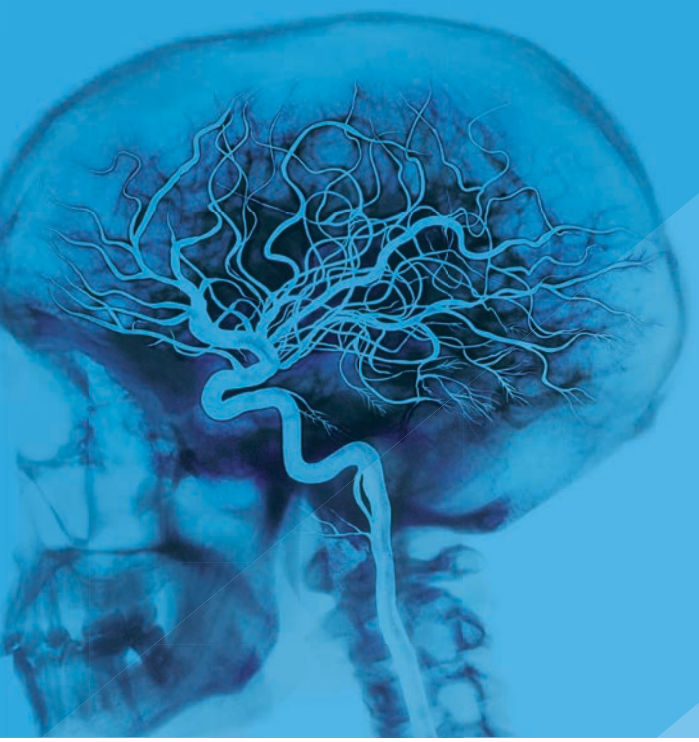
2016

Melbourne Neuroscience Institute

Annual Report



THE UNIVERSITY OF MELBOURNE

MELBOURNE NEUROSCIENCE INSTITUTE

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Every attempt has been made to ensure that the information in this publication was correct at the time of printing.

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EXECUTIVE SUMMARIES

Message from the Director

I am delighted to report that 2016 has been another vibrant and productive year for the Melbourne Neuroscience Institute and, by implication, Neurosciences at the University of Melbourne. The highlights are numerous and have been well catalogued in this Annual Report. I am particularly proud of the ongoing maturation of our public engagement program and of the continuing enrichment of the experience that we are able to provide to our graduate researchers. In addition, we continue to assist our researchers to develop their creative ideas, to strive for excellence and to publicise their achievements to the community at large.

A particular highlight for 2016 was the inception of the YARP Clinicians Research Network which has been sponsored by the Yulgilbar Foundation, Portland House and CF Leung Foundations. This initiative aims to promote clinically oriented dementia research in the hospital environment, whilst also advancing the academic careers of five Early Career Clinical Researchers through collaborative interaction. The clinicians fundamentally involved in the initiative are Dr Rosie Watson, Dr Samantha Loi, Dr Aamira Huq, Dr Nawaf Yassi and Dr Peter Van Wijngaarden. Research activities to be developed under the umbrella of the initiative include: a focus on the genetic determinants of young onset dementia; analysis of the factors that promote protection against dementia even in the presence of genetic predisposition to Alzheimer disease; the influence that vascular disease exerts upon the phenotype of Alzheimer disease; predictors of outcome for those suffering from dementia with Lewy bodies; and novel biomarkers of Alzheimer disease. Mentors to the young clinicians are Professors Bob Williamson, Colin Masters, Ingrid Winship, Dennis Velakoulis and myself. The dedicated involvement of the Myer Family, in particular of Mr Ballieu Myer and of his daughter, Mrs Samantha Ballieu, in supporting the initiative both financially and through their wise counsel, is much appreciated.

In 2016 we also chose to further optimise our links with related disciplines. We achieved this through organising a number of public events in partnership with the University's Hallmark Initiatives and with our sister Institutes, in particular the Melbourne Social Equity Institute and the Melbourne Institute for a Network Enabled Society. These events were a great success and speak to the important role that the University Institutes play in enhancing academic exchange throughout the University and with the community, in general.

I look forward to another successful year for Neurosciences at the University of Melbourne in 2017. In the forthcoming year, MNI will focus on developing an Enhanced Neuroscience Program for our graduate researchers that will commence in 2018. The program will assist in cementing our position as the premiere destination for neuroscience oriented research training in this country. We will also further develop our focus on Traumatic Brain Injury oriented research via participation in a bid for a Cooperative Research Centre in this area. In addition, we will further strengthen our international links with additional academic workshops planned to be conducted in collaboration with our partners at the Hotchkiss Brain Institute in Calgary and the ICM Institute for Brain and Spinal Cord Research in Paris.

I would also like to extend my thanks to the Members of the MNI Advisory Board for their ongoing wise counsel. A special thanks to Professor Liz Sonenberg who retired as Chair of the Board in 2016. Her dedicated guidance since taking on this role in 2010 has been much appreciated; clearly, MNI and Neurosciences in general owe her a great debt of gratitude. I would also like to thank everyone who has generously given us of their valuable time to contribute to our steering and grant/fellowship selection committees; it has been much appreciated. Finally, I would like to thank the MNI staff, Associate Professor Andrew Metha, Ms Vikki Marshall, Ms Amy Bugeja and Ms Carmel McFarlane for their tireless work and support to make MNI the success that it is today.

Professor Trevor Kilpatrick
Director, Melbourne Neuroscience Institute

Professor Trevor Kilpatrick

Message from the Dean

I am pleased to report that 2016 has been another outstanding year for the Melbourne Neuroscience Institute (MNI) and for neuroscience-related research at the University of Melbourne.

The MNI continues to break down silos and strengthen links between neuroscientists and those engaged in related disciplines within the academy. This has resulted in a strong collaboration which unites psychiatrists, psychologists, engineers, mathematicians, physical scientists and also those engaged with the social sciences. The MNI also continues to sponsor initiatives in Stem Cell Science, Neural Engineering, Magnetic Resonance Imaging and Music. These themes are now unequivocally integrated into the activities of our Neuroscience community, providing additional visibility for us, alongside our established, internationally renowned expertise in areas such as epilepsy, Alzheimer's disease, multiple sclerosis and schizophrenia.

Ground-breaking Neuroscience research relies heavily on strong links between fundamental research and clinical translation. It is therefore my pleasure to acknowledge the Yulgilbar Trustees who, in 2016, have provided $2.6m of support for Alzheimer's research at the University of Melbourne. The majority of this funding will be directed to a new initiative to support four young clinical scientists in their joint and individual research programs. The initiative should be instrumental in generating the next generation of leaders in dementia oriented research with expertise spanning clinical neurology, geriatric medicine, old age psychiatry, genetics and ophthalmology. The research outcomes from these emerging leaders will deepen our understanding of how low comorbidities contribute to dementia and lead to improved treatment models for patients and their caregivers.

The University continues to bolster its postgraduate researcher educational program with the inception of the University of Melbourne Neuroscience PhD Program. The program will be developed in 2017 and comprise several new components that will improve graduate researcher recruitment, and deliver an integrated and interdisciplinary student experience beyond the core thesis. This program derives from the highly successful advanced workshop program that MNI has coordinated which also extends to scholarships for secondment to our academic partner, the Hotchkiss Brain Institute in Calgary.

As in previous years, the MNI has continued to fund innovation by providing significant financial support to fellowships for postdoctoral researchers, interdisciplinary seed-funding and student stipends to some of our best and brightest.

In summary, I commend the Director and the staff of MNI for their accomplishments in 2016 and I look forward to another successful year for the Institute in 2017.

Professor Shitij Kapur

Prof Shitij Kapur
Dean, Faculty of Medicine, Dentistry and Health Sciences, Assistant Vice-Chancellor (Health)
22 May 2017

RESEARCH

Music, Mind and Wellbeing

Director: Prof Sarah Wilson

Deputy Director: Prof Gary McPherson

The Music, Mind and Wellbeing (MMW) initiative represents a unique set of collaborations spanning music, science, health, education, and industry. The past year was another busy and successful one for the MMW group, with our team involved in a broad range of research endeavours, community and public engagement events. Notably, Emeritus Prof Denise Grocke received an Order of Australia for her pioneering work in developing the profession of music therapy in Australia and the entire MMW team would like to congratulate her on this well-deserved recognition of her contribution to the field over many years. MMW also continues to expand and promote its research profile within the academic community, with 2016 seeing the first MMW Postgraduate Research Symposium as well as the first MMW Performing Wellness Symposium.

The research and interests of the MMW initiative combine three core research strands encompassing (i) music neuroscience, (ii) music education, and (iii) health and wellbeing. Through work conducted within and across these streams, MMW continues to investigate the intersection of music, the mind and its positive influence on our wellbeing. Our work promotes an understanding of the best ways to engage with music in a variety of settings, including schools, tertiary training programs, hospitals, aged and palliative care facilities, and the community. This has important implications for building inclusive communities that embrace diverse and creative participation. Our many community engagement activities provide a platform for us to communicate our research findings and educate around the power of music on the brain and psychological functioning, both in response to training in healthy individuals and as a tool for rehabilitation in individuals with brain injury and disease.

Research

Music Neuroscience Program

Research in the music neuroscience program covers a variety of topics, including (i) examining cognitive and personality factors underpinning our ability to engage with music, (iii) using music with people with brain disorders, to help improve their health outcomes and further our understanding of music

MMW Postgraduate Researcher Yi Ting Tan

networks in the brain, and (iii) methods to enhance the effectiveness of music therapy, such as eye tracking to measure visual attention during therapy.

An exciting venture from the music neuroscience program is being led by the Director of MMW, Prof Sarah Wilson, and the Deputy Director, Prof Gary McPherson, with the support of national and international collaborators and MMW Postgraduate researcher, Yi Ting Tan. This program has recently received funding through the Australian Research Council (ARC) to continue pioneering research investigating the genetic basis of music abilities. Individual differences in musical ability have sparked intense debate around the relative importance of nature and nurture in shaping music abilities. Our study will use singing to explore this issue. Pilot data has already been collected using an innovative online singing program with over 100 twins, recruited with the support of the Australian Twin Registry, to examine the heritability of singing ability. Our results show interesting effects that will now be fully investigated in a larger twin sample with the support of the ARC funding.

Educational Research Program

Under the leadership of Deputy Director, Prof Gary McPherson, and Research Fellow, Dr Margaret Osborne, our educational research program continues to investigate the impact of music ability and music training on child development and mental health. This includes key factors underlying student engagement in music learning and performance across primary, secondary and tertiary education settings, as well as the development of effective interventions for music performance anxiety in secondary school and conservatorium students. The findings of our team have directly contributed to the Victorian Parliamentary inquiry into music education, and MMW has been approached by the Victorian Curriculum and Assessment Authority (VCAA) to contribute to the development of a series of music programs for the new National Curriculum.

Health and Wellbeing Research Program

The year saw MMW Research Fellow and Music Therapist, Dr Jeanette Tamplin, awarded the Biomedical Research Victoria VCRN Early Career Clinician Researcher Award in recognition for her achievements as an early career researcher. MMW's health and wellbeing research program continues to conduct innovative research into the therapeutic use of music, for people with conditions such as acquired brain injury, spinal cord injury, cardiac disease, motor neuron disease, Parkinson's disease, dementia, and post-traumatic stress disorder. Dr Tamplin has received significant public recognition for her research into a telehealth application for music therapy. This work aims to develop an online virtual reality platform designed to deliver telehealth group singing interventions for people with quadriplegia to improve respiratory function, voice, mood, and social connectedness. The project involves the design and testing of a virtual environment (such as singing around a campfire) that will enrich both the group's experience and the participant's motivation to sing. New advances in virtual reality technology are being incorporated into the environment to enhance the depth of the group's participation experience.

Another exciting project underway by a member of Dr Tamplin's group, Dr Imogen Clark, examines the beneficial effects of participant-selected music on exercise after cardiac rehabilitation. This work shows that listening to music during exercise improves emotional functioning and alleviates patient concerns about exercise after cardiac disease, as well as having beneficial physical effects for weight management and fitness.

Outreach

The MMW community engagement program aims to promote new public attitudes that foster grass roots participation in music. In 2016, this involved a series of new successful public events, including hosting a panel discussion titled 'This is Your Brain on Music' at the inaugural 'Face the Music' Conference hosted by the City of Melbourne and well attended by musicians and music industry representatives, a public lecture on 'The Benefits of Music for the Brain: Neuroplasticity and Learning' hosted by the Melbourne Lyceum Club, and contributing to a Canadian based documentary entitled 'Music in Humans'. The Canadian documentary crew, headed up by Connie Edwards from The CBC, travelled to Melbourne to explore the work of Prof Wilson and her collaborators, which will be showcased in the coming year. We have also continued to run our academic seminar series, 'Music, Auditory Cognition and Mind,' which is attended by national and international researchers, postgraduate students, music performers and educators, to foster interdisciplinary dialogue in music research.

Public Lecture Series: 'Music on the Mind'

'Music on the Mind' is a popular public lecture series co-hosted each year by MMW and the Melbourne Recital Centre since 2010. In 2016, this included two lectures from the MMW initiative, addressing the topics of 'Music, Mind and Mozart' and 'Alive Inside', based on the documentary of the same name exploring the impact of music for people with dementia. The latter included a live choral performance by people living with dementia and their family caregivers, which was a real highlight. This series has led to greater public engagement in music research, not only through sell-out attendances but also through interviews and articles in print, radio and online about our lectures and research.

MMW Postgraduate Symposium

MMW seeks to promote early career researchers in order to build music research capacity in Australia. In 2016, MMW ran an inaugural Postgraduate Symposium, to showcase some of the latest research being conducted by our graduates. Topics ranged from psychological factors related to the experience of chronic tinnitus (ringing in the ears), to exploring the benefits of group music therapy for people with Borderline Personality Disorder. Invited speaker MMW Affiliated Researcher Dr Amee Baird closed the symposium with a presentation examining the benefits of music in people with dementia that forms part of her NHMRC-ARC Dementia Research Development Fellowship.

MMW Research Fellow Dr Tamplin testing the virtual therapy environment

Dr Bronwen Ackerman presenting at the inaugural MMW Performing Wellness Symposium

Performing Wellness Symposium

The stresses and strains of elite musical performance can have debilitating effects on musicians. Our first MMW Performing Wellness Symposium was launched in 2016, to promote the wellbeing of professional music performers as a way of maximising their performance potential and enjoyment. The symposium offered musicians the opportunity to share their own research findings and participate in practical activities. This included the opportunity to work with Bronwen Ackerman, a physiotherapist specialising in working with musicians and David Howard, founding member of the York Centre for Singing Science.

Partnerships

The MMW research program is underscored by highly-effective partnerships and interest from a wide range of research and service providers, including research collaborations with the Florey Institute of Neuroscience and Mental Health, the Melbourne Networked Society Institute, The Centre for Neuroscience of Speech, Parkinson's Victoria, Austin Health, Melbourne Health, Monash Health, Calvary Healthcare, and the National Disability Insurance Agency. MMW also disseminates research and engages the public in collaboration with the Australian Music Centre, The Music Trust, The Centre for Cultural Partnerships, the Australian Music Therapy Association, The City of Melbourne, Places Victoria, and the Melbourne Recital Centre, and provides ongoing advice and consultancies for the Victorian State Government (VCAA) and the Federal Government.

Goals for 2017

In 2017, MMW will continue to maintain its strong public engagement profile and innovative research programs with plans already underway for collaboration on international conferences, and continuing the successful symposia and community engagement events held this year.

Melbourne Brain Centre Imaging Unit

Director: Prof Roger Ordidge. Research Fellows: *Dr Brad Moffat (senior); Dr Amanda Ng; Dr Sonal Josan; Dr Jon Cleary*

Research

In 2016, we have initiated some important clinical studies on the 7Tesla Magnetic Resonance Imaging scanner and have facilitated ongoing development work to push the capabilities of the system forward even further.

Highlights include:

- The commencement of a study imaging multiple sclerosis patients using high resolution functional MRI to look at the effects of the disease on walking and balance and its impact on the brain.

- We have taken delivery of a special imaging coil for eye MRI (one of only two in the world) that enables impressive detailed images to be generated that can be used to assess patients with sight impairment, such as those with glaucoma.
- Alongside the Department of Anatomy and Neuroscience, we are using the scanner to make high quality models of brain structures which can then be used with 3D printing or virtual-reality to teach the next generation of anatomy and medical students.

It has also been an exciting and highly productive year for our work utilising positron emission tomography and computerised tomography (PET/CT). In particular, we have imaged more subjects on our scanner for amyloid related studies of fundamental relevance to the diagnosis of Alzheimer's disease than any other scanner in the world.

PET enabled research now includes assessing anti-tau therapy and monitoring stem cell therapy for Parkinson's disease and inflammation in MS. Our focus extends beyond medical research; our oldest subject was 25 million years old where we found the first fossil of the ancestor of baleen whales that had been buried in rock!

Outreach

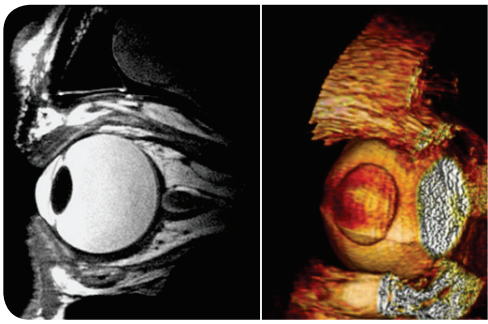
Lectures were delivered for 3rd year RMIT undergraduates and University of Melbourne Postgraduates (16 lectures and MRI demonstration). We also participated in the Steering Committee for Alzheimer's therapeutic trials. The Laboratory also hosted approximately a dozen tours for visitors.

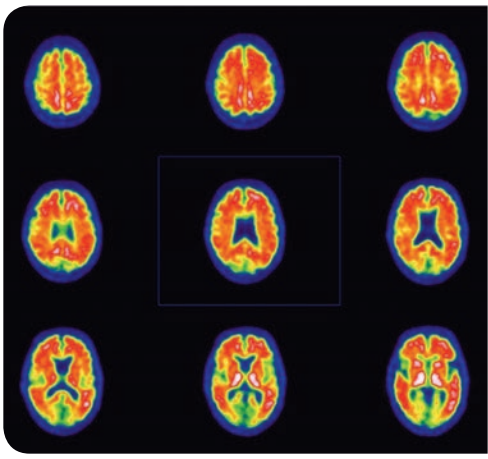
Partnerships

Partnerships were continued with the National Imaging Facility (NIF), Siemens Medical Systems, Nanyang Technological University (Singapore), the Hotchkiss Brain Institute (Calgary, Canada) [all MRI] and the Florey, Austin Health, US National institute of health, Alzheimer's Therapeutic Research Institute,
Lilly, AVID, GE-Pharma, CSIRO, The Alzheimer's Association International, PIRAMAL, Astra-Zeneca, Museum Victoria, UCSF School of Medicine, Alzheimer's Disease Neuroimaging Initiative, Monash University, Telemedicine and Advanced Technology Research Centre (United States Army) [PET/CT with some MRI].

Goals for 2017

The Laboratory will continue to expand the use of 7T MRI and PET/CT for medical research within our local and National Imaging Facility community and in particular, continue to be the a principal for Alzheimer's disease imaging using PET-based technology. We also seek to be involved in the development of new approaches to molecular imaging and MRI software development for 7 T MRI (with Siemens). In addition, we plan to develop a processing pipeline with Siemens and CSIRO for PET/CT image research.





From top down:

Sagittal Eye Images of a 37 year old volunteer and a surface rendered image of the 3D data set. Jon Cleary, Brad Moffat, Allison McKendrick, Bang Bui, Scott Kolbe, Roger Ordidge

PET images where the presence of Amyloid is shown by "hotter" colours on a thermal scale (right). Rob Williams, Chris Rowe, Colin Masters et al.

Stem Cells Australia

Director: Prof Martin Pera. ***Head of Education, Ethics, Law & Community Awareness Unit:*** *A/ProfMegan Munsie*

Stem Cells Australia (SCA) is the Australian Research Council's Special Research Initiative in Stem Cell Science, bringing together leading researchers from across Australia to explore the potential role of stem cells in a range of currently intractable diseases.

Led by Prof Martin Pera at the University of Melbourne, this unique collaboration links leading experts from across Australia to develop novel approaches to address stem cell regulation and differentiation. In addition to supporting excellence in stem cell research, SCA also leads public debate and discussion about important ethical, legal and societal issues associated with stem cell science, and provides core service to support the stem cell research community.

Research Highlights

Four main areas of stem cell biology were the focus of SCA's research activities in 2016 – control of pluripotency and reprograming, regeneration and repair in the brain, regeneration and repair in the heart and the development of blood – with members contributing to over 150 publications in prestigious journals such as Blood, Cell Stem Cell, Nature Biotechnology, Nature Communications, Nature Genetics and Nature Immunology.

One SCA discovery that attracted significant media interest in 2016 was the work by Murdoch Childrens Research Institute (MCRI) team that brings our understanding about how to create blood stem cells in the laboratory on step closer. Published in the journal Nature Biotechnology, and led by Dr Elizabeth Ng, Professor Andrew Elefanty and Professor Ed Stanley, the researchers were able to more closely mimic how blood cells form during early development. Through turning on the right genes, they made pluripotent stem cells turn into blood stem cells. While the blood cells will still need some degree of maturation in the laboratory before they would be ready for transplantation to treat blood disorders and childhood cancers like leukemia, the team has made an invaluable contribution towards this goal.

The caliber of Stem Cells Australia's scientists was also recognized at the 2016 Australian Museum Eureka Awards with Professor Melissa Little and Dr Minoru Takasato from the MCRI being awarded the UNSW Eureka Prize for Scientific Research for their work on recreating human kidney tissue from stem cells - Kidney in a Dish. This research opens the door to disease modelling, drug screening, and ultimately development of replacement organs. Also receiving an award was Professor Christine Wells from the University of Melbourne and Professor Ernst Wolvetang from the University of Queensland for their contribution to the international research consortium FANTOM5. This collaboration of 260 specialists from 20 countries, including 22 Australian researchers, is developing a comprehensive map of the genes expressed in each of our cell types. The map is being used to understand genetic diseases and engineer new cells for therapeutic use. Scientists involved in the FANTOM5 consortium are based at Harry Perkins Institute of Medical

Research; The University of Melbourne; University of Queensland; Translational Research Institute; Telethon Kids Institute; and RIKEN Japan. FANTOM5 was awarded the 2016 Scopus Eureka Prize for Excellence in International Scientific Collaboration.

Outreach and Education

Stem cell science remains a cornerstone of medical research, from using stem cells to better understand how we develop, what occurs during disease and injury, to the development of possible new cell-based therapies. Cutting edge research such as induced pluripotent stem cells – where cells can be created directly from a patient – now means it is possible to screen for new pharmaceuticals or biologics, making the prospect of precision medicine a step closer. However, for many in the community excitement about the progress and possibilities that stem cell research may offer, coupled with compelling direct-to-consumer advertising, has fostered a 'stem cell' industry where so-called treatments are offered now but without any credible scientific evidence to support the marketing claims.

Throughout 2016, Stem Cells Australia has partnered with key national and international research organisations, patient advocacy groups, teacher associations, academics, industry and professional bodies to deliver a suite of educational activities. We have also continued to raise awareness about the policy implications of stem cell research, especially related to the sale of unproven stem cell 'treatments' in Australia and abroad.

We joined colleagues from around the world to update the ISSCR 'Guidelines for Clinical Translation of Stem Cells' to set clear standards on how stem cell science should move from the laboratory to the clinic. Martin Pera and Megan Munsie also provided a submission on behalf of SCA to the Therapeutic Goods Administration (TGA) in response to their 2016 consultation on the current Australian regulations that govern autologous cell therapies – where the patient's own cells are used. Australian clinics and businesses continue to offer unproven, costly, and potentially hazardous medical treatments that claim to use stem cells. SCA believes there is an urgent need for more stringent regulatory oversight to protect the Australian public and overseas visitors from harm, and to ensure genuine efforts to translate promising stem cell research into clinical benefit are not stymied. Several other members of SCA also submitted submissions to the TGA consultation as representatives of their research institute, Australasian Society for Stem Cell Research or the Australian Academy of Science.

In addition, we have continued to liaise with the Australian Health Practitioner Regulatory, Royal Australasian College of Physicians, the Australasian College of Sports and Exercise Physicians, AusBiotech and other peak bodies to further enhance professional understanding and awareness about these unproven, and in many cases unfounded, practices.

Stem Cells Australia also continued to work closely with high school teachers, and specialty life sciences education initiatives such as Gene Technology Access Centre (GTAC), in an effort to take our research out of the lab and into the classroom.

Dr Anna Michalska at the Women in Stem Cell Science program

Students attended the Women in Stem Cell Science program

Keen to raise awareness about careers in STEMM (Science, Technology, Engineering, Mathematics and Medicine) for girls, Megan Munsie designed and co-hosted a full day program for high school students in years 8 and 9 with the assistance of MNI's Amy Bugeja. Students worked in the laboratory alongside scientists from the University of Melbourne, Murdoch Children's Research Institute, Centre for Eye Research, Florey Institute and GTAC to explore the world of stem cell research, ethics and communications. The Women in Stem Cell Science program was a unique and exceptional experience for students, teachers and the twenty scientists involved.

Through MNI, the Melbourne node of SCA continues to offer a workshop in the application of human pluripotent stem cell technology in neuroscience that has been very enthusiastically received. We continue to support our neuroscience colleagues here through the operation of our Flow Cytometry and Stem Cell Core laboratories.

Towards the end of 2016 Professor Martin Pera advised that he would be leaving the initiative in early 2017. Under his leadership, SCA has been able to establish an environment that has enabled excellence in stem cell research to thrive. Professor Pera has also championed training and mentoring opportunities for young researchers and has been a powerful advocate for stem cell science in the broader community.

Partnerships

Collaboration is core to SCA operations. Our initiative involves researchers from the University of Melbourne, the University of Queensland, the University of New South Wales, the Victor Chang Cardiac Research Institute in Sydney, the Walter and Eliza Hall Institute of Medical Research (WEHI), the Florey, Monash University, CSIRO Material Science Division and MCRI.

Goals for 2017

As we head towards our sixth year of funding, we can begin to shape our vision of the future. Australian stem cell research continues to maintain a high international profile, particularly in basic stem cell biology. While maintaining this momentum, we must ensure that translational research programs enable our discoveries to proceed to application in the clinic. In the next twelve months SCA will be seeking to:

- Introduce a new leadership team to head the initiative
- Further strengthen the collaborative focus within our current research portfolio and reposition our portfolio for the future
- Expand our national and international collaborative networks across bioengineering, nanotechnology, stem cell biology, advanced molecular analysis, clinical research and industry
- Continue to call for regulatory reform to curb the sale of unproven stem cell treatments in Australia
- Continue to provide bespoke educational opportunities for high school students, teachers and the public.
- Within the Parkville precinct we will support neuroscience researchers at UoM and the Florey through:

- Access to the latest high-end flow cytometric machinery and services in our Flow Cytometry Facility.

- Establishing stem cell platforms to investigate the genetics of epilepsy, the pathogenesis of Alzheimer's disease, and brain repair, and convening seminar and postgraduate student programs.

Centre for Neural Engineering

Director: Prof Stan Skafidas

Deputy Director: Prof Steven Petrou

The Centre for Neural Engineering (CfNE) was established by the University of Melbourne as a cross-faculty initiative in response to the developing convergence between the technological and life sciences, bringing together existing strengths in medical, physical and technology research to forge new pathways.

Research within the CfNE operates across discipline boundaries to further our understanding of the brain and neural system. Its multidisciplinary nature, along with the breadth of its collaborative links, provides opportunities for staff and students to develop and utilise expertise from outside their own core area. This environment encourages innovative ideas as participants bring a wide variety of viewpoints and approaches to research problems.

Research

Research at the Centre for Neural Engineering is focused on five main themes: Sensors and Imaging; Bionics; Stem Cells and Disease Models; Integrative Biological Psychiatry; and Computational Neurobiology. During 2016 participants in the CfNE were involved in a wide variety of projects, collaborating with fellow researchers, clinicians and industry partners to advance the field of neural engineering. Highlights of the year include:

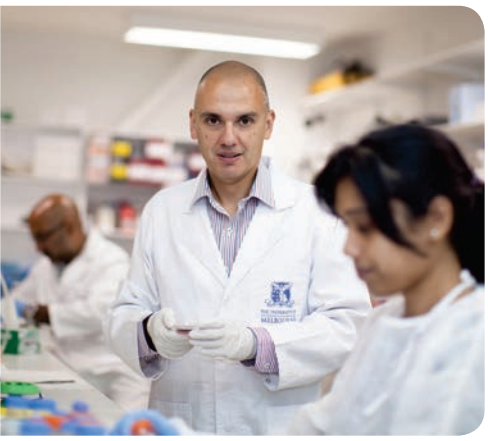
- Led by Lloyd Hollenberg and David Simpson, members of the CfNE from the School of Physics, have been working with their colleagues to develop new methods for the detection and study of essential transition metals such as iron, copper and cobalt, in biological systems. Current methods of imaging transition metals in biological systems tend to result in changes to the properties of the molecule the metal ion is a part of. Building on long-term studies in the School of Physics on the properties of atomic defects in diamonds, the team has showed that newly discovered quantum resonance microscopy can be used to detect transition metal ions in water-based solutions. In addition, the technique can determine specific properties of the metal ions at sensitivities far greater than current gold-standard methods. Potentially, quantum resonance microscopy could be used to study transition metals in living cells, leading to new discoveries about how these vital elements contribute to life.

- Following its commissioning in late 2015, the Centre's helium ion microscope has fast become an essential tool for both imaging and fabrication at the nanoscale level. The Integrative Biological Psychiatry

team, led by Gursh Chana, have quickly integrated the microscope into their studies of autism spectrum disorder (ASD). In what is believed to be a world-first, the microscope has been used to view the surface detail of mouse microglial cells (BV2). Microglia form a key part of the brain's immune response and are also thought to play an important role in synapse development and thus brain connectivity. There is increasing evidence that microglia function contributes to the underlying causes of conditions such as ASD and schizophrenia. Being able to study microglial cells at this new level of detail will contribute to our understanding of their structure and function along with their interactions with other cells.

- With colleagues from the University's Department of Electrical and Electronic Engineering, researchers at the Centre have determined a new class of electrically tuneable solid-state nanopore biosensors based on graphene. When molecules move through a nanopore, the identity of individual amino acids can be worked out from the changes to electrical properties caused as they travel through the gap. Graphene is composed of a single layer of atoms. This comparable size to amino acids means the electrical properties are highly sensitive to change when the biomolecules move through the gap. By constructing graphene nanopores in self-switching diodes, the nanopore becomes tuneable or adjustable. This greatly increases the sensitivity of the sensor, permitting detection of a single molecule in solution. In addition, it can also detect intra-molecular electrostatics, such as those caused by the presence of the carboxyl group within glycine molecules. These charges are similar to those produced by a single electron. These results are promising for creating a new generation of devices for detecting single biomolecules. Published in the Royal Society of Chemistry Nanoscale journal, the resulting paper was selected as one of the journal's Hot Papers for 2016 and featured as cover art.
- Three-dimensional cell cultures provide a more realistic representation of how cells grow and behave in living tissue than traditional two-dimensional techniques. Led by Mirella Dottori, members of the Stem cells and Disease Models team have continued developing these new techniques during the year and are now able to routinely grow two types of neurons on a graphene foam scaffold: glutamergic and GABAergic neurons. Gluatamate or gamma-aminobutyric acid (GABA) are secreted by different types of neuron and control the electrochemical signals that neurons use to communicate with each other. Now that the team are able to grow these cells in 3-D culture they are developing ways to study their communication and particularly, how it can be disrupted. This research will enhance our understanding of how neuronal network disruption contributes to chronic disorders and how it can be alleviated.
- David Grayden of the Bionic team has been a part of the multi-disciplinary team developing a matchstick sized implant that can be inserted in a blood vessel next to the brain to detect signals which can then be used to control an exoskeleton or bionic limb. Dubbed the 'stentrode', it removes the need for invasive brain surgery and has been tested in animals. First in human trials are expected to commence soon. The work was published in Nature Biotechnology early 2016 and received widespread media coverage.

Prof Stan Skafidas and CfNE laboratories



- A team of CfNE researchers have worked with colleagues at the Victorian Infectious Diseases Reference Laboratory, Austin Health and the Faculty of Medicine, Dentistry and Health Sciences to develop an inter-digitated electrode-base method to identify Staphylococcus aureus bacteria (Golden Staph) in a sample and determine how sensitive it is to the antibiotic flucloxacillin. The sensor is able to do this within 2 hours, an improvement on current culture methods which can take up to 5 days. The paper reporting this method was featured as the cover art for its issue of the Royal Society of Chemistry journal Analyst.

Outreach and Education

CfNE hosted a two-day ZEISS Technology Workshop & User Meeting on Multi-Ion Beam Applications for researchers early in 2016. Structured around addresses by Shinichi Ogawa of Japan's National Institute of Advanced Industrial Science and Technology (AIST) and Queensland University of Technology's Peter Hines the workshop included a live video link to the ZEISS Ion Microscopy Innovation Centre in Massachusetts. Bringing together researchers from nine institutions in the region, the workshop provided a great opportunity to find out more about the new helium ion microscope's nano-imaging and nano-fabrication capabilities and to start building user networks.

In the second half of the year, members of the Bionics team were involved in hosting an international competition to crowdsource potential algorithms for the prediction of seizures from electrical brain activity. Run through Kaggle, the data science competition platform, the competition attracted more than 10,000 entries analysing brainwave data collected over a period of months rather than the more common days. Being able to predict seizures from preceding brainwave activity has the potential to transform the lives of sufferers, providing a warning or ultimately enabling the programming of implantable devices that can prevent them.

Postgraduate students play a major role in the CfNE's research activities, with students from the Faculties of Science and Medicine, Dentistry and Health Sciences and the Melbourne School of Engineering undertaking research across a diverse range of topics. During 2016 six students had their thesis passed or submitted for examination.

Partnerships

Strong collaborative partnerships are a cornerstone of CfNE's activities and we would like to acknowledge the vital contributions made by key collaborators, particularly those that bring clinical expertise to projects.

Key partners of the CfNE include the Melbourne Neuropsychiatry Centre, the Bionics Institute, Austin Health, the Florey, Royal Melbourne Hospital, the Victorian Infectious Diseases Reference Laboratory, the ARC Centre of Excellence for Integrative Brain Function, Duke University, St Vincent's Hospital, the National Institute of Environmental Health Sciences, the Friedreich Ataxia Research Association, IBM Research, the Centre for Eye Research Australia, Smartstent, Cochlear, Bluechip and the National Vision Research Institute.

The Stentrode is a radically new approach in the field of "brain-machine interfaces" – technology that delivers mind-control over computers, robotic limbs or exoskeletons and gives people with paralysis the chance for more independence using the power of thought.

Goals for 2017

During 2017 CfNE will focus on increasing its engagement with colleagues in the Faculty of Medicine, Dentistry and Health Sciences. In particular, the work undertaken with the Department of Psychiatry on the role of neuroinflammation in disorders such as schizophrenia and ASD will be expanded. Flexible and biocompatible sensors developed over the last two years will be taken to the next stage of testing, in vivo, in collaboration with colleagues at the Departments of Neurosurgery and Anatomy and Neuroscience. As part of the expansion of its collaborative base CfNE is also looking to establish relationships with a number of new organisations such as the Murdoch Children's Research Institute and the Monash Institute of Pharmaceutical Sciences.

CfNE aims to begin commercialising its point of care diagnostic and testing device for selected applications during the year. The device is based on detecting and measuring changes in electrical properties following molecular bonding and is being developed for a range of applications including identification of patients susceptible to gene-linked drug reactions, early stroke detection and rapid identification of bacterial species and their antibiotic resistance.

Students of Brain Research Professional Development Dinner

SOBR is a not-for-profit, independent organisation that is run by students. Founded in 2011, SOBR aims to connect students interested in brain research from across Victoria. Without sponsors, including the Melbourne Neuroscience Institute, SOBR would not be able to hold events to provide opportunities for students to network.

On Wednesday 25 May, 2016 SOBR hosted its annual Professional Development Dinner at the State Library of Victoria. It was SOBR's largest ever event with 180 local brain research students, distinguished scientists, industry representatives, and science communicators from 14 local universities and research institutes attending. The theme of the night was "Beyond the Lab: Rebranding Your Science" and focussed on how to pitch yourself and your science to the public, governments, and industry.

Students of Brain Research

Our keynote speakers were experts in interfacing with industry and government; Leonie Walsh, then Victorian Lead Scientist and chair of the Victorian Government Innovation Expert Panel; and Adam Ferrier, a prominent consumer psychologist and regular panellist on the ABC's Gruen Series. Science communicator and 3RRR broadcaster, Dr Andi Horvath, was invited to once again host evening, as she has kindly done in previous years.

The second major event on the SOBR calendar is the Student Symposium, which was held at Storey Hall, RMIT, Melbourne. There was a great amount of student interest in the event, including attendees from interstate. Students had the opportunity to network, share their research, and receive feedback from expert reviewers and judges. The free symposium consisted of four student

oral sessions, two poster sessions, as well as two plenary lectures from Prof Ingrid Scheffer from the University of Melbourne and A/Prof Naotsugu Tsuchiya from Monash University.

Congratulations to all participating students, and special mention to the 2016 oral and poster presentation winners, who were each awarded research stipends.

Oral presentation winners:

1 Australasian Neuroscience Society Research Bursary – Rose Crossin (Florey)

2 Remika Mito (Florey)

3 Phillip Ward (Monash University)

Poster presentation winners:

Psychiatry, Psychology and Cognitive Neuroscience

1 Rebecca Norris (Florey)

2 Julian Matthews (Monash University)

Cellular and Molecular Neuroscience

1 Alex Reichenbach (Monash University)

2 Umesh Nair (Florey)

Neurodegeneration, Brain Injury and Repair

1 Anthony Boghdadi (Monash University)

2 Amy Shepherd (Florey) and Karen Biddiscombe (La Trobe University) – draw

Computational Neuroscience, Networks and System

1 Shuyu Zhu (Monash University)

Development, Plasticity and Stimulation

1 Sian Virtue-Griffiths (Monash University)

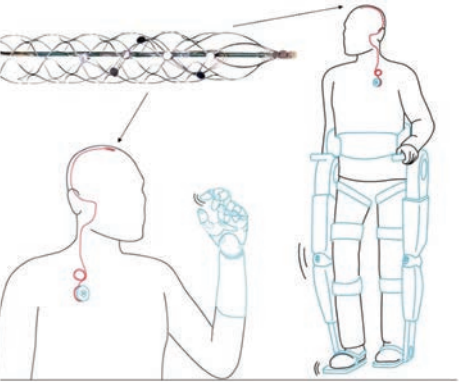
2 Sung Wook Chung (Monash University)

Research Highlights

Moving with the power of thought

A device the size of a matchstick, implanted next to the brain's motor cortex, could one day help paralysed people move their limbs.

A group of study subjects with paralysis will soon undergo a revolutionary procedure that could allow them to walk with the power of thought. The key to returning mobility is a tiny, matchstick-sized device called a stentrode. It will



The stentrode can record brain signals from within a blood vessel next to the brain. These thoughts are captured, decoded and passed wirelessly through the skin to enable control of an exoskeleton.

be implanted into a blood vessel next to the motor cortex, the brain's control centre – bypassing the need for complex brain surgery. From there it will pick up brain signals and allow patients to move a robotic exoskeleton attached to their limbs simply by thinking about it.

This notion of wirelessly thought-controlled limbs is within reach, thanks to a collaboration of 39 brilliant minds from 16 departments across the University of Melbourne's medicine, science, veterinary science and engineering faculties.

The stentrode can record brain signals from within a blood vessel next to the brain. These thoughts are captured, decoded and passed wirelessly through the skin to enable control of an exoskeleton.

A research paper published in Nature Biotechnology hails the pre-clinical animal trials of the stentrode, which measures only three millimetres wide, a success. The research team demonstrated the stentrode can pick up strong electrical frequencies emitted by the brain that are coded into a computer. The computer then sends a signal to an exoskeleton attached to the arms or legs, enabling movement. The work is the result of close collaboration between the University of Melbourne, the Royal Melbourne Hospital and the Florey.

In late 2017, a select group of patients with paralysis from the Royal Melbourne and Austin Hospitals in Australia will be chosen for the trial, where they will be implanted with the stentrode. If the trial succeeds, the technology could become commercially available in as little as six years. The stentrode could also benefit people with Parkinson's disease, motor neurone disease, obsessive compulsive disorder and depression and could even predict and manage seizures in epileptic patients.

Neurologist at the University of Melbourne, Florey and the Royal Melbourne Hospital, and current endovascular neurosurgery fellow at Mount Sinai Hospital, New York City, Dr Thomas Oxley, is the founder of this technology. In 2011, Dr Oxley was travelling in New York, after completing his internal medicine fellowship at The Alfred Hospital, Melbourne. He had been following the work of DARPA, the US Department of Defence's research unit, on brain-machine interfaces and decided to cold-call them to pitch a simple yet mind-boggling idea.

"I received an email back from Colonel Geoffrey Ling, the military neurologist directing DARPA's prosthetic limb program, who invited me for an informal chat," Dr Oxley says. "I put together a sketchy presentation and got on the bus to Washington DC. "Colonel Ling sat back in his chair and said: go home and put a team together we'll give you $1 million to create and test this device."

Under the supervision of Prof Terry O'Brien, from the Royal Melbourne Hospital and the University of Melbourne's Medicine, Dentistry and Health Sciences Faculty, Dr Oxley assembled a team of scientists, neuroscientists, surgeons, doctors and engineers. The DARPA funding was leveraged with two large grants from the Australian National Health and Medical Research Council for a further $2.2 million. "Prof Terry O'Brien made it happen. He walked me in to

the Department of Engineering and introduced me to Tony Burkitt and David Grayden, engineering professors who had worked on the bionic eye and bionic ear projects," Dr Oxley says.

Prof O'Brien, who is Head of the University's Department of Medicine at the Royal Melbourne Hospital, has dubbed Dr Oxley's new technology the 'Holy Grail' of medicine. "This technology is really exciting. It's the first time that we've been able to demonstrate and develop a device that can be implanted without the need for a big operation, to chronically record brain activity," Prof O'Brien says. "The most obvious benefit is for people who are paralysed following a stroke or spinal cord injury. It is simple and non-invasive and much safer for patients."

The stentrode is inserted into a blood vessel that sits over the motor cortex. The device is delivered through a small catheter, and when in position, the catheter is removed, deploying the stentrode. The stentrode expands to press the electrodes against the vessel wall close to the brain where it can record neural information and translate these signals into commands that can be used to control an exoskeleton. When the catheter is inserted into the blood vessel in the brain, it leaves a small cigar-shaped 'basket', wired with electrodes, which can record the brainwave activity.

"There is no craniotomy, no risk of infection, it's all run through the groin and passed inside the body up into the brain," Prof O'Brien says. "This has been the Holy Grail for research in bionics – a device that can record brainwave activity over long periods. Inside the blood vessel, it's protected; it doesn't damage the brain vessel and can stay there forever."

For Dr Oxley, the situation seemed surreal. He'd gone from having an idea to a multi-million dollar budget and a team within the space of several weeks. "All of a sudden I'd started my PhD and had several million dollars to work with and a whole area to start my own lab with the engineers," he says.

Three years of design, development and testing led to the unveiling of an ingenious stent device which can be implanted in a simple day procedure. Prof Clive May, the Florey, explains how the device is implanted using minimally invasive surgery that can be performed within a few hours. "As the device absorbed into the vein wall after nine or so days, the electrical signals continued to become clearer and stronger, up to 190 hertz, as strong as signals previously recorded with intricate invasive brain surgery," Prof May says.

These signals act as the electrical messengers that provoke intricate muscle movements and can, theoretically, be coded into software that links to an external skeleton. "Personally, the fact that our device can record signals up to 190 hertz is the most exciting finding in our Nature Biotechnology paper," Dr Oxley says. "The data between 70 to 200 Hertz is the most useful for brain machine interfacing. Very smart people told us that we would have big problems with blood creating so much noise it would interfere with the signal, but we showed this isn't true."

The chief engineer behind the device is the University of Melbourne's Dr Nick Opie, a Senior Research Fellow and co-head of the Vascular Bionics Laboratory at the Royal Melbourne Hospital. He and Dr Oxley co-founded

SmartStent, the company that will translate this research into reality. Dr Opie was recruited from the bionic eye project.

"I've always been fascinated by the integration of man and machine and the ways that people and machines could function together. Fortunately, I was born in the time to do this," Dr Opie says. His challenge: to engineer a tiny net-like device that could be fitted with electrode receivers. It needed the ability to collapse to a tiny few millimetres in diameter and spring back into shape to act as a scaffold to maintain the flow of blood and permanently settle into the vein. Crucially, the device needed to be biocompatible.

"The first iteration was pretty horrible," he admits. "I don't want to count how many we've made. It required a lot of microscope work and very steady hands." Hundreds of iterations later, Dr Opie and his team produced the winning design using a flexible material called nitinol, also used in bra underwires and for modern glasses frames. It is fitted with tiny recording discs, called electrodes, which sit on the wall of the blood vessel, right next to the brain tissue.

The stentrode device went through hundreds of design changes before researchers were satisfied it met their requirements of being light, flexible, bio-compatible and small enough to be threaded into a one millimetre blood vessel. Each disc records electrical activity fired by some 10,000 neurons, which is delivered via delicate wires that run out of the brain, into the neck and emerge into the chest into a wireless transmission system.

The researchers say this transmission can be coded into signals that control an exoskeleton. The first patient will work hard to 'code' each of these unique signals to their exoskeleton. Much like the process of learning to walk or speak again, the process will take many months, until finally, the movement becomes as effortless as driving a car, touch-typing, or writing your name on a form.

"Imagine someone bought a piano for you and you didn't know how to play," Dr Oxley explains. "You know that your hands are physically capable of playing it, but you don't understand the sequence in which the keys have to be struck. It will take time to use your hands to learn how to play the piano. With our device, you've essentially connected an electronic limb to the patient's brain, but they have to learn how to use it."

Human trials in 2017

In 2017, the stent will be implanted into carefully selected paraplegic or quadriplegic patients by surgeons at the Royal Melbourne Hospital. The long road to coding will begin at the Austin Hospital's Spinal Cord Service.

The first patients will most likely be young people who have suffered a traumatic spinal cord injury around six months to a year earlier, who are suitable for exoskeleton legs. They will be chosen for their level of determination, their resolve and their physiology, Dr Opie says.

Dr Opie will be there to guide the first patients through the journey. He says one of the remarkable aspects of his device is it does not require opening up

the skull to implant. “Other groups around the world have been looking at an invasive method, where you remove the skull and put electrodes on to the surface of the brain or use a pneumatic gun to fire them into the tissue,” he says. “There are issues with this. First, when the electrode is directly implanted into the brain it requires very invasive brain surgery, with a 26 per cent risk of bleeding and infection. “Secondly, the body sets off a series of immune responses that cover the electrodes in scar tissue and stops them functioning.”

Melbourne School of Engineering Prof David Grayden was the senior engineer overseeing the project. He was instrumental in securing the DARPA funding. Prof Grayden says the stentrode has potential to provide electrical stimulation, as well as receiving signals, and could be useful for the bionic eye. “In the future, these electrodes could stimulate the brain. It could be used as a complementary stimulation for a bionic eye,” Prof Grayden says.

He says if the retina is not functioning, some vision could be restored by stimulating the brain directly. But the challenge has always been the part of the brain responsible for sight is difficult to get to with surgery. There are, however, blood vessels that run near that area that could be fitted with the device, without the need to operate on the brain itself. “If we can record a signal coming from the brain, then maybe we can feed signals back in,” he says. “We’re only just starting to extend our research into that area.”

Researchers across all fields

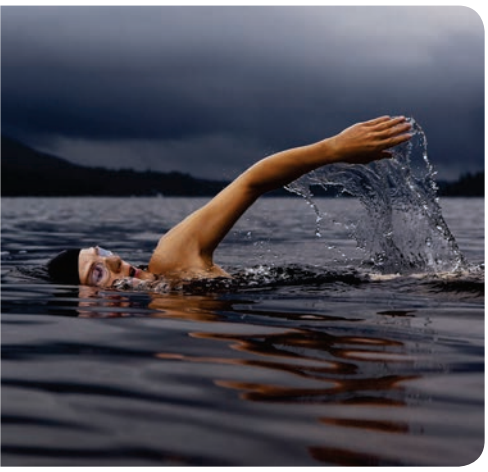
Prof Grayden says the expertise across the University of Melbourne was key to the stentrode project’s success. “This project shows enormous potential for the development of breakthrough technologies when researchers from engineering, science and medicine work together. The bionic ear was developed here, the bionic eye has been developed by us, so we’ve got a great track record in this area.”

Dr Oxley agrees. “None of this would’ve happened if I wasn’t with the University of Melbourne. No other institution in the country would be able to pull a project like this off. I was able to go back to DARPA and tell them I had the chief engineer from the bionic eye project on board,” Dr Oxley says.

“Having access to the Florey Institute for Neuroscience and the Royal Melbourne Hospital means you have a huge range of experts to get advice from.” But, he says, it will be a matter of years before people with paralysis will be able to ask for this treatment. “The process for getting commercial approval for new medical devices is a long process, so realistically, it could be another five to seven years away,” Dr Oxley says. “And during those five years, we’d have to do a broader clinical trial of closer to 30 to 40 people. So we are hopeful this will be on the market by 2022.”

By Jane Gardner for Pursuit. This work was funded by DARPA, the NHMRC, the US Department of Defense, US Office of Naval Research Global, the Australian Defence Health Foundation, the Brain Foundation.

An exoskeleton, similar to this one, will be used by patients implanted with a stentrode. Picture: Rex Bionics



Cumulative exercise, such as swimming each day, has the best results later in life. Picture: Pexels

Exercising in middle age can save your memory later

Landmark 20-year study shows regular physical activity is the No.1 protector against cognitive decline.

Regular exercise in middle age is the best lifestyle change a person can make to prevent cognitive decline in their later years, a landmark 20-year study has found. Recent research shows abnormalities in brain tissue begin several decades before the onset of cognitive decline, but little is known about the lifestyle factors that might slow the onset of decline in middle age.

As the incidence of Alzheimer's disease diagnosis doubles every five years after 65, most longitudinal studies examining risk factors and cognitive disease recruit participants over the age of 60 or 70. The new University of Melbourne study, published in the American Journal of Geriatric Psychiatry, tracked 387 Australian women from the Women's Healthy Ageing Project for two decades. The women were aged 45-55 when the study began in 1992.

A/Prof Cassandra Szoeke is director of the Women's Healthy Ageing Project and led the study. She says researchers were interested to find out how lifestyle and biomedical factors — such as weight, BMI and blood pressure — impacted memory 20 years down the track. "There are few research studies which have data on participants from midlife and have assessed cognition in all their participants in later life," A/Prof Szoeke says.

"This research is really important because we suspect half the cases of dementia worldwide are most likely due to some type of modifiable risk factor. Unlike muscle and vessels, which have the capacity to remodel and reverse atrophy and damage, neuronal cells are not nearly so versatile with damage and cell loss is irreversible."

Over two decades, A/Prof Szoeke and her team took a wide range of measurements from the study participants. They made note of their lifestyle factors — including exercise and diet, education, marital and employment status, number of children, physical activity and smoking.

And they measured hormone levels, cholesterol, height, weight, Body Mass Index and blood pressure at 11 points throughout the study. Hormone replacement therapy was factored in.

The women were given a Verbal Episodic Memory test in which they were asked to learn a list of 10 unrelated words and attempt to recall them 30 minutes later. When measuring the amount of memory loss over 20 years, frequent physical activity, normal blood pressure and high good cholesterol were all strongly associated with better recall.

A/Prof Szoeke says once dementia occurs, it is a slow moving freight train to permanent memory loss. "In our study more weekly exercise was associated with better memory. We now know that brain changes associated with dementia take 20 to 30 years to develop," she says.

"The evolution of cognitive decline is slow and steady, so we needed to study people over a long time period. We used a verbal memory test because that's one of the first things to decline when you develop Alzheimer's disease."

Regular exercise of any type, from walking the dog to mountain climbing, emerged as the number one protective factor against memory loss. In fact, the beneficial influence of physical activity and blood pressure together compensates the negative influence of age on a person's mental faculties.

A/Prof Szoeke says the best effects come from cumulative exercise, that is, how much you do and how often over the course of your life. "The message from our study is very simple. Do more physical activity, it doesn't matter what, just move more and more often. It helps your heart, your body and prevents obesity and diabetes and now we know it can help your brain.

"It could even be something as simple as going for a walk; we weren't restrictive in our study about what type." But the key, she says, is to start as soon as possible. "We expected it was the healthy habits later in life that would make a difference but we were surprised to find that the effect of exercise was cumulative," she says. "So every one of those 20 years mattered.

"If you don't start at 40, you could miss one or two decades of improvement to your cognition because every bit helps. That said, even once you're 50 you can make up for lost time. There is no doubt that intervention is better late than never, but the results of our work indicate that an intervention after 65 will have missed at least 20 years of risk.

By Jane Gardner for Pursuit. The study was funded by the National Health and Medical Research Council and the Alzheimer's Association.

Head injury seizure drug breakthrough by Melbourne researchers

A new drug that could one day be given to athletes in sports drinks to prevent epilepsy after a head injury has moved a step closer.

In preclinical trials, Melbourne researchers found the drug could slow the progression of brain changes that cause the disorder, as well as reduce the number and severity of seizures. The drug has already been shown to be safe and tolerated in humans for other health conditions, so if the promising results are replicated, it could quickly move from the lab to the bedside.

After a severe head injury during sport or in a car accident, the brain can undergo changes that cause the victim to suffer from seizures long after their recovery from the initial trauma. Royal Melbourne Hospital epilepsy specialist Prof Terence O'Brien said up to half of people who suffered severe head injuries developed epilepsy. In mild head injuries, it affects up to 10 per cent of patients. "It can take several years to manifest, which is why it is such a disabling problem, because people have often gone through rehabilitation and gotten their life back together and then the epilepsy appears and they are back to square one," he said.

Prof Terence O'Brien

Prof O'Brien, also the Head of the University of Melbourne Department of Medicine at the Royal Melbourne Hospital, and colleagues found the drug sodium selenate prevented tau proteins building up in the brain and forming toxic tangles in animal models.

The trial results, published in the journal Brain, showed it could slow the progression of changes in the brain and reduce the severity and number of seizures. This effect persisted after they stopped administering the drug. Sodium selenate has previously been shown to reduce long-term brain damage and the mental health and cognitive consequences of brain injury in experimental models.

Prof O'Brien said there were many medications to treat the symptoms of epilepsy, but nothing to prevent or reverse it. "The holy grail for epilepsy is to find a drug that is disease-modifying, but even if this drug made the seizures less frequent and severe it would prevent people from having to take tablets every day and reduce drug resistance developing," he said. Targeting the precise therapeutic window to administer the drug will be vital, but it could be a preventive treatment given in a sports drink.

By Lucie Van den berg for the Herald Sun.

Genetics of autism and gut changes the focus of new research & industry partnership

University of Melbourne researchers have teamed up with industry to explore the genetics underlying the relationship between autism and changes to the gut.

As well as the more well-known symptoms of impaired social communication and repetitive behaviour, people with Autism Spectrum Disorder (ASD) often have gastrointestinal problems like bloating, constipation and diarrhoea. Gut bacteria, or microbiota, which are known to affect mood and behaviour may be important in ASD.

University of Melbourne neuroscientist Elisa Hill, said by exploring the biome, or the genetic make-up, of these bacteria, researchers hope to pinpoint specific microbes as targets for new therapies that would restore gut balance. "We'll be mapping microbes in the gut to understand how the brain and bacteria interact," said Dr Hill, co-investigator on the project."

Dr Elisa Hill, pictured in her lab

Dr Hill is joined in a multidisciplinary team by La Trobe University microbiologist A/Prof Ashley Franks; and geneticist and paediatrician Prof Ravi Savarirayan of the Murdoch Children's Research Institute (MCRI) and the University of Melbourne.

They will explore a compound developed by ASX-listed biopharmaceutical company Immuron — anti-LPS IMM-124E — and the changes it brings about in mice. Dr Hill said environmental interactions between gut flora and people with ASD were difficult to capture, because "normal" human microbial profiles vary greatly.

"We do know that some waste products can affect the central nervous system. Since scientists first began suspecting a link between gut flora and brain function, there has been media speculation that autism may be caused by these processes, which is most likely overstating the link. "We believe our research has the potential to develop treatments that improve mood, behaviour and quality of life."

Research fellow unlocking new ways to boost myelin repair

The brain is able to repair the damage wrought by the immune system in the early stages of MS in a process known as remyelination.

However, once a person enters the progressive stage of MS, this process does not work as well, and disability accumulates over time due, in part, to a lack of repair to the damaged myelin. Dr Jessica Fletcher at the University of Melbourne was awarded a postdoctoral fellowship in 2015 with funding support from the Trish MS Research Foundation and the MS Angels which aimed to overcome this lack of repair by increasing myelin production in the brain.

Dr Fletcher's research concentratep on the brain derived neurotrophic factor (BDNF), a molecule known to be involved in myelin repair in the myelin-producing cells. BDNF works within a biological pathway and she specifically looked at other molecules involved in this pathway to see whether she can promote myelin repair. Now at the end of her first year Dr Fletcher has made substantial progress in achieving her aims.

Dr Fletcher has concentrated on the role of molecules which are switched on in response to activation of BDNF in myelin producing cells, known as Erk1/2. Dr Fletcher used animal models of an MS-like illness to show that activation of Erk1/2 was important for natural repair of myelin and further that increasing the signalling through the Erk1/2 pathway promoted the myelin repair. In a separate series of experiments, Dr Fletcher has also started to determine the underlying mechanisms used by Erk1/2 at a molecular level, to try to understand the way that myelin repair is regulated.

This work is important since identifying the way myelin is repaired at a cellular level will provide new targets for the treatment for progressive MS, to promote myelin repair, prevent nerve damage and halt MS disease progression in these patients. In a validation of the importance of her findings, Dr Fletcher has already presented her results at a number of national and international conferences with several more presentations planned for 2016.

Finance + Psychology: Finding a way to fight obesity

Researchers have used methods from finance and psychology to study the decision-making processes of lean and obese people

Obesity has long been regarded as a consequence of an individual's poor decision-making in health, mainly the ones concerning dietary choices and

physical activity. It is a disease that has, since 1997, been recognised as a global epidemic by the World Health Organisation, and is a major health concern for many Australians, resulting in tremendous costs for the health care system and the economy each year.

Recently, research conducted at the Max Planck Institute for Human Cognitive and Brain Sciences (MPI CBS) in Leipzig, Germany, has highlighted that such altered dietary choices and exercise behaviours in obese people are directly related to differences in brain structure and function in regions critical for the control of eating behaviour, which are also responsible for reward-processing and decision-making in other domains of life.

Differences in decision-making

Could this imply that the differences in decision-making between obese people and healthy people are of a more general nature? To answer this question, Dr Bode and colleagues teamed up with biologist Dr Annette Horstmann at the MPI CBS in Leipzig. Together with medical doctorate student, Jakob Simmank, they conducted an experiment in which one group of obese participants (who were otherwise healthy) and a second group of healthy, lean control participants were asked to make a series of financial decisions.

These decisions involved trading off a small but immediately available reward against a larger reward that was only available in the future. This task is often used in decision-making research to probe a person's level of impulsivity. When analysing the participants' decision behaviours, they found that the obese participants showed a stronger preference for immediate rewards, implying a higher degree of impulsivity. Moreover, this higher rate of discounting of future rewards observed in the obese participants was directly related to their self-stated tendency towards opportunistic eating.

Having established these general differences in financial decision-making between the two groups, they then investigated whether the decision environment might also have a stronger influence on decision-making in obese people, compared to healthy people.

Obesity has long been regarded as a consequence of an individual's poor decision-making in health. Picture: Pexel

Economic impacts

If obesity was associated with individuals being more likely to be nudged into unhealthy lifestyle decisions, could this effect also be found when making financial choices? To answer this question, Dr Bode and his colleagues added another layer to their financial decision-making task.

This time, both obese and lean participants were shown very positive, rewarding images before being asked to make the same financial decisions. Some of these images displayed desirable food, while others showed money, fancy boats and sports cars, positive social scenes, or romantic interactions, such as people kissing.

They found that after exposure to images of food and positive social scenes, obese women's financial choices tended to be more future-oriented – that is, less impulsive – while obese men's financial choices were more present-oriented.

No such effects were found in the lean, healthy control participants. Taken together, our study demonstrated that the specific decision environment did have an impact on obese people's financial decision-making – this is particularly remarkable because the images were topically unrelated to the decisions our participants were asked to make.

This means that people who are obese were observed to be more susceptible to environmental cues. Consequently, these findings demonstrate that a research focus on food-related decisions in obesity might be too narrow, and differences in health decisions could simply be just one aspect of more fundamental differences in decision-making processes in the brain.

Many of the major problems that contemporary societies face require solutions that are results of combined multiple academic disciplines. An interdisciplinary approach to research is therefore integral to understanding and tackling these problems, and researchers from different disciplines are increasingly working together to address these issues. In finance, research has already begun to utilise methods from neuroscience and psychology to study brain processes to better understand aspects of financial decision-making, such as risk-taking.

This interdisciplinary alliance can be equally productive when applied to gain a better understanding of health disorders that present abnormal decision-making processes as a core feature, such as obesity. However, this study is the first of its type investigating the influence of environmental cues on financial decision-making in obese people, and requires replication and follow-up experiments to clarify the exact circumstances under which such effects can be expected.

Just as importantly, the results also do not imply causality: at this stage, the team are reticent about whether the specific differences in decision-making that they observed play any role in developing or maintaining the disease, or whether they are a consequence of having lived with obesity for a long time. If the results are confirmed in the future, then this knowledge could potentially be used to design specific, positive decision environments, which could help obese people, or people at risk of obesity, to make better and healthier decisions.

The most important implication arising from this study – as well as from other researchers' work using similar approaches – is that combining tools from different disciplines, each of which appear to be so distinctive of the other, can provide us with novel perspectives on problems that the single disciplines alone might be inadequately equipped to solve.

By Dr Stefan Bode, Melbourne School of Psychological Sciences, University of Melbourne and Dr Carsten Murawski, Faculty of Business and Economics, University of Melbourne.

Dr Stefan Bode, Melbourne School of Psychological Sciences

Alzheimer's disease drug study by Melbourne researchers shows promise

A trial of a new drug to treat Alzheimer's disease has revealed it to be safe and well tolerated in patients, while showing promising signs it could slow the spread of the neurological disease.

There are more than 413,106 Australians living with dementia. Picture: Pexel

Patients diagnosed with the most common form of dementia face nerve cell death and tissue loss, which over time, causes the brain to shrink, eroding its functions. Attempts to slow the progression or stop the disease have long focused on reducing or preventing the build-up of amyloid plaques in the brain.

After limited success, the focus is shifting to a protein called tau, which forms toxic tangles in the brain. Royal Melbourne Hospital led a trial of the drug VEL015, or sodium selenate, which aims to prevent these tangles. The 36 patients with mild to moderate forms of the disease took three tablets daily for 24 weeks.

Prof Terence O'Brien, head of the University of Melbourne Department of Medicine at the Royal Melbourne Hospital, said the drug showed great potential. "It's a small study so it doesn't conclusively prove that this is going to be an effective treatment for Alzheimer's disease, but it provides a lot of promise," Prof O'Brien said. "Firstly, we showed it was well tolerated and safe and secondly, we used a highly sensitive MRI technique that showed quite significantly that progression was slowed in the treated group."

Although the drug didn't appear to impact on patient's cognition, or the levels of the proteins in their brain fluid, a sensitive form of MRI was able to show "significantly greater increase" in several clusters in the brain. Previous studies using animal models have shown the drug can reduce the levels of tau protein and reverse memory decline.

While there were no changes detected in patient's cognition levels, some families reported their loved ones' memory had improved. Only one patient dropped out of the trial because of side effects, which included fatigue, headaches and nausea. Prof O'Brien said after the trial's completion some patients still took the drug "off label" and continued to do well. The next step is to conduct a larger and longer trial, which will require finding a commercial partner.

The research was published in the Journal of Alzheimer's disease*. Originally published by Lucie Van den berg for the* Herald Sun*.*

New approaches to mental illness

For world-leading mental health researcher Christos Pantelis, unravelling the mystery of how schizophrenia changes the brain is more than just an academic curiosity. It's personal.

Prof Pantelis, a professor of medicine at the University of Melbourne, grew up watching his beloved aunt Paraskevi trying to cope with the delusional ideas and persecutory voices she heard as a result of schizophrenia. "She had a very warm personality and people quite liked her," he said. Typical of the disorder's onset in late adolescence and early adulthood, Paraskevi developed the illness in her early 20s. Remarkably, she lived for almost five decades without any treatment, somehow finding a way to cope with her symptoms.

Her experience with schizophrenia had a profound influence on Prof Pantelis, who has spent his career trying to better understand why the illness most commonly occurs during that critical period of development. Schizophrenia remains one of the more elusive mental disorders, affecting up to 200,000

Australians. Experts are hoping to raise awareness of it and other mental health issues during Mental Health Week, which runs until Saturday.

During his first major research project in 1985, when he was assessing patients with schizophrenia in Camden, London, Prof Pantelis became intrigued by how the brain was affected by the disorder. “At that time there wasn’t a great deal of brain research, it was all about looking at the social factors relevant to schizophrenia. I started to look at higher-level mental function and identifying where there were problems in the way the brain was functioning,” said Prof Pantelis, who was later part of a team that developed a technique for volumetric analysis of brain magnetic resonance imaging pictures.

He subsequently established the cognitive neuropsychiatry research unit in Melbourne, the first in the world to describe how the brain actively changes as schizophrenia develops. “We want to look at how we might develop new treatments to prevent the changes and ultimately prevent the illness. That would be the ideal,” he said.

As with Prof Pantelis, Anthony Stratford’s work in mental health is uniquely informed by experience. Mr Stratford’s onset of bipolar disorder in 1981 led to two three-month stints in a psychiatric hospital that year. He was 25.

An honorary fellow in the University of Melbourne’s department of psychiatry, Mr Stratford believes it was his father’s suicide six months earlier that triggered the first episode of mania. As was common at the time, many of the patients in the former Royal Park Psychiatric Hospital were heavily medicated, he said.

“The clinical model was about controlling and lessening symptoms,” he said. “It may have controlled the symptoms, but it took away your life.” Mr Stratford’s mother, who was a doctor, disagreed with her medical peers and set about developing a more holistic approach to help her son. “What often happens with a diagnosis is it takes away all your hopes and dreams. What my mother did for almost a year was, she held my hope. Where I saw no hope for myself, she did, and she just quietly reinforced that.”

The approach worked. Mr Stratford gradually got better, and went on to work for various mental health agencies. At Melbourne University, he has used his experience to shape the development of a module on recovery-oriented practice that is now a core unit in the masters of psychiatry.

The approach encourages budding psychiatrists to work in partnership with their patients, to focus on their hopes and aspirations. It also promotes self-determination and highlights the person’s resources and resilience. “It’s a holistic approach. While medication can play an important role, it’s no more important than relationships, families, work and secure housing.”

Prof Pantelis, meanwhile, advocates to young people the importance of managing stress, which his research has shown can be a precipitant in people who have a vulnerability for schizophrenia.

In her later years, Prof Pantelis’s aunt required nursing home care, and small doses of antipsychotics kept the symptoms of her schizophrenia at bay. She died, aged 90, a few years ago. Prof Pantelis said he felt an affinity for what

Prof Christos Pantelis

people living with schizophrenia, and their families, were going through. “I hope that understanding helps me in helping them.”

Originally published by Darragh O’Keeffe for The Australian.

Atomic-scale MRI holds promise for new drug discovery

Researchers at the University of Melbourne have developed a way to radically miniaturise a Magnetic Resonance Imaging (MRI) machine using atomic-scale quantum computer technology.

Capable of imaging the structure of a single bio-molecule, the new system would overcome significant technological challenges and provide an important new tool for biotechnology and drug discovery.

The work was published in Nature Communications, and was led by Prof Lloyd Hollenberg at the University of Melbourne, working closely with researchers at the ARC Centre of Excellence for Quantum Computation and Communication Technology (CQC2T) to design the quantum molecular microscope.

The team propose the use of atomic-sized quantum bits (qubits) normally associated with the development of quantum computers, but here would be employed as highly sensitive quantum sensors to image the individual atoms in a bio-molecule.

“Determining the structure of bio-molecules such as proteins can often be a barrier to the development of novel drugs,” said Prof Lloyd Hollenberg, Thomas Baker Chair in Physical Biosciences at the University of Melbourne. “By using quantum sensing to image individual atoms in a bio-molecule, we hope to overcome several issues in conventional biomolecule imaging," Prof Hollenberg said.

State-of-the-art techniques create a crystal of the molecule to be studied and use X-ray diffraction to determine the molecules’ average structure. However, the crystalisation and averaging processes may lead to important information being lost. Also, not all bio-molecules can be crystalised - particularly proteins associated with cell membranes, which are critical in the development of new drugs.

“Our system is specifically designed to use a quantum bit as a nano-MRI machine to image the structure of a single protein molecule in their native hydrated environments,” added Prof Hollenberg. “As part of our research in quantum computing we have also been working on the nearer-term applications of atomic-based quantum technology investigating the use of a single quantum bit as a highly sensitive magnetic field sensor,” says Prof Hollenberg.

Atomic qubits can be made to exist in two states at the same time, a disturbingly strange property that not only underpins the power of a quantum computer, but also the sensitivity of qubits as nano-sensors.

“In a conventional MRI machine large magnets set up a field gradient in all three directions to create 3D images; in our system we use the natural

magnetic properties of a single atomic qubit," says University of Melbourne PhD researcher Mr. Viktor Perunicic, who was the lead author on the paper.

"The system would be fabricated on-chip, and by carefully controlling the quantum state of the qubit probe as it interacts with the atoms in the target molecule, we can extract information about the positions of atoms by periodically measuring the qubit probe and thus create an image of the molecule's structure." says Mr. Peruncic.

"The system could be constructed and tested relatively quickly using diamond-based qubits. However, to capture really high resolution molecular images in the longer term, CQC2T's silicon-based qubits might have the advantage because they have very long quantum coherence," said Prof Hollenberg.

"The construction of such a quantum MRI machine for single molecule microscopy could revolutionise how we view biological processes at the molecular level, and could lead to the development of new biotechnology and a range of clinical applications."

Brain in box created by Melbourne researchers to grow cells to test medications

Melbourne researchers have grown a "brain in a box" — a 3D network of connected neurons made from a patient's cells — that will be used to test medications for brain disorders so the best drug and dose can be found.

The breakthrough technology will first be tested on patients with epilepsy, with the aim of delivering a personalised treatment plan in just one month to replace the years — and sometimes a lifetime — of trial-and-error medication combinations.

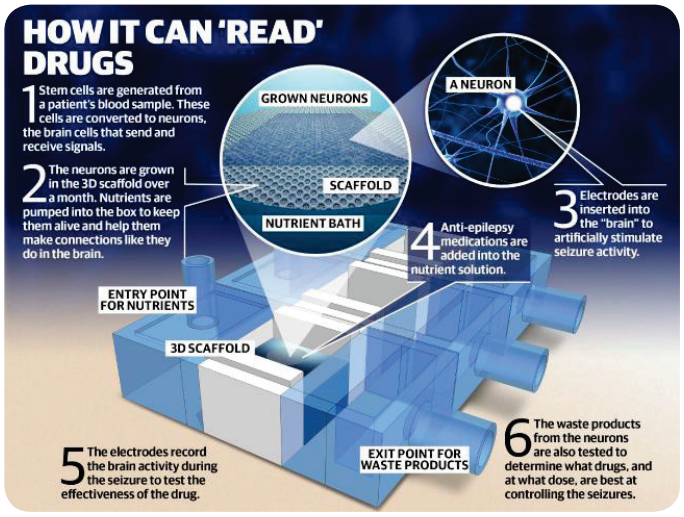
St Vincent's Hospital researchers have successfully transformed animal stem cells into neurons that connect and behave like those in the brain, and are using human cells for the first time to grow the "brain" in a 3D scaffold.

Prof Mark Cook, chair of medicine and director of neurology at St Vincent's, said side effects from anti-epileptic medications could be significant, and each patient responded differently to treatment. "When I give patients a new medication, I tell them it's like going to a restaurant and asking the waiter what the best meal is," he said.

"He can make some good guesses and tell you what everybody else likes and what he likes, but he can't tell you what you like. Side effects are the biggest problem, but we hope this system can answer those individual questions."

University of Melbourne biomedical engineer Dr Justin Bourke said while neurons could be grown as a flat 2D sheet and their electrical activity tested, growing neurons in a 3D space was a more realistic representation of activity in the brain.

Picture: Herald Sun



"The brain has a very complex layer and structure, and growing them in 3D is a step towards making the more complex connections that mimic other brain disorders down the track," he said. "At later stages we could look at disorders such as schizophrenia. It should revolutionise the way clinicians treat patients."

The design — including the 3D scaffold and the electrodes that will stimulate artificial seizures in the "brains" and record electrical activity to test if drugs are working — was created through the ARC Centre of Excellence for Electromaterials Science, which includes the University of Wollongong.

Simone Goudie, 34, has tried about 10 medications to control her seizures since being diagnosed with epilepsy at age 12. Some made her gain weight, others made her lose weight and the four medications she takes now cause tiredness and depression. A cell model that could uncover what combination of medications could quell her seizures would give her back her independence.

"As it is, I can't drive, I have to walk my dog with a family member. My parents pick me up from the station after work," Ms Goudie said. "To have my seizures under control would mean I could do normal things like feeling safe walking by myself in my neighbourhood."

By Brigid O'Connell for the Herald Sun.

Computer 'brains' solving mysteries of human behaviour

Computer science can help us understand why humans struggle with the complex dilemmas life throws at us – and why a better understanding of human problem-solving could help make computer 'thinking' more human-like, according to a new study out of the Brain, Minds and Markets Laboratory at the University of Melbourne.

Through the work of pioneering computer scientist Alan Turing, we know that some problems, even though theoretically solvable, would take even the most advanced computer longer than the rest of time to solve. So how is it that we humans nonetheless tackle and resolve these kinds of difficult problems daily: from which investments to buy for retirement, to which Facebook friends to pay attention to?

These are known as 'knapsack problems': they are like deciding how best to fill a knapsack, given an array of items of varying size and value to choose from. Co-lead author Dr Carsten Murawski, from the Faculty of Business and Economics, said mainstream economic models assume that people 'optimise' when faced with these kinds of problems. "But we know remarkably little about how humans actually approach problems that, in their most difficult form, choke the most powerful computers," he said.

Murawski and his co-lead, Prof Peter Bossaerts, gave twenty participants eight knapsack problems of varying difficulty (for a computer), not knowing whether complexity for computers would track what their participants found difficult, or whether human qualities of intuition or clever problem-solving would make computer complexity a poor model for humans.

Dr Carsten Murawski

Although people did much better than chance, they found that what is tricky for a computer is likewise harder for humans. “This implies that many everyday problems that involve allocating resources are simply too complex for us to solve,” said Dr Murawski, although the diversity of approaches participants took to trying to solve the knapsack problems supports a ‘wisdom of crowds’ view, and the importance of information sharing in intellectual discovery and innovation.

However, people did show one advantage over computers. “Our participants worked harder on more difficult problems, suggesting that they could somehow sense its difficulty,” Dr Murawski observed. In contrast, computers can only tell whether a particular knapsack problem is hard once they know the solution.

“Discovering how people detect whether something is difficult may turn out to be crucial to making computers more human-like,” said Prof Bossaerts.

The study has been published in the latest edition of Nature Group’s Scientific Reports.

Bionic eye: Melbourne preclinical testing a step closer

THE holy grail of bionic eyes, which would allow those with the most common and incurable causes of blindness to recognise facial expression and read large print, is about to begin preclinical testing in Melbourne.

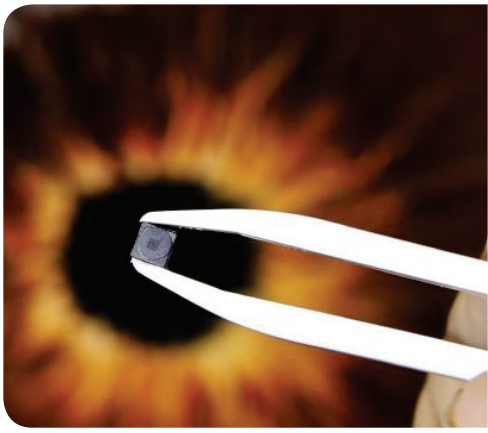
The University of Melbourne’s development of the 256-electrode diamond device has been boosted by a $1 million federal grant to fast-track testing, which could mean the device is trialled in humans in 4-5 years.

The unique design is man-made diamond electrodes inside a diamond case, to stimulate the retina at the back of the eye so messages can be sent to the brain and perceived as light. Lead researcher Dr David Garrett, from the department of physics, said what set his team’s device apart in a global race to restore vision to 50 million blind people was that it is fully wireless and the diamond casing would never erode in the body. A version already on the market overseas has a lead coming out of the eyeball.

“In some diseases, the light-sensing part of the eye — the rods and cones — are damaged, but all of the other nerves are basically intact,” Dr Garret said. “In a healthy person those nerves carry the signal from the rods and cones to the brain. We hijack it at that point with the electrode, tricking those nerves into firing and thinking they’ve perceived light.”

Those to benefit will be people with age-related macular degeneration, the major cause of blindness and vision impairment in people over 50, and retinitis pigmentosa, the most common cause of blindness in the young. While the initial proof-of-concept device had 256 electrodes on a 5mm-by-5mm microchip, Dr Garrett said they planned to insert four tiles into the back of the eye — for the squeamish, there are no pain receptors in the eye — to make the 1024 electrodes needed for resolution high enough to see faces and read.

Dr David Garret holds a tiny “tile” of 254 diamond electrodes that will be inserted at the back of the eye. Picture: David Caird



But the device almost slipped, along with many other promising medical prototypes into the "valley of death" last year, when it went dangerously close to running out of funding. But through a partnership established by lead inventor and physics professor, Steven Prawer, the Victorian group of engineers, mathematicians, physicists and neuroscientists from the university and National Vision Research Institute joined with Canadian eye surgeons and engineers to launch start-up company iBionics to move into clinical trials.

The National Health and Medical Research Council grant will allow preclinical testing to determine the stimulation patterns needed to achieve the best vision. It is the first major grant since an initial $50 million investment by the government in Bionic Vision Australia, a consortium of Melbourne research institutes, to develop two bionic eyes.

By Brigid O'Connell for the Herald Sun.

Concussion blood test may soon determine when safe to return to sport, play or work

A blood test could soon determine when athletes, car-crash victims and soldiers are out of the danger zone following concussion and safe to return to work or play, after Melbourne researchers found underlying brain damage can last for at least a month.

While concussion symptoms after mild Traumatic Brain Injury (mTBI) typically disappear within days or weeks, preclinical studies have found that the brain is vulnerable to more serious damage from repeated concussion even 30 days after injury.

Dr Sandy Shultz, a senior researcher from the University of Melbourne's Department of Medicine at the Royal Melbourne Hospital, said his team was aiming to protect healing brains in two ways through:

- DEVELOPING a test to measure brain damage independent of concussion symptoms; and
- PLANS for a trial of the drug sodium selenate — now being tested in human Alzheimer's patients — that is reducing brain damage in animals after repeated concussion.

"There is now emerging evidence that repetitive mild Traumatic Brain Injury can have persisting effects; from the mild effects on memory, language and cognition, through to the chronic traumatic encephalopathy reported in former American footballers," Dr Shultz said.

They tested the cognition and memory of mice that received multiple mild head injuries five days apart. The more repeated injuries they sustained, the longer they showed deficits over 30 days in cognition as measured through brain scans and blood tests.

"There is a theory this may be due to the repeated injury occurring while the brain is still in a period of increased vulnerability after the first mTBI," Dr Shultz said. "If that's the case it becomes very important not just to diagnose the initial

Concussions and other types of repetitive play-related head blows in American football are hypothesized to be the cause of chronic traumatic encephalopathy. Picture: Pexel

injury, but also to determine who has recovered and is no longer in that period of increased vulnerability.

“Current management revolves around presence or absence of symptoms, usually self-reported scales, so this adds more fuel to whether or not current medical or clinical management tools are conservative enough.”

The findings were presented at the Australasian Neuroscience Society’s Annual Scientific Meeting in Hobart. Dr Shultz’s team, which also involves the University of Newcastle, is now using long-term studies of Melbourne amateur football players to identify a biomarker — such as blood or saliva — that could be tested to tell if brain damage still exists, despite concussion symptoms long disappearing.

They have recruited about 40 players from the Melbourne University Blacks Football Club, taking blood samples, brain scans and neuropsychological assessments before the season starts. The eight men who have so far had concussions over the past two seasons repeat these tests at 48 hours, one week, two weeks and one year after injury. They expect to publish their findings at the end of next football season.

Originally published by Brigid O’Connell for the Herald Sun.

3

ENGAGEMENT

Public Outreach

Melbourne Neuroscience Institute Public Seminar Program

The MNI has enjoyed keen engagement with the general public by hosting an extensive number of free public seminars on a substantial range of topics. This year's series saw a number of the seminars being subscribed to capacity.

In order to deepen its engagement with the newly instituted Hallmark initiatives and partner networks, the MNI focused on partnering with the Hallmark Initiatives to co-host events on a variety of shared topics. MNI also partnered with the State Library in order to increase event accessibility and to broaden our audience, thereby facilitating outreach.

The increase in attendance can be attributed to an excellent array of interesting and engaging local and international speakers who focused on topics that are both relevant and important to society in general.

Our 2016 seminars were as follows:

Stem Cells on the Scientific Frontier: Hopes for Cures and Scientific Realities (1 March 2016)

Held in conjunction with Stem Cells Australia, this public forum explored issues associated with taking stem cell science from the bench to clinical practice. The discussion focussed on the scientific, ethical and regulatory considerations facing the field together with the complexities of managing patients' hopes and dreams for urgent cures in the context of frontier science and featured keynote speaker, Prof Jeremy Sugarman, Harvey M Meyerhoff Prof of Bioethics and Medicine, and Deputy Director for Medicine at the Johns Hopkins Berman Institute of Bioethics.

Screening of 'The Connection' – Chronic illness and our state of mind (27 April 2016)

After being diagnosed with an autoimmune disease, journalist and filmmaker Shannon Harvey travelled the world in search of the missing link in healthcare. From interviewing world leading scientists to meeting people with remarkable stories of improvement from severe back pain, heart disease, infertility, cancer and multiple sclerosis, this documentary delves into the link between our mind and body.

Following the screening, our panel of experts explored how integration of complementary mind body therapies into our conventional healing toolkit may benefit some people.

Alzheimer's disease: what does genomic analysis tell us? (29 April 2016)

The MNI welcomed Prof John Hardy from University College London, who is a geneticist and molecular biologist whose research interests focus on neurological disease to provide a public seminar on Alzheimer's disease.

While early onset "pure genetic" Alzheimer's disease (AD) is rare, gene analysis of these families identified mutations in the amyloid (APP) and presenilin genes as causes of AD. Presenilins were later shown to be the major component of gamma secretase, the enzyme responsible for releasing amyloid from the APP precursor protein. The involvement of these three genes, although rare as causes of AD, strongly supports the "amyloid hypothesis", which focuses on the central role of amyloid-beta in AD. Whole genome analysis of the much more common late onset disease has recently shown the importance of genes involved in brain cholesterol metabolism and microglial activation. Current challenges include determining how do these latter findings fit with the amyloid hypothesis and what the implications of these findings are for drug discovery programmes?

Musical Prodigies: Early Manifestations, Catalysts And Outcomes (8 June 2016)

One of the most contentious debates spanning psychology, education, biology and other related disciplines centres on the source of exceptional ability. To what extent can the remarkable achievements of eminent musicians, intellectuals, visual artists, writers and other gifted individuals be explained through "nature" (genetic endowment) or "nurture" (the environment)? How can these achievements, regardless of their source, be identified and fostered?

Keynote speaker, Prof Gary McPherson, Ormond Professor and Director, Melbourne Conservatorium of Music, addressed fundamental issues surrounding the nature/nurture debate in music and, in doing so, scrutinized much of the folklore that typically accompanies opinions concerning what underpins remarkable achievement in music.

Connected homes for an ageing population (15 June 2016)

The world is constantly changing, and for most developed countries the impact of ageing is being felt economically, socially and in the healthcare sector. The traditional notion of aged care is often associated with residential aged care, but many people want to stay independent, remain in their home and connected to family and community. Substantial developments in technology and design have occurred in the last decade to enable this, but how do we translate this to ensure that it is relevant/accessible by the ageing community? And how do we ensure elderly people with cognitive disabilities are well-supported by adaptive and intuitive technologies?

From top down:

George Aristovoulou Not titled 2015 (Courtesy of Arts Project Australia)

Pianist and child prodigy, Tiffany Poon

Despite these uncertainties the future is bright, with better design and more efficient products on the market every year. Advances in telemedicine will see the provision of remote health and social care to preserve people's self-sufficiency and increase their quality of life.

This panel of experts investigated the future of connected homes and communities for our ageing population.

The Roadmap to close the gap for vision - Where are we on the path? (26 July 2016)

This public forum focussed on some of the significant successes emerging in Indigenous eye health in Australia. Australia is the only developed country to still have trachoma, and until recently the rates for trachoma in Australian Aboriginal communities were amongst the highest in the world. Blindness rates in Aboriginal and Torres Strait Islander people are six times higher than for other Australians. Around 94 per cent of vision loss is unnecessary and much of it can be fixed overnight, yet 35 per cent of Indigenous Australians have never had an eye exam.

We were joined by some of the leading experts in the field who detailed where the research is at, the social aspects of accessibility and utilisation of services, health promotion and what still needs to happen to close the gap for vision.

Persons with Disabilities: Cure or Accommodate? (8 November 2016)

From a medical perspective, disability may be viewed as the result of a physical condition intrinsic to the individual which may reduce that person's quality of life and cause disadvantages. A major purpose of medical research can thus be viewed as aiming to discover ways of limiting and, if possible, 'curing' disabilities to alleviate disadvantage.

On the other hand, the United Nations Convention on the Rights of Persons with Disabilities includes within its definition of persons with disabilities those with impairments 'which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others'.

The Convention requires governments to make 'reasonable accommodation' for persons with disabilities. This means making 'necessary and appropriate modification and adjustments' to ensure those with disabilities can enjoy their rights on an equal basis with others.

Where should scarce governmental resources be channelled: to improving function and finding cures or making reasonable accommodations to ensure persons with disabilities can effectively and fully participate in society?

It is the voices of people with disabilities themselves that must guide this debate. This event included diverse voices of people with disabilities with varying perspectives on the topic and highlighted the 'social' and 'medical' models of disability and stimulatea discussion about rights and research.

This event was kindly hosted by our partner, the State Library Victoria, and was moderated by Jon Faine, host of the morning show on 774 ABC Melbourne and included a fantastic panel of experts:

Music on the mind. Picture: Pexel

Dr Dianne Ashworth: First recipient of bionic eye transplant and Lecturer In Social Work, Deakin University

Prof Richard Dowell: Graeme Clark Chair in Audiology and Speech Science at The University of Melbourne

Prof Helen Herrman: Director at Orygen, The National Centre of Excellence in Youth Mental Health

Mr Graeme Innes AM: Previous Disability Discrimination Commissioner

Prof Anne Kavanagh: Director of the Centre for Women's Health, Gender and Society, Melbourne School of Population Health, University of Melbourne

Music on the Mind: this is your brain on music (17 November 2016)

Does listening to Mozart make you smarter? Do rock and techno have the same effect? Can we experience intellectual transfer effects when learning a musical instrument? Internationally recognised music educators and psychologists offered critical insights into the impact of music on the mind and what is happening to your neurons when the stereo is pumped up on high!

An exceptional group of speakers from the Music, Mind and Wellbeing initiative provided an overview of the effect of music on the mind to a mixed group of music industry professionals, musicians and the general public. Speakers included: *Prof Sarah Wilson, Prof Katrina McFerran, Dr Margaret Osborne, Dr Solange Glasser*

The No-Bell Prize (13 December 2016)

Communicating science is tricky. We tend to get a lot of information from celebrities, politicians, and the media – but not necessarily directly from scientists. How do we navigate this complex landscape? How do we, as consumers, filter through this information and decide for ourselves what is important and true?

Once again we were expertly hosted by MC Dr Shane Huntington as we explored how difficult is it for academics to speak in layperson's terms when describing their research.

In 2016, we added in a few extra segments to challenge our brave contestants even further. In the end, Prof Allison McKendrick, Head of Department, Optometry & Vision Sciences was crowned the 'No-bell' prize victor!

Melbourne Brain Symposium and Mendelsohn Award (13 October)

The Melbourne Brain Symposium 2016 took place on Thursday 13 October and featured a program of esteemed local and international speakers. The Melbourne Neuroscience Institute, University of Melbourne and the Florey share a proud history of hosting the annual Melbourne Brain Symposium.

In this, the fifth anniversary of our occupancy of the Kenneth Myer Building, we paid tribute to the remarkable breadth of neuroscience focused research

From top down:

No-Bell Prize contestants

No-Bell Prize winner and judges

From top down:

Matias Maturana, Mendelsohn Lecturer awardee with Prof Fred Mendelsohn

Melbourne Brain Symposium Speakers

happening here and internationally. We owe a great deal of gratitude to our speakers, which comprised Mu-ming Poo, Carolyn Sue, Matias Maturana, Linda Richards, Mark Cook and Read Montague who collectively provided us with an excellent scientific program.

This year, we also established the Mendelsohn Student Lecture in honour of Frederick Mendelsohn, AO FAA, Emeritus Professor the University of Melbourne and past Director of the Howard Florey Institute and R Douglas Wright Professor of Experimental Physiology and Medicine from 1997 to 2009. Prof Mendelsohn held a Personal Chair in Medicine at the University of Melbourne until 1996 and during that time was the Scientific Director of the Positron Emission Tomography Centre, Austin Hospital.

This prestigious award recognises and honours outstanding students in the Neurosciences, and provides them with the platform to deliver a lecture to communicate the outcomes of their graduate research to the Neuroscience community, alongside presentations from eminent scientists.

Congratulations to our student finalists:

First: Mr Matias Maturana (Next generation bionic eye: identifying patient-specific spatiotemporal interactions in the retina.)

Second: Mr Dean Wright (Modulating glutamate dysfunction in Huntington's disease using N-acetylcysteine)

Third: Mr Daniel Bennett (A need to know: Neural substrates of information seeking in decision making under uncertainty)

Education

Advanced Research Workshops in Neuroscience

Since 2014, the Melbourne Neuroscience Institute has co-ordinated and supported a series of advanced, hands-on workshops for PhD students. The workshops offer students the opportunity to develop skills in key areas that they identify to be directly related to their research project. Each program has been designed by the Workshop Leader to provide a comprehensive, small group In 2016, four workshops were offered. Workshop titles, the name of the workshop leader and the number of attendees in each workshop is shown below. Workshops run between 18-30 hours duration and participants receive a Certificate of Completion in recognition of completed assignments, project tasks or presentations as set by the workshop leader.

Magnetic Resonance Imaging: Prof Roger Ordidge

Fundamentals of Ion Channel Function in the Brain: Intracellular and Extracellular Recordings: Prof Ian Forster

Introduction to Bioinformatics resources for Neuroscientists: Dr Victoria Perreau

Neural Computational Modelling: Dr Levin Kuhlman

The Neural Computational Modelling workshop was offered for the first time this year.

Feedback from students on workshop content was extremely positive. They reported that the workshops were not only extremely beneficial to their core research project and in honing skills, but also opened their eyes to the amount of background and theory behind techniques commonly used in medical or disease research, and when they can or can't be applied . Student feedback on the operational aspects of the Advanced Neuroscience Workshops including changes to contact times and the frequency of student contact through the workshop will be implemented in 2017, along with the offer of an expanded repertoire of workshop topics including Human Genetics and Regenerative Medicine, and Confocal Microscopy.

Melbourne Neuroscience PhD Enhancement Program

In 2016, the MNI was awarded a $50,000 establishment grant from the Chancellery, University of Melbourne, to fund the development of the Melbourne Neuroscience PhD Enhancement Program.

Neuroscience research is inherently interdisciplinary and it therefore follows, crosses different Faculties. More than 200 PhD students undertake neuroscience-based PhD studies at any one time at the University of Melbourne. Faculties, Schools and Departments integrally involved in this program include:

Faculty of Medicine, Dentistry and the Health Sciences (MDHS)

- Melbourne School of Population and Global Health
- Melbourne School of Health Sciences
- Melbourne Medical School
- Department of Medicine
  - » Department of Paediatrics (RCH, MCRI)
- Melbourne School of Psychological Sciences
- School of Biomedical Sciences
  - » Department of Anatomy and Neuroscience
- Florey Department of Neuroscience and Mental Health

Faculty of Engineering

- Melbourne School of Engineering
- Centre for Neural Engineering

Faculty of Science

This program aims to deliver an integrated yet interdisciplinary, cross-faculty student experience beyond a single core thesis (research) project. Key

elements of the program are to optimise successful candidature and future employment opportunities include:

1 Appointment of a mentor to guide and coach each student, complementing the roles of supervisors and the Advisory Panel;

2 Internship options with industry partners

3 Participation in the Melbourne Neuroscience Institute (MNI) Advanced Workshops in Neuroscience program (small group, focused 'hands on' experience in technique(s) directly relevant to the core project)

4 Immersion within a newly inaugurated University of Melbourne Neuroscience Students Club, providing a cohesive peer support system for students based on shared interest and challenges in neuroscience rather than the physical location of the candidate's home Institute/Department.

5 Optional PhD coursework in the neurosciences with additional subjects taken from disciplines that will facilitate the coming together of RHD students with a focus on Neuroscience and those with interests in a broader range of disciplines.

An experienced project officer has been appointed to implement the new PhD program, which should be in place for the 2018 academic year.

Yulgilbar Alzheimer's Clinicians Research Network (YACRN)

In 2016, the MNI was awarded philanthropic grants totalling $2.6M, to establish the Yulgilbar Alzheimer's Clinicians Research Network (YACRN). Generous funding from the Yulgilbar Foundation, Myer Foundation, the Portland House Foundation and the CF Leung Memorial Trust have made the program possible. The program commenced in July 2016.

This program has brought together five clinical academics with a diverse range of clinical and research skills and expertise spanning clinical neurology, geriatric medicine, geriatric psychiatry, genetics and ophthalmology, with the goal of achieving a deeper understanding of mixed pathologies and clinical symptoms of dementia to significantly advance applied research.

Funds are managed by the MNI which provides in-kind support for the program along with partners Melbourne Health.

A distinguishing feature of this program is that the same dementia clinicians who see and treat patients on a daily basis, are those that also design and conduct the research, under the close and focussed mentorship of clinicians, researchers and more senior clinician-researchers. This remit challenges the previous 'silo' mentality of researchers and clinicians operating separately which among other advantages significantly improves patient recruitment to study cohorts.

A core part of the group's mission is to champion the need for renewed commitment to research in Alzheimer's disease and dementia more broadly, as well as advocacy for improved access to services that can facilitate early diagnosis, genetic tests and PET imaging for those affected by dementia. The initiative is being widely promoted and is dedicated to

Yulgilbar Alzheimers/ Dementia Clinician Researchers. Left to right – Dr Rosie Watson; Dr Nawaf Yassi; Dr Aamira Huq; Dr Samantha Loi; Dr Peter Wijngaarden.

engaging the next generation of clinician-researchers in dementia research. An essential aim of the promotion being to facilitate recruitment of top class research students and staff.

The clinicians have embarked on a range of complementary projects that seek to inform the diagnosis and genetic determinants of dementia, as well as the impact of comorbidities on the presentation and progression of these diseases. They have set ambitious goals and are collaborating widely both within the network and with experts around the world. Regular robust discussions have been fostered through bimonthly meetings of the network and mentorship group as well as through YARP scientific forums and special seminars. The group hap had the privilege of discussions with luminaries and policy makers including Prof John Hardy, Prof Colin Masters, Dr Howard Fillit and Hon Greg Hunt MP.

Projects that will be undertaken as part of the initiative include:

- A longitudinal cohort study of dementia with Lewy bodies (Dr Rosie Watson MBBS, FRACP, PhD)
- Investigating Genetic and Environmental Resilience Factors relevant to Alzheimer's Dementia, and (ii) Diagnostic Utility of Whole Genome Sequencing in Young Onset Dementia (Dr Aamira Huq MBBS, FRACP%
- BEYOND: A longitudinal cohort and characterization of people with young-onset dementia (Dr Samantha Loi MBBS, FRANZCP, PhD)
- Vascular Study – cerebrovascular disease and strokes-quantifying the contribution of cerebrovascular disease towards cognitive impairment using brain imaging (Dr Nawaf Yassi MBBS, BSc (Med), FRACP, PhD)
- "The eyes as a window to the brain" - Retinal hyperspectral imaging as a surrogate for amyloid load in the brain (Dr Peter van Wijngaarden, ophthalmologist MBBS, PhD, FRANZCO)

Dr Rosie Watson, consultant physician in geriatric medicine, is the inaugural Fellow of the Yulgilbar Alzheimer's Clinicians Research Network (0.3FTE, with Dr Aamira Huq, consultant clinical geneticist, obtaining a Yulgilbar PhD scholarship. Fellowships for other clinicians in the program will commence in 2017. A part-time dementia research co-ordinator and part-time research nurse were appointed in late in 2016.

Secondary Schools Work Experience

The MNI is proud to run one of the most comprehensive and diverse science-based work experience programs for secondary school students in Australia.

Students have the opportunity to gain valuable work experience in a diverse range of neuroscience related research groups. The MNI is committed to providing a secondary schools work experience program designed to:

- contribute to the development of the skills of young people;
- ease the transition of students into the workplace; and
- demonstrate the wide variety of interesting careers available within neuroscience research.

Students have the opportunity of working with a different researcher each day, covering disciplines as broad as engineering, neurology, clinical science, medicine, music and ethics. Students may visit several laboratories and clinical settings which could provide exposure to bionics, neural engineering, disorder-based laboratories (eg Parkinson's disease, Alzheimer's disease, multiple sclerosis, epilepsy) and imaging facilities. Students take part in varied activities, including dissections, experiments, and other hands-on activities. They also learn about the scientific process, how funding is obtained and, above all, how science works in the 'real-world'.

The MNI work experience program received excellent feedback in 2016, with one student commenting 'this program was life-changing for me. It has inspired me to reach new highs and to try my best to change the world for the better through science'.

Elizabeth Blackburn School of Sciences Extended Investigation Program

In 2016, over 30 volunteer research mentors from The University of Melbourne supported Year 11 students from the Elizabeth Blackburn School of Sciences with their Extended Investigation projects.

Mentors and matched students met regularly to discuss the various phases of the research process including developing a research question, designing a method, analysing data and writing a 4,000-word written report.

Here is a sample of some of the research questions which the students pursued in 2016:

Emma: *How does close proximity affect the social behaviour of orang-utans?*

Nikki: *What is the most effective method for removing or killing bacteria on the hands of adolescents age 16-17?*

Frank: *What are the prevalence rates of the co morbidity of anorexia nervosa and anxiety disorders in adolescent males?*

Christian: *Do Luminescent Solar Concentrating Screen Protectors cause an increase in effectiveness in Traditional Solar Cells in their ability to power Mobile Phones?*

Rulin: *Which treatment method is more effective in managing chronic back pain, TCM acupuncture or opioids?*

Ruby: *Is nitric oxide inhalation or intravenous L-arginine more effective at reducing endothelial dysfunction caused by malaria?*

Karl: *Is there a correlation between methane concentration in groundwater and the distance from hydraulically fractured wells in Queensland?*

Ben: *What are the factors responsible for the growing resistance of the malaria parasite to artemisinin in the Greater Mekong Subregion that was not observed in Africa?*

Student in laboratory

Highlights of the year included the October poster-symposium, at which students, mentors, teachers and family members met to view and discuss the cohort's research.

Women in Stem Cell Science

The Melbourne Neuroscience Institute joined forces with Stem Cells Australia and the Gene Technology Access Centre (GTAC) to host a program for students in years 8 and 9 to celebrate the achievements of women in STEMM (Science, Technology, Engineering, Mathematics and Medicine).

The day commenced with a screening of the award-winning film 'Stem cell stories' which provided an introduction to the world of stem cell research. Innovative hand-drawn animation, beautiful cell photography and documentary interviews capture the fascination and complexity of this cutting-edge area of science.

Following the film, students split into groups in the GTAC laboratories. Students worked alongside young scientists from the University of Melbourne, the Murdoch Children's Research Institute, and the Centre for Eye Research, the Florey and GTAC to explore the world of stem cell research, ethics and communications. Students used microscopes and played games in this interactive session that was aimed at embedding knowledge about different types of stem cells, stem cell technologies and modelling, critical thinking and scientific principles and ethics.

In the afternoon, students were treated to a fascinating and personal insight into the lives of our three key note speakers. Christine Wells, Director, Centre for Stem Cell Systems, University of Melbourne, Maja Divjak, Scientific Animator, GTAC and Mirella Dottori, Group Leader of the Stem Cell Laboratory at the Centre for Neural Engineering, University of Melbourne. All three gave inspiring and honest narratives of their journey into the world of science and science communications.

Following fun lunchtime activities (including an entertaining and competitive stem cell game), students participated in a session 'Communicating your Science'. Students worked with young scientists to attempt to understand their research by reviewing two posters and then meet the poster presenters to ask questions about their research.

The Women in Stem Cell Science program was a unique and exceptional experience for all involved and the MNI are proud to be a partner in such a valuable program.

Many thanks to the organisers of this event: Megan Munsie (Stem Cells Australia, University of Melbourne), Jacinta Duncan, Fran Maher and Alex Sipidias (GTAC), Amy Bugeja (Melbourne Neuroscience Institute, University of Melbourne) and Jennifer Hollands (Florey).

Australian Brain Bee Challenge

On Wednesday 13 July, one hundred and eighty-four Victorian Year 10 students and 36 teachers from as far as Donald, Bright and Warrnambool,

'Communicating science' session at the Women in Stem Cell Science program

From top down:

Adam Bandt opens the 2016 Brain Bee

Brain Bee students touring the Anatomy Museum

gathered at the Melbourne Brain Centre to participate in the 2016 Australian-New Zealand Brain Bee Challenge State Final.

This annual event, hosted by the Melbourne Neuroscience Institute (MNI), University of Melbourne and the Florey, and further sponsored by the Centre for Eye Research Australia (CERA, was once again a huge success with the buzz of excitement palpably evident in the eyes of all attendees.

Prof Geoff Donnan of the Florey welcomed the gathering to the Victorian "home of the brain" and introduced newly re-elected Federal Member for Melbourne Dr Adam Bandt, who spoke of the exciting future in neuroscience awaiting the next generation who are eager to participate in fundamental and clinical research. Prof Kathy North, AM, Director of the Murdoch Children's Research Institute gave the plenary address that plotted her personal path to research success in the neurogenetics field and provided a wide vista of opportunities available to the future brain pioneers in the audience.

The business of the Brain Bee Challenge began in earnest as excitement built over who would emerge the State's Individual and Team finalists, vying for prizes including a giant model of the human torso (later dubbed "Sam" by the winning team, trophies, cash and Elsevier books. Results after tense competition in the Team Challenge were: 1st – Methodist Ladies College; 2nd – John Monash Science School; and 3rd – The Mac Robertson Girls' High School. Congratulations to all!

A highlight of the day for both teachers and students was the pre-lunch tour of the Harry Brookes Anatomy Museum, the DAX Centre gallery and neuroscience laboratories. The volunteer tour leaders deserve special commendation for inspiring the students with their infectious enthusiasm for science. After lunch it was the teachers' turn to show their neuroscience prowess as they competed in a friendly game of Neuro Trivial Pursuit.

Dr Christine Nguyen, MNI Fellow and researcher at the Department of Optometry and Vision Sciences gave the Young Neuroscientist address, outlining how a passion to do good in helping others can become a reality in the field of brain sciences. Our 2015 State Champion, Miss Nebula Chowdhury of the Mac Roberston Girls' High School described her year as Champion, attending the Australian Neuroscience Society annual conference and taking out 2nd place in the National Finals.

After a closely contested final round amongst six contestants, the Individual State Champions for 2016 emerged as: 1st – Alysha Wanigaratne of John Monash Science School; 2nd – Ajay Jay of Marymede Catholic College; and 3rd – Juulke Castelijn of Bacchus Marsh Grammar. Congratulations to each of these fine students, and to all contestants (and their teachers)! All those involved in this excellent event should feel deservedly proud of their efforts to promote interest in brain science, which clearly remains at a high level of in the State of Victoria.

Mindfields

The ongoing, year-round Mindfields program, run in conjunction with the Florey and the Dax Centre, gives Year 12 students an insight from University of Melbourne and Florey scientists into the biological processes underpinning brain function, and what happens to the brain during mental illness. Students and scientists also hear from a speaker who has experienced mental health problems.

Scientists in Schools

Scientists and Mathematicians in Schools (SMiS) is a national program managed by CSIRO on behalf of the nation. It provides skilled volunteers the opportunity to have a positive impact and make a difference to science, technology, engineering and maths (STEM) education in primary and secondary Australian schools.

Creating and supporting flexible partnerships between STEM professionals and teachers, provides access to real-world, contemporary experiences that promote understanding of the importance of STEM and inspiring students.

The MNI is a proud ambassador of this program.

4

PARTNERSHIPS

Melbourne Brain Centre and the Florey Institute of Neuroscience and Mental Health

We continue to work with our partner organization, the Florey. The MNI and the Florey continue to have complementary roles, with MNI delivering a breadth of opportunity to neuroscientists given our strong focus on interdisciplinarity involving active engagement with the physical sciences, engineering, psychology and the social sciences.

We partner with the Florey on a number of key initiatives. These initiatives include:

- course work and advanced workshops for our graduate researchers
- outreach to secondary schools
- the annual Melbourne Brain Symposium
- partnerships with the Universite Pierre et Marie Curie and with the University of Calgary
- shared Chairmanship of the Directors Coordination Forum to provide a seamless oversight of operational matters pertaining to the three campuses of the Melbourne Brain Centre
- shared Chairmanship of the Neurosciences Coordination Forum to scope high level strategic initiatives in the Neurosciences and in related disciplines on campus

IBM

Strong collaborative initiatives continue to percolate between the University and IBM in neuroscience related endeavours. These collective interests include analysis of extant data-bases, in particular those with rich phenotypic data characterising people either at risk of or who already have already developed neurodegenerative diseases. The aim here is to develop algorithms that can more accurately stratify risk and predict outcome to assist treating clinicians in managing their patients more effectively. Another collaborative project involves the development of algorithms to improve the capacity to predict and inhibit epileptiform activity before overt seizures develop. The University and IBM are also in the process of strengthening their partnership focused on enhancing

the experience of students and early career researchers with emerging expertise in computational biology.

Traumatic Brain Injury Initiative

During 2016, the MNI interacted with Monash University and Neurosciences Victoria to adopt a leadership role in facilitating interactions between the various academic, clinical and industry parties involved in traumatic brain injury research and health care delivery in our community. The long-term aim is to forge deep collaborative interactions for mutual benefit thereby improving outcomes for all people suffering TBI, independent of the nature and the severity of the injury. An important participant in this initiative is Siemens Healthcare, emphasising the central role that technological development can play in improving health care delivery and the direct and indirect economic benefits that will surely follow. A visionary development of this nature requires a robust governance structure and funding base; hence the intention to apply for a Cooperative Research Centre.

Siemens

The partnership between Siemens Healthcare Pty Ltd and the Melbourne Brain Centre Imaging Unit (MBCIU) has continued to flourish. A patented invention based on improved 7 Tesla (7T) MRI radio frequency (RF) pulse sequence has proven to be experimentally successful.

Dr Sonal Josan, Siemens Ultra-high Field MRI Scientist continues her placement in the MBCIU (Parkville) working with MBCIU staff on sequence development and improvements, MRS methods and QSM pulse sequence improvements and online reconstruction.

Siemens was the main industry partner in a multi-partner Expression of Interest submitted to the Federal Government by the Centre for Brain Injury (CBI), to establish a Cooperative Research Centre (CRC) in Traumatic Brain Injury (TBI). The multi-million dollar financial commitment by Siemens to co-investment in to the Centre is testament to the strength of the University's partnership with Siemens.

Hotchkiss Brain Institute

The Rebecca Hotchkiss International Scholar Exchange

Our partnership with the Hotchkiss Brain Institute, University of Calgary, remains strong. In 2016, one PhD student and one post-doctoral research fellow from the University of Melbourne and from the Florey respectively, were hosted in a laboratory at the Hotchkiss Brain Institute. As part of the reciprocal hosting arrangement, Dr Adrian Tsang from the University of Calgary spent 4 weeks at the Melbourne Brain Centre hosted by the laboratory of Dr Sandy Shultz, University of Melbourne Department of Medicine.
All three exchange scholars reported fruitful interactions where techniques and knowledge were exchanged and collaborations strengthened. These are summarised below:

Mr Nicholas Ryan (University of Melbourne)

Date of Exchange: January 1 to 31, 2016. Home Laboratory Supervisor: Prof Vicki Anderson. Host Laboratory Head: Prof Keith Yeates at the Hotchkiss Brain Institute. Project title: "Cognitive and Social Outcomes of Chronic Pediatric Traumatic Brain Injury in Australia and USA: A cross-national comparison of outcome".

Project objectives:

1 Evaluate the influence of acute treatment site on chronic social and cognitive outcomes after paediatric traumatic brain injury, and

2 Examine the contribution of injury and non-injury related risk and resilience factors to individual variability in outcome

Key accomplishments and successes from this exchange include:

1 Delivery of lecture to researchers and clinicians from the Hotchkiss Brain Institute and Alberta Children's Hospital;

2 Consultation and discussions with key investigators involved in the multi-site project focusing on research design and analysis, selection of key outcome variables and development of specific study hypotheses;

3 Meetings with researchers and clinicians at Alberta Children's Hospital to discuss mutual research interests and collaborations across the trauma and oncology units;

4 Discussions with researchers and clinicians at University of Calgary, including staff at the concussion clinic conducting similar research to my group in Australia;

5 Lab visit and presentation at the University of Montreal;

6 Presentation of fellowship experience to researchers and clinicians at the Murdoch Children's Research Institute.

Mr Ryan reported of the exchange:

"I was [also] very privileged to have worked with a world-leader in paediatric concussion research, Prof Keith Yeates, who was an outstanding mentor and facilitator of various meetings with key researchers and clinicians in the field. I felt that these opportunities were highly valuable and allowed me to explore possible avenues for post-doctoral employment. It also gave me the opportunity to work with a large dataset, and to investigate research questions that would not have been possible with data obtained from a single country."

Dr Adrian Tsang (University of Calgary)

Date of Exchange: September 1 to October 1, 2016. Home Laboratory Supervisor: Dr Richard Frayne, University of Calgary. Host Laboratory Head: Dr Sandy Shultz of the University of Melbourne. Project Title: "Impact of concussion in athletes on functional and structural brain connectivity."

Dr Tsang reported of the exchange:

"…Sports-related concussion is a common injury among adolescents and young adults who are actively involved in contact sports. The need to develop a more objective diagnosis and thus to improve patient management is of

paramount importance. This project involves the investigation of multimodal MR imaging as well as blood and other neuropsychological biomarkers of concussive injury among Australian rule football players. During this exchange, I met other researchers and students who investigate the impact of concussion at the neuronal or cellular level using a mouse model of induced traumatic brain injury. It is important to interact with researchers who are tackling the same topic from different perspectives so as to enable a broader and more comprehensive understanding that may lead to quicker translation of novel tools in clinics. I also received dedicated computational support needed to perform data processing and analysis for this project."

Dr Tsang was invited to give a neuroscience seminar to UoM on 7th September 2016 and wrote of the experience:

"The seminar was attended by students and researchers in the Melbourne Brain Centre and the Florey Institute. A wine and cheese reception was served after the seminar so I got a chance to meet other students and researchers within the institute. The interaction after my seminar led to a fruitful collaboration with a student who was interested to apply my image processing and analysis method to the resting state fMRI data collected from another study. I was given a tour of the animal MR imaging facility at the Melbourne Brain Centre and also met with researchers in the Department of Radiology at the Royal Melbourne Hospital who are involved with the MR imaging data acquisition for the concussion study.

Dr Amir Omidvarnia (Florey)

Date of Exchange: 1–22 December 2016. Home Laboratory Supervisor: Prof Graeme Jackson. Host Laboratory Head: Dr Paolo Federico. Project Title: "Detection of epileptic functional networks with scalp EEG-fMRI coupling in refractory focal epilepsy."

Project objectives:

1 Detect epilepsy-specific brain functional networks driven by focal epileptiform discharges at rest

2 Obtain simultaneous intracranial EEG-fMRI datasets for performing the analysis required to complete the first objective

Dr Omidvarnia wrote of the exchange:

"The technology and recording procedure of simultaneous intracranial EEG-fMRI in epilepsy patients is still very rare across brain research centres worldwide. While HBI has started collecting data and diagnosing patients with this approach, the Florey Institute has not benefited from this as yet. The iEEG-fMRI datasets recorded by Dr Federico's group will be a rich source of information which will hopefully enhance our understanding about functional aspects of focal epilepsy in the next steps of this project."

Memorandum of Understanding

As an indication of the strength of our partnership with the Hotchkiss Brain Institute, the Memorandum of Understanding between the two institutes was reviewed and extended for the next 5 years.

Ongoing Collaborative interactions

As of March 2016, active research collaborations are underway between HBI and Melbourne researchers in the areas of international sports concussion (led by Drs Willem Meeuwisse, HBI, and Paul McCrory, Florey), preclinical TBI studies (led by Drs Sandy Shultz, University of Melbourne, and Richelle Mychasiuk, University of Calgary) and paediatric concussion (led by Drs Keith Yeates, HBI, and Vicki Anderson, The Royal Children's Hospital Melbourne). These collaborations were either initiated or extended as a result of the joint symposium on Sports Concussion held at the Melbourne Brain Centre, hosted by the Melbourne Neuroscience Institute, in August 2015.

Planning for Epilepsy Symposium in 2017

Plans have been put in place for an Epilepsy Symposium to be hosted at the Hotchkiss Brain Institute in May 2017. This symposium is seen as complementary to the symposium held at the Melbourne Brain Centre in August 2015, and it is envisaged that going forward, further symposia will be hosted in reciprocal locations at least bi-annually.

A total of $15,000 has been committed by MNI to support the travel of 9 epilepsy researchers to Calgary. Attending the Epilepsy Symposium from the University of Melbourne will be:

Dr Michael Hilderbrand – Head, Translational Neurogenetics Laboratory, Epilepsy Research Centre, Austin Hospital

Dr Sandy Shultz – Group Leader, Translational Traumatic Brain Injury Laboratory, Melbourne Brain Centre (Department of Medicine, University of Melbourne)

Dr Katherine Howell – Consultant Neurologist and epileptologist, Royal Children's Hospital, Melbourne

Dr Dean Freestone – Department of Medicine, St. Vincent's Hospital, Melbourne (Neural Engineering - epilepsy, brain-machine interface)

Dr Andre Peterson – Department of Medicine, St. Vincent's Hospital, Melbourne. Electrophysiology and epilepsy.

A/Prof Chris Reid – Florey Department of Neuroscience and Mental Health; Honorary, Department of Medicine, Royal Melbourne Hospital

Prof Steve Petrou – Florey Department of Neuroscience and Mental Health and University of Melbourne

Dr Ken Myers – Department of Medicine, Austin Health (honorary)

Prof Sam Berkovic – Laureate Professor in the Department of Medicine, University of Melbourne, and Director of the Epilepsy Research Centre at Austin Health.

FUNDING INITIATIVES

Grants and External Funding

Highlights of grant and external funding active in 2016

Targeting the canonical wnt signalling pathway to promote central nervous system remyelination in vivo

NHMRC – Early Career Fellowships NHMRC/MSRA

$329,674; 2016–2020; Gonsalvez

Novel ways of treating angiogenisis in the eye

NHMRC – Development Grants

$288,804; 2016–2018; Fletcher

A potential analgesic target in a novel clinically-relevant neuropathic pain pathway

NHMRC – Project Grants

$623, 412; 2016—2019; Gunnerson

Novel strategies to promote myelin repair in the brain

NHMRC – Project Grants

$621,905; 2016–2019; Murray

The role of immune cells in controlling blood flow

Australian Research Council – Discovery Projects

$374,781; 2016–2020; Fletcher

Super resolution confocal microscopy facility

Australian Research Council – Linkage Infrastructure

$347,500; 2015–2018; Fletcher

Targeting nerve cells to restore brain function in multiple sclerosis

The Cass Foundation – Science & Medicine Grants

$50,000; 2016–2017; Xiao

Picture: Pexel

Understanding functional connectivity of sensory and motor pathways to specific regions of the lower urinary tract

National Institute of Health – NIH The Common Fund's Stimulating Peripheral Activity to Relieve Conditions

$1,092,918 (USD); 2016–2018; Keast

Closed-loop deep brain stimulation: optimising treatment of Parkinson's disease using adaptive stimulation

NHMRC – Project Grants

$761,588; 2016–2020; Thevathasan

Genomics of antiepileptic drug-induced Stevens Johnson syndrome

NHMRC – Project Grants

$517,500; 2016–2019; Kwan

Treatment with gsk2606414 in mouse models of motor neurone disease and traumatic brain injury

Motor Neurone Disease Institute of Australia – Grants-in-Aid

$100,000; 2015–2017; Shultz

Decoding change of mind decisions and errors from brain activity in humans

Australian Research Council – Discovery Projects

$372,148; 2016–2020; Bode

Multimodal retinal imaging provides 'insight' into cerebrovascular ageing

Australian Research Council – Linkage Grants

$280,000; 2016–2021; Nguyen

Towards new drugs for multiple sclerosis

The Cass Foundation – Science & Medicine Grants

$55,000; 2016–2017; Northfield

Resilient brain networks in patients with schizophrenia and their unaffected siblings

NHMRC – Project Grants

$498,499; 2016–2020; Zalesky

Interdisciplinary Seed Funding

3D geometry of the optic nerve in glaucoma imaged with 7TMRI and optical coherence tomography

CI: *Allison McKendrick.* Co-Investigators named on grant: *Roger Ordidge, Bang B Vui, Rishma Vidyasagar*

Research project detail

Glaucoma is the leading cause of irreversible blindness worldwide. The primary site of injury in glaucoma is at the optic nerve, where the ganglion cell axons come into close proximity to the connective tissue sclera and lamina cribrosa. However, it is increasingly apparent that interactions between the optic nerve axons and the connective tissue structures at the lamina cribrosa, sclera and optic nerve sheath (including the subarachnoid space) may play a crucial role.

At present our capacity to understand how optic nerve structures are altered in glaucoma is hampered by a lack of imaging modalities that can resolve these deeper structures. The only current imaging approach that is not depth ambiguous is optical coherence tomography (OCT). However, the tissue penetrance of near infrared light limits OCT imaging to the retina, choroid and anterior surface of the lamina cribrosa. The sclera and posterior surface of the lamina cribrosa are not observable in vivo using OCT. Thus less is known of the relationship between ganglion cell axons and the deeper structures behind the optic nerve. This project aims to reveal new insights to this anatomy via magnetic resonance imaging (MRI) which is capable of imaging soft-tissue at high contrast without any depth limitation.

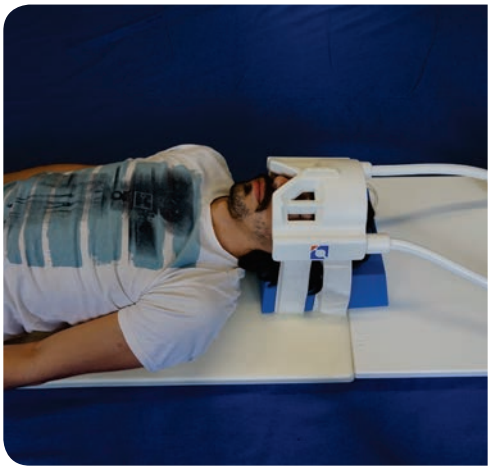
The specific advantage of this study is access to the 7 Tesla J O scanner together with a coil specifically designed for imaging the eye that will provide a significant increase in the capacity to resolve ocular structures. This will be the first study of its kind. The specific aims are:

1 To determine if 7T MR imaging using the eye coil can resolve the anatomical relationship between the sclera, lamina cribrosa and optic nerve sheath

2 To examine the relationship between anterior optic nerve structures imaged using optical coherence tomography and posterior optic nerve structures imaged using 7T MRI

3 To provide proof of principle that 7T MRI together with OCT provides novel insights into optic nerve geometry

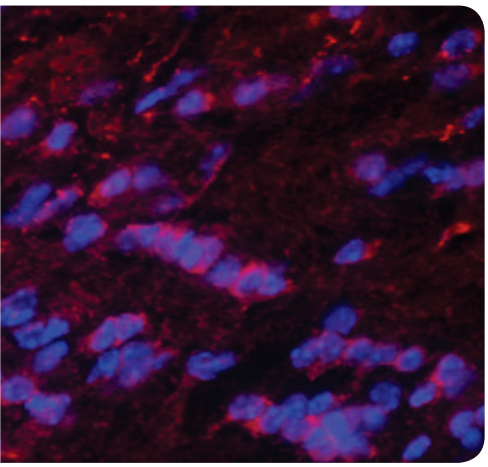
In order to achieve these aims we will scan 5 age-matched individuals with healthy optic nerves and 5 individuals with established glaucomatous optic neuropathy. We will provide preliminary data that MR imaging at the Melbourne Brain Centre Imaging Unit has the spatial resolution to provide 3D imaging of the entire eye including the deeper structures of the optic nerve. Subjects will also undergo high resolution spectral domain optical coherence tomography imaging to construct a 3D image of the retina and anterior optic nerve structures. Where possible, OCT derived parameters of optic nerve geometry will be directly related to those derived from MRI.



EyeCoil. Picture: Siemens

Protection of oligodendrocyte physiology and metabolism under oxidative stress to facilitate the maintenance of cell function and myelination through the use of a novel antioxidative strategy

CI: *David K Gardner.* Co-Investigators named on grant: *Alexandra Harvey, Simon Murray, Trevor Kilpatrick*



The gap junctional protein connexin-47 (red) is highly expressed in oligodendrocytes that are localised within linear arrays. Nuclei are labeled with Hoechst (blue). Expression of connexin-47 on the surface of oligodendrocyte cell bodies suggests that adjacent oligodendrocytes within linear arrays are likely to possess functional gap junctional connections with one another, enabling exchange of intracellular signaling molecules. Permission from: Leigh Johnston

Research project detail

Oligodendrocytes are best known for their ability to synthesize the myelin sheath, and are considered to be the most prolific producers of cellular membrane in the body, requiring significant amounts of cellular materials to synthesize the myelin sheath. To achieve this, oligodendrocytes must attain high levels of glucose flux to ensure maximal activities of biosynthetic pathways, which require glucose carbon and reducing equivalents generated via key metabolic pathways. To meet the required high demand for glucose, oligodendrocytes utilise aerobic glycolysis, in which 50% or greater of the glucose consumed is converted to lactate, even in the presence of sufficient oxygen for its complete oxidation.

Should metabolism be compromised in oligodendrocytes, this will result in de-myelination due to their compromised ability to synthesise myelin. A consequence of metabolism is the production of reactive oxygen species (ROS). Oxidative stress, induced by environmental perturbations such as increased oxygen tension or curprizone, therefore represents a major contributor to metabolic abnormalities in embryos and embryonic stem cells, and likely underlies the pathology of oligodendrocytes in multiple sclerosis (MS), given that antioxidants such as melatonin can provide protective effects against the oxidative stress induced by cuprizone on myelination. Further, it is of note that one of the recent advances in MS therapy, dimethyl fumarate (DMF), has been shown to have a significant effect on oligodendrocytes through antioxidant pathways and increases the levels of intracellular glutathione.

Using technologies developed to analyse single embryos and embryonic stem cells, we are currently determining the baseline metabolic characteristics of oligodendrocytes through metabolomic screening and the analysis of intracellular reduced glutathione and reactive oxygen species (ROS; using a new probe created by the ARC CoE of Nanoscale Biophotonics of which Gardner is AI). The effects of several antioxidants on the ability of oligodendrocytes to maintain their physiology following oxidative stress challenge, created by increasing oxygen concentration or cuprizone, is also being analysed.

Synchronised conduction along myelinated axons is optimised by populations of interconnected activity – responsive oligodendrocytes

CI: *Leigh Johnston.* Co-Investigators named on grant: *Tobias Merson, David Grayden, Steven Petrou*

Research project detail

This project aims to understand the function of a specific type of glial cell in the brain, called an oligodendrocyte. We seek to understand the extent to which oligodendrocytes function to help synchronise electrical activity in the brain. The membranes of oligodendrocytes form fat-rich membranous sheets that wrap around and insulate the fibres of nerve cells. This insulation results in a dramatic increase in the speed of signal conduction along the nerve fibres. We

wish to understand whether individual oligodendrocytes function in a concerted manner to insulate nerve fibres. Specifically this project is investigating whether individual oligodendrocytes respond cooperatively by signaling to one another. Evidence that these cells coordinate their responses by transmitting and sensing signals would identify a new form of cell-cell communication between glial cells that could play an important role in regulating the formation of the nervous system and in optimising neuronal function.

Understanding the role of tau protein post-translational modifications in axonal transport

CI: *Laura Jacobson and Andrew Metha.* Co-Investigators named on grant: *Kevin Barnham, Cameron Nowell*

Research project detail

Neurons (brain cells) extend their processes throughout the brain to communicate with neurons in other regions. In order to function properly, neurons must transport different type of cargos along their processes. This process, called "axonal transport", performs jobs such as taking detritus back to the cell body for destruction, and supplying nutrients and important signaling components to neuron terminals where neuron-to-neuron communication takes place. Axonal transport is disrupted in devastating neurodegenerative diseases such as Alzheimer's disease, frontotemporal dementia and Parkinson's disease. The reason for this failure is thought to be due to alterations to a protein called "tau", which helps to stabilize the microtubules that are the rail roads for axonal transport. This hypothesis, however, has not been robustly tested before. In this project we examine the importance of tau and disease-related alterations to tau on axonal transport. Neurons harvested from mice are grown in special devices that allow us to video axonal transport real-time in live cells. Capturing this process requires state-of-the-art microscopy and advanced image analysis techniques. Using these methods, we will define the role of tau in axonal transport, and determine whether or not modifications to tau that are common in these diseases are detrimental to axonal transport.

Exploiting the Neuroprotective Strategies of Viruses to Combat Neuroinflammatory Diseases

CI: *Gregory Moseley.* Co-Investigators named on grant: *Paul Gooley, Peter Crack*

Research project detail

Signalling by proteins called signal transducers & activators of transcription (STATs) has a major role in neuroinflammatory pathologies such as stroke, traumatic brain injury and Alzheimer's disease. STATs are thus considered important therapeutic targets, but conventional drug discovery approaches to target STATs have been unsuccessful, largely owing to poor specificity and efficacy. We plan to examine the alternative possibility of exploiting potent STAT-targeted anti-inflammatory strategies that have already been perfected by pathogens that infect the central nervous system.

Rabies virus is an "expert" at suppressing neuroinflammation, by using the viral 'P protein' to target and disable STATs. We plan to examine the novel concept that RABV's powerful immune-suppressive function might be harnessed to develop specific, potent interventions for acute and degenerative neuroinflammatory conditions. Importantly, P protein is highly specific in targeting STATs directly engaged in inflammatory signaling, presumably as a mechanism to limit off-target effects. This is a highly desirable property for therapeutics.

We have now established a new research program which will use established models of neuroinflammation to demonstrate that P protein has therapeutic potential, structural biology to define in detail the molecular basis of P protein's inhibition of STATs, and molecular screening to identify compounds able to mimic P protein's targeting of STAT1. The ultimate aim is to identify lead compounds that could be used to develop anti-inflammatory drugs with potential application in a range of neuro-pathologies.

An interdisciplinary investigation of biomarkers for brain concussion and recovery

CI: *Sandy Shultz.* Co-Investigators named on grant: *Leigh Johnston, Richard Frayne, Denes Agoston, Terence O'Brien, Patricia Desmond, Vicki Anderson*

Research project detail

Brain concussion is a serious medical and societal issue. Of particular concern are individuals who are at high risk of suffering multiple concussions – such as athletes playing collision sports – because repeated concussions may contribute to chronic neurological impairments and neurodegenerative disease. There is evidence that the long-term adverse effects of repeated concussion are due to the recurring insults occurring before the brain has recovered from the initial concussion and is still in a period of increased vulnerability. Currently there are no reliable markers that indicate when the brain is no longer in this state of increased vulnerability, but the identification of such biomarkers would allow them to be used to guide medical decisions, so as to reduce the effects of repeated concussion.

In this study our interdisciplinary research team is investigating novel and multimodal MRI, blood, and neuropsychological biomarkers of concussion in amateur athletes from the University of Melbourne Blacks Australian Rules Football Club. We have completed baseline testing on 30 athletes and are currently collecting data from athletes that are concussed during the season (end of August 2016). Once the season ends we will complete data analysis.

Optimising visual attention in children with autism spectrum disorder: a comparison of singing and speech

CI: *Grace Thompson.* Co-Investigators named on grant: *Larry Abel, Gary McPherson*

Research project detail

Many children with autism spectrum disorder (ASD) are at risk of social isolation and limited social development due to difficulties with eye gaze

and visual attention to people. Despite the negative impact that poor visual attention can have on developmental outcomes, little is known about how to optimize this behaviour. Previous studies indicate that children with ASD may have a preference for music over other stimuli. However, there is a lack of understanding about whether children's preference for music translates into better visual attention that is crucial for social learning and development. This pilot study aims to provide preliminary data exploring the conditions where visual attention is optimised.

We hypothesise that children with ASD will:

1 Have better engagement with singing compared to speech in terms of: a) arousal (pupil dilation) in the first 15 seconds of being presented with music (initial response) and average response over the duration of the music event (transience); b) fixation of visual attention on the person when presented with singing versus speech events; and c) period of attention for singing versus speech events.

2 Engage differently with singing depending on whether: a) familiar or unfamiliar songs are presented; and b) songs are presented by family members or strangers.

Melbourne Neuroscience Institute Fellowships

The MNI awarded Fellowships to Dr David Simpson, School of Physics and Dr Julian Simmons, Department of Psychiatry and the Melbourne School of Psychological Sciences to promote the University's interdisciplinary research projects in the Neurosciences.

'Sub-cellular imaging of transition metals in vitro' – Dr David Simpson

In order to address significant biological problems, I sought to apply fundamentally new ESR imaging techniques pioneered at the School of Physics, University of Melbourne. The specific aim of this project was to collaborate with neuroscientists and biologists to obtain the first set of 2D sub-cellular images of transition metals and potentially superoxide radicals in vitro. By imaging transition metals in such systems we can begin to address questions regarding the role these elements play at the single cellular and network level. Overall the fellowship is delivering on these aims, having produced our first publication on quantum magnetic resonance microscopy (see: arXiv:1702.04418 [physics.bio-ph]). This new imaging technique will form the basis of future studies into transition metals and organic radicals with researchers at the Florey."

'Do endocrine factors mediate relationships between childhood adversity and mental health? – Dr Julian Simmons

This project investigates the role of endocrine function in the substantiated links between adversity in childhood and poor mental health outcomes. Cutting edge analyses and varied biological samples will be employed to evaluate if relative levels of key hormones (i.e., levels of one hormone when controlling for levels of others) of the hypothalamic-pituitary-adrenal (HPA) and–gonadal (HPG) axes, each central to development, reproduction, stress and behaviour, mediate relationships between adversity and poor health outcomes

MNI 2016 Fellows

across cohorts of Australian children. These aims will be achieved by utilising existing data sets and biological samples, international collaborations, and ongoing longitudinal studies to address important gaps in the literature linking relationships between the environment, biology and health.

Strategic Research Australian Postgraduate Awards

In 2015, the MNI conducted an Expression of Interest for up to 3 Strategic Australian Postgraduate Awards (STRAPAs) to support cross-disciplinary graduate research in the Neurosciences and related disciplines, for commencement in 2016. The MNI STRAPAs are designed to attract outstanding graduates who have demonstrated excellence in neuroscience, science, biomedical science, chemistry or other related disciplines.

MNI STRAPA recipients receive an additional support package for their research of $5,000 per annum from the MNI for 3 years. These funds are allocated as follows:

- $3,000 per annum stipend top-up
- $2,000 per annum to be held by the supervising laboratory and used for direct research costs for the student's project and attendance at conferences.

The recipients of the MNI Strategic APAs for 2017 commencement are:

Madeline Nicholson: *Investigating the roles of nerve cell signals in enhancing brain myelination.*

Laura Ellett: *The role of prion strain in disease progression and pathogenesis*

Hayley Jach: *Towards a Neurobiologically Plausible Model of Personality*

All STRAPA recipients are to be congratulated on this outstanding achievement. Applications were extremely competitive.

Change of Name for Strategic Research Australian Postgraduate Awards (STRAPA's)

In 2016, the Australian Federal Government introduced new legislation that will replace the Australian Postgraduate Award (APA) Scholarship and the Research Training Scheme (RTS) that provides a fee exempt place in a research degree, with a new Australian Government Research Training Program (RTP) Scholarship.

The APA and RTS will cease on 31 December 2016 and the RTP Scholarship will come into effect on 1 January 2017. From 2017, use of the previous name (abbreviated to "STRAPA's") will cease, and the awards must be referred to as the "Australian Government Research Training Program Scholarship".

All conditions and benefits associated with the Scholarship remain the same, although it is now a strict condition of acceptance of the scholarship that the

PhD student acknowledges the contribution of the Australian Commonwealth Government when they or their supervisors or any other party, publish research outputs in any form, by any method. The acknowledgement must include the mention of the support through an “Australian Government Research Training Program Scholarship”.

To qualify for the scholarship, the PhD student must have obtained overall marks in the highest grade band (e.g. H1 or HD) in a relevant Honours or Masters degree (H1 – 80 to 100%). The minimum of grade of 85% that has been required in previous years has been reduced to 80%.

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GOVERNANCE

Advisory Board

The Advisory Board aims to ensure the MNI is aligned with important developments in the Neurosciences and to provide avenues for engagement with those who might wish to commission or undertake research through collaborative interaction in the Neurosciences and related disciplines of research at the University. Board members have strong credentials whether at the University of Melbourne, or in the private, public and non-government sectors and act as advocates on behalf of the MNI.

The MNI would like to extend thanks to Prof Liz Sonenberg who was Chair of the Advisory Board throughout 2016. MNI welcomes back Prof Mark Hargreaves as Chair who will continue in the role through to 2017. Both Prof Hargreaves and Prof Sonenberg have provided impeccable oversight and guidance to the MNI.

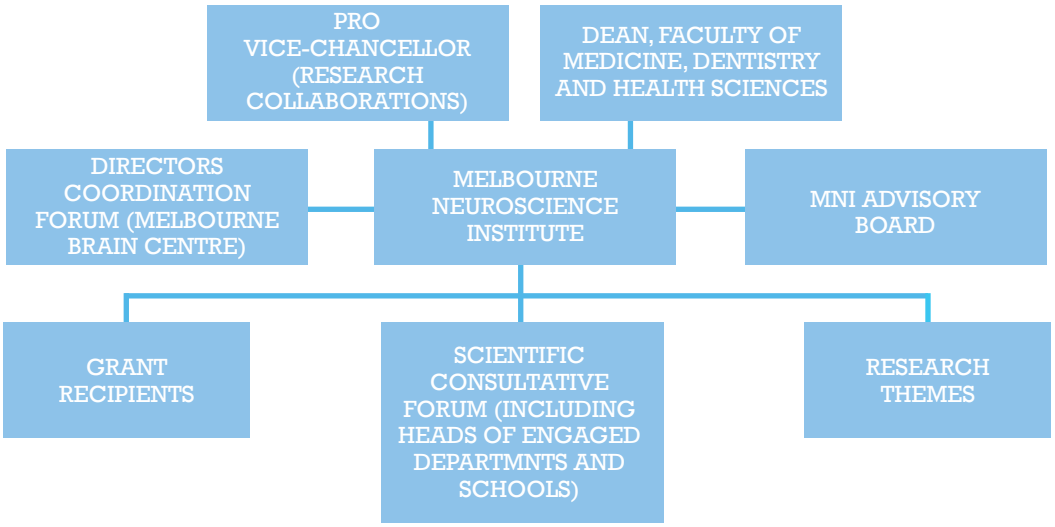
MNI extends a warm thanks to departing member, Prof Richard Head for his exceptional service to the MNI Advisory Board. In mid-2016, MNI welcomed Prof Perry Bartlett from Queensland Brain Institute.

Name	Title
Prof Liz Sonenberg (Chair)	*Pro Vice-Chancellor (Research Collaboration & Infrastructure), UoM*
Prof Trevor Kilpatrick	*Director, Melbourne Neuroscience Institute, UoM*
Prof Mark Hargreaves	*Dean, Faculty of Medicine, Dentistry and Health Sciences, UoM*
Prof Greg Qiao	*Assistant Dean (Research), Melbourne School of Engineering, UoM*
Prof Karen Day	*Dean, Faculty of Science, UoM*
Dr Andrew Milner	*Chief Executive Officer and Managing Director, Neurosciences Victoria*
Prof Richard Head	*Deputy Vice Chancellor & Vice President: Research & Innovation, University of South Australia*
A/Prof Andrew Metha	*Deputy Director, Melbourne Neuroscience Institute*
Prof Glenn Bowes	*Associate Dean (External Relations), Faculty of Medicine, Dentistry and Health Sciences, UoM*
Prof Bob Williamson	*Chief Scientific Officer, Yulgilbar Foundation, Ex-Secretary for Science Policy, Australian Academy of Science, Faculty of Medicine, Dentistry and Health Sciences, UoM*
Dr Keith McLean	*Theme Leader: Biomedical Materials and Devices, CSIRO*
Prof Perry Bartlett	*Inaugural Director, Queensland Brain Institute*

Scientific Consultative Forum

The Scientific Consultative Forum comprises Heads or delegates from University Departments involved in neuroscience-related research. Members of the forum assist the MNI by providing a coordinated vision for the award of core research support funds provided by MNI and by providing key strategic advice, ancillary to that provided by the MNI Advisory Board.

Governance Structure



The Melbourne Neuroscience Institute Team

From left: Andrew Metha, Vikki Marshall, Trevor Kilpatrick, Amy Bugeja, Carmel McFarlane

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