Western

The Brain and Mind Institute

ANNUAL REPORT

September 2015

Exploring one of nature's great mysteries:
how the human mind emerges from the human brain.

Western The Brain and Mind Institute

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WELCOME FROM THE DIRECTOR

The study of the human brain is one of the most rapidly growing scientific enterprises of the 21st Century. The explosion in research linking neurobiology of the brain to complex human activities is not simply confined to the laboratory and to clinical applications, but has begun to inform fundamental questions about the nature of human consciousness and what it means to be human. Research on the relationship between the human brain and human mind even influences our understanding of world economies and the behaviour of the marketplace – and promises to give us new insights into why some children, and not others, fail to flourish in the classroom. Not a day goes by without some sort of brain-related story appearing in major newspapers or other media outlets. Western has been a major contributor to these news headlines. In fact, over the past decade, Western has emerged as a leader in research on the relationship between brain and mind – a field known as ***Cognitive Neuroscience*** – resulting in the establishment of the Brain and Mind Institute (BMI) in 2011.

The BMI provides a centralized and visible presence for cognitive neuroscience at Western. Our institute currently brings together researchers from eight faculties across the University, and from Robarts Research Institute and the Rotman Institute of Philosophy. The BMI has a highly visible presence internationally, and has been extremely competitive with respect to attracting research funds from both federal and provincial governments, and from international funding agencies.

By establishing three new Western Research Chairs in Cognitive Neuroscience, and investing $5 million in the Western Cluster of Research Excellence in Cognitive Neuroscience, the University has recognized the critically important position of cognitive neuroscience in its research profile. These investments will ensure the BMI continues to be the leading Canadian centre for research in this field, and will enable the institute to potentiate opportunities for knowledge translation, technological transfer, and commercialization.

Melvyn A. Goodale, PhD, FRSC, FRS
Distinguished University Professor
Canada Research Chair in Visual Neuroscience

HIGHLIGHTS FROM 2014

Daniel Ansari was elected to the Inaugural cohort of the Colleges of New Scholars, Artists and Scientists in the Royal Society of Canada.

Jessica Grahn was awarded one of the eight Scholar Awards in 'Understanding Human Cognition' by the James S. MacDonnell Foundation. These are highly competitive awards, open to researchers around the world, providing $600,000 USD.

Raechelle Gibson from Adrian Owen's lab was one of only seven Western graduate student recipients of the Vanier Canada Graduate Scholarship.

Chao Gu, a PhD student in Brian Corneil's lab, was awarded a 2014 *Brain Star* Award from the CIHR-Institute for Neuroscience, Mental Health and Addiction, for a paper published in the *Journal of Neuroscience.* His work promises an improved understanding of how transcranial magnetic stimulation (TMS), a common form of non-invasive brain stimulation, influences neural activity throughout the brain.

Steve Lomber was awarded a James McKeen Cattell Fellowship. It was only the second time the award has been made to a scholar at a Canadian institution in the past 20 years.

He was also named Canada Research Chair (Tier 1) in Brain Plasticity and Development.

As a Fellow of the Royal Society (UK), **Mel Goodale** represented Western and Canada at the Commonwealth Science Conference in Bangalore, India. This was the first Commonwealth Science Conference for nearly 50 years and was organized under the aegis of the Royal Society and supported by the Government of India.

HIGHLIGHTS FROM 2014

Lorina Naci from the Owen lab was lead author on "A common neural code for similar conscious experiences in different individuals" in PNAS. Lorina and her colleagues used an Alfred Hitchcock movie and fMRI to decode the contents of conscious thought in healthy individuals and then to detect covert awareness in a patient thought to have been vegetative for 17 years. The finding was discussed widely in both the academic (e.g., Science) and popular press.

In 2014, **Ken McRae** was a Distinguished Guest Professor at the University of Connecticut where he gave an invited talk about his work on the organization and structure of concepts in semantic memory.

Dan Alferov, a local high school student who worked with Li-Ann Leow and Lars Strother at the BMI, won the first-place $2500 Psi Chi International Honor Society in Psychology Award, at the prestigious Intel International Science and Engineering Fair. In exciting work crossing the fields of visual perception and music, he showed that the perception of facial emotions is sensitive to changes in the individual's emotional state induced by music.

After a year-long international competition, the Canadian Institute for Advanced Research (CIFAR) selected **Adrian Owen** and **Mel Goodale** to lead a new research network focused on the brain, mind and consciousness. Their proposal was one of four chosen from more than 260 Letters of Intent from eight countries on five continents. The network bridges a full spectrum of questions in the social sciences, medicine, health, the biological and physical sciences, the humanities, policy and engineering.

Ingrid Johnsrude, one of Canada's most innovative neuroscientists, was named the first Western Chair in Cognitive Neuroscience. Her research explores our ability to extract meaning from speech, including what types of information we use to aid our understanding of speech. Her work also examines the effects of a listener's cognitive state on their ability to understand speech.

HIGHLIGHTS FROM 2014

Andrew Pruszynski, recently recruited to the BMI, published an exciting paper in *Nature Neuroscience* with his former postdoctoral supervisor, Dr. Roland Johansson, from Umeå University in Sweden. Their paper, entitled *Edge-orientation processing in first-order tactile neurons*, showed that touch receptors in the fingertips actually carry out much of the computation that allows us to perceive the shape of objects. This work could have *a big* impact on rehabilitation treatments and exercises following nerve injury, as current strategies are based on the assumption that the cerebral cortex does all the work.

Lindsay Oliver, a PhD student working at the Brain and Mind Institute with Drs. Derek Mitchell and Elizabeth Finger, was awarded the Alzheimer Society of London and Middlesex Doctoral Scholarship for her research involving patients with frontotemporal dementia. This award will help support her work using fMRI and other cognitive neuroscience techniques to elucidate and objectively measure the beneficial effects of the neuropeptide oxytocin on social cognition in these patients.

Former postdoc, **Gavin Buckingham**, together with Mel Goodale and PhD student, Jen Milne, published a paper in *Psychological Science* showing that blind people who use echolocation (via tongue clicks) are susceptible to the size-weight illusion, just like sighted people. These findings suggest that echolocation is not just a functional tool to help visually-impaired individuals navigate their environment, but actually has the potential to be a useful sensory replacement for vision.

Brian Corneil organized a satellite meeting at the 2014 Annual Meeting of the Canadian Association for Neuroscience in Montreal on neuroscience careers in government and industry. This meeting gave trainees from across Canada an opportunity to learn about careers outside of the academy that would make use of their expertise in neuroscience research. Speakers were drawn from a broad range of non-academic sectors and offered advice to trainees interested in entering industry or government.

HIGHLIGHTS FROM 2014

Adrian Owen published a feature article in in the May 2014 issue of Scientific American. The article, entitled "Is Anybody in There?" explores his recent work demonstrating the presence of consciousness in the patients in vegetative state. These experiments continue to capture the imagination of scientists, clinicians, and the lay public – and raise important clinical, legal, and ethical issues.

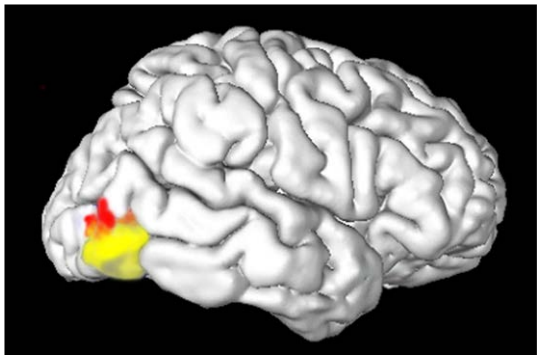
Dan Stolzberg, a postdoctoral fellow in Steve Lomber's lab was awarded one of only two Canadian Institutes of Health Research Fellowships at Western in 2014. Dan finished in the top 2 percent of all applications. The award, $135,000 over three years, will allow him to advance the understanding of why the enhanced visual abilities of some long-term deaf individuals might be interfering with the effectiveness of cochlear implants.

Andrea Soddu was senior author on a paper published in *Cortex* showing that functional magnetic resonance imaging (fMRI) 'resting state analysis' can be used to establish whether or not the connections between different brain areas in groups of brain-damaged patients are sufficient for supporting awareness. Such analysis represents the first step in the development of a clinical tool for single-patient diagnostics which is imperative as the global medical community investigates the customization of health care and the personalized medicine model.

A study by **Stefan Köhler's** lab, published in *Frontiers in Human Neuroscience*, is giving researchers and clinicians new insights into a particularly debilitating memory problem involving a loss of familiarity that is present in some patients suffering from Alzheimer's disease and other neurodegenerative disorders. The study was discussed in *New Scientist*.

For more BMI 2014 news stories, see: http://www.uwo.ca/bmi/news/bmi_news/2014.html.

BMI MISSION AND PRIMARY OBJECTIVES



Cognitive Neuroscience – with its concern about perception, action, memory, language and selective attention – will increasingly come to represent the central focus of all Neurosciences in the 21st century.

Eric R. Kandel, M.D. 2000 Nobel Laureate

Cognitive neuroscience is a new interdisciplinary endeavour that seeks an understanding of how the brain gives rise to mind. A range of disciplines – including psychology, linguistics, neurophysiology, neuroanatomy, artificial intelligence, computational theory, philosophy, economics, and anthropology – are all brought to bear on common problems of mind and brain. The success of future research in this challenging area relies on an integrative approach that bridges these more traditional disciplines. The BMI plays a key role in making this happen by fostering interdisciplinary links amongst a number of departments, centres, and institutes based in different faculties across campus. By virtue of its collaborations with other successful research enterprises on campus, including the Rotman Institute of Philosophy, the BMI is taking us even closer to solving one of nature's great mysteries: how the human mind emerges from the human brain.

Primary functions of the BMI are as follows:

- Promotion of research and research translation in cognitive neuroscience;
- Training of highly qualified personnel;
- Fostering of national and international collaborations in cognitive neuroscience; and
- Facilitation of successful grant applications, both within the BMI and between the BMI and other research groups across the University and at other leading centres.

The BMI brings together research programs in cognitive neuroscience from across the campus -- programs that are already outstanding – and takes them to the next level by providing unparalleled research and training facilities. Indeed, the BMI serves as the flagship for the University's research in cognitive neuroscience – and signals Western's commitment to this signature area to the international research community. Since its inception, the BMI has been immensely productive; we have attracted substantial funding from provincial, federal, and international sources, and have been recognized as a successful research enterprise by both the scientific community and general public. We look forward to creating even more opportunities to foster research in cognitive neuroscience that is unmatched by any other research institute in the world.

THE BMI'S INTERDISCIPLINARY NATURE

Historically, the BMI (and the Centre for Brain and Mind before that) was administered through the Faculty of Social Science and the Schulich School of Medicine and Dentistry. Over the years, however, core members and associate members of the BMI have been drawn from many Faculties across the University.

The faculties, schools, and institutes at Western currently represented in the BMI include:

- **Arts & Humanities**: Philosophy
- **Engineering:** Electrical and Computer Engineering
- **Health Sciences**: Communication Sciences and Disorders, Kinesiology
- **Ivey Business School**: Marketing
- **Schulich School of Medicine & Dentistry**: Departments of Anatomy & Cell Biology, Clinical Neurological Sciences, Medical Biophysics, Ophthalmology, Physiology & Pharmacology, Psychiatry
- **Science**: Computer Science, Physics & Astronomy
- **Social Science**: Psychology

In addition, we draw a number of our core and associate members from other institutes at Western, including:

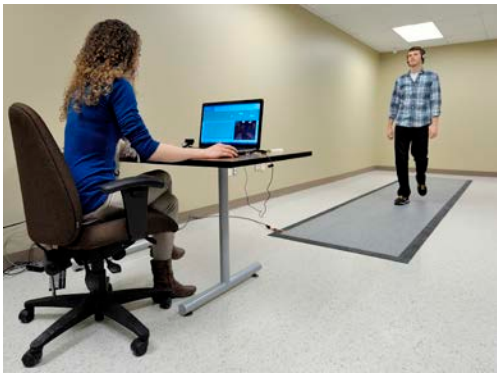
- **Robarts Research Institute**: Centre for Functional and Metabolic Mapping
- **Rotman Institute of Philosophy**

One of the major reasons the BMI is successful is its interdisciplinary nature. By bringing together researchers from different disciplines to address fundamental questions about brain bases of human nature, the BMI has been able to move beyond typical research silos that characterize a significant portion of university-based research; moreover, the BMI has provided a clear focus for communicating Western's outstanding, and often ground-breaking, research in this field to the wider community – both in Canada and around the world. We have no shortage of stories to tell – and media interest is already considerable.

RESEARCH AND RESEARCH TRANSLATION

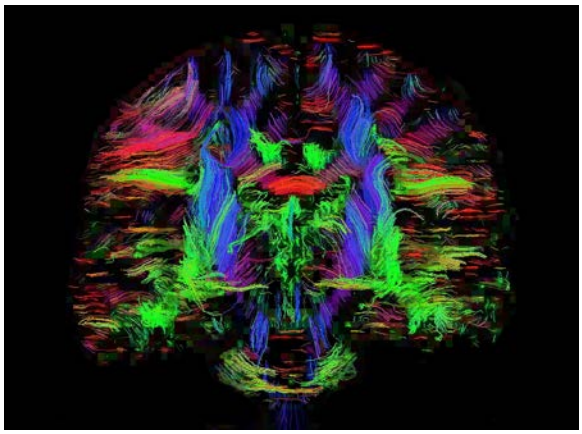
Research at the BMI is already making significant contributions to our understanding and treatment of neurological and psychiatric disorders – and is poised to make even more. Hospitalizations resulting from neurological disease alone vastly outnumber those of any other physical disorder – including heart disease and cancer – with an estimated cost of at least $30 billion annually in direct health costs in Canada alone. When psychiatric disorders are included, the numbers are overwhelming; however, this is not just an economic problem. The lives of patients and their families are terribly disrupted – and whole communities suffer as a consequence. Cognitive neuroscience is in a position to provide breakthrough insights into our understanding of cognitive dysfunction associated with a broad range of neurological and psychiatric disorders, including Alzheimer's disease, frontotemporal dementias, stroke, schizophrenia, and epilepsy. In fact, as the Canadian population ages, increased incidence of cognitive deficits will be one of most significant social and economic problems the nation faces this century.

At the other end of the life-span spectrum, the effects of environmental, social, and educational factors on the development of cognitive abilities in young children – such as language and reading – are also of critical concern. Again, the tools of cognitive neuroscience are being brought to bear. This is equally true for developmental disorders, such as autism, for which cognitive neuroscience and imaging provide a window into how normal brain development can be perturbed, and what treatments might intervene in the disease process.



BMI researchers are also developing computational models of brain function. Biologically inspired models of spatial memory, sensorimotor transformations, executive decision-making, and optimal feedback control emerging from this work can be usefully applied in areas as diverse as clinical assessment, VR-based training, and collaborative engineering design. For example, the principles that underlie sensory processing and sensorimotor control in the human brain are directly applicable to the design of human-machine interfaces in a range of settings, from prosthetic devices for patients to interactive virtual reality displays, ergonomics, and automation in industry. These biological principles can also provide new directions for the design of computer vision/robotic systems and implementation of engineering control systems with both medical and industrial applications. For examples of research programs at the BMI, see: http://www.uwo.ca/bmi/research/featured/index.html.

RESEARCH SUPPORT



The BMI has an enviable record of research and research support – and recent and future recruitments will only augment our output. As of 2014, our core members and associate members collectively held more than $100 million in external funding (see Table 1), including grants from the Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, Brain Canada, Canada Foundation for Innovation and provincial agencies, such as the Ontario Research Fund. In addition, a number of our members hold Canada Research Chairs, including Adrian Owen who is a Canada Excellence Research Chair.

RESEARCH AND KNOWLEDGE TRANSFER

As can be seen in Table 2, our core members have collectively published more than 2,000 peer-reviewed papers during their lifetimes, with an average of more than 70 papers per investigator (adjusted for joint publications). It is also worth noting BMI researchers are remarkably collaborative, which has resulted in many papers authored by more than one BMI member. Papers from BMI researchers are routinely published in the best journals in the world, including Nature (IF-36), PNAS (IF-10), Nature Neuroscience (IF-15), Neuron (IF-16), Science (IF-31), The Lancet (IF-34), Journal of Neuroscience (IF-7), and The New England Journal of Medicine (IF-52). PIs in the BMI do exceptionally well when measured against usual bibliometric indices. [For more details on the BMI and its research, see: uwo.ca/bmi.]

In addition to publishing our work in peer-reviewed journals, we also regularly present our research at leading national and international conferences; many of us are routinely invited to give keynote addresses at such gatherings. All of this ensures our research is communicated to other leading groups working in this field, including groups working in industry and clinical settings.

BMI researchers also engage end-users directly. One effective example of this comes from research related to the relationship between brain plasticity and education. Daniel Ansari and Marc Joanisse (both core members of the BMI), who study the neural substrates of arithmetic reasoning and reading, routinely meet with educational practitioners and researchers in Western's Faculty of Education and relevant experts in local school boards to discuss their work – and to seek advice about particular problems encountered in the schoolroom that can then be investigated in the laboratory. As new findings emerge, researchers meet with curriculum developers in the Ministry of Education and with representatives from companies who design digital tools for education. We believe this iterative cycle, from the classroom to the laboratory and

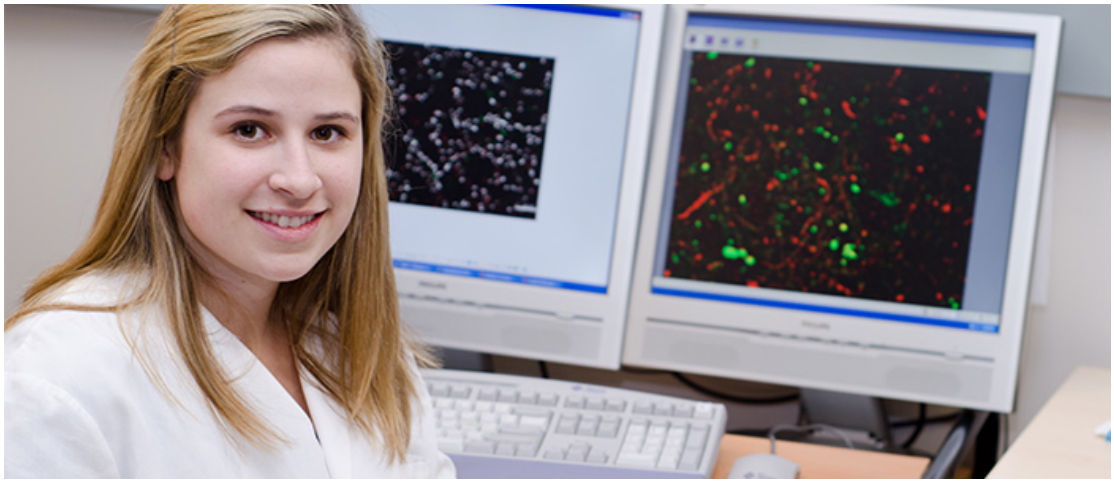
back again, is a highly effective way to enhance evidence-based approaches to education – and ultimately to develop sound educational policy and practice.

Similar approaches are being used to determine how best to teach second languages, critical thinking, and a host of other skills. The interplay between new research in cognitive neuroscience and problems identified by potential end-users is particularly relevant as we move into a digital age where education and workplaces rely increasingly on the Internet, mobile technology, and other digital media tools. The effects of these technologies on the developing brain are poorly understood, and almost no data exist comparing such methods with more traditional approaches.

The reiterative cycle between laboratory and end-users also works effectively in clinical settings. For example, the work of Adrian Owen (core member) and Charles Weijer (associate member) on coma, vegetative state, and other disorders of consciousness has already had widespread influence, both in clinical practice throughout Canada and the rest of the world, and for the families of patients themselves. Development of ethically responsible strategies for disclosing research results to the families of patients who have sustained serious brain injuries is an important theme of this research program. The group meets regularly with local physicians who are directly responsible for these patients' care to guide conversations with families about the results of research studies in which they have been involved, and to make recommendations about any interventions that might be made on the basis of these studies. The research program itself is then shaped further by feedback from these physicians, based on their long-term, intimate involvement with the families and patients themselves.

The BMI also has excellent relationships with industry partners, including IBM Canada, CISCO, Siemens Canada, and Northern Digital Inc. BMI researchers are developing new approaches to brain analyses, human-machine interfaces, visualization graphics, and other projects that are of significant interest to these companies, and others in the private sector. Indeed, it is worth emphasizing that the range of possible partners who have a stake in issues central to research at the BMI is very large. These include computer hardware and software companies, the entertainment industry, military, professional sports, automakers interested in development of intelligent and crashless cars, hotel chains (for whom sleep is an important commodity), and manufacturers of video games and educational software.

TRAINING AND EDUCATION



The BMI is committed to training the next generation of researchers in cognitive neuroscience. Collectively, institute researchers supervise more than 120 graduate students and 45 postdoctoral fellows, most of whom hold competitive salary awards, including five Vanier Canada Graduate Scholarships and three of the six Banting Postdoctoral Fellowships awarded to Western over the past 5 years. We have attracted talented graduate students and postdoctoral fellows from leading labs around the world, with backgrounds ranging from cognitive psychology to engineering. Part of the reason we have been successful is that we can provide trainees with access to state-of-the-art facilities for research in cognitive neuroscience, including imaging facilities that rank amongst the very best in the world. To help attract the best and the brightest young minds to the BMI, we have created the Western Cognitive Neuroscience Postdoctoral Fellowships program, for which the BMI provides up to five annual awards of $25,000 for each of two years, matched by funds from the supervisor. In addition to attracting young graduates from institutions across Canada, BMI researchers have recruited top talent from the United States, Australia, Israel, Spain, Albania, the UK, Italy, China, Japan, Taiwan, Lebanon, the Netherlands, and Germany. Our trainees routinely secure positions in leading universities across the globe. As importantly, we have retained some of the best and the brightest of our trainees from overseas in Canada.

Although the BMI is involved in supervision of graduate students across campus, the institute is not formally involved in undergraduate or graduate instruction. Nevertheless, we work closely with the Graduate Program in Neuroscience and other relevant graduate programs to develop new directions for graduate education geared towards trainees in cognitive neuroscience. The institute also works closely with departments across campus to ensure honors students have opportunities to do research at the BMI for their honors thesis. Many of these honors students and undergraduate student volunteers work closely with graduate students and postdoctoral fellows in the BMI.

INTERNATIONAL SCIENTIFIC ADVISORY BOARD

The BMI has set up an International Scientific Advisory Board, comprising some of the leading researchers in the field, to guide the institute in charting future directions for the development of cognitive neuroscience at Western. The following individuals have agreed to serve on the board, which will meet for the first time from September 20-21, 2015, in concert with our first annual BMI Fall Symposium.

David Burr, PhD
CNR Institute of Neuroscience, Pisa
Department of Psychology
University of Florence Stella Maris Foundation, Pisa, Italy

Alfonso Caramazza, PhD
Daniel and Amy Starch Professor of Psychology Department of Psychology
Harvard University Cambridge, MA 02138, USA

Stanislas Dehaene, PhD
Director, Inserm-CEA Cognitive Neuroimaging Unit Collège de France
75231 Paris Cedex 05, France

John Duncan, PhD
Programme leader, Executive processes group
MRC Cognition and Brain Sciences Unit
Cambridge, CB2 7EF, United Kingdom

Jeffrey Schall, PhD
E. Bronson Ingram Professor of Neuroscience,
Professor of Ophthalmology and Visual Sciences
Director of Center for Integrative Cognition & Cognitive Neuroscience
Vanderbilt University, Nashville, TN 37235, USA

Irene Tracey, PhD
Nuffield Professor of Anaesthetic Science
Director of the Oxford Centre for fMRI
University of Oxford, United Kingdom

BMI CORE MEMBERS

Faculty members from the University who are actively engaged in cognitive neuroscience, whether basic or applied, can be considered for core membership of the BMI. There are currently **31 Core Members** leading research activities at the Brain and Mind Institute.

Daniel Ansari
Website: Ansari Lab
Department: **Psychology**

Research Areas

- Developmental Cognitive Neuroscience; Mind, Brain and Education
- Development of numerical and mathematical skills
- Developmental Dyscalculia

Robert Bartha
Website: Bartha Lab
Departments: **Medical Biophysics, Medical Imaging, Psychiatry**

Research Areas

- The development of high-field magnetic resonance imaging (MRI)
- Spectroscopy techniques for early diagnosis of disease and monitoring of treatment response

Blaine Chronik
Website: Chronik Lab
Department: **Physics & Astronomy**

Research Areas

- Developing new hardware systems and techniques for magnetic resonance imaging (MRI)

Adam Cohen
Website: Cohen Lab
Department: **Psychology**

Research Areas

- How theory of mind and attention work, develop, and interface using behavioural and neuroimaging methods

BMI CORE MEMBERS

Brian Corneil
Website: Corneil Lab
Departments: **Physiology & Pharmacology, Psychology**

Research Areas
- Neurophysiological and behavioural studies of the neural control of movement

Jody Culham
Website: Culham Lab
Department: **Psychology**

Research Areas
- Neuroimaging of human brain regions involved in vision and hand actions

Rhodri Cusack
Website: Cusack Lab
Departments: **Psychology, Medical Biophysics**

Research Areas
- The emergence of cognition in the first 1,000 days
- Neuroimaging methods for newborns and infants
- The effects of perinatal brain injury

Mark Daley
Website: Daley Lab
Departments: **Computer Science, Biology**

Research Areas
- Natural Computing; Theoretical Computer Science
- Mathematical Modelling of Biological Systems
- Computational Neuroscience & Neuroinformatics

BMI CORE MEMBERS

Jörn Diedrichsen
Website: Diedrichsen Lab
Departments: **Computer Science, Statistics**

Research Areas
- Computational Neuroscience
- Motor Control and Learning
- Neuroimaging

Stefan Everling
Website: Everling Lab
Departments: **Physiology & Pharmacology, Psychiatry, Psychology**

Research Areas
- Organization of the primate prefrontal cortex
- Saccadic eye movements

Melvyn Goodale
Website: Goodale Lab
Departments: **Physiology & Pharmacology, Psychology**

Research Areas
- Visual perception and visually guided actions, using behavioural studies, fMRI, and neuropsychology

Jessica Grahn
Website: Grahn Lab
Department: **Psychology**

Research Areas
- Neuroscience of music

BMI CORE MEMBERS

Paul Gribble
Website: Gribble Lab
Departments: **Physiology & Pharmacology, Psychology**

Research Areas
- How the brain controls voluntary movement, and how movement is learned

Elizabeth Hayden
Website: Hayden Lab
Departments: **Psychiatry, Psychology**

Research Areas
- Developmental psychopathology of mood disorders
- Assessment of temperament and personality

Marc Joanisse
Website: Joanisse Lab
Department: **Psychology**

Research Areas
- How children acquire, and their brains process, first and second languages
- Developmental language and reading impairments, including dyslexia

Ingrid Johnsrude
Website: CoNCH Lab
Department: **Psychology**

Research Areas
- The neural basis of speech understanding
- How people understand speech in challenging listening situations

BMI CORE MEMBERS

Stefan Köhler
Website: Köhler Lab
Department: **Psychology**

Research Areas

- The relationship between the cognitive and neural processes that allow humans to remember their pasts

Stephen Lomber
Website: Lomber Lab
Departments: **Physiology & Pharmacology, Psychology**

Research Areas

- How does experience influence brain development?
- Cortical processing in hearing and deaf individuals

Penny MacDonald
Website: MacDonald Lab
Department: **Clinical Neurological Sciences**

Research Areas

- Understanding the neural bases for cognitive processes with particular interest in defining the unique role of the basal ganglia

Julio Martinez-Trujillo
Website: Martinez-Trujillo Lab
Department: **Physiology & Pharmacology**

Research Areas

- Cognitive Neuroscience
- Autism

BMI CORE MEMBERS

Ken McRae
Website: McRae Lab
Department: **Psychology**

Research Areas

- How people understand language

Ravi Menon
Website: Menon Lab
Departments: **Medical Biophysics, Medical Imaging, Physics & Astronomy, Psychiatry**

Research Areas

- Development and application of magnetic resonance imaging (MRI) and spectroscopy (MRS) techniques

Paul Minda
Website: Minda Lab
Departments: **Psychology**

Research Areas

- How people learn about categories and concepts and how conceptual structure influences thinking, reasoning, and decision-making

Derek Mitchell
Website: Mitchell Lab
Departments: **Anatomy & Cell Biology, Psychiatry**

Research Areas

- Determining how dissociable neural systems integrate emotion with cognition and behaviour

BMI CORE MEMBERS

J. Bruce Morton
Website: Morton Lab
Departments: **Psychiatry**

Research Areas

- The development of self-regulation and control, and its link with changes in brain function in children and teens

Adrian Owen
Website: Owen Lab
Departments: **Psychology, Anatomy & Cell Biology, Physiology & Pharmacology**

Research Areas

- Understanding the effects of brain injury to improve diagnosis and early detection, and to find possible new treatments

Dante Pirouz
Website: Pirouz Lab
Affiliation: **Ivey Business School**

Research Areas

- Using both neuroscience and cognitive science tools and theories to examine the "dark side" of risky consumer behaviour

Andrew Pruszynski
Website: Pruszynski Lab
Department: **Physiology & Pharmacology, Psychology**

Research Areas

- Neural mechanisms of sensory perception and motor control

BMI CORE MEMBERS

Andrea Soddu
Website: Soddu Lab
Department: **Physics &Astronomy**

Research Areas

- Study of resting-state fMRI connectivity in altered states of consciousness
- Modelling of the structure-function relationship in the human brain

Brian Timney
Website: Timney Lab
Department: **Psychology**

Research Areas

- Human vision, with a focus on the effect of alcohol, and binocular vision
- The visual system in horses and camels

Tutis Vilis
Website: Vilis Lab
Departments: **Medical Biophysics, Ophthalmology, Physiology & Pharmacology, Psychology**

Research Areas

- Brain areas involved in vision and directing motor actions

BMI ASSOCIATE MEMBERS

The BMI also engages with other members of the Western community, including research scientists and Principal Investigators in clinical departments. For more information on current associate members, visit http://www.uwo.ca/bmi/members/associate_members.html.

Damian Cruse	Psychology
Sandrine de Ribaupierre	Clinical Neurological Sciences
Neil Duggal	Clinical Neurological Sciences
Roy Eagleson	Electrical & Computer Engineering
Elizabeth Finger	Clinical Neurological Sciences
Stuart Fogel	Psychology
Alexander Fraser	Clinical Neurological Sciences, Ophthalmology
Matthew Heath	Kinesiology
Kevin Johnston	Psychology, Physiology & Pharmacology
Angela Mendelovici	Rotman Institute of Philosophy
Lindsay Nagamatsu	Kinesiology
David Purcell	Communication Sciences & Disorders
Kevin Shoemaker	Kinesiology, Physiology & Pharmacology
Rob Stainton	Rotman Institute of Philosophy
Jackie Sullivan	Rotman Institute of Philosophy
Jennifer Sutton	Psychology, Brescia University College
Chris Viger	Rotman Institute of Philosophy
Charles Weijer	Rotman Institute of Philosophy

ADMINISTRATIVE AND TECHNICAL CORE

Florence Lourdes	Administrative Officer
Denise Soanes	Secretary and Receptionist
Haitao Yang	Systems Manager and Software Engineer

INTERNATIONAL COLLABORATIONS

National and international collaborations are a key strength of the BMI's researchers, who work closely with leading groups around the globe. These collaborations are testament to the strong international reputation the BMI and individual BMI researchers enjoy. The figure below illustrates just some of the research partners we have collaborated with over the past five years.

Liege
Parma
Maastricht
Nijmegen
Zurich
Verona
Durham
Ben-Gurion

Oxford
Aberdeen
Nanjing
INSERM
Cambridge
Nottingham
Aberdeen
Buenos Aires

Taipei
ATR Kyoto
Sydney
U. Victoria
Beijing
Queensland
Durham
Bologna

Bristol
Erasmus
Sao Paulo
Tübingen
Umeå
Melbourne
Monash
UCLA

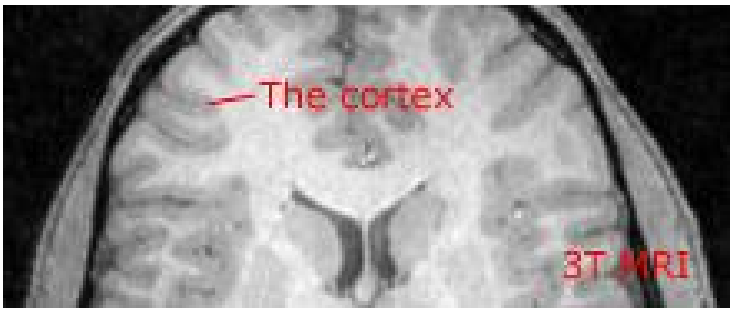
Harvard
MIT
McGill
Stanford
UC Davis
Caltech
UC San Diego
Vanderbilt U.
U. Minnesota
NIH
U. Mexico
Nairobi
U. Calgary
U. Lethbridge
UBC
Carnegie Mellon
NYU
Dalhousie
U. Texas (Dallas)
York U.
U. Toronto
NRC Winnipeg
UCL
Wilfrid Laurier
Waterloo

RESEARCH FACILITIES AND RESOURCES

The exciting pace of developments in cognitive neuroscience is fed by new technology for measuring the brain and behaviour.

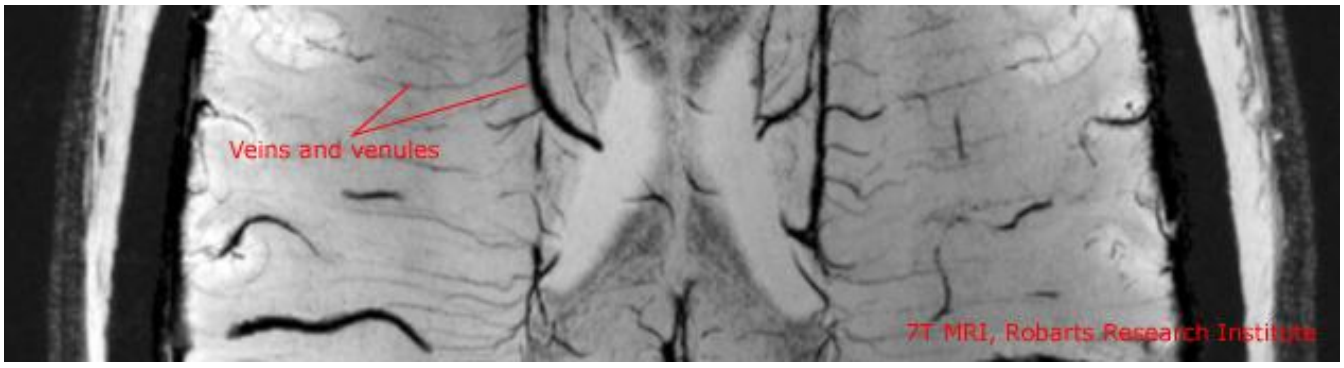
MRI: MEASURING BRAIN ANATOMY WITH A 375-MEGAPIXEL CAMERA

At the BMI, we have access to Canada's foremost neuroimaging facility: the Centre for Functional and Metabolic Mapping (CFMM). Ravi Menon, a core member of the BMI, is director of the CFMM, which has a suite of research-dedicated high-field MRI scanners, including 9.4T, 7T, and 3T magnets.



Using MRI, we can measure many different characteristics of brain anatomy, such as:

- *Thickness of the cortex on the surface of the brain;*
- *Strength of "white matter" connections between brain regions;*

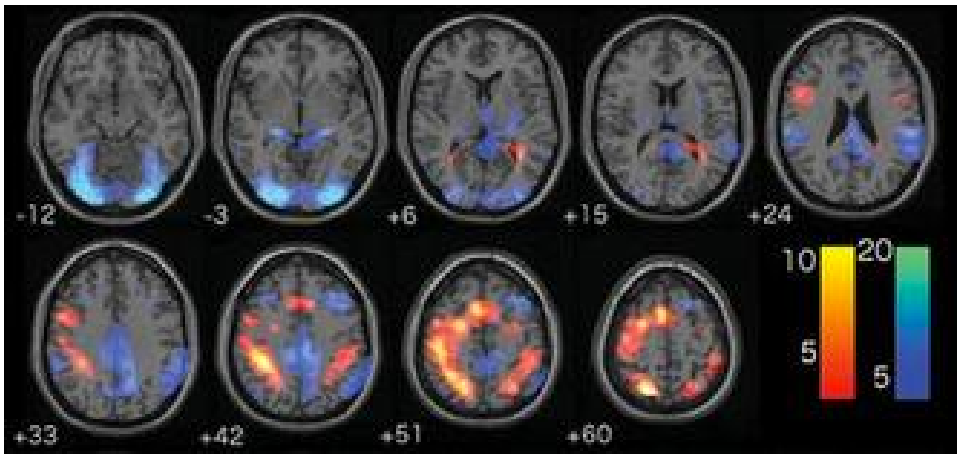


- *Locations of veins and venules (the 3D volume this detail comes from was 375 megapixels in size);*
- *Location of brain injury; and*
- *Chemical properties of brain regions*

One of the great benefits of MRI is, by simply downloading a new "app," the scanner can measure new property: temperature, blood flow, microstructure -- the list is enormous and growing. New imaging capacity can also be created by adding hardware, such as smaller MRI "coils" for newborn brains, or new inserts for measuring specific neurotransmitters in the brain.

RESEARCH FACILITIES AND RESOURCES

FUNCTIONAL MRI (fMRI): SEEING THE BRAIN IN ACTION



We need to be able to measure the brain in non-invasive ways. In an active brain, blood vessels change in size and blood flow and oxygenation increase when a person is performing a task, which can be detected safely and quickly using functional magnetic resonance imaging (fMRI). As an example, here are nine slices through the brain (from low to high): the 'hot' colours are brain regions that are activated more when people are remembering a visual pattern than when they are just resting; the 'cool' colours show deactivated regions. We use MRI scanners at CFMM, in the adjacent Robarts Research Institute, including the 3T Siemens Prisma scanner and Canada's only 7T MRI scanner. Scanners at nearby hospitals are also used for examining inpatients, including newborn babies, and patients with disorders of consciousness.

ELECTROENCEPHALOGRAPHY

Another way to measure the brain is to record electrical signals on the surface of the scalp, a method known as electroencephalography (EEG). The BMI has two electrically shielded recording rooms, and a number of EEG systems (ranging from 14 to 128 channels). It has a geodesic sensor net for measuring the positions of electrodes on the head and an MRI-compatible EEG kit for doing both simultaneously. The institute regularly acquires EEG data in patients at local hospitals.

STIMULATING THE BRAIN

We can also investigate which bits of the brain do what by stimulating a local region and measuring how this interferes with a task. We use transcranial magnetic stimulation (TMS) to stimulate a local region of the brain in a non-invasive way. The institute has a TMS machine and the equipment needed to target particular brain regions in an individual person.

RESEARCH FACILITIES AND RESOURCES

MEASURING EYE AND BODY MOVEMENTS

Much can be learned about the mind from careful observation of behaviour, both in healthy volunteers and in patients with brain injury. The institute has special expertise in measuring movements of the whole body, a single limb, or just the eyes. It has a number of pieces of sophisticated equipment that can track movements, including, for example, as a participant walks or grasps an object. It is also now possible to track movements as someone reaches for real objects while in a brain scanner.

COMPUTING SYSTEMS

Brain imaging methods yield many terabytes of data each year. As time goes by, an increasing number of more complex methods become available, which provide all sorts of new information about the brain, but place ever-increasing demands on computing. The institute has its own cluster, with 50 terabytes of storage. It is also is closely involved with the Canada-wide SHARCNET high-performance computing clusters – administered at Western – and uses commercial cloud computing from Amazon Web Services.

SKILLED RESEARCHERS IN A BROAD RANGE OF DISCIPLINES

Effective cognitive neuroscience requires a great number of skills. Brain imaging equipment needs physicists to build it and to interpret the results. Mathematicians are needed to help create analytical methods or build models of the brain. Cognitive psychologists are needed to build models of the mind, and to design tasks that isolate particular mental processes. Physicians – from neurologists to neonatologists – are needed to help understand problems patients most commonly encounter, and to determine how our growing knowledge of the brain can assist clinical practice. Philosophers are needed to answer new ethical questions, and to help guide development of this new science. Developmental psychologists help us understand how the brain grows, and what can go wrong during childhood; computer scientists run complex computer systems; and engineers build laboratory equipment to administer all manner of tasks. Only by bringing all of these people together can the brain and mind be understood. This is the purpose of the Brain and Mind Institute.

RESEARCH FACILITIES AND RESOURCES

ANIMAL MODELS OF THE HUMAN BRAIN

Modern methods for study of human brain function, in particular functional neuroimaging, provide unprecedented new insight into the broad topography of cognitive neuroscience. Understanding the detailed neurophysiological mechanisms underlying such processes requires complementary studies in animal models. For study of complex cognition, nonhuman primates (NHPs) represent the ideal animal model. A unique strength of the BMI is the availability of the NHP animal model; indeed many of our members run parallel programs in humans and animals. For example, complementary research is ongoing in both humans and NHPs into such topics such as neuroplasticity, resting state networks, neuro-vascular coupling underlying the BOLD signal for fMRI, and the neural basis of higher-order and sensorimotor behaviour. The results of such programs illuminate the work of other BMI members, and constrain theories of brain function with biologically plausible mechanisms. Consequently, BMI researchers are poised to play key roles into the development of emerging animal models of higher-order diseases, such as autism, schizophrenia, frontotemporal dementia, and brain plasticity following stroke. While animal models will never be able to answer all aspects of human brain function, the insights that can be gained through neurophysiological investigations will remain central to the core mission of the BMI. Moreover, continued development of animal models for human brain dysfunction will remain central to funding success within the BMI, as agencies such as the Canadian Institutes of Health Research, Brain Canada, and the Ontario Brain Institute, place increasing emphasis on the translation of research results.

NEUROBIOLOGY OF SLEEP AND SLEEP DISORDERS

We spend nearly a third of our life asleep. But what is the function of sleep and what goes on in our brain when we are asleep? Working out the answers to these questions is crucial to understanding the impact of sleep loss, sleep disruption and of sleep disorders, which, in North America, has reached epidemic proportions. About one in five Canadians suffers from sleep loss, which wreaks havoc on society's productivity, safety, physical and mental health.

A Canada Excellence Research Chair (CERC) award and related CFI grant have contributed significantly to renovations to the BMI, which now includes a fully equipped three-bedroom sleep laboratory with three in-lab 32-channel

RESEARCH FACILITIES AND RESOURCES

EEG and polysomnographic systems for recording and analysis of overnight sleep studies. This sleep laboratory permits scientists within the BMI and from elsewhere on campus to apply the latest and most advanced EEG and neuroimaging technology to some of the most important unresolved scientific questions, such as “what is consciousness” and “why do we sleep.” It also allows scientists to characterize the function of sleep for learning and memory, and to identify the neural substrates and activity that support sleep-dependent memory processing and synaptic plasticity.

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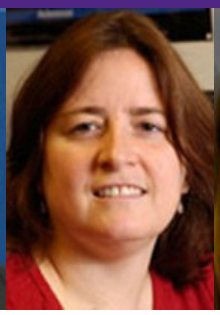
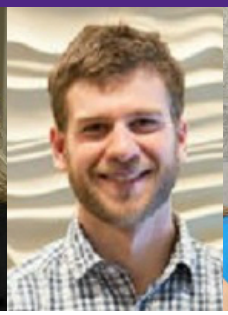
All peer-reviewed publications listed above were submitted by BMI core members. Publications and other research details about the associate members can be found at: http://www.uwo.ca/bmi/members/associate_members.html.

BMI STEERING COMMITTEE

2014- 2015 Members

The Steering Committee meets on a monthly basis to discuss the development of policies and procedures for the institute, space allocation and the optimization of research resources, the selection of student and postdoctoral awardees, application reviews for BMI membership, and the preparation of the annual report. This committee consists of the BMI Director, six Core Members, and a representative from each of the following constituencies: Associate Members, graduate students, postdoctoral fellows, and administrative/technical staff.

MEL GOODALE DIRECTOR & CHAIR	DANIEL ANSARI CORE MEMBER	BRIAN CORNEIL CORE MEMBER	JODY CULHAM CORE MEMBER	JESSICA GRAHN CORE MEMBER	STEFAN KÖHLER CORE MEMBER
					
EMAIL: mgoodale@uwo.ca	EMAIL: dansari4@uwo.ca	EMAIL: bcorneil@uwo.ca	EMAIL: jculham@uwo.ca	EMAIL: jgrahn@uwo.ca	EMAIL: stefank@uwo.ca

ADRIAN OWEN CORE MEMBER	CHARLES WEIJER ASSOCIATE MEMBER	PATRICK CALLAGHAN FINANCIAL ADVISOR	LORINA NACI POSTDOCTORAL REPRESENTATIVE	DAN CAMERON GRADUATE REPRESENTATIVE	FLORENCE LOURDES STAFF REPRESENTATIVE
					
EMAIL: uwocerc@uwo.ca	EMAIL: cweijer@uwo.ca	EMAIL: pcallag@uwo.ca	EMAIL: lnaci@uwo.ca	EMAIL: dcamer25@uwo.ca	EMAIL: flourdes@uwo.ca

The Brain and Mind Institute
Western University
Tel 519-661-2111 ext. 86057
Fax 519-661-3613
www.uwo.ca/bmi

TABLE 1: GRANT FUNDS HELD BY BMI MEMBERS IN 2014

Funding Source	BMI Core Members	BMI Assoc. Members	Total*
Alzheimer's Society	100,000	142,609	$242,609
Canadian Consortium on Neurodegeneration in Aging	674,842	0	$674,842
CERC	10,000,000	0	$10,000,000
CFI IOF	1,187,007	840,721	$2,027,728
CFI LOF	1,757,260	2,577,602	$4,334,862
CFI Other	3,752,383	0	$3,752,383
Children's Health Research Institute	21,693	0	$21,693
CHRP	545,139	0	$545,139
CIFAR	360,000	0	$360,000
CIHR Catalyst	99,576	100,000	$199,576
CIHR Operating	15,231,027	3,352,994	$18,584,021
CIHR Other	1,484,691	688,959	$2,173,650
CRC	3,800,000	2,800,000	$6,600,000
CRC Team	0	2,787,612	$2,787,612
NSERC CREATE	1,355,739	0	$1,355,739
NSERC Discovery	5,249,753	1,717,000	$6,966,753
NSERC RTI	336,814	0	$336,814
OBI	715,336	128,550	$843,886
Ontario Institute for Cancer Research	230,950	0	$230,950
Ontario Ministry of Res. & Innovation	140,000	420,000	$560,000
ORF	6,418,882	3,102,184	$9,521,066
Parkinson's	185,902	0	$185,902
SSHRC	0	72,850	$72,850
Other	12,530,536	5,978,387	$18,508,923
Total	**66,177,530**	**24,709,468**	**$90,886,998**

*Total amount over all years of tenure of grants, held in 2014 by lead PI.

TABLE 2: PUBLICATIONS* BY BMI CORE MEMBERS

PI	Only BMI PI	Jointly with another BMI PI
Ansari, Daniel	71	5
Bartha, Rob	69	8
Chronik, Blaine	52	0
Cohen, Adam	9	0
Corneil, Brian	44	2
Culham, Jody	34	31
Cusack, Rhodri	54	4
Daley, Mark	77	1
Diedrichsen, Jörn	80	0
Everling, Stefan	52	23
Goodale, Mel	231	45
Grahn, Jessica	25	6
Gribble, Paul	49	5
Hayden, Elizabeth	56	1
Joanisse, Marc	64	5
Johnsrude, Ingrid	66	14
Köhler, Stefan	47	8
Lomber, Steve	86	9
MacDonald, Penny	19	4
Martinez, Julio	35	0
McRae, Ken	63	3
Menon, Ravi	120	45
Minda, Paul	46	0
Mitchell, Derek	42	13
Morton, Bruce	29	1
Owen, Adrian	194	32
Pirouz, Dante	7	0
Pruszynski, Andrew	19	0
Soddu, Andrea	30	4
Timney, Brian	66	4
Vilis, Tutis	65	14

*Lifetime publications as of the end of 2014.