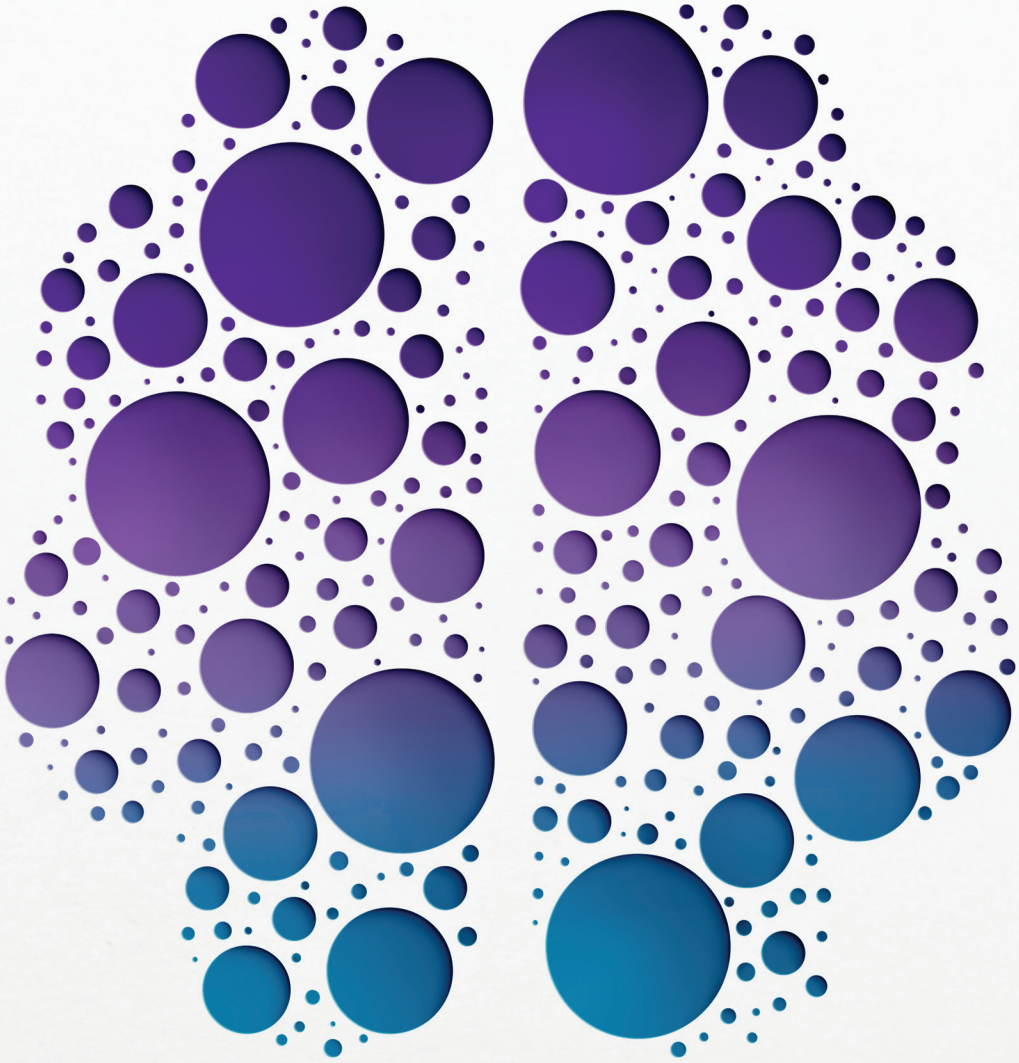
Western BrainsCAN
Transforming brain research.



MIDTERM REPORT | 2021

CANADA FIRST
RESEARCH EXCELLENCE FUND

Artist's work a reminder of work to be done

BY SONIA PRESZCATOR, WESTERN NEWS

On June 7, 2006, while on a lunch break as a special education instructor with the Thames Valley District School Board, Vanessa Zita Vanderidder was pronounced dead along the side of her car.

A 20-pound rock fragment had bounced into her open window and shattered her skull, leaving her frontal temporal lobe exposed.

Miraculously, she regained consciousness after being intubated at the scene.

After several emergency and planned surgeries, Vanderidder found herself relearning how to walk and talk again – and then, somehow, started to paint.

On April 12, 2018, the work of this self-described 'accidental artist' surrounded a group of Western neuroscientists dedicated to reducing the burden of brain injuries and disorders.

Vanderidder's work, as seen in the image above, now hangs among Western's BrainsCAN group, located on the sixth floor of the Western Interdisciplinary Research Building.

The Co-Scientific Directors and Executive Director also each purchased a painting of their own.

"We all saw this as a great opportunity," Fay Harrison, BrainsCAN Executive Director said. "Having Vanessa's work hanging in the office is an important reminder to all of us of the impact BrainsCAN research will have on people in our local community and across Canada."

"This collection of brain researchers here in London are kicking ass around the world," Vanderidder said.

"As a survivor of a traumatic brain injury, I am excited about the good they will do for those of us with this 'invisible illness."

"As a peer mentor for others with TBI, and now this relationship with the people at BrainsCAN, I'm helping to educate others about it. Even though TBI changed who I was, I'm learning about who I am now and what I have to offer."

London artist Vanessa Zita Vanderidder will have three of her latest works surround a group of Western researchers dedicated to reducing the burden of brain injuries and disorders at the Western Interdisciplinary Research Building.

LETTER FROM THE VICE PRESIDENT (RESEARCH)

"By providing faculty, graduate students, postdoctoral scholars, and Medical Innovation Fellows what they need to flourish, we offer an unparalleled opportunity – across a broad range of disciplines that don't normally interact – to focus on basic, clinical, and translational neuroscience."

— LESLEY RIGG

When BrainsCAN launched four years ago, Western University already ranked among the world's best in neuroscience and neuroimaging research, excelling in the breadth of cognitive, computational, clinical, technological, and translational approaches.

BrainsCAN-aligned researchers seek to reduce the burden of brain disorders, which affect 3.6 million Canadians and millions more around the world. These brain impairments create deficits in memory, attention, knowledge, problem solving, and communication – affecting how people interact with everything and everyone around them. Finding solutions has global relevance.

The Canada First Research Excellence Fund's (CFREF) investment in BrainsCAN has helped Western accelerate important discoveries through internal funding awards, unique research and innovation cores, and by supporting exceptional staff, faculty, and trainees.

This support has allowed us to attract some of the world's brightest early career researchers to Western and helped earn additional federal and international funding for high-impact research projects. It has led to discoveries, including a study that ruled out a potential treatment focus for Alzheimer's disease and another demonstrating how diet and obesity can have an impact on the formation of memories.

BrainsCAN has provided internal funding awards to raise the bar, promote interdisciplinarity, and to help researchers reach higher. To date, BrainsCAN's Accelerator Program has funded 49 high-risk, high-reward projects valued at more than $4.3M. An additional seven grants, valued at $3.4M, were awarded through a joint program with McGill University's CFREF-funded Healthy Brains, Healthy Lives initiative, which leverages complementary expertise to better understand epilepsy, auditory cognition, Alzheimer's disease, memory, and consciousness and cognition.

Strategic investments in personnel are essential to BrainsCAN's success. By providing faculty, graduate students, postdoctoral scholars, and Medical Innovation Fellows what they need to flourish, we offer an unparalleled opportunity – across a broad range of disciplines that don't normally interact – to focus on basic, clinical, and translational neuroscience. At the halfway mark of this landmark grant, BrainsCAN has already made an impact.

Together, we are transforming brain research.

Lesley Rigg
Vice President (Research),
Western University;
Chair, BrainsCAN Board of Directors

LETTER FROM THE EXECUTIVE AND SCIENTIFIC DIRECTORS

"BrainsCAN's work in and out of the lab benefits from excellence in underrepresented populations by having equity, diversity and inclusion (EDI) best practices underpin everything we do. Our innovative approaches to EDI in research aim to directly influence the University's strategic planning."

One in three Canadians will be affected by a brain disease, disorder or injury at some point in their lives. Countless family members and loved ones will be affected.

BrainsCAN aligned researchers have the common goal to reduce these numbers. Since 2016 we have been bringing together molecular biologists, geneticists, cognitive neuroscientists, neurologists, psychiatrists, philosophers, physicists, engineers and computer scientists together to build bridges across levels of the nervous system—from molecule to behaviour—to accelerate important discoveries.

BrainsCAN's work in and out of the lab benefits from excellence in underrepresented populations by having equity, diversity and inclusion (EDI) best practices underpin everything we do. Our innovative approaches to EDI in research aim to directly influence the University's strategic planning.

Thanks to our funding agency, the Canada First Research Excellence Fund, and the dedicated individuals that comprise BrainsCAN, our understanding of life-changing neurological disorders and healthy brain function is constantly expanding.

We know more about the complexities of the human mind; how the brain allows us to perceive the world, perform actions, form memories and communicate our thoughts.

We have enhanced our ability to diagnose debilitating neurological diseases and mental disorders, inform and physically guide brain surgery and design hearing aids.

We better understand behavioural deficits and brain circuits, and how brain function leads to cognition.

Our research will continue to answer challenging questions about the brain, leading to outcomes that will inform evidence-based interventions, ethical frameworks and public policy to improve the lives of countless people in Canada and around the world.

Lisa Saksida, Ravi Menon
Scientific Directors, BrainsCAN

Fay Harrison
Executive Director, BrainsCAN

OUR VISION

We aim to facilitate breakthroughs in our fundamental understanding of the brain, which will radically transform our approach to brain disorders. This will lead to evidence-based interventions in the clinic, the classroom and in the operating room, and will inform ethical frameworks and public policy to guide the use of these novel interventions.

OUR MISSION

1. **Fostering collaborative interdisciplinary research**
2. **Developing technologies and reducing barriers to access**
3. **Training the next generation of neuroscientists**
4. **Building community**
5. **Redefining research culture**

SUPPORT FOR OUR MISSION

Fostering collaborative interdisciplinary research

We promote curiosity-driven discovery science, motivating inter-disciplinary teams of researchers to address grand challenges in brain health across the lifespan. Our focus is on high-risk/high-reward projects and projects that can demonstrate potential for substantial impact to facilitate breakthroughs in our fundamental understanding of the brain, which will radically transform our approach to brain disorders.

Developing technologies and reducing barriers to access

Recent technological advances have fueled unprecedented progress in neuroscience. We support the large development teams with diverse expertise that are essential for such technological innovation. Technical and financial barriers make it difficult, and often impossible, for scientists to adopt the full range of these technologies individually in their own labs. We democratize these tools by facilitating access to our unique technical expertise and infrastructure.

Training the next generation of neuroscientists

Our trainees have access to world-class education in fundamental concepts and methods emphasizing interdisciplinary and integrative approaches to understanding the brain and cognition. A unique aspect of our programs is that trainees are required to work across at least two different labs, to gain the range of skills that are essential for inherently interdisciplinary subjects such as neuroscience.

Building community

Our research community draws from multiple disciplines beyond neuroscience, including math and statistics, computer science, pharmacology, physiology, psychology, education, philosophy, medicine, and biomedical, electrical and software engineering. We encourage and support collaborations across Western and through our partnerships with leading institutions around the world. We build bridges to our community through our local MPs, community events, and by sharing our skills with local organizations to facilitate their initiatives.

Redefining research culture

We aim to cultivate, reward and encourage research excellence within a working culture that is creative, authentic and inclusive. When considering excellence, we go beyond standard metrics to emphasize the real impact that our research has on many different communities. We acknowledge the barriers to access that many groups face in research spaces because of systemic biases and despite meritorious qualification, and apply an intersectional lens to improve working culture for everyone.

GOVERNANCE

The BrainsCAN Board of Directors is chaired by the Vice-President (Research), Western University and is responsible for oversight of the initiative and ensuring that Western's obligations to its partners are met.

BOARD OF DIRECTORS

Dr. Lesley Rigg
Vice-President (Research), Western University, Chair, Fellow of the Royal Canadian Geographic Society

Dr. Matt Davison
Dean, Faculty of Science, Western University

Dr. Joan Finegan
Dean (Acting), Faculty of Social Science, Western University

Dr. S. Jayne Garland
Dean, Faculty of Health Sciences, Western University

Dr. John Yoo
Dean, Schulich School of Medicine & Dentistry, Western University

Dr. Martha Crago
Vice-Principal (Research & Innovation), McGill University

Dr. Calvin Stiller
Professor Emeritus, Western University

Cynthia Stewart
Director R&D Alliances, GE Healthcare

Dr. John Hepburn
CEO and Scientific Director, Mitacs

Dr. Jane Roskams
Professor, Centre for Brain Health, University of British Columbia

Dr. Allison Sekuler
Professor, McMaster University and University of Toronto

LEADERSHIP

CO-SCIENTIFIC DIRECTOR
Lisa Saksida
Tier 1 CRC in Translational Cognitive Neuroscience, FCAHS, FRSC

EXECUTIVE DIRECTOR
Fay Harrison
CMI

CO-SCIENTIFIC DIRECTOR
Ravi Menon
FCAHS, FRSC

DATA DRIVEN GOVERNANCE

From internal funding awards to developing new programs, the concept of data-driven governance is a key element of our BrainsCAN implementation plan. Data is essential to proactively develop and refine action plans to be as effective as possible, and it also allows us to understand the precise status of our endeavour. This evidence-based approach provides important insights and allows our staff and board to hold BrainsCAN accountable and to continuously enhance the endeavour's initiatives.

Fostering collaborative interdisciplinary research.

BrainsCAN FACULTY

Recruiting two star computational neuroscientists has catalyzed the development of a formal Computational Brain Sciences Group at Western. Strategic investments in research funds also supported the recruitment of two Tier 2 Canada Research Chairs and a research scientist.

YALDA MOHSENZADEH

Yalda's lab works at the intersection of cognitive neuroscience and computer science, closing the loop between theory and experiment.

In 2019, she joined Western's department of Computer Science, having previously completed postdoctoral fellowships in the Computer Science and A.I. Lab (CSAIL) and McGovern Institute for Brain Research at MIT and the Centre for Vision Research at York University.

COREY BARON

Corey's focus is on developing multidimensional imaging biomarkers for ultra-high field MRI, and using them to learn more about the brain.

In essence, this work endeavours to allow a completely non-invasive virtual microscopy of tissue inside the brain. Corey has a PhD in Biomedical Engineering from the University of Alberta and completed a postdoctoral fellowship at Stanford University before joining Western's Department of Medical Imaging. Corey was recently awarded Tier 2 Canada Research Chair in Diffusion Magnetic Resonance Imaging.

LYLE MULLER

Lyle's research centres on developing new approaches to analyze and model large-scale recordings of neural population dynamics in cortex.

After studying computational neuroscience at Brown University, Lyle completed a PhD in computational and theoretical neuroscience with Alain Destexhe (CNRS Gif-sur-Yvette). He then moved to San Diego for postdoctoral research with Terry Sejnowski in the Computational Neurobiology Laboratory (CNL) at the Salk Institute. In 2019, he started a research group in computational neuroscience at Western University in the Department of Applied Mathematics.

BrainsCAN STAFF

The following five individuals are just a snapshot of the exceptional staff with specific expertise that are essential to our success. Investment in staff support includes 44 technical staff members supporting key research facilities as well as a forward-thinking administrative team who lead our important initiatives including equity, diversity and inclusion; impact, outreach and communications.

TAYLOR SCHMITZ

Taylor's research focuses on developing an integrated understanding of the organization, function and age-related vulnerability of the cholinergic system. He is examining such questions as 'how and why are certain cholinergic neurons selectively vulnerable to neurodegenerative diseases of aging, such as Alzheimer's?' and 'how can we better treat cholinergic dysfunction with personalized lifestyle and pharmacological intervention?'.

Taylor was recruited to Western's Department of Physiology and Pharmacology from the University of Cambridge's Medical Research Council Cognition and Brain Sciences Unit.

ALI KHAN

Ali's research focuses on the development of intelligent image processing and analysis technologies, and their application in the diagnosis and treatment of neurological disorders. This multidisciplinary research program spans across several domains, with applications in epilepsy, cancer, cardiovascular disease and neuroscience.

Ali is Assistant Professor in the Department of Medical Biophysics and Medical Imaging at Western University and recently was awarded a Tier 2 Canada Research Chair in Computational Neuroimaging.

MIGUEL SKIRZEWSKI PRIETO

RESEARCH ASSOCIATE, RODENT COGNITION
RESEARCH AND INNOVATION CORE

Miguel's research aims to understand the cross-talk between cognitive and motivational network circuitry mechanisms in mouse models, and how its disruption underlies endophenotypes relevant to psychiatric disorders.

"This position at the RCRIC gives me access to state-of-the-art technology such as automated touchscreens, fibre photometry, miniscopes and optogenetics to answer fundamental questions about cognition and motivation."

LAURA GONZALEZ-LARA

COMMUNITY RESEARCH COORDINATOR,
HUMAN COGNITION AND SENSORIMOTOR
RESEARCH AND INNOVATION CORE

Laura manages OurBrainsCAN, Western University's Cognitive Neuroscience Research Registry, to facilitate recruitment of research participants. Laura also builds relationships and facilitates collaborations with community partners for outreach events.

"My goal is to increase Western's research profile in the community and reduce barriers to research for researchers and participants. This allows BrainsCAN's research to be more inclusive and generalizable, resulting in higher impact."

SUZANNE WITT

NEUROIMAGING ANALYST,
COMPUTATIONAL RESEARCH AND INNOVATION CORE

Suzanne facilitates other researchers' fMRI research. She works with researchers who have a vision and helps them figure out how to make that vision a practical reality.

"I feel it is important for all researchers, but especially more junior researchers and students, to have a safe, non-intimidating space in which to seek help. No question or problem is ever too basic. BrainsCAN is a fantastic group of people to work with, as everyone is curious about and interested in what others are doing and are always ready and willing to help each other out."

KYLE GILBERT

SENIOR RF ENGINEER, IMAGING RESEARCH
AND INNOVATION CORE; RESEARCH SCIENTIST AND
ADJUNCT RESEARCH PROFESSOR, DEPARTMENT OF
MEDICAL BIOPHYSICS

Kyle leads the hardware development team within IMGRIC. The team specializes in the design, fabrication and integration of hardware (primarily radiofrequency coils) for the IMGRIC MRI scanners.

"BrainsCAN has allowed us to reduce costs for our users, allowing us to pursue hardware projects that may not have otherwise been financially viable. It allows us to work with researchers and trainees to facilitate their projects in a more timely and cost-effective manner."

RYAN SALEWSKI

PROJECT MANAGER AND METRICS ANALYST,
BRAINSCAN SUPPORT TEAM

Ryan works with stakeholders to develop research programs and support mechanisms that align with their specific needs in the neuroscience research community. He also gathers and analyzes evidence of researchers' performance and productivity with quantifiable metrics that probe beyond just publications and citations.

"I strive to promote impact in all areas of work. The opportunity to use my background in neuroscience to work with world class researchers and help support their worthwhile research goals is what drew me to BrainsCAN."

RESEARCH FUNDING: ACCELERATOR INTERNAL GRANTING PROGRAM

BrainsCAN funding programs are designed to push the limits of cognitive neuroscience and transform its landscape by supporting interdisciplinary research programs that could not be funded through traditional channels. Our granting climate fosters transformative research with the potential to produce a major impact on important problems in cognitive neuroscience.

Detecting fine-grained population codes in human prefrontal cortex

- **PI:**
  Marieke Mur
- **COLLABORATORS:**
  Julio Martinez-Trujillo, Ravi Menon, Joe Gati
- **ACCELERATOR GRANT:**
  $92,847

For a long time, neuroscientists have tried to explain the prefrontal cortex as a set of distinct brain regions, each specialized for a specific cognitive function. Unfortunately, this modular approach to brain function hasn't been very successful in understanding cognition. Mounting evidence is suggesting an alternative view: we can better understand the prefrontal cortex as a population of neurons with diverse functions which together can flexibly code a wide variety of functions. This ability is key to cognitive flexibility because it allows the same population of neurons to represent different situations at any given moment. The interdisciplinary and inter-institutional team combines neuroimaging expertise with advanced computational approaches to unlock how neurons in the prefrontal cortex work together to support cognitive flexibility. This project directly fits BrainsCAN's high risk / high reward funding model as it combines an alternative view of executive function with a novel imaging approach to create a new standardized mapping tool that will be essential for understanding how the brain supports higher order cognition, and ultimately, for treating dysfunctions of cognitive flexibility in the clinic.

Development of virtual gaming environments for FMRI

- **PI:**
  Jody Culham
- **COLLABORATORS:**
  Ingrid Johnsrude, Julio Martinez-Trujillo
- **ACCELERATOR GRANT:**
  $89,854

Researchers in neuroscience and psychology typically investigate the human brain using simple images and tasks. Creating more realistic tasks within the constraints of imaging equipment is very challenging and difficult to control. New technologies such as video game platforms and 3D projectors offer an exciting opportunity to enable researchers to develop immersive, fluid and naturalistic environments, even inside a brain scanner, to unlock a broader range of natural brain functions. This funding brought together BrainsCAN researchers with a Canadian technology company to address the fundamental challenges in this approach thereby providing the foundation for Jody Culham's successful New Frontiers in Research Fund Exploration grant entitled "Naturalistic Cognitive Neuroscience Through Immersive Virtual Games", that will ensure the full realization of this paradigm shifting technology.

Relating functional and structural signatures of Parkinson's disease to changes in dopamine signalling: A PET/fMRI study

- **PI:**
  Penny MacDonald
- **COLLABORATORS:**
  Udunna Anazodo, Justin Hicks, Alain Dagher, Frank Prato
- **ACCELERATOR GRANT:**
  $98,500

Cognitive impairments in early Parkinson's disease (PD) are known to be linked to complex changes in the neurotransmitter dopamine. Dopamine-replacement therapy (DRT) produces improvements in certain cognitive functions, but unfortunately it also produces impairments in others. A current theory for this effect is because the degeneration of dopamine-producing neurons is not at the same rate throughout the brain, DRT is successfully addressing a deficit in one region but effectively over-dosing other regions that are not yet affected by PD. This project brings together clinical and basic scientists at Western, the Lawson Health Research Institute and McGill University to visualize dopamine activity in the brain using positron emission tomography (PET). Given the novel nature of this approach in PD models, BrainsCAN funding was absolutely required to tackle this high-risk and critical milestone. This research has the potential to drastically change the way PD is treated, and will lead to more effective and targeted treatments for the millions of people affected this disease.

Development of a novel pharmaceutical to prevent hearing loss and cognitive impairment following loud noise exposure

- **PI**:
  Brian Allman
- **COLLABORATORS:**
  Paul Walton, Shawn Whitehead, Elena Batrakova, Brian Shilton, Stan Leung, Patti Kiser
- **ACCELERATOR GRANT:**
  $112,560

Accelerator funding is being used to support the development of a novel drug to prevent hearing loss and cognitive impairment following loud noise exposure. This research team to developing the world's first catalase-based (anti-oxidative stress) pharmaceutical to limit damage to vulnerable sensory hair cells in the cochlea in the hours/days post- noise exposure. BrainsCAN funding was initially used to show that the therapeutic effectively crossed the blood brain barrier, entered the target cells and mitigated oxidative stress. Additional BrainsCAN funds have been secured to further develop this pharmaceutical approach that will have the potential to transform the way the field approaches mitigating the damaging effects of noise exposure on the inner ear and brain. With the ultimate goal of translating this research, the team will work with Western's experts in industrial commercialization to establish partnerships with pharmaceutical companies to move towards testing the therapeutic in other animal models and clinical populations.

BrainsCAN RESEARCHER SUPPORT LEVERAGED IN INTERNATIONAL NETWORKS

NeuroNex: Working Memory & Mental Representations

16 RESEARCH GROUPS - $10M

WESTERN RESEARCHERS:
Lyle Muller, Julio Martinez-Trujillo, Stefan Everling, Wataru Inoue

How does the brain generate mental representations that are the foundation of abstract thought?

Researchers at NeuroNex, an international consortium that takes an interdisciplinary approach to neuroscience's greatest questions, are working to understand this.

Mental representations that are independent of sensory input and the execution of motor output are a step up in brain evolution: they exist in a virtual space, so that the brain can use information acquired in the past to solve complex problems, simulate situations, and predict future outcomes without the need to invest energy in motor actions.

The team of researchers, including four Western neuroscientists, is studying the mechanisms underlying working memory using a combination of electrophysiology, immunoelectron microscopy, transcriptomics, and mathematical modeling. Working memory representations may hold the key to human intelligence and evolutionary success, as well as to understanding

A New Approach to Study How The Brain Controls Behaviour

8 RESEARCH GROUPS - $3.4M

WESTERN RESEARCHER:
Andrew Pruszynski

Recently, a great deal of progress in systems and cognitive neuroscience has come from various technologies that interrogate hundreds to thousands of neurons in the central nervous system simultaneously during behaviour using electrophysiology or fluorescence imaging.

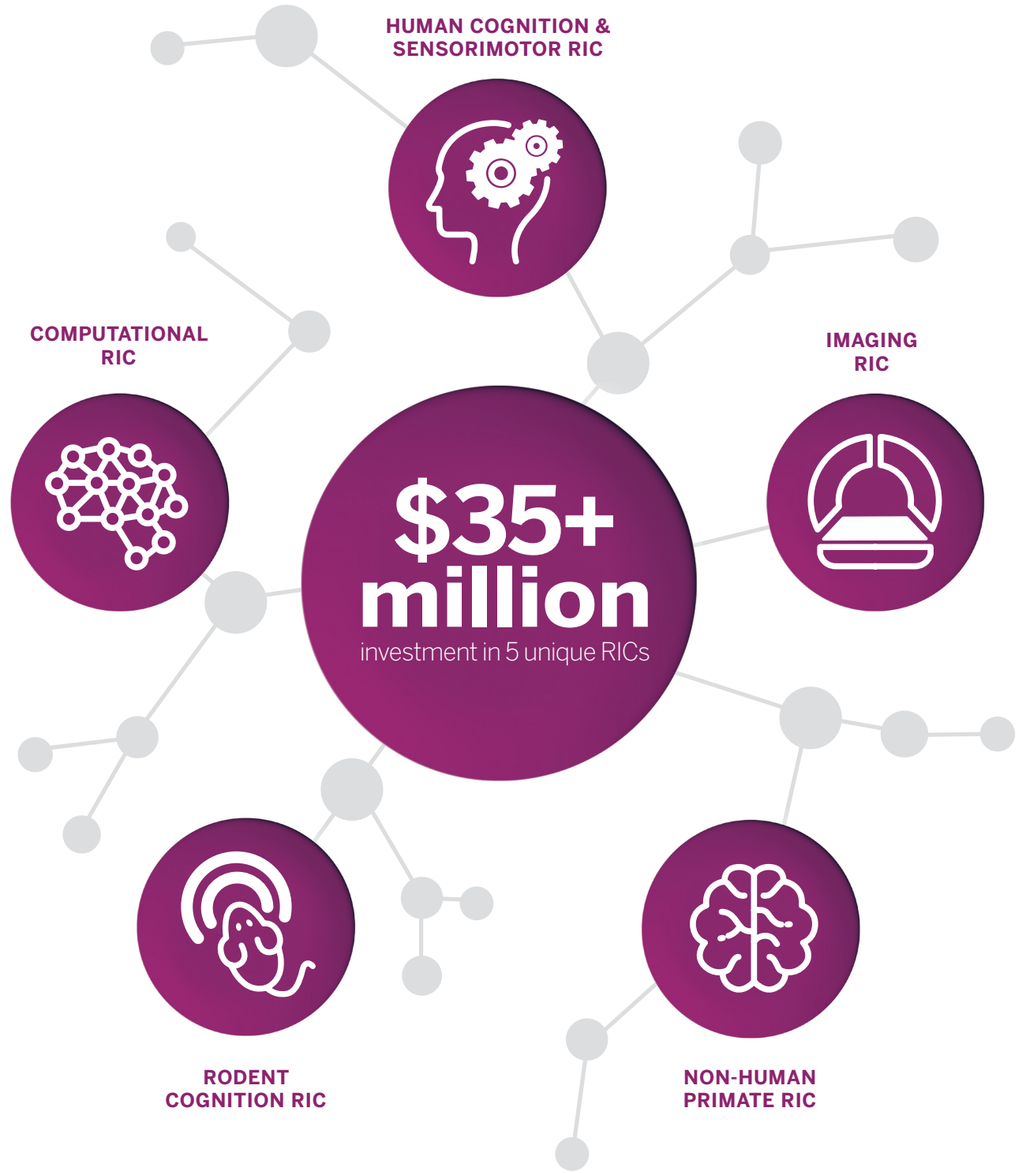
However, there has been little progress in understanding how the neurons that ultimately generate all behaviour – the motor units that contract muscles – work together at the population level.

Researchers at NeuroNex, a $10M grant consortium of researchers in the United States, Canada, and Germany that takes an interdisciplinary approach to neuroscience's greatest questions, are working to understand this.

The lasting impact of this work will be twofold. First, combining and comparing the labs' results will allow the researchers to answer entirely new questions about motor control strategies across taxa, revealing general principles of motor control. Second, the work will create tools that can be used to study motor control in many

Developing technologies and reducing barriers to access.

RESEARCH AND INNOVATION CORES



403

CORE SUPPORTED PROJECTS ENGAGING...

135

FACULTY MEMBERS

8

FACULTIES

35

DEPARTMENTS

544

GRADUATE AND POSTDOCTORAL STUDENTS

114

EXTERNAL COLLABORATORS

79

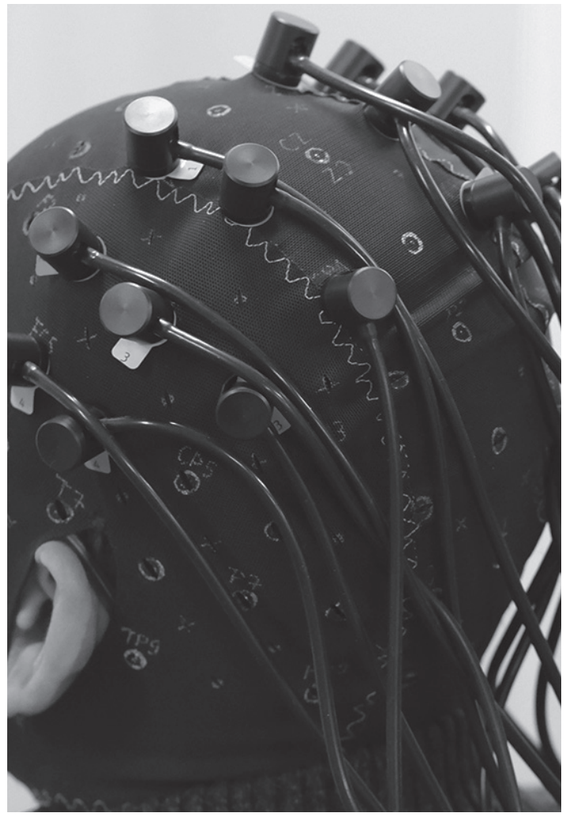
INSTITUTES IN... 17 COUNTRIES

BRAINSCAN SUPPORTS FIVE RESEARCH AND INNOVATION CORES that span the breadth of cognitive neuroscience research at Western. The RICs support research in preclinical animal models and humans, incorporating (and often developing) numerous innovative technologies for observing and manipulating the brain during rigorous assessment of cognition and behaviour. CFREF operating funds leverage existing investments in infrastructure by Western University, and individual researchers (through grants from CFI, NSERC, donors etc.), to provide stable, reduced-rate access to these neuroscience core facilities. This access is supported by 44 BrainsCAN-funded technical staff. Through these approaches, the financial and technical barriers to usage often associated with sophisticated methods is lowered. This engages a larger community of researchers who have not previously had access to such methods, enabling them to address new questions and increase their potential impact.

Uniquely, several of our BrainsCAN RICs are international leaders in the development of cutting-edge neuroscience-related methods and technology. Thus, in addition to providing access to the cores, CFREF funding supports the large development teams with diverse expertise that are essential for such technological innovation, including translating those developments to be broadly accessible. In this manner, BrainsCAN advances the state-of-the-art in areas of strength at Western, and enables sharing these advances with the international community in an open science framework. This type of technological innovation is challenging to support via conventional project funding mechanisms, and reflects the considerable added value that the CFREF program provides to the Canadian scientific community.

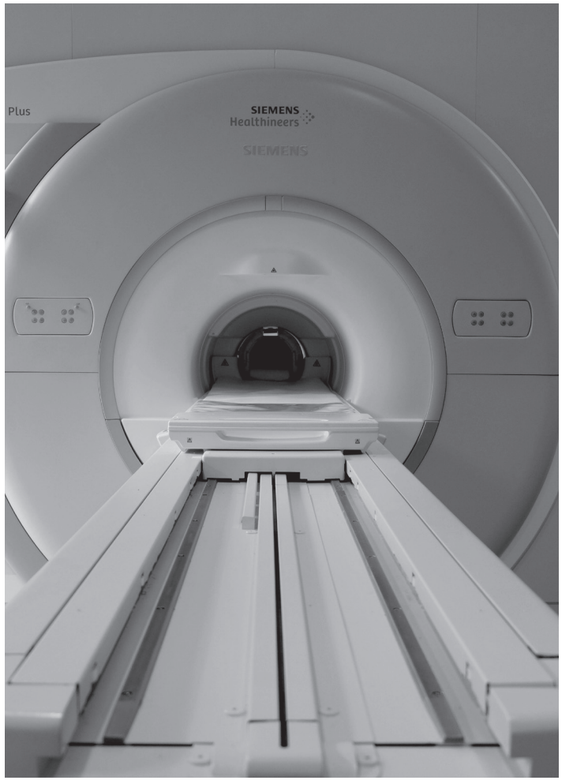
COMPUTATIONAL

Behavioural, imaging and electrophysiological data sets are becoming larger and more complex. Progress in understanding the brain will depend crucially on developing theories that are formulated in a mathematical, quantitative language. The COMPRIC develops such methods and reduces the barriers to apply computational tools for the cognitive neuroscience community at Western via educational resources, personnel (including Neuroimaging Analyst, Research Software Engineer and Hardware/Software Engineer), data analysis pipelines (AutoBIDS, fMRIprep, AnalysisWiki) and a central storage and computing server. The Virtual Augmentation and Simulation for Surgery and Therapy (VASST) laboratory provides further staff support for neuroscience researchers engaged in image-guided surgery and the development and validation of computational tools to be used for planning and carrying out neurosurgical procedures.



HUMAN COGNITION & SENSORIMOTOR

The HCSRIC provides state-of-the-art equipment and resources for measuring cognitive abilities, emotional and social behaviour, psychophysics, and sensorimotor performance in neurotypical and neurologically-impaired humans throughout the lifespan. In addition to equipment, HCSRIC provides access to staff with expertise in computer programming, data analysis, design and fabrication of specialized equipment, recruitment of participants, including from special populations, and the development of databases.

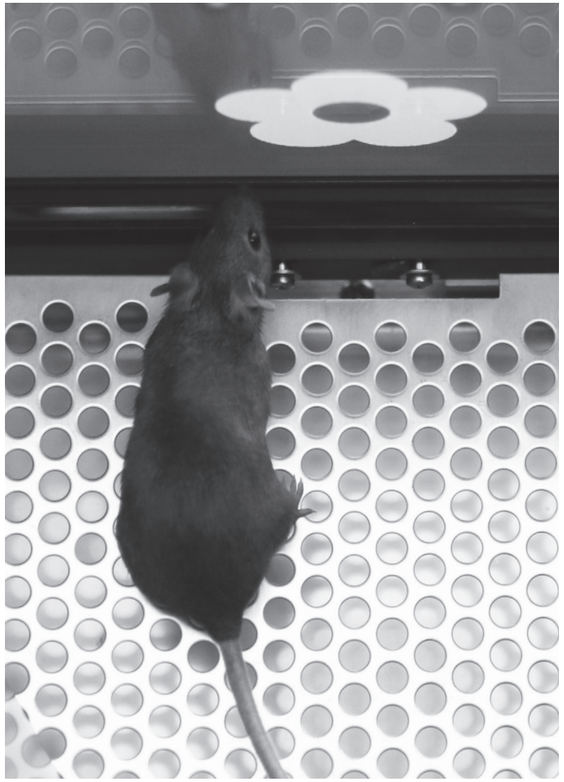


IMAGING

Non-invasive neuroimaging is an essential technique for observing brain function that can be used across species, from mouse models to humans. Western is a world leader in this area, and continues to drive major technological developments including innovative RF coils, scanning protocols and analysis pipelines. CFREF support of the IMGRIC has allowed users to accrue more subjects to make statistically stronger conclusions, encouraged researchers whose traditional funding streams (e.g. NSERC and SSHRC) weren't substantial enough to pursue neuroimaging, and have enabled new researchers without imaging expertise to take the plunge.

NON-HUMAN PRIMATE

NHP RIC focuses on research that employs behavioural and neurophysiological methods, including investigations of neurovascular coupling and the neurophysiological basis of resting state networks using MRI, neuroplasticity following sensory augmentation or deprivation, reversible lesions using cooling and chemical intervention, network effects of forms of brain stimulation, and fine-grained representation of sensory information, motor control and cognition at the single-neuron level. This work is supported by 15 state-of-the-art neurophysiological rigs dedicated to NHP work alone, featuring any number of technical customizations including virtual-reality environments, robotic manipulandums, high-channel count acquisition, two-photon microscopy, microneurography, comprehensive assessments of movement, and neuromodulatory, inactivation and brain stimulation approaches including iontophoresis of isolated neurons, optogenetics, microstimulation, cryogenic inactivation and TMS.



RODENT COGNITION

The huge advances made in understanding the fundamental neurobiology of the brain using mouse models have not translated to success in the clinic. One reason for this is that assessment of cognition in animal models is rarely done in a way that is directly relevant to humans. The RCRIC focuses on developing and providing access to rigorous and human-relevant cognitive assays for mice, including a touchscreen-based system we developed that allows us to assess mice on tests of high-level cognition that are identical to those used in human patients. The RCRIC pairs these tests with cutting-edge technologies to record or manipulate neuronal, glial or neurochemical activity, which makes it possible to match—millisecond by millisecond—what is happening in the brain with human-relevant cognitive performance. This can be done in healthy mice or in our extensive catalogue of next-generation disease models, making the RCRIC a state-of-the-art platform for assessment of robust, reproducible and human-relevant cognitive outcomes in mouse models, for either fundamental discovery research or development of knowledge-based therapeutic interventions.

CASE STUDY

A paper published in Nature Methods by BrainsCAN researchers in collaboration with neuroscientists at Peking University embodies how scientists are helping each other in the most atypical year. The work reports a significant improvement in a methodology to detect acetylcholine – a neurotransmitter that is reduced in dementia – in freely behaving mice. The researchers used a mouse model generated by the RCRIC to demonstrate that the new methodology works well to measure the neurotransmitter. The method will help advance our understanding of acetylcholine's role in dementia and will bring scientists another step closer to developing more accurate treatments.

The pandemic presented a unique opportunity for this important collaboration. In late January 2020, the manuscript reporting these findings came back from review requesting additional experiments. At the same time, China went into lockdown – interfering with lab access at Peking University. That's when researchers at Western were able to step in and conduct key experiments for the manuscript. The Western team used mice that lack a critical gene in the brain, modelling some of the changes observed in Alzheimer's disease, and showed that the brain cells of the mice did not secrete acetylcholine efficiently. The mice also show impairments in memory and attention, reminiscent of the symptoms of Alzheimer's disease.

COVID-19 has made 2020 a year like no other. Nonetheless, through all the noise, researchers on opposite sides of the world helped each other to advance research tools and generate new knowledge for a disease that affects almost 1 million Canadians.

Training the next generation of neuroscientists.

PROGRAMS

Postdoctoral Fellowship Program

Our Postdoctoral Fellowship (PDF) Program funds two levels of trainees:

- Tier I PDFs have considerable postdoctoral experience and the goal is to develop them to be competitive for their first independent position, whether in academia, industry or the non-profit/ government sector.
- Tier II Fellows are more junior; generally no more than two years from their PhD.

A unique aspect of our PDF Program is that fellows are required to work across at least two different labs to gain the range of skills that are essential for inherently interdisciplinary subjects such as neuroscience. To promote their independence, BrainsCAN PDFs receive their own research stipends, and are eligible to apply for our PDF Collaborative Research Grants, which provide additional funds for teams of at least two PDFs from different labs to pursue a novel research direction.

Graduate Studentship and Medical Innovation Fellowship Programs

BrainsCAN is bringing aspiring cognitive neuroscientists to Western University through the Graduate Studentship Program. The program supports master's and PhD students with outstanding potential, who get an immersive, intensive research experience. To promote interdisciplinary training, students have two supervisors in different labs.

The Medical Innovation Fellowship (MIF) Program is a first-of-its-kind program in Canada that immerses highly talented young scientists, engineers, and clinicians in a training and research heavy environment with the goal of developing future leaders and innovators of world-class medical technologies.

The MIF Program provides opportunities for trainees to develop leadership through interdisciplinary experience and runs in partnership with Western's BrainsCAN, WORLDiscoveries and University of Minnesota's Medical Devices Center Innovation Fellows Program. *(Read more about the MIF Program on page 41).*

18
TIER 1 FELLOWSHIPS AWARDED

COMPLETED BrainsCAN TRAINING **10**

7
ACCEPTED ACADEMIC POSITIONS AT WORLD-LEADING INSTITUTIONS

2
TIER II PDFs ACCEPTED FACULTY POSITIONS IN ALBERTA

OVER FIVE RECRUITMENT CYCLES, THIS PROGRAM HAS RECEIVED

120
APPLICATIONS FROM AROUND THE WORLD

$40,000
28 PER CENT (11 OF 39) OF BrainsCAN PDF AWARD HOLDERS CONCURRENTLY SECURED EXTERNAL FUNDING GREATER THAN $40,000, INCLUDING TWO BANTING AWARDS.

BRAIN BASIS OF OBESITY

A review in Trends in Cognitive Sciences, authored by BrainsCAN PDFs Cassandra Lowe and Amy Reichelt, suggested a reciprocal relationship between obesity and self-control.

Focusing on how obesity and prefrontal activity are related, how this relationship affects our brain, and how it can ultimately allow us to exert control and make better dietary choices will be key in thwarting the obesity epidemic.

This work received considerable media attention, including The Globe and Mail, CTV news, The Sydney Morning Herald, Medical News Today, Today's Farmer and Knowridge Science Report. Reichelt's related article for the general public in The Conversation—"Your brain on sugar: What the science actually says"—is Western's 2nd most-read article with 317k reads, and has been translated into French, Spanish, Malay and Indonesian.

PROGRAMS

MD/PhD Program

BrainsCAN supports Western's MD/PhD program by funding exceptional candidates with a declared project in neuroscience, to support training of clinician scientists who will help translate fundamental research to the clinic.

Shahnaza Hamidullah
MD/PhD Student

While conducting their MSc project, Shahnaza gained an appreciation towards efforts to bridge the gap between preclinical and clinical research while addressing questions such as 'how is cannabis used by humans and how is cannabis constituents administered in animals models?' and 'what are the most common patterns of cannabis use among adolescents that can put them at risk for adverse neurobiological consequences in adulthood?'. This was Shahnaza's motivation to pursue an MD/PhD degree.

"I'm excited to dive further into improving translation of animal research into the clinic under the supervision of Dr. Lisa Saksida and Dr. Tim Bussey in the Translational Cognitive Neuroscience Lab.

I chose Western University as it is home to world renowned researchers across many disciplines who I can learn from and collaborate with to transform my research experience, with the ultimate goal of enhancing our understanding the brain."

- SHAHNAZA HAMIDULLAH

BRAINHACK WESTERN

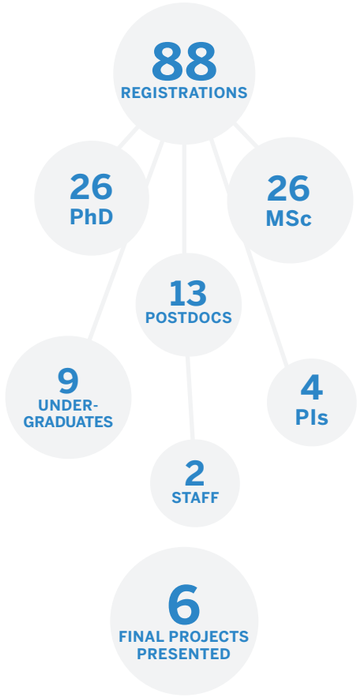
BrainHack Western is supported by the Computational Core. The event was held in the context of the global BrainHack – in the first round of the event in 2017, Western's event was the largest in Canada that year. The 2019 BrainHack was successfully held from November 13 – November 15, 2019. The Program was:

November 13: Project pitches and introductory imaging and analysis tutorials

November 14: Deep learning and Diffusion Tensor Imaging

November 15: fNIRS and Hackathon

We had 88 registrations: 26 PhD, 26 MSc, 13 postdocs, 4 PIs, 2 staff and 9 undergraduates. We had 6 final projects to present at the end of the event. All of our course days were well attended and are shared on Youtube for anyone who is interested in learning from them. We also co-hosted a talk on deep learning by Blake Richards during the hackathon. We were additionally able to provide travel awards to support the attendance of 10 non-Western participants. For more information and images from the even, see: https://brainhackwestern.github.io.



NEUROSCIENCE RESEARCH DAY

The annual Neuroscience Research Day (NRD) was developed to build community by creating a singular event to bring all Western Neuroscience researchers together with 250 HQP and faculty attendees.

BRAIN BEE

The London Brain Bee is an annual neuroscience outreach program in partnership with BrainsCAN for students in grades 9-12 from London and surrounding areas.

The aim of this daylong event is to motivate high school students to learn about the brain and inform them about the role of neuroscience in research and medicine. The day is comprised of a trivia event, mock diagnoses, neuroscience demonstrations and an anatomy scavenger hunt. In 2019, 36 students from 12 high schools attended the event.

RIKEN SUMMER SCHOOL

BrainsCAN's relationship with RIKEN CBS in Tokyo, Japan, one of the highest-ranked research centres in the world, led to BrainsCAN Postdoctoral Fellows Amy Reichelt and Kaitlin Laidlaw attending their Summer School to learn from world-renowned neuroscientists.

Reichelt and Laidlaw were joined by 45 early-career researchers from 13 countries to take part in the prestigious, highly selective program designed to accelerate the professional development of early-career neuroscientists and emerging researchers as they enter the international neuroscience community.

For Reichelt and Laidlaw, it was a chance to learn about leading-edge brain research currently taking place in top research labs at RIKEN CBS and around the world.

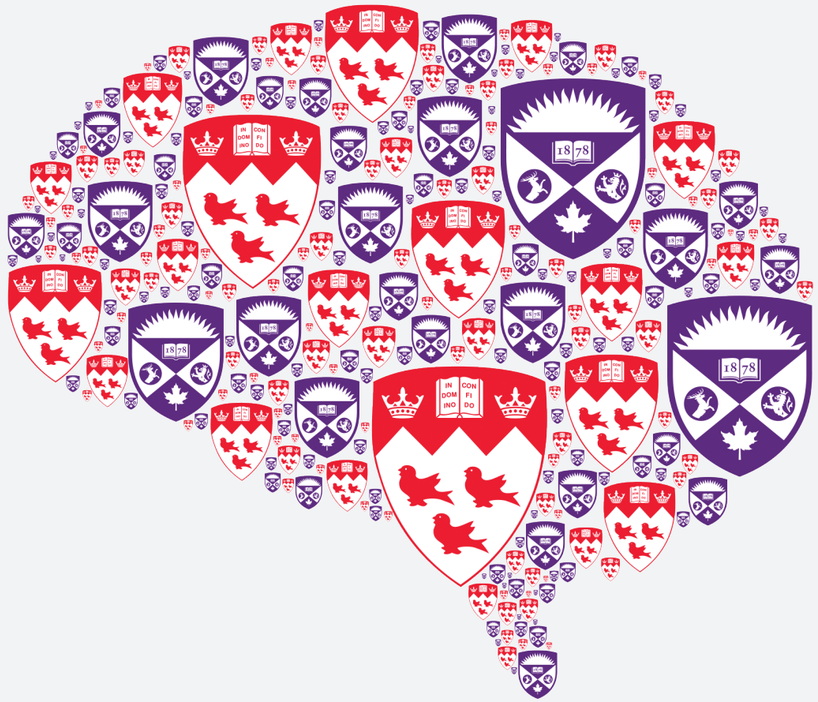
"We learned about research that looks at biomarkers of mental illness, particularly in schizophrenia.

It was inspiring to hear about the ways in which basic research was being translated in ways that could potentially help predict clinical outcomes."

- KAITLIN LAIDLAW

Building community.

McGILL-WESTERN COLLABORATION

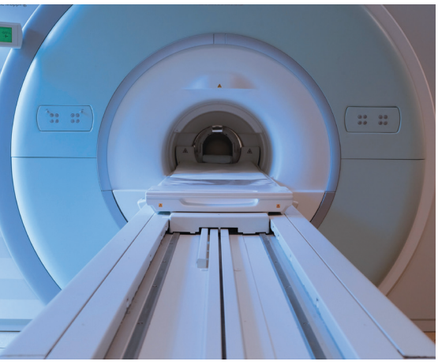


HEALTHY BRAINS, HEALTHY LIVES (HBHL; McGill) and **BrainsCAN** (Western) have a shared vision, focused on fundamental neuroscience research that will lead to urgently needed diagnostic approaches, interventions, and treatments for brain and mental health disorders.

Both institutions have vibrant preclinical neuroscience programs using sophisticated animal models and complementary expertise in clinical neurosciences and psychiatry. The partnership takes this strong foundation to the next level by synergizing the complementary, world-leading strengths of each institution: neuroscience and big data neuroinformatics at McGill and translational cognitive and neuroimaging assessments at Western.

In addition to making impactful research contributions, a major goal is to use this partnership to create an extensible collaborative platform that could serve as the framework for a pan-Canadian neuroscience research consortium. Such a consortium would elevate individual institutional strengths to more effectively address the challenges and complexities of brain health, and would significantly enhance Canada's international leadership in the area.

Joint activities include interdisciplinary, cross-institution strategic research projects and technical collaborations around the development of tools and other critical contributors to cutting-edge research that are difficult to achieve with standard, project-based funding. Embedded throughout is a strong emphasis on open science. These initiatives are supported by mechanisms to facilitate interaction, including joint workshops/annual symposia, as well as joint graduate and PDF training.



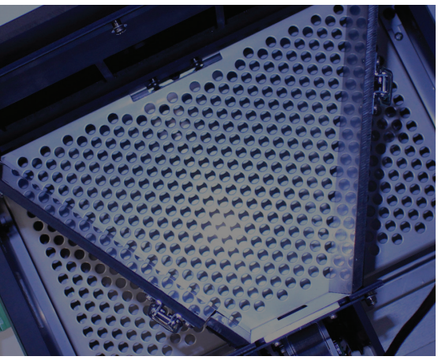
NEUROIMAGING

Non-invasive brain imaging is
a powerful tool for establishing structure-function relationships in humans and in animal models of health and disease.

CFREF funding to the IMGRIC at BrainsCAN is supporting the construction of the world's first spine radiofrequency coil for fMRI and DTI at 7T in partnership with the CFI. This RF coil is not available as a commercial product and is a collaboration between Western, Harvard/MGH, MIT, École Polytechnique and McGill, and will operate on the 7T scanner
at McGill.

CFREF funds allow McGill and Western to participate in this international initiative, leveraging strengths in MRI hardware design at Western and expertise in spinal cord function at McGill. CFREF is also supporting the creation and curation of open repositories with 3D-printing files for mouse, rat and marmoset MRI, developed at Western, to enable
open access for researchers around the world.

Our synergy in transgenic models (McGill) and MRI/electrophysiology (Western) of marmosets has led to the submission of an exciting NFRF proposal to use marmosets as a social development model, led by Dr. Guy Rouleau at McGill, and NHP and imaging researchers at Western.



CIRCUITS TO COGNITION (C2C)

C2C is an exciting BrainsCAN-HBHL partnership aimed at illuminating neural mechanisms of cognition and accelerating translational research. Western's Mouse Translational Research Accelerator Platform (MouseTRAP) and McGill's Mouse-Miniscope (M3) Platform are complementary platforms that integrate touchscreen-based cognitive assessment in mice – using tests identical to those used in human patients – with state-of-the-art neurotechnology to record and manipulate molecular and circuit-level activity in vivo in mouse models.

Each site focuses on their unique strengths: at Western, the focus is on molecular and neurochemical changes, whereas McGill focuses on neuronal population dynamics, with a common backbone of rigorous, human-relevant, touchscreen-based cognitive assessment.

C2C also emphasizes knowledge and data-sharing practices to create an epistemic community of scientists who share common methodology and are united in the goals of increasing methodological transparency and improving the reliability and reproducibility of research findings.

McGILL-WESTERN COLLABORATION GRANT

Integrating behavioural, imaging and transcriptional profiling to discover the impact of midlife stress in Alzheimer's disease

PIs:
Tim Bussey (Western),
Mallar Chakravarty (McGill)

PROJECT TEAM:
Rosemary Bagot, Claudia Kleinman, Sylvain Williams (McGill); Flavio Beraldo (Western)

FUNDING RECEIVED:
BrainsCAN: $135,700
HBHL: $422,200

Western has developed novel translational tools and approaches that enable sensitive and robust measurement of cognition, brain structure and function that are directly comparable across species and can be used to discover new therapeutic targets.

This project integrates this cognitive assessment with imaging of brain structure and function to understand the mechanisms by which a risk factor, in this case modifiable life stress, influences Alzheimer's disease-related decline. The resultant data will be integrated and disseminated using the open-access neuroinformatics platform developed at Western (MouseBytes.ca), which will become a unique resource for open science investigations and set the standard for sharing of behavioural data across the world.

It is bringing together broad, complementary expertise at the two institutions to extend our understanding of this brain disorder, supporting a comprehensive, interdisciplinary approach to the research that would not be possible in any single lab.

CIFAR

Adrian Owen and Mel Goodale co-founded the CIFAR-funded Brain, Mind & Consciousness Program, and Lisa Saksida is a Fellow. This Western-led program is one of only three international CIFAR programs focusing on the brain and CIFAR is exploring ways to use these programs as building blocks for a larger, nationwide brain initiative that would promote research alliances without institutional, disciplinary or geographic borders.

THE ONTARIO NEUROINFORMATICS CONSORTIUM (ONiC)

The Ontario Neuroinformatics Consortium (ONiC) is a regional alliance focused on developing and promoting neuroinformatics initiatives for Ontario scientists.

The group consists of the Rotman Research Institute at Baycrest, the Krembil Centre for Neuroinformatics at CAMH, BrainsCAN at Western University, and the Ontario Brain Institute. ONiC works in tandem with other national partners in the Canadian Open Neuroscience Platform to coordinate national efforts in support of INCF's mandate.

The International Neuroinformatics Coordinating Facility (INCF) serves as a standards organization dedicated to open and FAIR neuroscience by vetting, endorsing, and promoting the use of community standards and best practices. Special Interest Groups and Working Groups, users and developers work collaboratively to implement these standards and practices in tools and resources.

Ali Khan represents BrainsCAN on the INCF Council for Training and Infrastructure.

Baycrest

camh
mental health is health

ONTARIO BRAIN INSTITUTE

Western UNIVERSITY · CANADA

INTERNATIONAL PARTNERSHIPS

BrainsCAN researchers attract collaborators across Canada and the world. Beyond direct engagement at the project level, we foster national and international collaborative research excellence through our formal partnerships. These partnerships have been pursued strategically, focusing on world-leading institutes that have complementary expertise with the potential to support synergistic outcomes in neuroscience research.

159

global collaborators engaged in BrainsCAN-supported research

FROM

79

institutes

LOCATED IN

17

countries

Cardiff University

Cardiff University is the only Welsh member of the Russell Group of research-intensive British universities and a powerhouse in cognitive neuroscience and neuroimaging. This partnership is funded by the Welsh Government Ser Cymru program totalling $68k, match funded by BrainsCAN. Our researchers are working closely with Cardiff researchers to share expertise and resources. A formal PDF exchange program, the Transatlantic Exchange for Neuroscience Discovery (TEND), generates significant links between the two institutions to increase understanding in neuroscience and brain disease.

The Florey Institute of Neuroscience and Mental Health

The Florey Institute of Neuroscience and Mental Health, Melbourne, Australia, is the largest brain research centre in the southern hemisphere, with expertise in various brain disorders including stroke, epilepsy, Alzheimer's disease, autism spectrum disorder, schizophrenia and addiction. The partnership between BrainsCAN and the Florey Institute officially began in March 2020 to enable principal investigators, postdoctoral fellows and graduate students from Western and the Florey Institute to have increased access to the training opportunities and institutional resources available at both locations.

UK Dementia Research Institute

The major goal of the £290M UK DRI initiative is to develop new technologies and treatments for dementia. The UK DRI has a preferential partnership with BrainsCAN to investigate cognitive function and dysfunction in mouse models of neurodegenerative diseases. UK DRI recommend that their investigators interested in using touchscreen technology for mouse phenotyping work directly in our Rodent Cognition Research and Innovation Core facilities or in collaboration with BrainsCAN researchers. All UK DRI datasets obtained with touchscreen technology will be deposited in MouseBytes, and a UK DRI database for mouse phenotyping will link to MouseBytes.

RIKEN Center for Brain Science

RIKEN CBS is one of the most prestigious neuroscience research institutes in Japan. This partnership facilitates joint lectures, seminars and symposia and projects. BrainsCAN's postdoctoral and doctoral students also benefit through participation in the RIKEN CBS Summer Program, designed to accelerate the professional development of early-career neuroscientists.

Yonsei University

Yonsei University is one of Korea's three SKY universities, a group of universities widely regarded as the most prestigious in the country. The partnership with Yonsei broadens BrainsCAN's ability to offer a collaborative, world-class, international research environment for neuroscience researchers. In addition to training opportunities, researchers from the two institutions work together on joint collaborative research projects and benefit from increased access to scientific and technological information, and institutional resources.

Redefining research culture.

Current practices prioritize grant income and publications as the major metrics of success. However, we believe that focusing solely on these outcomes misses the opportunity to create impact and engagement with the population that our research strives to help. For BrainsCAN to lead on the development of research impact and culture, we challenged ourselves to redefine what is research success, who accesses our research, how we share data and, possibly most importantly, the diversity in the environment where research takes place. Key actions to change research culture are described in the Declaration on Research Assessment (DORA) framework formally endorsed by Western University and BrainsCAN. This framework will guide BrainsCAN's assessment of success as our research investment matures during the remainder of the term.

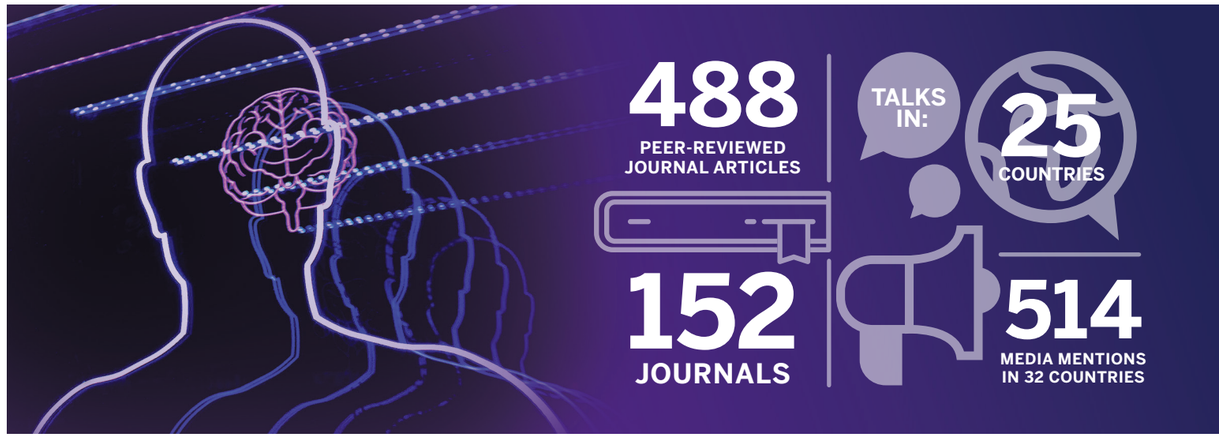
KNOWLEDGE MOBILIZATION AND IMPACT

To reach our full potential we will need to go beyond traditional ways of tracking success.

To date, BrainsCAN has supported 488 peer-reviewed journal articles that have been cited 2,166 times. BrainsCAN supported research has appeared in 152 journals including Nature Neuroscience, Neuron, Nature Communications, Brain, Annals of Neurology, JAMA Neurology, Current Biology and Brain. However, we consider this to be only the first step in realizing our impact.

We use global reach both within and outside of academia as a key measure of success. BrainsCAN has over 800 Knowledge Dissemination activities—including conference abstracts, oral presentations, keynote/platform talks, general audience talks, invited talks and community engagement—which have occurred in 25 countries. We also use Altmetrics to provide leading measures of global reach.

BrainsCAN publications have garnered 10,935 unique attention points from traditional media, social media, and other online repositories. These include 10,135 Twitter mentions originating from 100 different countries, and 514 mentions in the news media from 32 countries, including The Globe and Mail, National Post, CBC News, Global News, Discover Magazine, New York Times, Daily Mail, Le Monde, and Sydney Morning Herald.



CAMBRIDGE BRAIN SCIENCES

In 2010, Adrian Owen launched cambridgebrainsciences.com, an online cognitive assessment platform that now has 1.2M users around the world and has hosted more than 300 academic and pharmaceutical trials (Owen et al., 2010; Hampshire et al., 2012).

Cambridge Brain Sciences (CBS) has two web-based platforms (to which Western has the exclusive license from the MRC) for the controlled assessment of cognitive function. One website (cambridgebrainsciences.com) allows members of the public anywhere in the world to evaluate and track their cognitive abilities using tests that have been developed and validated in Owen's lab over the last 25 years. Participants can track scores over time and compare their results against Western's repository containing over five million data sets.

The other web site (cbstrials.com) allows academic and commercial users (including Pfizer, Merck, Lilly and others) to design and implement custom cognitive trials using the same tests. Over 300 clinical and research trials in a variety of settings (from universities to major pharmaceutical companies) have been run on this platform over the last five years.

The BrainsCAN strategy is designed to translate careful lab measures validated through imaging and other approaches and deliver them to target audiences via the web. In addition, as a new functional taxonomy of disorders that affect brain function emerges through the BrainsCAN initiative, we will be in a position to devise novel and more effective tools for measuring cognitive performance in both humans and non-human species across the life span.

These include new testing paradigms for CBS Trials and the translational touchscreen test batteries developed by Lisa Saksida and Tim Bussey for cross-species studies of cognitive markers in neurodegenerative and neuropsychiatric diseases. Novel platforms for drug testing—the marriage of the appropriate animal model with the appropriate cognitive test(s)— will provide standardized, consistent and validated combinations of mouse models and human relevant cognitive assays to allow the rapid screening of compounds in vivo.

MEDICAL INNOVATION FELLOWSHIP

The Medical Innovation Fellowship (MIF) Program is a first-of-its-kind program in Canada that immerses highly talented young scientists, engineers, and clinicians in a training- and research-heavy environment with the goal of developing future leaders and innovators of world-class medical technologies. The MIF Program provides opportunities for trainees to develop leadership through interdisciplinary experience and runs in partnership with Western's BrainsCAN, WORLDiscoveries and University of Minnesota's Medical Devices Center Innovation Fellows Program. The MIF Program has recruited 11 fellows from institutions such as McGill and Manitoba, with strong backgrounds in neuro-related fields prioritized.

The impact of the program within its first four years includes certificates of completion for 20 subsequently highly qualified and trained individuals. Fellows have gone on to obtain employment with industry, Ontario research institutes, research centres and have obtained their first choice of residency program within Canada.

NEUROREHABILITATION TECHNOLOGY

Approximately 4.5 million North Americans use a walker to help their mobility, but unfortunately, falls while using one are not uncommon and result in over $330M in health-care costs per year.

That's why Wagner Souza, a BrainsCAN Medical Innovation Fellow, developed a walker that has been patented and led to a spin-off company, Thalamus Assistive Technologies.

Souza's experience as a patient with very limited mobility combined with his expertise as a Harvard-trained physiotherapist and a McGill neuroscience PhD recipient, fuelled his desire to fill the gaps he saw in medical devices to provide tools and knowledge in a clinical setting to translate the solution into reality. His smart walker has seen media exposure on CTV News.

"Giving people with limitations a better quality of life. That's the point. That is my ultimate goal."

- WAGNER SOUZA, MEDICAL INNOVATION FELLOW 2019-2020

CONCUSSION

Ultimately, our success will be directly measured against our ability to impact the lives of those affected by neurological disorders. To achieve this, we must show evidence that our research has reached the target populations.

CONCUSSION AND DEMENTIA

The US Department of Veteran's Affairs estimates that more than 750,000 veterans have Alzheimer's disease (AD) or other dementias. Multiple studies have shown that concussion increases the risk for the development of AD, yet we have limited understanding about the underlying mechanisms for the increased risk.

The Accelerator program enabled the development of a collaboration between Arthur Brown and colleagues in the RCRIC and IMGRIC to study the effects of concussion on cognition and imaging biomarkers, and how this relates to long term health effects such as dementia.

The unique concussion model developed led to significant findings that were used as preliminary work to support a successful $1.7M USD application to the US Department of Defence to study the relationship between the history of concussion and the development of dementia, which will have implications for veterans and others with high risk for concussion.

CONCUSSIONS AND RETURN TO PLAY

A series of studies by Kathryn Manning and BrainsCAN Co-Scientific Director, Ravi Menon, published in Neuroimage: Clinical and Neurology found that concussion causes clear changes in both structure and function of the brain and that the signal changes persist at least six months after an injury. Even smaller, subconcussive impacts produced cumulative damage over the several years of this study. In a collaboration with Christian Beckmann at Oxford University and the Donders Institute for Cognitive Neuroimaging, Manning and Menon developed an objective way to monitor an athletes' response to brain impacts that had not been shown before.

The studies showed that the simple cognitive measures used to assess concussion returned to normal long before the MRI signals did and this raises the question of whether athletes are being returned to play too soon. The studies also showed that simple cognitive tests do not detect any symptoms in those who receive multiple subconcussive hits. This work was cited in the decision by the UK youth soccer governing body to ban heading under the age of 10 and discourage it in practises for those below the age of 13.

HEARING LOSS

Hearing loss can lead to social isolation and depression, and is associated with progression toward dementia. Several BrainsCAN projects are directly related to more sophisticated hearing assistance approaches, which are badly needed. For example, a study published in Psychological Science by Emma Holmes and Ingrid Johnsrude demonstrated that speech is easier to understand when it's spoken by someone familiar.

Understanding the factors that improve speech intelligibility, such as familiarity, is relevant to industries who develop interventions to improve hearing, and to clinicians who frequently encounter patients who report difficulties listening in noisy places. A second example is from BrainsCAN Postdoctoral Scholar Björn Herrman, who found that our brains become more sensitive to sounds as we age, likely leading to hearing challenges over a lifetime.

In a study published in the Journal of Neuroscience, Herrman examined the auditory cortex responses of participants in their 20s and 60s finding differences in responses to soft and loud sounds. The research received a lot of media attention, such as CTV News. The study showed that hearing difficulties can arise because of brain processing and not just problems in the ear, and that hearing aids that tend to boost the volume of all sounds may not be an optimum approach to improving hearing in older adults.

Finally, Brian Allman is exploring the use of a naturally found molecule in the body to prevent hearing loss and cognitive impairment following loud noise exposure. The challenge is to deliver the molecule to the cochlea, where it can help protect the fine hair cells that allow us to hear. The initial principle for an exosome-packaged naturally-occurring molecule that could cross the blood brain barrier, target the cells and mitigate oxidative stress was supported via the Accelerator Stimulus program. Following success at that foundational stage, a Full Accelerator grant to realize the transformational potential was awarded. Should this novel pharmaceutical approach prove effective, the result would have the potential to transform the way clinicians mitigate the damaging effects of noise exposure on the inner ear and brain.

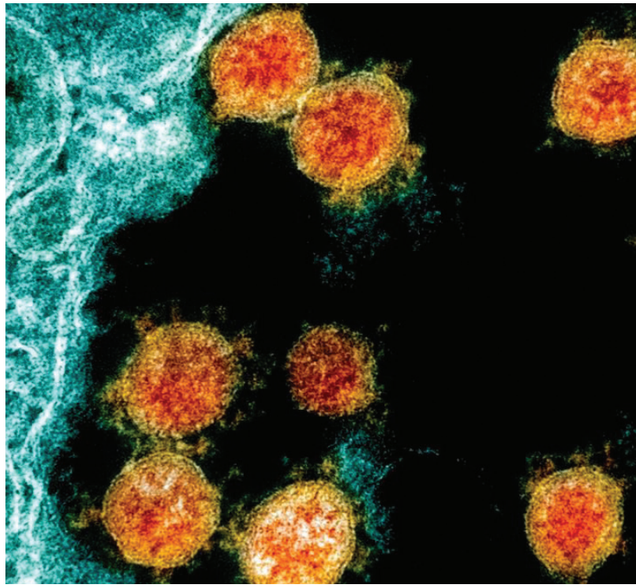
The team will work with Western's commercialization office to establish partnerships with pharmaceutical companies to move towards testing the therapeutic in other animal models and in clinical populations.

LARGE SCALE COGNITIVE TESTING OVER THE INTERNET

The Owen lab has validated online cognitive assessment tools to enable the collection of unprecedented levels of data over many years.

Using this web-assisted cognitive testing platform, commercialized by Western through Cambridge Brain Sciences, two large scale studies are revolutionizing how large-scale cognitive neuroscience studies are being performed. This has led to Owen launching the world's largest sleep study that targets recruiting 100,000 participants from around the world.

Furthermore, this methodology has been particularly impactful during this pandemic with the Owen Lab using it to develop a survey of the cognitive effects of COVID-19. The COVID-19 Brain Study is recruiting 50,000 individuals who have, or have had, the virus to investigate the disease's direct and indirect effects on the brain to assess which brain functions (e.g. memory) are hindered. Both studies have garnered extensive national and international media coverage including BBC, The Globe and Mail, National Post, CBC and Global News.



NEW INSIGHTS INTO QUALITY OF LIFE IN DEMENTIA

Through meeting with Alzheimer Society London and Middlesex (ASLM), BrainsCAN Metrics Analyst Ryan Salewski and Communications Specialist Maggie MacLellan learned that ALSM was unable to quantify the impact of their work with people living with dementia and their care partners.

This lack of quantifiable impact was affecting the ability of ASLM to secure additional funding. The resultant formal partnership with the ASLM, the Alzheimer Society of Ontario and the surrounding area led to BrainsCAN developing and implementing a survey on the impact of Alzheimer's Societies on the community they serve.

For the first time, the AS involved were able to make statements on the millions of dollars saved by the health-care system through their role in reducing acute care interventions (i.e. emergency room visits) and increased ability to provide care in the home. The survey also uncovered new insights into the quality of life of dementia care partners, finding that the well-being of care partners declines rapidly as caregiving responsibilities initially become more frequent rather than linearly with disease progression. The survey methodology and data are being used to develop the AS engagement strategy, as well as being scaled for implementation Ontario-wide in 2021.

OPEN SCIENCE

In addition to fostering high-quality and more reproducible research, a core strength of open science is its ability to advance innovation.

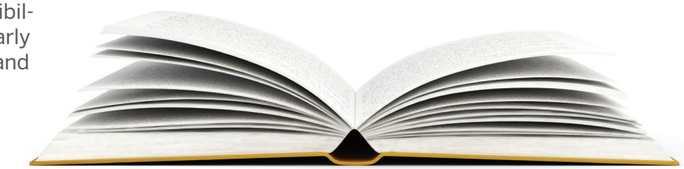
As our open science initiatives enable rapid dissemination of the latest datasets, techniques, and breakthrough discoveries, the wider community of stakeholders can freely access this information for rapid translation. Open science promotes more innovation than traditional practices like patents and licences that can create barriers to access.

Open science best practices will ensure the legacy of CFREF funding. Data management plans registered in an open science database (e.g., www.aspredicted.org) are required for all internal grants and we have invested in frameworks that enable easy and robust sharing of resources, methods and data.

Beyond simply making data openly available, we have made leading-edge progress toward development of new open science platforms with mouse-bytes.ca, touchscreencognition.org, AutoBIDs, the PRIME-DE NHP database, and 3D printing files for animal holders and RF coils.

Another key open science achievement is our partnership with The Canadian Open Neuroscience Platform (CONP), to create a network of scientists to collaborate on open neuroscience research, interdisciplinary student training, clinical translation and open publishing.

The Canadian Open Neuroscience Platform (CONP) aims to create a network of scientists to collaborate on open neuroscience research, interdisciplinary student training, clinical translation and open publishing. CONP funded two research trainees and an advanced research trainee totalling $100k in partnership with BrainsCAN, along with over $244k in research projects.



EQUITY, DIVERSITY, AND INCLUSION

BrainsCAN's research excellence combined with our role as innovators in equity, diversity and inclusion (EDI) initiatives puts us in a position to motivate systemic change. By providing equal opportunities to and encouraging participation from underrepresented groups across our programs, we are supporting marginalized and highly-accomplished researchers to realize their full potential, and at the same time, strengthening our impact in the research and neuroscience communities.

Our EDI and Executive Committees are constantly working hard in collaboration with researchers to identify specific areas of concern within the BrainsCAN community to develop training opportunities and embed EDI into all aspects of BrainsCAN.

EDI ACTION PLAN

1 Embed EDI into all aspects of BrainsCAN

We achieve this by:

- Ensuring everyone is aware of their responsibility to foster an inclusive learning, working and social environment, and understands best practices as they relate to EDI policies, guidance and support;
- Embedding structures and resources to uphold EDI initiatives; and
- Ensuring our decision-making committees reflect diversity, and each committee member actively contributes to promoting equality and inclusive practices.

2 Attract, retain and succeed

We achieve this by:

- Proactively engaging with diverse groups and encouraging applications for BrainsCAN-affiliated faculty and staff roles that are under-represented;
- Inspiring trainees from diverse backgrounds to apply for BrainsCAN-funded opportunities, and employing fair and inclusive application processes; and
- Ensuring we monitor and address differences in degree outcomes and employment opportunities of our diverse student community and promote equality in participation and progression for all.

3 Be flexible and adaptive

We achieve this by:

- Supporting flexible ways of learning and working to meet the needs of our diverse community;
- Embedding inclusive practices to support research excellence; and
- Promoting equality and inclusion within all our working policies and practices.

4 Develop and implement an inclusive approach

We achieve this by:

- Encouraging disclosure, and collecting and analyzing the information to understand the diverse composition and needs of our staff, trainees and researchers;
- Providing accessibility and inclusive practices to accommodate for our staff, trainees, researchers and visitors; and
- Committing to promoting a culture based on the principles of respect, dignity and inclusion for everyone.

YOUNG WOMEN IN STEM

Approximately 250 undergraduate students, researchers and volunteers attended the second biennial Inspiring Young Women in STEM (IYWSTEM) Conference on in March 2018, hosted at Western and organized by the Western Women in Neuroscience graduate student group, in partnership with Western's BrainsCAN initiative and the Schulich School of Medicine & Dentistry. The one-day conference was to inspire, engage and empower young women who are considering a career in STEM.

The agenda provided students with opportunities to learn from academic and industry leaders, connect with graduate programs and company representatives, and showcase their own research through an undergraduate student poster competition.

Four local STEM leaders presented keynote lectures as part of the conference, including Lisa Saksida, Co-Scientific Director of BrainsCAN. Saksida addressed the unique challenges they encounter as women in STEM fields, and also offered advice and encouragement to the young people in the room.

Attendees at the the 2018 Inspiring Young Women in STEM Conference

The annual Inspiring Diversity in STEM conference (formally titled 'Inspiring Young Women in STEM') aims to increase awareness around equity, diversity and inclusion issues. Recognizing the difficulties or roadblocks all underrepresented groups face, it encourages more inclusivity of people from various backgrounds.

Lisa Saksida, Western University neuroscientist and BrainsCAN Co-Scientific Director, understands the importance of an equity, diversity and inclusion (EDI) strategy for the research community.

Saksida was a Professor of Cognitive Neuroscience at the University of Cambridge when she was involved in a working group for Athena SWAN, the United Kingdom's internationally-recognized EDI program that aims to advance the representation of women in all disciplines.

Now as a Western researcher, Saksida sits on the Canada Association for Neuroscience (CAN) EDI and Advocacy Committees, and is Chair of Western BrainsCAN's Equity and Diversity Committee.

When the Government of Canada developed an EDI strategy, it was no surprise that Saksida and BrainsCAN Executive Director, Fay Harrison were involved in the made-in-Canada Athena SWAN consultations that took place from August 2018 and April 2019 and resulted in Dimensions EDI.

EDI PILOT PROGRAM

Lisa Saksida and Fay Harrison at the announcement for the new Dimensions: Equity, Diversity and Inclusion Canada program made by Minister Kirsty Duncan on May 9, 2019

The EDI pilot program aims to address systemic barriers in the research community, including those experienced by members of underrepresented or disadvantaged groups such as women, Indigenous Peoples, persons with disabilities, members of a visible minority, and members of LGBTQ2S+ communities.

As part of the new Dimensions EDI program, the Government of Canada also launched a new Dimensions charter. The charter encourages postsecondary institutions to embed EDI principles in their policies, practices, action plans and culture. Western is among several universities that have backed the Dimensions Charter of Eight Principles of Inclusion.

"EDI strengthens the scientific community and enhances research excellence and innovation - this is why EDI policies are such an important aspect of BrainsCAN strategies – we want to ensure all participants have equal opportunities to excel."

- FAY HARRISON
EXECUTIVE DIRECTOR, BRAINSCAN

ACKNOWLEDGEMENTS

The leading-edge research taking place at BrainsCAN would not be possible without dedicated researchers, trainees, staff, partners and CFREF. Together, we will radically transform our understanding of the brain.

Western BrainsCAN
Transforming brain research.

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