the Australasian Cognitive Neuroscience Society Conference

Title of presentation: Anomalous functional network integration in response to cognitive control demands in human callosal dysgenesis.

Conference: 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Jamadar SD, Chen Z, Li S, Sforazzini F, Baran J, Ward PGD, Egan GF. *New advances in simultaneous BOLD-fMRI and dynamic [18F]FDG-PET imaging of human brain function.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Travis S. *Neural correlates of goal-directed attentional capture in the absence of conscious perception.* 7th Australasian Cognitive Neuroscience Society Conference. 23-26 November 2017; Adelaide, Australia.

Mukta K. *Bangladeshi woman physicist working on eigenmode analysis of the spherical brain activity.* Abdus Salam International Centre for Theoretical Physics (ICTP) Career Development Workshop for Women in Physics. 9-13 October 2017; Trieste, Italy.

Grünert U, Nasir Ahmad S, Lee SC, Martin PR. *Melanopsin-expressing ganglion cells in human retina.* Annual Meeting of the Association for Research in Vision and Ophthalmology. 7-11 May 2017; Baltimore, USA.

Jamadar SD, Chen Z, Li S, Sforazzini F, Baran J, Ward PGD, Egan GF. *Assessment of Brain Reserve using Simultaneous MR-PET Imaging.* Australian Dementia Forum 2017. 15-17 October 2017; Melbourne, Australia.

Ferdousi M, Babaie T, Robinson PA. *Nonlinear harmonic heneration and wave-wave interactions in the brain.* Brain, Mind, Research Institute Symposium. 13 October 2017; Sydney, Australia.

Mukta K, MacLaurin J, Robinson PA. *Eigenmode analysis of spherical brain activity via neural field theory.* BrainModes 2017. 11-14 December 2017; Delhi, India.

Karle T. *Lightsheet microscopy.* Epilepsy Research Retreat. June 2017; Marysville, Australia.

Richards K. *Multimodal imaging pipeline.* Epilepsy Research Retreat. June 2017; Marysville, Australia.

Wijetunge C. *Light-sheet fluorescence microscopy: a promising technique for mesoscopic level connectotomics.* Epilepsy Research Retreat. June 2017; Marysville, Australia.

Grünert U, Chandra A, Lee SCS. *Morphological and neurochemical characterization of narrow and broad thorny ganglion cells in marmoset retina.* European Retina Meeting 2017. 5-7 October 2017; Paris, France.

Martin PR, Eiber CD, Pietersen ANJ, Zeater N, Solomon SG. *Contrast summation of opponent cone inputs to blue-on (S-cone) cells in marmoset monkeys.* European Retina Meeting 2017. 5-7 October 2017; Paris, France.

Munn BR, Zeater N, Pietersen AN, Solomon SG, Cheong SK, Gong P, Martin PR. *Fractal property of maintained spiking activity in parvocellular, mag-noncellular and koniocellular cells of marmoset lateral geniculage nucleus.* Federation of European Neuroscience Societies. 20-23 September 2017; Pécs, Hungary.

Presentations

Yang DP, Robinson PA. *Transitions from normal arousal states to epileptic seizures and from seizure suppression to generalization.* International Conference on Technology and Analysis for Seizures. 20-23 August 2017; Minneapolis, USA.

Ward PGD, Ferris NJ, Raniga P, Ng ACL, Dowe DL, Barnes DG, Egan GF. *Regional variations in cerebral venous contrast using susceptibility-based MR.* International Society of Magnetic Resonance in Medicine 25th Annual Meeting. 22-27 April 2017; Hawaii, USA.

Yates JL, Cloherty SL, DeAngelis GC, Mitchell JF. *Motion estimation in the common marmoset.* Sunposium 2017, Max Planck Florida Institute for Neuroscience. 13-14 February 2017 Forida, USA.

Ward PGD, Ferris NJ, Raniga P, Dowe DL, Ng ACL, Barnes DG, Egan GF. *Improving venous blood vessels analysis in the brain using anatomical patterns and MR.* Monash University Faculty of Medicine, Nursing and Health Sciences Early Career Researcher Symposium, 2017. 30 October 2017; Melbourne, Australia.

Close TG, Sforazzini F, Ward PGD, Chen Z, Egan GF. *NeuroImaging Analysis (NiAnalysis): archive-centred analysis of neuroimaging data.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Testa-Silva G, Häusser M, Stuart G. *Backpropagating action potentials boost dendritic inhibition.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Huang H, Stuart G. *Cortical processing of binocular information in the mouse.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

De Vitis M, Hadjidimitrakis K, Breveglieri R, Bosco A, Galletti C, Fattori P. *Segregated processing of reach depth and direction signals in the macaque area PE.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Fillipini M, Breveglieri R, Hadjidimitrakis K, Bosco A, Galletti C, Fattori P. *Decoding of real reaching targets in 3D space from monkey area V6A.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Müller EJ, van Albada SJ, Kim JW, Robinson PA. *Unified neural field theory of brain dynamics underlying oscillations in Parkinson's disease and generalized epilepsies.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Munn BR, Zeater N, Solomon SG, Cheong SK, Gong P, Martin PR. *Fractal property and non-Gaussian dynamics of maintained spiking activity in parvocellular, magnocellular and koniocellular cells of marmoset lateral geniculate nucleus.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Centre Fellow Dongping Yang, from the University of Sydney, received an international travel award from conference organisers to attend and present at the International Conference for Technology and Analysis of Seizures.

Title of presentation: *Transitions from normal arousal states to epileptic seizures and from seizure suppression to generalization.*

Conference: International Conference on Technology and Analysis for Seizures. 20-23 August 2017; Minneapolis, USA.

Cloherty SL, Yates JL, DeAngelis GC, Mitchell JF. *Motion perception in the common marmoset.* Society for Neuroscience 47th Annual Meeting 2017. Washington DC, USA; Washington DC, USA.

Gharaei S, Arabzadeh E, Stuart G. *Impact of the superior colliculus on cortical processing of somatosensory (whisker) input.* Society for Neuroscience 47th Annual Meeting 2017. 11-15 November 2017; Washington DC, USA.

Lowery A. *The Challenges of Brain Machine Interfaces.* Students of Brain Research (SoBR) Student Symposium. 11 October 2017; Melbourne, Australia.

Almasi A, Cloherty SL, Wong YT, Grayden D, Ibbotson MR, Meffin H. *On classification of simple and complex cells in primary visual cortex.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Chen G, Gong P. *Computing by modulating spontaneous activity patterns: A mechanism of active cortical processing.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Gao X, Robinson PA. *Global signal effect in functional connectivity using eigenmode analysis.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Liu X, Sanz-Leon P, Robinson PA. *Gamma-band correlations in primary visual cortexq.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Liu Y, Gong P. *Gamma oscillations as dynamical patterns for optimally implementing distributed information communication.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Presentations

Qi Y, Gong P. *Spatiotemporal probabilistic inference emerging from balanced cortical circuit.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Wardak A, Gong P. *A fractional diffusion theory of balanced, heterogeneous cortical circuits.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Yang DP. *High-frequency transient wave at onset of focal seizure generalization.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Dzafic I, Randeniya R, Garrido M. *Impaired regularity learning in healthy individuals with psychotic experiences is mediated by reduced top-down frontotemporal effective connectivity.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Larsen KM, Morup M, Birknow M, Fischer E, Hulme O, Vangkilde A, Schmock H, Baare W, Didriksen M, Olsen L, Werge T, Siebner H, Garrido M. *Altered auditory processing and top-down connectivity in 22q 11.2 Deletion Syndrome.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

McFadyen J, Mattingley J, Garrido M. *Fibre density of the subcortical route to the amygdala enhances fearful face perception: a tractgraphy and DCM Analysis of the HCP dataset.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Oestreich L, Randeniya R, Garrido M. *White matter connectivity distruptions associated with psychotic experiences in healthy individuals.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Renton A, Mattingley J, Painter D. *Translating thoughts into text: rapid communication with a brain computer interface virtual keyboard.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Rowe E, Harris C, Randeniya R, Garrido M. *Bayesian model selection maps for group studies using EEG data.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Smout C, Tang M, Garrido M, Mattingley J. *Independent effects of attention and expectation on stimulus representation in the visual cortex.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Taylor J, Matthews N, Michie P, Rosa M, Garrido M. *Auditory prediction errors as individual biomarkers of schizophrenia.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Wang C, Marek R, Stratton P, Sah P. *State-specific neural activity in the medial prefrontal cortex and hippocampus that encodes fear learning and extinction behaviour.* Systems & Computational Neuroscience Down Under (SCiNDU). 13-15 December 2017; Brisbane, Australia.

Deeba F, Sanz-Leon P, Robinson PA. *Dynamics of absence seizures.* The American Physical Society - March Meeting 2017. 13-17 March 2017; New Orleans, USA.

CENTRE PROGRAMS

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Education programs

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Brain Dialogue users

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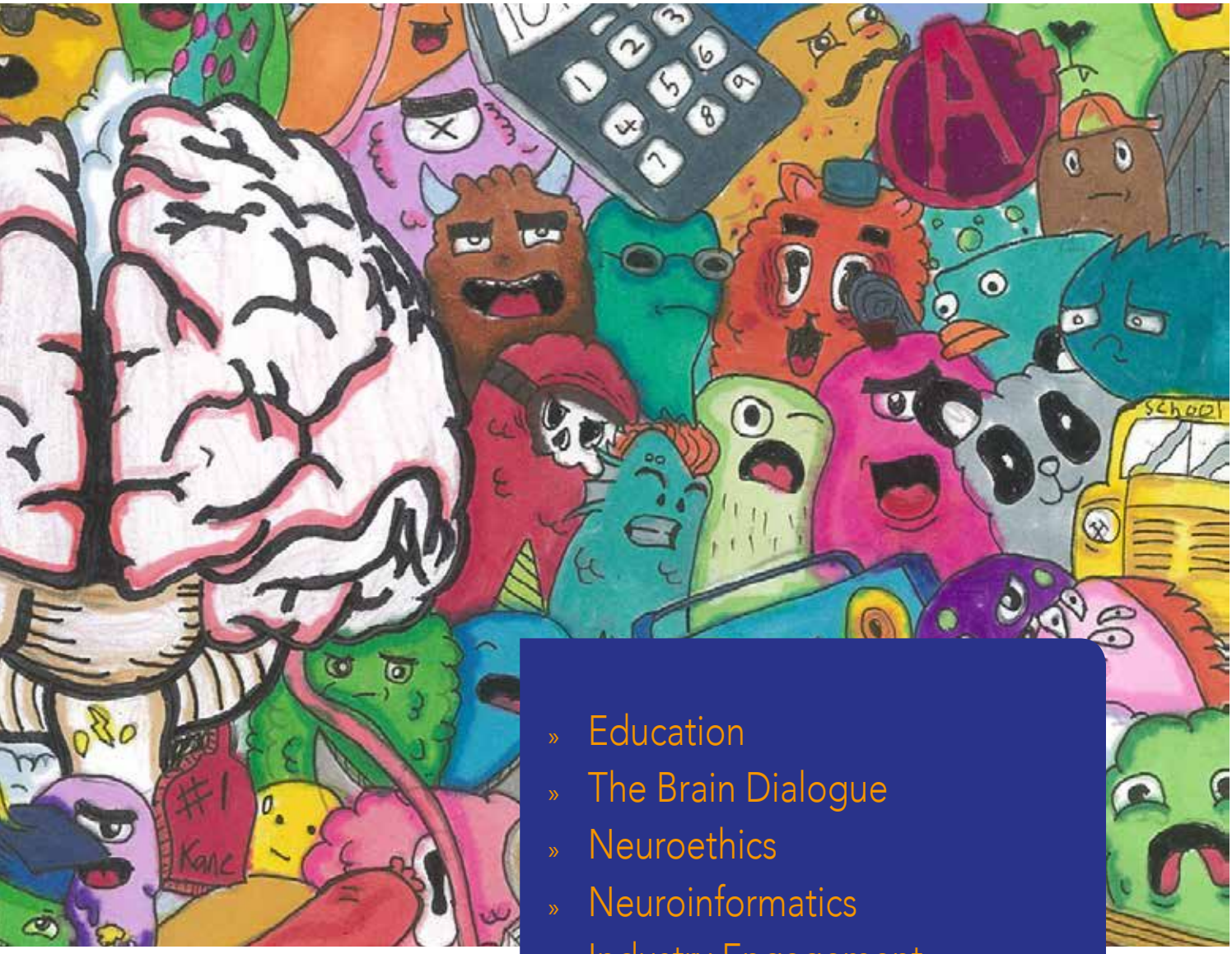
Publicly available software tools



- Education
- The Brain Dialogue
- Neuroethics
- Neuroinformatics
- Industry Engagement
- Gender, Equity and Diversity
- Centre Events
- Sponsorship

Education and Early Career Researchers

Dr Maria del Mar Quiroga, Education and Outreach Officer

The Centre's Early Career Researcher (ECR) Program aims to provide a network of support for Centre-associated ECRs and enhance their career development. The ECR Executive Committee plans and drives activities for Centre ECRs through monthly video conference meetings with the Education and Outreach Officer.

The Centre offers professional support, development and mentoring opportunities. The ECR cohort were brought together to elect an Executive Committee to represent their interests at Centre meetings, and to coordinate events and activities to support their research interests and professional development requirements. The 2017 elected committee facilitated an inaugural ECR retreat, as well as continued to commit funding to an inter-lab exchange program, travel award funding and state-based events to foster networking and collaboration.

The ECR Committee met monthly and reported to the Centre's Executive Committee twice per year. The 2017 representatives on the ECR Committee were:

- Dr Matthew Tang, Chair (QLD)
- Dr Tara Babaie (NSW)
- Dr Saba Gharaei (ACT)
- Mr Daniel Fehring (VIC)

Sunshine and science at ECR retreat

The 2017 Centre ECR retreat was held at North Stradbroke Island near Brisbane in June and was attended by 28 Centre ECRs.

During the four-day retreat, Centre ECRs were given opportunities to share their research and better understand the research being undertaken by other groups within the Centre. Specific career development activities were held with Centre Chief Investigators Professors Jason Mattingley, Michael Ibbotson, Pankaj Sah and Gary Egan, and invited external speakers, including interactive discussions on a variety of topics such as research collaboration, publishing, and transitioning to mid-career research positions.

Other sessions included information on career pathways within and beyond academia, and on opportunities such as neuroscience startups, publishing in generalist journals, popular science writing and media training. For example, the former Editor-in-Chief of the Brisbane Times gave an interactive workshop on how ECRs can present and engage with the media about their research, and a former PhD student from the ARC CoE in Vision Science presented on careers outside academia.

Ice-breaking activities included an interactive debate on whether neuroscience can fully explain consciousness. There were many breakout sessions so the group could enjoy the sunshine and informally share their own research. Overall, the retreat was a great success and provided excellent opportunities for the ECRs to network with each other.

To ensure that the Centre continues to support its young researchers appropriately and that the ECR Program reflects their career development needs and preferences, all ECRs were asked to complete a survey at the end of the retreat, the results of which inform planning for future program initiatives.






Pitch competition

To address the gaps in cross-institutional collaborations and industry engagement for the Centre's early career researchers, we ran a 'pitch competition' during 2017. ECRs with bright ideas and enthusiasm to work collaboratively were invited to form teams containing members from at least two of the Centre's participating institutions, and work on a proposal for:

1. an exciting new neuroscience experiment (NeuroX), or
2. an innovative brain technology project that could lead to commercialisation (BrainteX).

Teams benefited from working with Mr Amir Eldad, co-founder of MassChallenge Israel and Monash University's Entrepreneur in Residence. Each team received a 30-minute Zoom coaching session with Mr Eldad and Dr Maria del Mar Quiroga, to help refine their idea and three-minute pitch.

The final pitches took place during the Centre's Annual General Meeting dinner in Sydney in December 2017. The ECR workshops preceding the dinner focused on preparing for the final pitches and included interactive sessions to get feedback from other ECRs, self-work sessions, and a session on entrepreneurship by Mr Eldad.

Teams presented their three-minute pitch, and all attendees, including Centre Advisory Board members, Chief Investigators, Associate Investigators, ECRs and staff, voted for their favourite. The results were announced at the end of the dinner, with the winning team, formed by Molis Yunzab, Babak Nasr and Ali Almasi from the University of Melbourne, receiving $4000 to conduct their project in 2018. All winning team members also received individual prizes. The second-place winner was deemed to be a three-way tie between the other participating teams, which each received $2000 to conduct their project, plus individual prizes. The winning team will present its results at the Centre's 2018 Annual General Meeting.

All the teams may also be invited to participate in a potential Centre delegation to Israel in March 2019 for the Brain Tech 2019 conference and joint scientific symposium.

ECR travel awards

The ECR Executive Committee organised two rounds of travel awards during 2017. These awards facilitate travel that benefits ECRs' research and/or careers. Applications were competitively judged, and a total of 12 ECRs were awarded around $18,000 collectively to travel to eight international and four national conferences.

Images:

Opposite page: Centre Early Career Researchers at the inaugural Stradbroke Island retreat.

Below: Centre Early Career Researchers pitch competition winning team from the University of Melbourne at the Centre's AGM in Sydney.

Primary and secondary education programs

Secondary schools
Australian and New Zealand Brain Bee Challenge

The Centre is the host of the Australian and New Zealand Brain Bee Challenge from 2017 to 2020, with Professor Ramesh Rajan from the Department of Physiology, Monash University, and the Centre's Education and Outreach Officer, Dr Maria del Mar Quiroga, as the National Coordinators.

The Brain Bee Challenge is an annual neuroscience competition for students in year 10 in Australia and in year 11 in New Zealand. The competition encourages students to learn about the brain and how it works, aiming to dispel myths about brain disorders and inspiring students to pursue brain-related careers in medicine and research.

The competition began with an online quiz managed by partner Education Perfect during Brain Awareness Week in March. The top-performing students were invited to participate in regional finals, organised by the Brain Bee's local coordinators, and one finalist per state or region progressed to the national finals. The 2017 national final was held on Monday 4 December during the Australasian Neuroscience Society (ANS) conference in Sydney.

The Australian winner was Elaine Cheung from Mac. Robertson Girls' High School in Melbourne, VIC, and the runner-up was Wenjing Chen from James Ruse Agricultural High School in Carlingford, NSW.

The New Zealand winner was Alan Li from Lincoln High School, near Christchurch, and the runner-up was Jemima Po from the Diocesan School for Girls in Auckland.

The finalists were invited to attend the rest of the ANS conference, with three of them taking the opportunity to be escorted around the conference by Dr Quiroga, who took them to a variety of talks and to view posters. The students also had the opportunity to talk with some of the Centre's researchers and were invited to visit the researchers' labs.

In our first year of hosting in 2017, we implemented a range of procedural and academic changes to improve the competition, including a major overhaul of branding, reactivation and updating of website and social media, documentation of the process for future National Coordinators, and major updating of the questions asked in the different rounds of the competition. We are currently working to develop a new set of online interactive study materials for all rounds of the competition to further engage and motivate students.

Primary schools drawing competition

The Centre continued its successful neuroscience drawing competition as part of Brain Awareness Week, 14–20 March 2017. Brain Awareness Week is a global campaign, led by The Dana Foundation, which aims to increase awareness of the importance and current state of brain research in the world.

We invited primary school students from around Australia to create a drawing inspired by the thought: "I use my brain to…". We received over 400 entries across three categories:

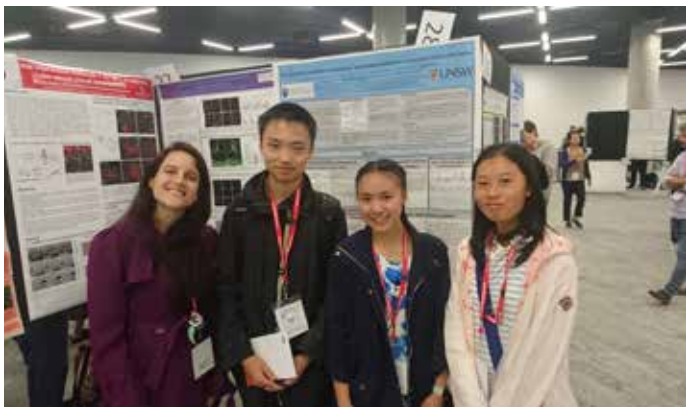
- Category 1: Foundation year (Prep) and Year 1 (ages 5–7)
- Category 2: Years 2–4 (ages 7–10)
- Category 3: Years 5–6 (ages 10–12)

Prof Jason Mattingley and Dr Maria del Mar Quiroga engaged the help of more than 30 researchers from Monash University to shortlist the drawings. Around 15 drawings per category were placed online, and 96 Centre members voted for their favourite drawings.

Three winners each received a prize pack containing brain-related books, activities, puzzles and games. Each winner's school received a brain-related resource pack and a voucher to purchase more educational resources.

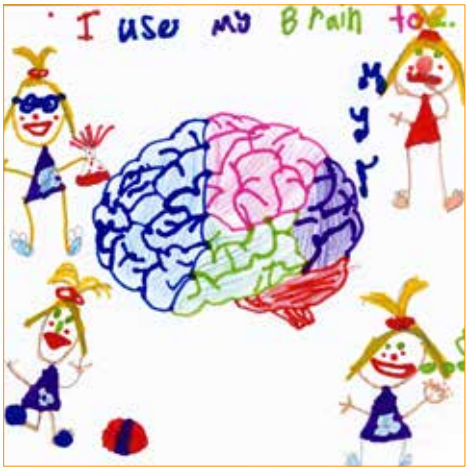
Centre members, including Prof Michael Ibbotson, Dr Quiroga, and ECRs Ms Rania Masri, Dr Natalie Zeater, Kirsty Petrie and Dr Matthew Tang, visited the winners' schools to award the prizes and to speak about their work as neuroscientists.

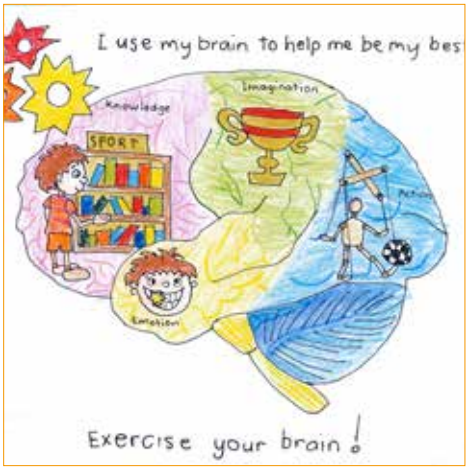
A hardcover 'coffee-table' book was published with the winning artworks from the 2016 and 2017 competitions for display and distribution at our Centre nodes. Some of the most popular entries were also printed as nine different large-scale collages and exhibited at Lionel Bowen Library (part of Randwick City Library) in Maroubra, NSW, for four weeks in October.

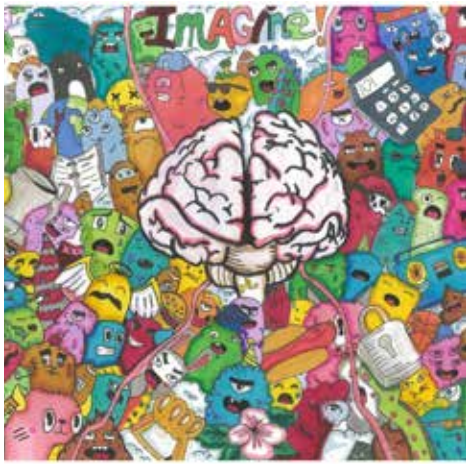


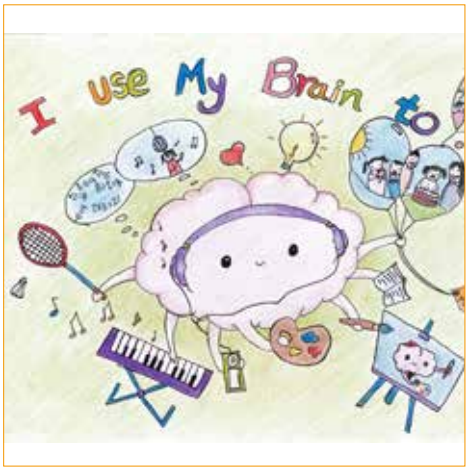
Students competing at the national finals of the Australian and New Zealand Brain Bee Challenge in Sydney.

“I use my brain to.....









Row 1: Category 1, 1st place by Stefanie, 2nd place by Tess, 3rd place by Jai.
Row 2: Category 2, 1st place by Ghil, 2nd place by Riley, 3rd place by Gabby.
Row 3: Category 3, 1st place by Kane, 2nd place by Lok Yi, 3rd place by Amelia.

The Brain Dialogue

Dr Maria del Mar Quiroga, Education and Outreach Officer
Dr Rachel Nowak, Director (until May 2017)

Brain-computer interface demonstration at 'Machines That Read Your Mind'

The Brain Dialogue is a neuroscience engagement program that uses 'responsive research and innovation' tactics to strengthen connections between end users and researchers. Our aim is to facilitate knowledge sharing to maximise the social, economic and scientific benefits of brain research.

The Centre continues to share knowledge among different communities, including:

- The Australian public who need to be kept abreast of the rapid progress in brain research and the issues and opportunities it offers, and to have a say in the research pathway;
- Investigators who benefit from insight into end users' needs and aspirations, allowing them to better align their research with public needs;
- Industry that benefits from understanding the Centre's interests and capabilities.

Visit The Brain Dialogue's website: cibf.edu.au

Plain-language summaries

On the Discovery section of the Brain Dialogue website (cibf.edu.au), we write plain-language summaries of recently published Centre research. These include 'In A Nutshell' single-sentence summaries; 'Big Picture' translations that explain the paper and its significance in plain English; and 'Next Steps' to encourage further exploration. Communicating our research in this way not only informs the broader community as to what the Centre does, but also opens up opportunities for interdisciplinary research and linkage within the scientific community and industry.

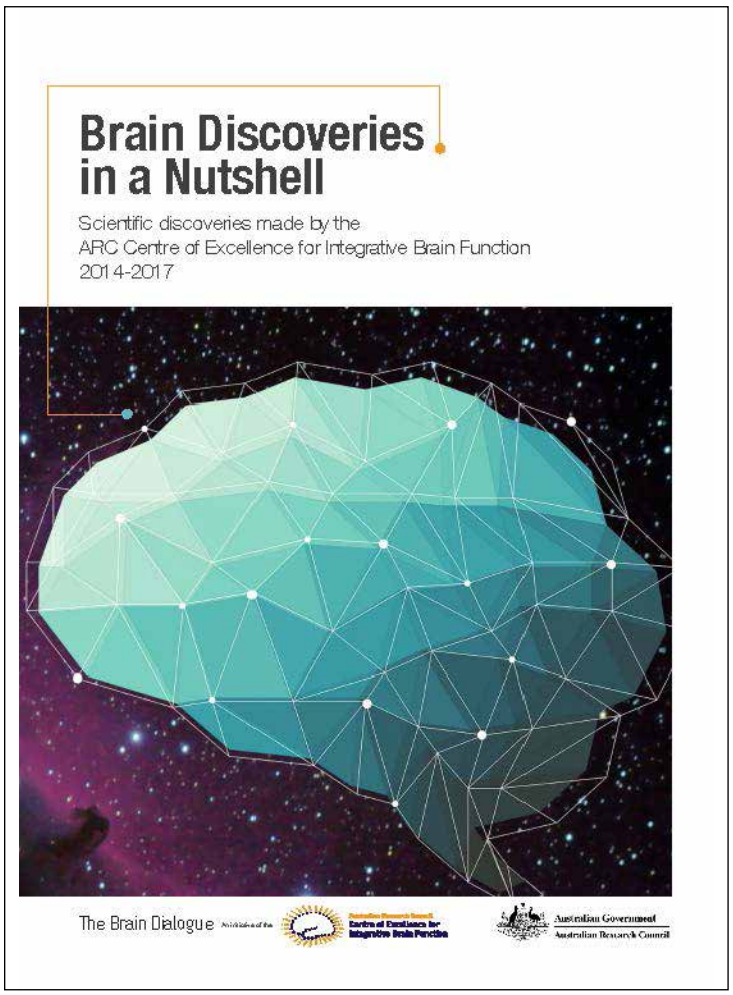
The Brain Dialogue also fosters discussion by publishing 'Ideas and Issues' pieces on topics such as artificial consciousness.

To encourage knowledge sharing, content produced by the Brain Dialogue is published under a Creative Commons Attribution 4.0 International (CC BY 4.0.) license. This means that anyone can adapt and reuse the content, including for commercial purposes.

In 2017, we wrote and published a total of 18 plain-language summaries, which were shared on all our social media accounts. Three of these summaries were republished in the news sections of several of the Centre's collaborating organisations' websites.

Together, the summaries of Centre research on the Brain Dialogue website received over 4500 visits in 2017. We also worked with the Altmetric team to include the Brain Dialogue's website feed in their database, and have seen great improvements in the scores for Centre publications with plain-language summaries.

In 2017, the Centre produced a printed 'In a Nutshell' booklet collecting 32 summaries selected from the more than 80 published on the Brain Dialogue website so far. The booklet was distributed free to the public to further broaden the Centre's communication of its research findings.



Social media

The Brain Dialogue uses a COPE (Create Once, Publish Everywhere) strategy — the same content is pushed out through different social media streams to ensure that we maximise the impact of our resources. The Brain Dialogue Facebook page provides followers with curated content about new discoveries in brain research from the Centre, as well as the world's top journals and news outlets, and now reaches over 2,300 followers. In 2017, the Brain Dialogue's Twitter feed increased its followers to nearly 700 across the globe, including research institutions, med-tech organisations, women-in-science groups, journalists and, importantly, neuroscientists. All Brain Dialogue articles are further shared through the Centre of Excellence LinkedIn company page, as well as LinkedIn neuroscience groups, such as the Society for Neuroscience (which has nearly 45,000 members).

2,300 followers

700 followers

Machines that Read your Mind – exploring the impact of brain-computer interfaces

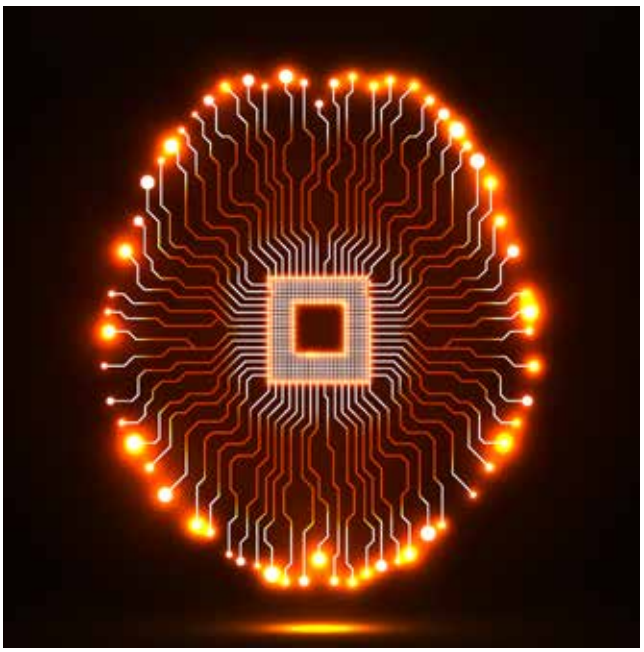
Moving a prosthetic limb with thoughts alone. A bionic brain part that restores memory in the elderly. Using brain scans to reveal which movie a person watched, their capacity for criminal behaviour, or simply what they are thinking. Barely a week goes by without another headline about our ever-increasing power to read the human mind.

These examples of machine-brain interfaces (also called brain-computer interfaces) are newsworthy — even though none of them is fully developed. Progress is rapid, and neuro-scientists are confident it is only a matter of time. Now is the time to consider their impact.

Following the success of 'Zap My Brain', a series of events and online discussions about non-invasive brain stimulation technologies, the Brain Dialogue kicked off its second public dialogue series in 2017, focused on the impact of brain-computer interfaces on modern society.

'Machines that Read your Mind' explores the notion that as we increase our understanding of exactly how a kilogram or so of brain tissue can take in new information, store it, process it and recall it, we are moving inextricably towards a point where we can read the brain – a tipping point that will raise new opportunities, but also new problems.

Before each event, we used social media to circulate Centre plain-language summaries, research publications and popular accounts of the research, to help attendees and others to prepare for the discussions.



Machines that Read your Mind – Brisbane

The inaugural event in the series was hosted by Centre Chief Investigator Dr Marta Garrido at the Queensland Brain Institute in the University of Queensland on 22 March. The event was also included as an affiliate event of the World Science Festival Brisbane 2017.

The panel included Dr Lilach Avitan, a computational neuroscientist at the Queensland Brain Institute; A/Prof Michael Milford, a robotics engineer at the Queensland University of Technology; A/Prof Elizabeth Stevens, a cultural studies expert at Southern Cross University; and Dr Femke Nijboer, a neuropsychologist working in patient-centred tech development at Leiden University in The Netherlands, who joined via teleconference.

Centre Chief Investigator Prof Jason Mattingley led a demonstration of a commercially available brain-computer interface. Two ECRs from his group, Dr David Painter and Angela Renton, demonstrated a much more sophisticated EEG-based brain-machine interface that they currently use in the lab, giving a unique and authentic insight into what these technologies can do.

The event was a great success, with a full auditorium and more than 400 people watching the live video stream on Periscope. As responsive research and innovation engagement aims to facilitate mutual learning, in which non-scientists and experts learn from each other, we surveyed both our expert panelists and the audience after the event to determine whether this had occurred. According to the post-event survey, the experts gained new insights from each other and from the public about the broader societal issues surrounding the use of machines to decode brain activity, and the public came away with new insights into the capabilities of brain-computer interface technologies.

Machines that Read your Mind – Melbourne

The second event in this series was included as a highlight event in Melbourne Knowledge Week, a City of Melbourne initiative that ran from 1–7 May 2017.

The panel included Centre Chief Investigator Prof Michael Ibbotson, a neuroscientist at the National Vision Research Institute and the University of Melbourne; Dr Nick Opie, a biomedical engineer and founding director and Chief Technology Officer at SmartStent; and Dr Nijboer, who joined via teleconference.

The Centre's Education and Outreach Officer, Dr Maria del Mar Quiroga, and PhD student Matthew Davidson from the Monash Institute of Cognitive and Clinical Neuroscience led a demonstration of a commercially available brain-computer interface, which wowed the event's 400+ attendees. The event sold out two weeks in advance.

The City of Melbourne filmed the event and broadcast it live on Facebook, receiving over 1600 views, and the Brain Dialogue's Periscope video was live-streamed by 132 people. Significantly, 80% of the audience were not scientists, which is highly unusual for this type of event.

Media coverage included a 3RRR Breakfasters radio interview with Prof Michael Ibbotson before the event, and a recap of the forum by Breakfaster hosts Geraldine Hickey and Sarah Smith afterwards.

Neuroethics program

A/Prof Adrian Carter (Program Coordinator)

It has been an exciting year for neuroethics in Australia. The Neuroethics Program at the Centre has played a leading role in the national emergence of the discipline.

Neuroethics is an internationally recognised field that aims to successfully translate brain research in ways that maximise social benefit while minimising harms. The need for Neuroethics has been recognised by all major brain projects around the globe, including the US BRAIN initiative and EU Human Brain Project, and other brain initiatives in Japan, Korea, China, Canada and Australia. The Australian Brain Alliance has made Neuroethics a key priority for the Australian Brain Initiative. The leadership of the Centre in this area has greatly facilitated this development.

The Inaugural Australian Neuroscience and Society Conference

In September 2017, the Brain Function CoE Neuroethics program, in partnership with the Centre for Agency Values and Ethics at Macquarie University, Sydney Law School, and Brain and Mind Centre at the University of Sydney, held its inaugural two day conference, Neuroscience and Society: *Ethical, Legal and Clinical Implications of Neuroscience Research in Sydney.*

This was a sold out event with 110 registrants from government, law, health, academia, and industry. The event included 13 international speakers, including four keynote presentations from Prof Katrina Sifferd (Elmhurst College, USA), Brian Earp (Oxford University, UK and Yale, US), Dr Katy de Kogel (Ministry of Security and Justice, The Netherlands), and Prof Tom Buller (Illinois State University, USA). The call for papers elicited an unexpectedly large number of applications. Eight parallel sessions of speakers were featured, covering themes such as:

» Ageing and dementia

» The developing brain

» Disability and mental health

» Disorders of self control

» Moral cognition

» Neurotechnologies (e.g. brain computer interfaces, Artificial intelligence, brain organoids)

Selected papers from the meeting will be published as a special issue of the journal Neuroethics in 2018. The Neuroethics Program is currently planning the program for the 2018 meeting.

The Australian Neuroethics Network

In 2017 the Australian Neuroethics Network (ANN) was launched, an interdisciplinary collaboration that brings together leading Australian practitioners in neuroscience, law, ethics, policymaking, clinical practice, patient populations, the public and other end-users to examine the ethical and social implications of neuroscience research.

The aim of the ANN is to:

» Foster neuroethics scholarship in Australia through research and teaching

» Provide a platform to gather local and international researchers and practitioners

» Provide links to international neuroethics initiatives (e.g. International Brain Initiative, US BRAIN Initiative, International Neuroethics Society), and

» Provide recommendations and guidance to policy makers

The ANN was launched by Prof Julian Savulescu (University of Oxford) and includes over 120 members. The Network has recently prepared its first consensus statement emerging from the 2017 meeting: *Australia's de facto prohibition of e-cigarettes is an ethically indefensible policy*.

Public engagement

As part of the 2017 Neuroscience and Society conference, a public lecture was given on the legal implications of neuroscience research by Prof Katrina Sifferd (Elmhurst College), entitled *Is neuroscience relevant to criminal responsibility?* Yes and No. Like the conference, this event was at capacity.

International engagement

In June, the Neuroethics program hosted a special symposium at the Organization for Human Brain Mapping meeting in Vancouver: *The neuroethical implications of human brain mapping*. This was the first time that a symposium looking at the neuroethical issues of brain imaging was held at the meeting.

The symposium was chaired by Centre Director, Prof Gary Egan and featured leading international scholars in the field including:

» Prof Judy Illes (Director, National Core for Neuroethics, University of British Columbia and the President, International Neuroethics Society): *Disorders of Consciousness, Neuroimaging, and Physician-Assisted Death: Interpreting Communication to Establish Competence*

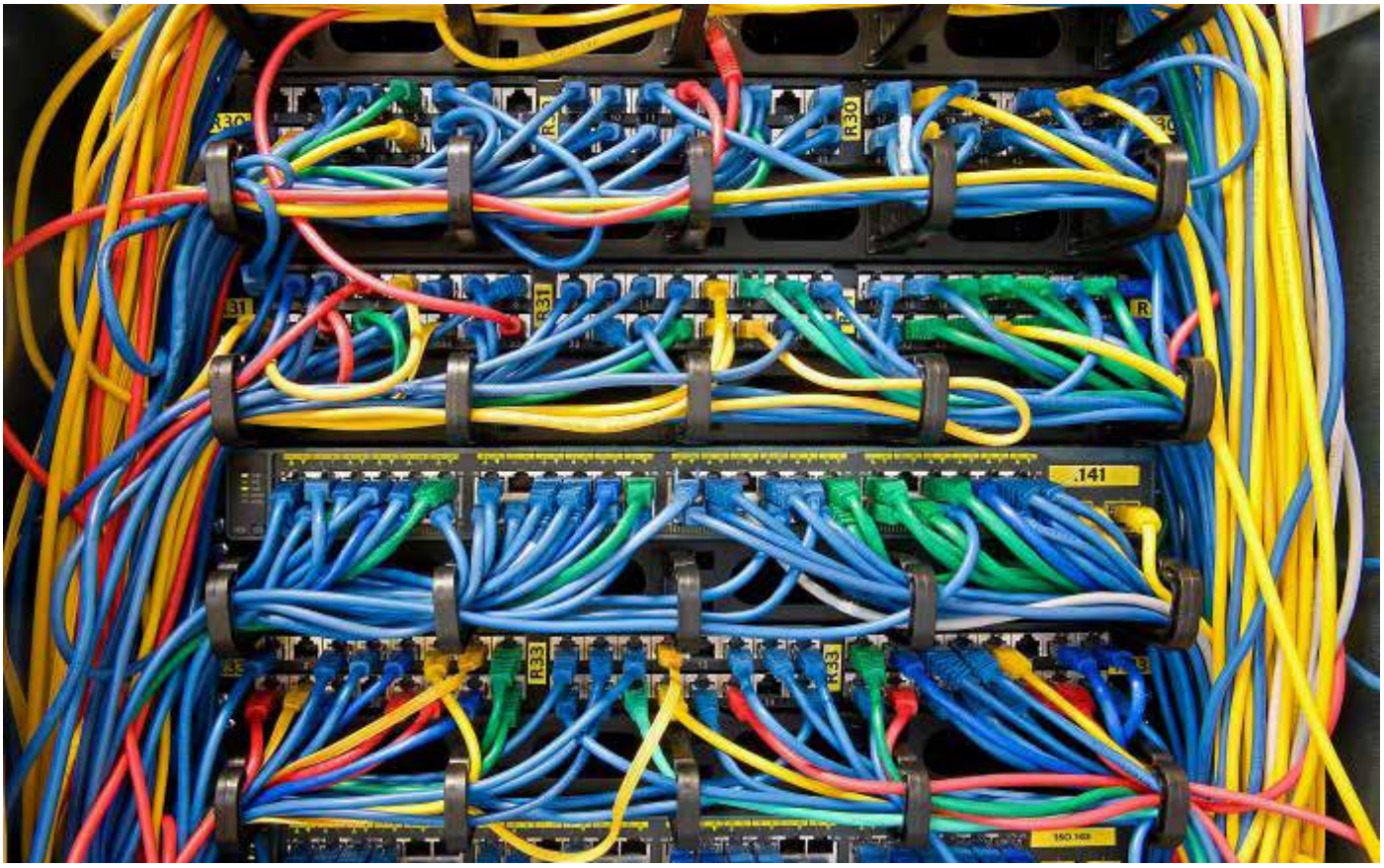
» A/Prof Eyal Aharoni (Georgia State University): *Ethical Implications of Neuroprediction*

» Dr Philipp Kellmeyer (Department of Neurosurgery, University Medical Center Freiburg): *Not exactly picture-perfect: Ethical, legal and social implications of the methodological crisis in neuroimaging*

The Neuroethics Program is forging strong links with international partners. A/Prof Carter was invited to participate in two global neuroethics initiatives in 2017. The first was a workshop looking at the ethics of emerging neurotechnologies and artificial intelligence in Columbia University, New York in June, the results of which was published in Nature. The second was a Global Neuroethics Summit in Deagu, South Korea in September to look at different cultural perspectives to ethical issues raised by neuroscience research. A/Prof Carter also attended a meeting of Neuroethics Program leaders at the International Neuroethics Society (INS) meeting (a satellite of the Society for Neuroscience) in Washington DC in November, as the Australian Ambassador to the Society. Similar events are proposed for 2018. These developments will put the Centre's Neuroethics Program at the heart of international activities in neuroethics.

Neuroinformatics program

Dr Wojtek Gosckinski (Program coordinator)
Dr Pulin Gong (Program coordinator)



Brain Function CoE's Neuroinformatics program supports the Centre's neuroscience research in three key areas:

1. The provision of access to data processing, advanced analysis and visualisation resources.
2. Supporting and enhancing the publication of Centre tools and data.
3. Building partnerships with international neuroinformatics infrastructure initiatives.

Development of software tools

Centre neuroinformatics researchers have developed and made available to Centre researchers a suite of software tools for neural population modelling and analysis.

NeuroPatt

NeuroPatt is a MATLAB toolbox to automatically detect, analyse and visualise spatiotemporal patterns in neural population activity, developed by Dr Pulin Gong's group at University of Sydney. NeuroPatt can be used to analyse signals recorded by multi-electrode arrays, EEG, MEG, fMRI and other imaging methods such as VSD can optionally be filtered to extract the phase or amplitude of oscillations within a specified frequency range. Spatiotemporal activity patterns can be detected and analysed by adapting methods from the fields of turbulence fluid and computer vision. This toolbox is now available to Centre researchers.

SpikeNet

SpikeNet provides a computational and mathematical platform for studying the working mechanisms of cortical microcircuits. SpikeNet supports any synaptic coupling topology, strength and conduction delay defined by users. In addition, it supports a variety of spiking neuron and synaptic plasticity models. SpikeNet comes with a collection of user-friendly Matlab functions that allow for (1) easy configuration of the spiking network, (2) streamlined post-processing for a wide range of standard analysis results, (3) and visualisation.

NFTsim

NFTsim (Neural Field Theory simulator) is written in C++ and implements streamlined standard methods to solve hyperbolic partial differential equations such as the damped 2D wave equation; time stepping methods to solve ordinary differential equations; and procedures for delay differential equations. Careful numerical analysis has resulted in a suite of methods that is fast, accurate, and robust. This work obviates the need for users to become familiar with all these techniques and underlying theory, program them, and then debug several thousand lines of code. The code has been tailored to use these state equations to solve an unlimited number of user-defined continuum neural field models. The input and output files are both plain-text, so NFTsim can be easily integrated into existing workflows and analyses written in other programming languages. NFTsim comes with a collection of custom made Matlab functions that allow for an easy access to the compiled code, for users without prior knowledge of C++. End-users need only to write plain text files as described in the User Manual.

Data collected from Centre Chief Investigators has been systematically categorised based on different neural level and recording methods. In 2018 the Centre's Neuroinformatics team will organise a list of novel experimentally testable predictions arising from our modelling studies about brain dynamics and functions, which can be used to facilitate more collaborations between experimentalists and theoreticians in the Centre. This data catalogue will be completed and made publicly available.

Clinical imaging data – improvements to access and storage

As part of a national project, *Delivering durable, reliable, high quality image data*, jointly funded by the National Imaging Facility (NIF), Australian National Data Service (ANDS) and Research Data Services (RDS), informatics experts from the Centre and around Australia have combined their expertise to build a network of Trusted Data Repository Services (TDRS) to provide researchers with secure places to store, share and/or publish their imaging data easily and freely. The TDRS are guaranteed to store the data and sufficient metadata for at least 10 years for use in future research. The Centre's Neuroinformatics team at Monash Biomedical Imaging (MBI), MASSIVE and the Monash eResearch Centre at Monash University, along with informatics colleagues from the University of Western Australia, University of Queensland and University of NSW, has established best practices for TDRS that store imaging data from clinical MRI scanners. The clinical MRI TDRS would soon be able to connect to the Australian Access Federation, with the intention to streamline access to TDRS so that anyone with an Australian university email address can easily log in and access their data.

Industry engagement

Prof Gary Egan (Program coordinator)

Centre industry engagements in 2017 were conducted around the themes of Global Connectivity and Entrepreneurship, aided in large by Mr Amir Eldad, a global entrepreneurial ecosystem builder and entrepreneur-in-residence at Monash University.

Global connectivity

A multi-node Centre delegation (Monash University, University of Melbourne, Australian National University and University of Queensland) travelled to Israel in March 2017, in cooperation with the Israel Brain Technologies organisation. The purpose of the delegation was to link Centre researchers to the Israeli BrainTech communities, to foster scientific collaboration, entrepreneurship, and the potential commercialisation of brain-related technologies. Facilitated by Austrade's Israel 'Landing Pad' in Tel Aviv, the delegation attended the Israel BrainTech 2017 'Converging Technologies' conference, and met with multiple Israeli startups to foster collaborations and industry partnerships with Centre researchers.

Image above: Centre personnel attending as part of the 2017 Israel Innovation Delegation.

From L-R: Vincent Daria (ANU), Gary Egan (Monash), Amir Eldad (Monash), Michael Ibbotson (UMelb), Lilach Avitan (UQ)

Entrepreneurship

The Centre held a successful entrepreneurship workshop and neuroscience experiment/neurotechnology pitch competition at the all-Centre meeting in Sydney in December 2017. The goals of the workshop and competition were to promote inter-node collaborations; promote duality in viewing technology and applications; stimulate a culture of innovation and entrepreneurship; provide ECRs with valuable experience on being concise and persuasive; stress importance of oral communication and public speaking; stimulate good performance under pressure; stimulate ECRs to think about the bigger picture and application areas; and empower ECRs to lead.

Following the success of the workshop, the Centre is leading an initiative to expand this with other ARC Centres of Excellence, beginning at Monash University in cooperation with its Enterprise team.

Gender, equity and diversity

Prof Melinda Fitzgerald (Committee Chair)

In late 2017 the Centre established a Gender, Equity and Diversity Committee comprising newly appointed Committee Chair, Professor Melinda Fitzgerald, and volunteer representation drawn from Centre personnel. The purpose of the Committee is to provide advice and guidance to the Executive team with regard to issues pertaining to gender, equity and diversity in the Centre, and to propose strategies to improve gender balance, equity and diversity.

The Committee initiated the formalisation of Terms of Reference and have recommended new policies within the Centre regarding, for example, travel support for primary caregivers. The Committee has made a number of further recommendations to the Centre's Executive team aimed to ensure equitable representation for all Centre members across Centre scientific and non-research programs.

In a short period of time the Committee has made substantial progress towards improving equity and diversity within the Centre, and towards a goal of serving as a model and advocate for improving equity throughout the research sector more broadly.

Centre attendees at the AGM welcome dinner, Sydney.

Centre events

Public lecture

Brains and Computers

In April 2017, Brain Function CoE hosted the free public lecture 'Brains and Computers: the future of neuroscience and understanding the complexity for the human mind' - at the Melbourne Convention and Exhibition Centre.

Addressing the public lecture were two internationally acclaimed brain researchers, Prof Christof Koch, President and Chief Scientific Officer of the Allen Institute for Brain Science, and Prof Karlheinz Meier, Co-Director and Vice Chair of the Human Brain Project. Moderated by ABC's Bernie Hobbs, the event featured two short presentations by each brain researcher, in an effort to address some of the developments and challenges of the latest international endeavor in brain research, followed by an interactive discussion with the audience.

Both guests stayed on in Melbourne for a week-long series of collaborative meetings and events across both of the Centre's Melbourne nodes, and in addition contributed to an Australian Brain Alliance workshop. The public lecture had phenomenal interest and booked-out twice-over.

Bernie Hobbs, Christof Koch, Karlheinz Meier and Gary Egan at 'Brains and Computers, Melbourne.

International symposia

As part of the Centre's commitment to promote our research and researchers internationally, Centre members were successful in their bids to host symposia during three international conferences during 2017.

Centre Director Gary Egan ran The Neuroethical Implications of Human Brain Mapping as part of the 2017 Organization for Human Brain Mapping's annual meeting, held in Vancouver Canada. The symposium featured presentations from international researchers Judy Illes (University of British Columbia, Canada), Eyal Aharoni (Georgia State University, USA) and Philipp Kellmeyer (University Medical Center Freiburg, Germany).

Michael Ibbotson (CI) and Nic Price (AI) co-organised the symposia Motion Processing in Monkey Middle Temporal Area: Computations and Physiology at the 37th Annual Meeting of the Australasian Neuroscience Society. The symposium held in Sydney in December, invited international neuroscientist Douglas Ruff (University of Pittsburgh, USA) to lead the session, alongside presentations from Centre ECR Elizabeth Zavitz (Monash), Centre AI Anthonk Burkitt (Uni Melbourne) and collaborator James Bourne (Monash).

Monash based ECRs Elizabeth Zavitz and Hsin-Hao Yu also hosted an international symposia as part of the 13th Asia Pacific Conference on Vision, held in Taiwan. To present at the symposium, organisers invited Centre ECRs Maureen Hagan (Monash) and Natalie Zeater (U Sydney), alongside international presenters Alessandra Angelucci (U Utah, USA), Tetsuo Yamamori (RIKEN, Japan) and Jake Yates (U Rochester, USA).

Centre meetings

Mid-Year Science Meeting

June 2017 saw Chief Investigators and ECR representatives come together for their annual face to face Science meeting in Melbourne. Due to the geographic disparity of our Investigators, it is important to meet face-to-face to discuss progress and new collaborative opportunities. This two day meeting provided a valuable opportunity to gather input from all research teams in preparation for the Centre's mid-term review conducted by the Australian Research Council in November.

AGM and Science Meeting

The Centre's Annual General Meeting (AGM) and Science meeting was held in Sydney in December, in conjunction with the Australasian Neuroscience Society's (ANS) 37th Annual Meeting. This annual event has gained significant support from the entire Centre cohort, and this year saw over 100 attendees over the course of three days.

Each year the event welcomes CI's, AI's, Fellows, Scholars, Professional Staff and Affiliates, to gather for a series of scientific, professional development and networking events. Included in the December meeting was our AGM, which provides an opportunity to update Centre members on non-scientific programs, a social networking dinner, and our annual Science meeting, which was included as an official satellite meeting of ANS 2017. In addition to the larger whole centre events, a series of smaller breakouts were run for specific groups, including an ECR workshop, a PhD 'careers beyond academia' mentoring session, a Node Administrators Meeting, meeting of the Equity and Diversity committee and a face to face meeting of our Advisory Board.

For the first year our annual science meeting 'Paint a Bigger Picture' was opened to public registrants, which provided a significant opportunity to share Centre research with the wider neuroscience community. The event was nearly booked out, with 98 guests in attendance. The meeting, featuring International PI Mathew Diamond (SISSA), and Advisory Board member Ulf Eysel (Ruhr University) was aimed at showcasing the Centre's integrative research, and focused on the bigger picture for findings in neuroscience, with presenters asked to outline what their experiments mean for the field and where they think the field is heading.

The welcome dinner provided the perfect opportunity for networking across the entire cohort, with Advisory Board members and CIs mingling with ECRs, and professional staff. The dinner also played host to the Centre's inaugural ECR pitch competition, whereby four teams pitched their technology and research ideas, which were then judged by all in attendance. It also provided the opportunity for Centre Director Gary Egan, to acknowledge significant achievements and outstanding contributions to the Centre with the presentation of five awards:

- Ulf Eysel Award for Most Highly Cited Publication – Marcello Rosa and Tristan Chaplin
- Lyn Beazley Award for Outstanding Contribution – Matthew Tang
- David van Essen Award for Outstanding Early Career Researcher – James Roberts
- John Funder Award for Outstanding Staff Member – Jessica Despard
- Amanda Caples Award for Outstanding Alumnus – Lisa Hutton

The entire three-day program was a massive undertaking, however the involvement and contribution from all attendees made it a tremendous success. We are thankful that each year the Centre grows, and so too does the commitment of our members.

Centre attendees at the Centre's annual science meeting 'Paint a Bigger Picture', Sydney.

Sponsorship

In 2017 Brain Function CoE provided sponsorship for numerous events, held both nationally and internationally. Support ranged from $250 to in excess of $3000, and has been integral in contributing towards event costs and international travel allowances to ensure the participation of internationally renowned scientists. Just some of the events the Centre contributed towards in 2017 are featured below.

Systems and Computational Neuroscience Down Under (SCiNDU)

Once again, Centre AI Geoff Goodhill hosted the Queensland Brain Institute's biennial conference, Systems and Computational Neuroscience Down Under (SCiNDU), a forum for systems and computational neuroscientists to interact and share their insights into the function of neural circuits and systems. With support from the Centre, the SCiNDU meeting attracted almost 200 delegates from both Australia and internationally. A total of 26 talks and 71 posters were presented during the conference, with keynote presentations from Tobias Bonhoeffer (Max Planck Institute of Neurobiology), Daphne Bavelier (University of Geneva), Rafael Yuste (Columbia University), among other international and national guests.

Funding provided the Centre went to support the travel costs of invited international speaker Alex Pouget (University of Geneva), who presented on the optimal policies for value-based decision making, and gave a tutorial on probabilistic inference and multisensory integration in decision making.

The event was very well received, with attendees scoring the overall conference a 4.8 out of 5.

Ethics in Science

In December 2017, Centre AI Trichur Vidyasagar and Deputy Director Marcello Rosa co-hosted the public forum: *Ethics in Science*. Held in Melbourne, the forum invited internationally renowned scientists Sir Colin Blakemore (University of Oxford), Michael Goldberg (Columbia University), David Vaux AO (Walter and Eliza Hall Institute), and the Centre's Lyn Beazley AO (UWA) and Jakob Howhy (Monash) to take part in a panel discussion to address some of the ethical dilemmas arising in the field.

Moderated by ABC's Bernie Hobbs, discussions broached topics such as the use of animals in research, deciding how much power to give robots and artificial intelligence, how far to go with clinical trials in humans, using modern technology to decide whether one should turn off the life support of someone in coma, and the need to ensure transparency and accountability in the reporting of scientific results, as well as additional questions arising from the audience.

The event was an outstanding success with the public and scientists alike, with all tickets completely booked out. It followed on from a scientific symposium on visual Neuroscience featuring Profs Blakemore and Goldberg, who presented on topics such as the interface between fine arts and neuroscience, and the importance of basic neuroscience research as the foundation for future clinical applications.

Symposium at the Asia Pacific Conference on Vision

Centre ECRs Elizabeth Zavitz and Hsin-Hao Yu based at Monash University coordinated an international symposium as part of the 13th Asia Pacific Conference on Vision, held in Taiwan in July last year. Aimed at introducing the marmoset model to vision scientists in the Asia-Pacific region, the symposium helped foster interdisciplinary collaborations across computational, animal, and human vision research.

With Centre funding contributing towards international travel costs for speakers, the symposium was able to highlight work of Centre researchers, including ECRs Maureen Hagan (Monash) and Natalie Zeater (USyd), alongside international presenters Alessandra Angelucci (University of Utah), Tetsuo Yamamori (RIKEN) and Jake Yates (University of Rochester).

Students of Brain Research (SoBR)

The Students of Brain Research (SoBR) Network, held their annual professional development dinner in July in Melbourne. The event was very well received once again, and has become a core event for the SOBR community, bringing together postgraduate students, early career researchers, and academics for an enjoyable and informative evening.

With keynote presentation by Prof Emeritus Richard Silberstein, the event saw over 100 student registrants in attendance. The night entailed panel discussions and a Q & A session, prior to networking opportunities for students to liaise with each other, and academic VIPs, including our Centre Director Prof Gary Egan. Overall, SoBR student members and guests were highly satisfied with the event, with 100% of feed-back respondents said they would attend again in future.

Australasian Society for Social and Affective Neuroscience (AS4SAN)

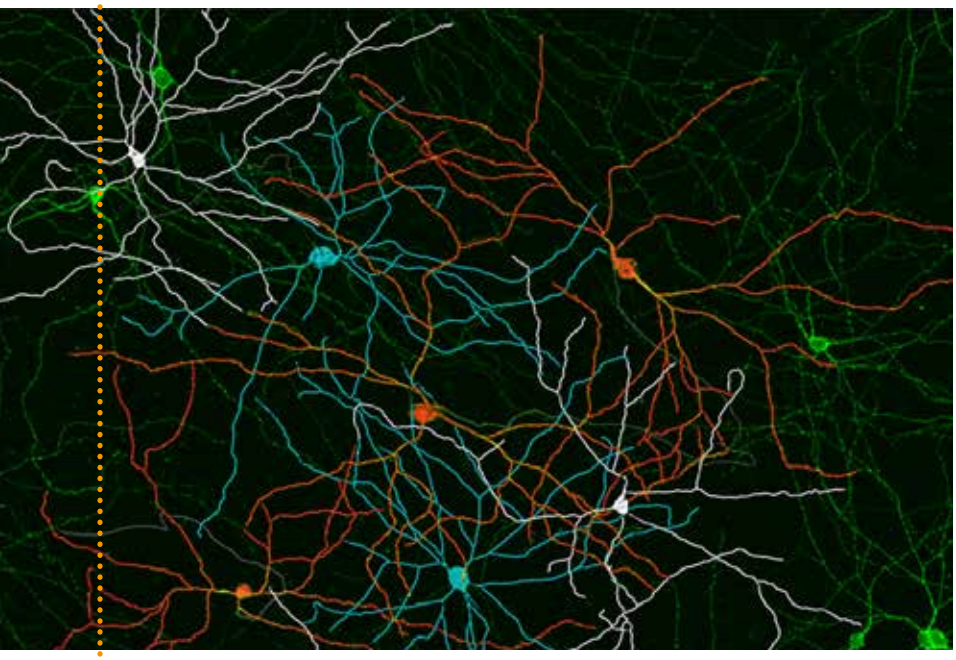
The Australasian Society for Social and Affective Neuroscience (AS4SAN) 4th Annual Meeting was held at the Melbourne Brain Centre in June 2017. The event was attended by around 100 participants, with 28 registrants registering for additional workshops hosted in the lead up to the meeting. These workshops were provided at no cost to PhD and early career researchers and covered neuroimaging methods and clinical assessments for social and affective neuroscience research.

Over two days, registrants were presented with both basic and applied work in neuroscience research, concerning animal and human social behaviour, social cognition, emotion and motivational processes. There were also extensive discussions on clinical disorders that affect social and affective processes. This work covered a range of research paradigms including behavioural, psychophysiological, biological, genetic and neuroimaging techniques.

The funding provided from the Centre was used to cover keynote speaker registrations, and to contribute towards prizes for early career awards, including a PhD and ECR grant for laboratory visits.

Images:
Far left: left to right: Elizabeth Zavitz, Leo Lui, Natalie Zeater, Alessandra Angelucci, Jake Yates, Tetsuo Yamamori and Hsin-Hao Yu.
Far right: Back row: Rafael Yuste (Columbia University), Alex Pouget (University of Geneva), Geoff Goodhill (UQ); middle Row: Tobias Bonhoeffer (Max Planck Institute), John Bekkers (ANU), Adrienne Fairhall (University of Washington), Andre van Schaik (Western Sydney University); Front Row: Rosa Cossart (INMED Marseille), Daphne Bavelier (University of Geneva), Kenji Doya (Okinawa), Marta Garrido (UQ)

Looking ahead - plans for 2018



Research program

In the next three years, the Centre aims to further the understanding of the brain mechanisms underlying attention, prediction and decision via research projects that each span two or more of the Centre's research themes.

Attention

The Centre will use sensitive behavioural probes and computational modelling tools to understand how mechanisms of attention prioritise goal-relevant visual and auditory stimuli. Further collaborative investigations will examine the pathways and cellular mechanisms in binocular vision in rodents, and its role in attention, including quantifying in an unbiased way the attention state of rodents, as has been demonstrated for humans and non-human primates.

Prediction

The Centre will study prediction on multiple levels in animal models and humans. New technologies will assist by enabling targeted electrical stimulation of specific brain regions. The outcomes are expected to encompass a novel understanding of prediction at the theoretical, neurophysiological and neuroanatomical levels.

Decision

The Centre will study decision via three interconnected lines of research: developing suitable behavioural paradigms for probing the neuronal correlates of decision-making; understanding the circuitry underlying sensory information processing and decision-making; and developing and modelling new neurotechnology.

Industry engagement

To ensure that the Centre's research outputs have maximum impact, we will identify and engage relevant industry partners capable of translating research outputs towards outcomes with public impact. The Centre will promote an active interaction with end users from both commercial entities and consumer representative groups, including local companies and industry clusters, professional associations, and consumer end-user organisations.

Education and outreach

Primary

As part of its Primary School neuroscience education programs, the Centre will continue its successful neuroscience drawing competition as part of Brain Awareness Week, a global campaign that aims to increase awareness of the importance and current state of brain research in the world. In 2018, primary school students from around Australia will be invited to create an artwork and/or write up to 50 words on the theme of:

"What makes 'sense' in the brain? What would you do, and how would you feel, if:

» *you couldn't see, hear, taste, touch or smell?*

OR

» *you had an extra sense found in nature but not available to humans (for example, infrared or ultraviolet vision, ultrasound hearing or magnetic sense)?"*

Secondary

As part of its secondary school neuroscience education programs, the Centre will again host the Australian and New Zealand Brain Bee Challenge in 2018. We are working in partnership with online education partner Education Perfect to develop a new set of online interactive study materials for all rounds of the competition in 2018, with the aim of further engaging and motivating students to participate.

Public engagement

The Brain Dialogue

The Centre is committed to the continued growth of its neuroscience engagement program, The Brain Dialogue, which facilitates Centre knowledge sharing for mutual advantage and maximises the social, economic and scientific benefits of brain research. We will further grow the Discovery section on the Brain Dialogue website, which presents Centre research outcomes (either accepted for publication or recently published) with 'In A Nutshell' single-sentence summaries; 'Big Picture' translations that explain the paper and its significance in plain English; and 'Next Steps' to encourage further exploration. Communicating our research in this way not only informs the broader community as to what the Centre does, but also opens up opportunities for interdisciplinary research and linkage within the scientific community and industry.

Early Career Researchers (ECRs)

To ensure we are appropriately supporting the Centre's ECRs and their career development, we will incorporate the results of a 2017 feedback survey into the design of the professional development program in 2018. The self-elected ECR Executive Committee will design a program that reflects the career development needs and preferences of our young neuroscience researchers.

Neuroinformatics

In 2018, the researchers working in the Centre's Neuroinformatics program will compile a list of novel, experimentally testable predictions arising from our modelling studies of brain dynamics and functions, which can then be used to facilitate more collaborations between the Centre's experimentalists and theoreticians. On completion, this data catalogue will be made publicly available.

Neuroethics

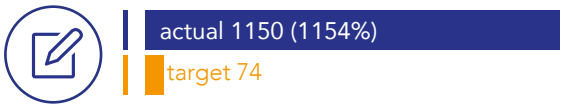
In 2018, the Neuroethics program will seek to examine new ethical, social and legal implications of the neuroscience research being conducted at the Centre.

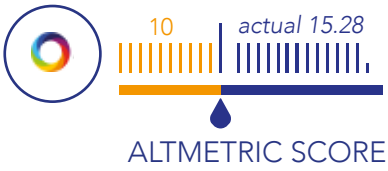
Key performance summary

RESEARCH OUTPUT AND IMPACT

JOURNAL ARTICLES

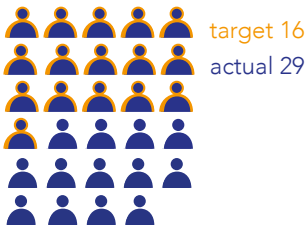
CITATIONS





PERSONNELL

POSTDOCTORAL RESEARCHERS



PhD SCHOLARS

PhD COMPLETIONS

INTERNATIONAL PROFILE

INTERNATIONAL COLLABORATIONS

INTERNATIONAL PRESENTATIONS

INTERNATIONAL VISITORS

COMMUNITY

PUBLIC LECTURES/EVENTS

PRIMARY & SECONDARY EDUCATION PROGRAMS

MEDIA ARTICLES

THE BRAIN DIALOGUE REACH

Standard Key Performance Indicators for the ARC Centre of Excellence for Integrative Brain Function

Performance KPIs	Target	Actual	%
Research Outputs – with Centre acknowledgement or inclusion as an author affiliation			
Journal articles	14	64	457%
Book chapters	0	2	200%
Conference papers	2	3	150%
Films	0	1	100%
Creative Works	0	1	100%
Publication Quality – with Centre acknowledgement or inclusion as an author affiliation			
Citations (cumulative)	74	1150	1154%
*Average impact factor	4	4.98	125%
Average web views per article	750	1818	242%
*Average Altmetric score	10	15.28	153%
*(New revised KPI submitted in 2017 - target set at 2018 goal)			
Number of Training Courses Offered By Centre			
*Professional development training (including media training, pitch training, research translation, journal writing)	2	3	150%
*(New revised KPI submitted in 2017 - target set at 2018 goal)			
Number of workshops/conferences held/offered by the Centre			
*National science meeting	1	2	200%
*International meeting/ workshop	1	2	200%
*ECR workshop	1	2	200%
*(New revised KPI submitted in 2017 - target set at 2018 goal)			
Additional Researchers			
Post-doctoral researchers	16	29	181%
Honours students	8	9	113%
PhD students	16	29	181%
Masters students	0	4	400%
*Affiliate Investigators (students and researchers contributing to Centre activities who do not receive centre funding)	70	101	144%
*(New revised KPI submitted in 2017 - target set at 2018 goal)			
Number of Postgraduate Completions	4	7	175%
Number of Mentoring Programs Offered by Centre	2	2	100%
Number of Presentations/Briefings to the Public, Government, Industry, Business, Community, End-User Or Other Professional Organisation or Body	9	11	122%
Number of New Organisations Collaborating with, or Involved, in the Centre	2	23	1150%
End User Impact			
Public lectures/events	1	3	300%
Primary & secondary education programs	1	4	400%
The Brain Dialogue reach (number of web hits)	10,000	20,956	210%
Media – articles	1	28	2800%
Media – invited expert commentary	0	12	1200%
National/ International Awards	1	20	2000%
Accessibility of Research			
Analysis tools available to centre researchers/ public	2	6	300%
Datasets available to centre researchers/ public	2	2	100%
Integrative Research			
Number of research outputs with authors from more than one group	5	32	640%
Number of interdisciplinary research programs	3	8	266%
International Profile			
Number of international visitors	5	37	740%
Number of international presentations	16	51	319%
Number of visits to overseas laboratories	16	22	138%

Finance

Statement of income and expenditure

FUNDS CARRIED FORWARD FROM PREVIOUS YEAR	2014	2015	2016	2017	Est. 2018
	$	$	$	$	$
Adjustment to carry forward from previous year	-	2,741,132	3,323,469	3,352,518	2,748,592
			1,976	12,984	
INCOME					
ARC grant Income	2,943,492	2,996,205	3,047,140	3,092,847	3,139,331
Australian National University cash contribution	111,324	111,324	111,124	111,324	111,324
Monash University cash contribution	318,434	318,434	371,625	318,795	331,546
University of New South Wales cash contribution	-	4,445	148,002	49,334	49,334
University of Queensland cash contribution	120,390	206,800	120,390	154,370	160,521
University of Melbourne cash contribution	153,706	155,579	146,444	162,839	153,707
University of Sydney cash contribution	132,711	241,810	153,706	186,745	153,707
Human Brain Project (École polytechnique fédérale de Laus-anne-EPFL) cash contribution 2	-	25,000	-	-	37,500
International Neuroinformatics Coordinating Facility (INCF) cash contribution	3,142	4,335	22,189	40,399	4,800
Queensland Institute of Medical Research (QIMR) Berghofer cash contribution	-	-	42,028	31,698	24,343
Bridge to Mass Challenge	-	-	225,000	25,000	-
Other income	4,955	5,700	4,130	16,000	21,250
TOTAL INCOME AND CARRY FORWARD	**3,788,154**	**6,810,764**	**7,717,223**	**7,554,853**	**6,935,955**
EXPENDITURE					
Personnel	657,528	1,892,966	2,585,168	2,822,705	3,104,975
Consultants	21,287	392,266	352,984	414,111	420,000
Scholarships and support	28,274	115,058	37,517	112,961	115,000
Purchased Equipment	35,517	132,753	147,279	259,461	200,000
Lease/ Hired Equipment	4,163	65,607	4,583	15,903	15,000
Maintenance (IT and lab)	429	78,640	2,889	77,864	80,000
Research Materials / Experiments	107,769	304,054	172,246	240,924	300,000
Travel and conferences	102,608	319,067	275,872	345,879	380,000
Sponsorships - scientific workshops & conferences	4,500	10,429	11,000	20,845	20,000
Non-research Initiatives	80,217	151,752	259,710	134,553	150,000
INCF Subscription	-	-	339,905	311,643	320,000
Other Expenditure	4,730	22,727	175,552	49,412	70,000
TOTAL EXPENDITURE	**1,047,022**	**3,485,319**	**4,364,705**	**4,806,261**	**5,174,975**
BALANCE CARRIED FORWARD TO FUTURE YEARS	**2,741,132**	**3,325,445**	**3,352,518**	**2,748,592**	**1,760,980**

In kind contributions

ADMINISTERING AND COLLABORATING ORGANISATIONS	$
Monash University	729,981
The Australian National University	246,359
University of New South Wales	100,000
University of Melbourne	197,856
University of Sydney	332,687
University of Queensland	500,082
TOTAL	**2,106,965**

PARTNER ORGANISATIONS	
Brain Science Institute, Riken	12,500
Cold Spring Harbor Laboratory	12,500
Duke University	25,000
International School for Advanced Studies	12,500
Karolinska Institute/INCF	107,542
National Institute for Health and Medical Research	12,500
National Institute for Medical Research	26,000
National Institute of Mental Health	12,500
New York University	0
QIMR	134,886
Swiss Federal Institute of Technology/Human Brain Project	0
Weill Cornell Medical College	17,278
TOTAL	**373,206**
TOTAL	**2,480,171**

Additional funding

Collectively the Centre has been awarded in excess of $53.8M in ARC funding. Our Chief Investigators hold 10 international grants, totalling over $6M and over $36M in NHMRC funding.

ARC FUNDING

ARC Centres of Excellence:
Project Title: ARC Centre of Excellence for Ultrahigh Bandwidth Devices for Optical Systems
CE1101018
$ 23,800,000 (2011-2017)
Centre Chief Investigator: Arthur Lowery

ARC Special Research Initiatives:
Project Title: The Science of Learning Research Centre
SR120300015
$ 16,000,000 (2013-2017)
Centre Chief Investigators: Jason Mattingley and Pankaj Sah

ARC Industrial Transformation Research Hubs:
Project Title: ARC Research Hub for graphine enabled industry transformation
IH150100003
$2,611,346 (2016-2022)
Centre Chief Investigator: Stan Skafidas

ARC Laureate Fellowships:
Project Title: The Physical Brain: Emergent, Multiscale, Nonlinear, and Critical Dynamics
FL140100025
$ 2,617,462 (2014-2020)
Centre Chief Investigator: Peter Robinson

Project Title: Cognitive control of attention and its role in regulating brain function in health and disease
FL110100103
$ 2,649,836 (2012-2017)
Centre Chief Investigator: Jason Mattingley

ARC Discovery Projects:
Project Title: Neural substrates of paired decision-making training and brain stimulation
DP180101885
$583,271 (2018-2021)
Centre Chief Investigators: Jason Mattingley and Paul Dux

Project Title: Brain connectome: from synapse, large-scale network to behaviour DP180103319
$360,517 (2018-2021)
Centre Chief Investigator: Pankaj Sah

Project Title: Multimodal testing for a fast subcortical route for salient visual stimuli
DP180104128
$414,792 (2018-2020)
Centre Chief Investigator: Marta Garrido

Project Title: Seeing is believing: Nanophotonic Pixels for Subwavelengh imaging on a chip
DP170100363
$452,000 (2017-2021)
Centre Chief Investigator: Stan Skafidas

Project Title: Functional Magnetic resonance imaging: Decoding the palimpsest
DP170101778
$370,500 (2017-2020)
Centre Chief Investigator: Peter Robinson

Project Title: Neuronal activity underlying efficient sensory processing
DP170100908
$387,500 (2017-2019)
Centre Chief Investigator: Ehsan Arabzadeh

Project Title: Hierarchical information processing in the primate visual cortex
DP170104600
$392,000 (2017-2019)
Centre Chief Investigators: Marcello Rosa, Adam Morris, Hsin-Hao Yu

Project Title: Propagating Neural Waves: Combined Experimental and Modelling Study
DP160104316
$366,939 (2016-2018)
Centre Chief Investigators: Pulin Gong and Paul Martin

Project Title: Neural spike variability: Unifying conflicting views of neural dynamics
DP160104368
$240,000 (2016-2018)
Centre Chief Investigator: Pulin Gong

Project Title: Quantification of whole brain structural connectivity and fibre densities
DP160104193
$345,000 (2016-2018)
Centre Chief Investigator: Steve Petrou

ARC Linkage Projects:
Project Title: Development of far infrared multispectral thermal image sensors LP160101475
$330,000 (2017-2020)
Centre Chief Investigator: Stan Skafidas

Project Title: Models of structure vision
LP140100763
$389,000 (2014-2017)
Centre Chief Investigators: Greg Stuart and Ted Maddess

ARC LEIF Grants:
Project Title: Cryogenic quantum microscope facility
LE180100037
$223,000 (2017)
Centre Chief Investigator: Stan Skafidas

Project Title: Ultrafast optoelectronic characterisation for optical and wireless systems
LE160100203
$420,000 (2017)
Centre Chief Investigator: Stan Skafidas

Project Title: Rapid prototyping 3D nano-pattern large area writer
LE160100124
$300,000 (2017)
Centre Chief Investigator: Stan Skafidas

Project Title: Distributed ultrafast optical clocks for terabit/s communications
LE170100160
$250,000 (2017)
Centre Chief Investigator: Arthur Lowery

ARC DECRA Awards:
Project Title: Integration of feedforward and feedback circuits for decision-making
DE180100344
$ 385,551 (2018-2020)
Centre Chief Investigator: Maureen Hagan

OTHER FUNDING BODIES

NHMRC Program Grants:
Project Title: Precision Medicine in Genetic Epilepsy
APP1091593 (2016-2021)
Centre Chief Investigator: Steve Petrou

NHMRC Infrastructure Grants:
Project Title: National non-human primate breeding and research facility
APP1054055 (2012-2018)
Centre Chief Investigator: Marcello Rosa

NHMRC Development Grants:
Project Title: Development of a high acuity retinal prosthesis
APP1118223 (2017-2019)
Centre Chief Investigators: Michael Ibbotson and Hamish Meffin

Project Title: Restoring vision with a wireless multi-electrode cortical device: towards commercialisation
APP1075773 (2016-2019)
Centre Chief Investigators: Marcello Rosa and Arthur Lowery

NHMRC Principal Research Fellowships:
Project Title: Targeted Therapy in genetic epilepsy
APP1106035 (2016-2020)
Centre Chief Investigator: Steve Petrou

Project Title: Neural circuits that underpin fear and anxiety
APP1079929 (2014-2019)
Centre Chief Investigator: Pankaj Sah

NHMRC Project Grants:
Project Title: Optimising myelin repair and restoring neuronal conduction in the demyelinated brain
APP1140962 (2018-2021)
Centre Chief Investigator: Greg Stuart

Project Title: Caress the Detail: A Comprehensive MRI Atlas of the in Vivo Human Brain
APP1140295 (2018-2020)
Centre Chief Investigator: George Paxinos

Project Title: Do ongoing cognitive demands affect the efficacy of transcranial electrical brain stimulation in young and older healthy adults?
APP1129715 (2017-2020)
Centre Chief Investigators: Jason Mattingley and Paul Dux

Project Title: Rapid plasticity in sensory systems - linking neuronal adaptation and perception
APP1120667 (2017-2020)
Centre Chief Investigators: Nick Price, Adam Morris and Hsin-Hao Yu

Project Title: Neural circuits that mediate fear extinction
APP1128427 (2017-2020)
Centre Chief Investigator: Pankaj Sah

Project Title: Role of calcium-activated potassium channels in neuronal excitability, synaptic plasticity and sensory processing
APP1125915 (2017-2020)
Centre Chief Investigator: Greg Stuart

Project Title: Learning and network plasticity in a primitive sensory cortex
APP1128320 (2017-2019)
Centre Chief Investigators: Ehsan Arabzadeh and John Bekkers

Project Title: Mapping the human retina: A foundation study
APP1123418 (2017-2019)
Centre Chief Investigators: Ulrike Grünert and Paul Martin

Project Title: Neural circuits for residual vision after damage to striate cortex
APP1122220 (2017-2019)
Centre Chief Investigators: Marcello Rosa, Partha Mitra and Hsin-Hao Yu

Project Title: Neural computations for predictive coding in visual cortex
APP1128755 (2017-2019)
Centre Chief Investigators: Marcello Rosa, Adam Morris and Hsin-Hao Yu

Project Title: Next generation cybernetics: Long term carbon fibre dual stimulation/recording electrode arrays for closed loop neural implants
APP1101717 (2016-2019)
Centre Chief Investigators: Michael Ibbotson and Hamish Meffin

Project Title: Neuro-feedback for improved efficacy of retinal prosthesis
APP1106390 (2016-2019)
Centre Chief Investigators: Michael Ibbotson, Shaun Cloherty, Anthony Burkitt and Hamish Meffin

Project Title: Voltage gated calcium channels and vitamin D: exploring the convergent links between risk factors for schizophrenia
APP1099709 (2016-2019)
Centre Chief Investigator: Pankaj Sah

Project Title: Auditory processing in the amygdala
APP1103891 (2016-2019)
Centre Chief Investigator: Pankaj Sah

Additional funding

Project Title: Selective modulation of neural network activity using focal brain stimulation
APP1099082 (2016-2019)
Centre Chief Investigators: Marcello Rosa, Adam Morris and Hsin-Hao Yu

Project Title: Understanding the roles of dendritic domains in neuronal function
APP1105944 (2016-2018)
Centre Chief Investigator: Greg Stuart and Vincent Daria

Project Title: Modelling epileptic encephalopathies using induced stem cells
APP1106027 (2016-2018)
Centre Chief Investigator: Steve Petrou

Project Title: ASPREE NEURO Study: Cerebral micro-haemorrhages and aspirin in the elderly: cognitive and clinical consequences. A prospective randomised controlled trial
APP1086188 (2015-2018)
Centre Chief Investigator: Gary Egan

Project Title: Dendritic activity and neuronal output during sensory perception
APP1086082 (2015-2018)
Centre Chief Investigator: Greg Stuart

Project Title: Mimicking slow wave sleep to enhance plasticity in the elderly brain
APP1078464 (2015-2018)
Centre Chief Investigator: Jason Mattingley

Project Title: Visuomotor integration in the medial parietal cortical areas
APP1082144 (2015-2017)
Centre Chief Investigators: Marcello Rosa and Sofia Bakola

Project Title: Neural circuits for active vision in the primate cerebral cortex
APP1083152 (2015-2017)
Centre Chief Investigator: Marcello Rosa

Project Title: Brain pathways serving conscious and sub-conscious vision
APP1081441 (2015-2017)
Centre Chief Investigators: Paul Martin, Ulrike Grünert and Marcello Rosa

International, Industry and Philanthropic Grants:
Project Title: Mechanisms of action of phytocannabinoids
Lambert Initiative for Cannabinoid Therapeutics
(2018-2019)
Centre Chief Investigator: Steve Petrou

Project Title: Regulation of expression in SYNGAP1 related disorders
Epilepsy Australia (2018-2019)
Centre Chief Investigator: Steve Petrou

Project Title: Representational similarity in marmoset and human visual motion processing
German Academic Exchange Service (DAAD)
(2018)
Centre Chief Investigators: Marcello Rosa and Maureen Hagan

Project Title: Precision therapy in SCN2A epileptic encephalopathies
Ophthalmic Research Institute of Australia
(2018)
Centre Chief Investigator: Ulrike Grünert

Project Title: Retinal gene therapy delivery: best route, right place
RogCon Inc
(2018)
Centre Chief Investigator: Steve Petrou

Project Title: Plasticity of perceptual space under sensorimotor interactions
European Research Council
(2017-2020)
Centre Chief Investigators: Marcello Rosa and Adam Morris

Project Title: Program in Brain, Mind, & Consciousness Senior Fellowship
Canadian Institute for Advanced Research (CIFAR)
(2017-2020)
Centre Chief Investigator: Jason Mattingley

Project Title: Dopamine dysregulation syndrome and N-acetlcysteine
Parkinson's NSW
(2017-2018)
Centre Chief Investigator: Teri Furlong

Project Title: Maternity Funding
Advance Queensland Women's Academic Fund
(2017-2018)
Centre Chief Investigator: Marta Garrido

Project Title: Optimizing cognitive performance by mimicking slow-wave sleep in the awake brain
US Office of Naval Research, USA
(2017)
Centre Chief Investigator: Jason Mattingley

Project Title: Repurposing and ASO therapy in SCN2A epileptic encephalopathy
Mallinckrodt, USA
(2017)
Centre Chief Investigator: Steve Petrou

Project Title: In vivo assessment of novel therapies in epileptic encephalopathy
Lulu Foundation, USA
(2017)
Centre Chief Investigator: Steve Petrou

Project Title: Computational drug repurposing for CDKL5 using target-disease interaction networks
Praxis Precision Instruments, USA
(2017)
Centre Chief Investigator: Steve Petrou

Project Title: Eyes on road: Intelligent smart sensors for road safety
Transurban
(2017)
Centre Chief Investigator: Stan Skafidas

Additional funding

Project Title: Victoria Fellowship study mission
Victorian Endowment for Science Knowledge & Innovation (VESKI)
(2017)
Centre Chief Investigator: Phillip Ward

Project Title: Precision medicine in epilepsy: therapeutic assessment using patients derived stem cell neurons
SCN2A Research Foundation
(2016-2020)
Centre Chief Investigator: Steve Petrou

Project Title: Funding for 3 year Research Fellow appointment
Lions Victoria and LEW Carty Foundation
(2016-2018)
Centre Chief Investigators: Michael Ibbotson and Hamish Meffin

Project Title: Building a roadmap for the Brain
DHB Foundation
(2016-2017)
Centre Chief Investigator: Steve Petrou

Project Title: Development of a Non-Invasive and Automated Point-of-Care Immunosensor for Malaria Elimination in the Asia Pacific
Bill & Melinda Gates Foundation
(2016-2017)
Centre Chief Investigator: Stan Skafidas

Project Title: Low temperature range sensor for biological samples (Phase 2)
Bluechiip Ltd and the Dept of Industry, Innovation and Science
(2016-2017)
Centre Chief Investigator: Stan Skafidas

Project Title: Peptide therapeutic for Dravet Syndrome
Epilepsy CURE (USA)
(2015-2017)
Centre Chief Investigator: Steve Petrou

Institutional Project Grants:
Project Title: Towards a new primate model for visual behavioural neuroscience
Monash University Postdoctoral Bridging Fellowship
$60,000 (2017)
Centre Chief Investigators: Tristan Chaplin and Marcello Rosa

Project Title: Salary Support
Claffy Foundation
(2017)
Centre Chief Investigators: Sammy Lee

Project Title: Centre of Complex Systems
The University of Sydney Inter-Faculty Project
(2017)
Centre Chief Investigators: Peter Robinason

Project Title: Revealing the neural basis of visual motion perception through multi-scale brain imaging
Monash University Strategic Grants Scheme
(2017)
Centre Chief Investigators: Marcello Rosa, Shaun Cloherty, Adam Morris and Nick Price

Project Title: Brain pathways of salient information processing
University of Queensland Fellowship
(2016-2019)
Centre Chief Investigator: Marta Garrido

Project Title: Selective modulation of neural network activity using focal brain stimulation
Queensland Institute of Medical Research
(2016-2017)
Centre Chief Investigators: Jason Mattingley, Luca Cocchi and Olaf Sporns

Institutional Equipment Grants:
Equipment type: KidSTIM: A non-invasive neuromodulation laboratory to simultaneously improve insight and treatment of brain disorders for children in Queensland
UQ Major Equipment and Infrastructure
(2018)
Centre Chief Investigator: Jason Mattingley

Equipment type: Portable Neurophysiological Assessment Suite
Monash University Equipment and Infrastructure
(2017)
Centre Chief Investigators: Gary Egan, Marcello Rosa, Alex Fornito and Adam Morris

Equipment type: Ultramicroscope II: 3D Fluorescence Light-Sheet Microscopy from Macro Structure to Cellular Resolution
Monash University Equipment and Infrastructure
(2017)
Centre Chief Investigator: Marcello Rosa

Acronyms

AI	Associate Investigator
ABBC	Australasian Brain Bee Challenge
ABI	Australian Brain Initiative
AGM	Annual general meeting
ANS	Australasian Neuroscience Society
ANU	Australian National University
ARC	Australian Research Council
CI	Chief Investigator
CoE	Centre of excellence
DREADDs	Designer receptors exclusively activated by designer drugs
DTI	Diffusion tensor imaging
ECR	Early career researcher
EEG	Electroencephalography
EPFL	École polytechnique fédérale de Lausanne
fMRI	Functional magnetic resonance imaging
HBP	Human Brain Project
IIT	Integrated Information Theory
INCF	International Neuroinformatics Coordinating Facility
LGN	Lateral geniculate nucleus
MASSIVE	Multi-modal Australian ScienceS Imaging and Visualization Environment
MBAP	Marmoset Brain Architecture Project
MRI	Magnetic resonance imaging
OECD	Organization for Economic Cooperation and Development
PET	Positron emission tomography
PI	Partner Investigator
QBI	Queensland Brain Institute
QIMR	Queensland Institute of Medical Research
SISSA	Scuola Internazionale Superiore di Studi Avanzati
SOBR	Students of Brain Research
tDCS	Transcranial direct current stimulation
TMS	Transcranial magnetic stimulation

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ARC Centre of Excellence for Integrative Brain Function

Monash University
770 Blackburn Rd
Clayton, VIC 3800 Australia