

The Canadian Brain Research Strategy

Transforming the future through brain science

Neuroscience is entering a new era of discovery that could yield dramatic advances in our understanding of the human brain, and our treatment of neurological and mental health disorders. Success will depend on forging a new model of global neuroscience. The Canadian Brain Research Strategy can provide a roadmap to getting there. It draws on our rich scientific history, robust research talent and collaborative culture to transform the future through brain science.

The Challenge: Understanding the Brain

Understanding the brain is one of the greatest—and most urgent—scientific challenges of our time. The massive burden of brain disorders such as autism, neurodegenerative diseases, depression and addiction is acute and growing. At the same time, technology is rapidly changing every facet of the way we live, including how we learn, communicate and perhaps even think. Only through advances in brain research will these challenges be addressed.

The Opportunity: A New Era for Neuroscience

There is ample reason for optimism. A revolution in neuroscience is underway, yielding new insights into how the brain works. But much more needs to be done.

Scientists know more about the universe than they do about the human brain, which has more internal connections than there are stars in the Milky Way. Unravelling this complexity will not be done by individual scientists working harder alone. Instead, spurred by this grand challenge, multidisciplinary teams of brain researchers should come together to discover how the brain gives rise to a rich tapestry of thoughts, feelings and actions. The benefits would be profound.

The Brain Research Imperative

1 in 3

Canadians will be affected by a brain or nervous system disorder or injury in their lifetime.

\$61 Billion

Total cost of neurological and mental health disorders to the Canadian economy annually.

Emergence of a Global Collaborative Neuroscience

In fact, the extraordinary momentum in the field is being channelled into the creation of large-scale brain initiatives around the globe, many of which are focused on creating new research tools and technologies. For example, the Human Brain Project, funded by the European Commission, is building the digital infrastructure needed to model the brain. The U.S. Brain Research through Advancing Innovative Neurotechnologies (BRAIN) initiative is catalyzing the development of new tools for studying the brain. Israel Brain Technologies aims to develop and commercialize new “neurotechnologies” at the intersection of mind and machine. Japan has also launched a national initiative, while Canada, South Korea, China and Australia are each developing their own.

In 2017, Canada also joined these nations to form the International Brain Initiative (IBI), a consortium of researchers working on brain projects around the world, and Canadian neuroscientists continue to play a leadership role in the organization. The IBI aims to move neuroscience forward by increasing collaboration and knowledge sharing, leveraging talent and resources, and reducing repetition among independent, national brain initiatives.

Canada’s neuroscience strategy can distinguish itself from the others by focusing on understanding the brain’s most fundamental processes and by setting the standard for open, collaborative, transdisciplinary and ethical brain research. To prepare for this new era of discovery, our strategy must focus on training the next-generation of transdisciplinary scientists, developing national technology platforms for the benefit of all brain researchers, and maximizing data sharing and analysis both at home and abroad.

“Researchers working on brain initiatives from around the world recognise that they are engaged in an effort so large and complex that even with the unprecedented efforts and resources from public and private enterprise, no single initiative will be able to tackle the challenge to better understand the brain.”

–*Declaration to create an **International Brain Initiative** (December 2017)*

The Future of Neuroscience in Canada

We know that as we learn and make memories, some of the connections between nerve cells increase and strengthen, while others weaken or are removed. This remodelling, also called neuroplasticity, is constant from morning to night and from infancy to adulthood, shaping how we perceive and interact with the world around us. Simply put, it is what makes us human.

But neuroplasticity is complex. When it is abnormal, it can lead to a wide variety of developmental disorders, mental illnesses and addictions. As a result, understanding this changeability is essential to finding ways to protect the brain against insult; heal it after injury; treat developmental, learning and psychiatric disorders; and enhance its resilience throughout the aging process.

Against this backdrop, Canada’s neuroscience community envisions a unified, national brain initiative: the Canadian Brain Research Strategy (CBRS). CBRS will bring together researchers and Canadians living with brain conditions from across the country to address a fundamental question:

How does the brain learn, remember and adapt?

To answer this fundamental question, CBRS will move Canada toward a big-science model for brain research that is collaborative, transdisciplinary and open. The power of CBRS comes from Canada’s deep scientific expertise in brain research, artificial intelligence and neuroethics combined with clinical excellence that leverages our universal health-related data to inform basic research and patient care. It also builds on a history of collaborative research and the commitment of our scientific leaders to work together across disciplinary boundaries.

CBRS embraces Canada’s science vision and will focus on creating an equitable, diverse and collaborative science workforce and an enhanced research infrastructure through which tools, technology and data can be shared. In so doing, it will strengthen the brain research ecosystem, creating a fertile research environment for studying how the brain learns, remembers and adapts.

We believe CBRS will produce new knowledge about the brain that will lead to policies that enhance and enrich the lives of Canadians.

Enabling Principles

Collaborative Understanding how the brain learns, remembers and adapts requires a collective effort rooted in diversity. CBRS will strengthen Canada scientific culture of collaboration, building on more than a dozen pan-Canadian consortiums focused on brain and mental health research.

Transdisciplinary Now more than ever, breakthroughs in neuroscience depend on the combined efforts of scientists from many fields. To achieve its goals, CBRS will build a common scientific language and shared vision across disciplines, and will train a new generation of transdisciplinary researchers.

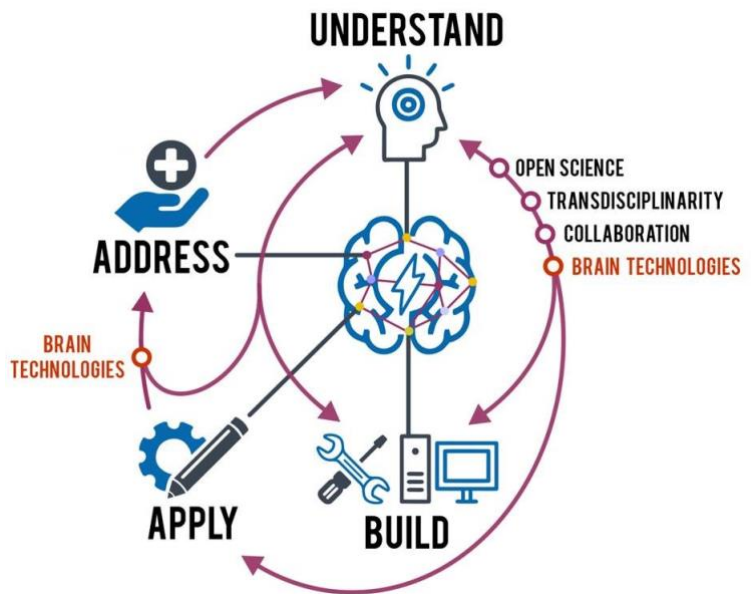
Open Sharing data and research tools openly is essential to a better understanding of the brain and transformation of Canadian brain research. CBRS will build on Canada’s existing open-science initiatives, such as its national high-performance computing platform and open neuroscience data platform.

Mission & Vision

The mission of CBRS is to build on Canada's strengths and current investments in neuroscience to transform neurological and mental health for Canadians. Its vision is of innovative and collaborative brain research that will drive policy as well as social, health and economic advancement for Canada and the world.

The strategy rests on **four pillars**:

- **Understand** focuses on understanding how the normal brain develops and functions, and how it evolves throughout a lifetime.
- **Address** focuses on translating fundamental new knowledge about the brain into better brain health for all Canadians.
- **Apply** uses the new knowledge to inspire discovery in other fields, notably information and communication technology, economics, complex systems, human social behaviour and education.
- **Build** drives the development of new tools to visualize and measure the brain, computational techniques to understand its complexity, as well as brain-inspired technologies, including improved artificial intelligence, which will have widespread applications in health, education and beyond.



Canada's neuroethicists will guide these endeavours and continue to provide national and global leadership in aligning ethical, social, legal and policy considerations with advances in neuroscience.

The CBRS Strategy

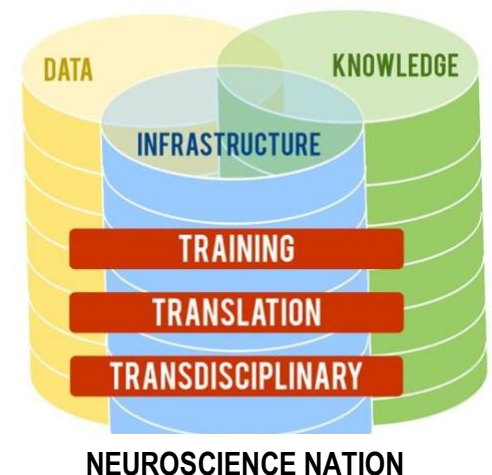
CBRS will transform Canadian brain research through **three major initiatives**:

1. National Transdisciplinary Training Platform

Young Canadians are tomorrow's leaders in academia, health care and industry, and they will ensure that advances in brain research broadly inform a knowledge-based society. But to make breakthrough discoveries about how the brain learns, remembers and adapts, Canada needs to equip a new generation of scientists to do transdisciplinary neuroscience and mental health research. A national training platform will create a shared language among biologists, physical and computational scientists, and social scientists, and will break down the barriers between scientific disciplines that impede progress. It will also build capacity in neuroscience-related areas of ethics, law and policy to empower the design of studies and translation of new discoveries for the benefit of everyone. Finally, it will ensure Canada's neuroscience future reflects the nation's diversity.

2. Distributed Technology Development & Dissemination Platforms

CBRS will hardwire Canadian brain research, creating a national infrastructure that eliminates the geographic and institutional barriers to developing and disseminating new brain research tools, technologies and methods. These platforms will enable scientists to conduct research beyond the scope of their own laboratories; in much the same way that astronomers can access telescopes to probe the universe or nanoscientists can use molecular foundries to create new materials with nanoscale precision, Canadian scientists will be able to access the most powerful brain research tools through a series of distributed technology



platforms, and use them to uncover new insights about neuroplasticity. Beyond providing access to shared tools, these platforms will be dynamic, collaborative hubs that connect technology developers, testers and users, to accelerate the development and open dissemination of new tools.

3. International Neuroscience Open Data Platform

New technologies are enabling scientists to collect unprecedented amounts of data about the brain. The challenge in the coming decades will be to integrate these data into a holistic model of brain structure and function. Achieving such a model will require greater collaboration between experimentalists and theorists, powerful computational resources, new approaches to data analysis, and a workforce with the quantitative skills to extract meaning from large datasets. CBRS will connect and enhance Canada's existing computational resources and experts. For example, it will bring together theoretical and experimental brain researchers to advance our understanding of how the brain learns. These researchers will collaborate to formulate new theories of learning and memory, and to make predictions that can be tested experimentally to discover the brain's neural code and how it adapts. Finally, CBRS will also foster and facilitate data sharing among the countries involved in the IBI.

Building on a Strong Foundation

The Government of Canada and many other public and private funders have consistently recognized the importance of investing in brain research. They include the Canadian Institutes of Health Research, the Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council, as well as the Canadian Institute for Advanced Research, the Canada Brain Research Fund, the Canada Research Chairs Program, the Canada Excellence Research Chairs Program, the Canada Foundation for Innovation, the Kid Brain Health Network, the Canada First Research Excellence Fund and numerous brain-focused health charities. As a result of this support, Canadian neuroscience has flourished. But an additional dimension is needed to meet the grand challenge of understanding the brain. To create a neuroscience-driven nation, Canada must link together existing brain research initiatives and then maximize their potential through shared knowledge, infrastructure and data. CBRS, with its focus on open, collaborative and transdisciplinary brain research, provides the road map to take us there.

Neuroscience and Artificial Intelligence

Recent programs funded by the Canada First Research Excellence Fund:

1. Healthy Brains for Healthy Lives (McGill)
2. Data Serving Canadians (IVADO) (UdeM)
3. BrainsCAN: Brain Health for Life (Western)
4. Vision: Science to Applications (VISTA) (York)
5. Sentinel North (Laval)

Programs funded by the Canadian Institute for Advanced Research:

1. Child & Brain Development
2. Brain, Mind & Consciousness
3. Learning in Machines & Brains

By leveraging existing investments in brain science and adopting a big-science approach to discovery, CBRS can transform the future of Canadian society.

**Brain research is a national strength.
Now is the time to make it a national treasure.**