CANADIAN BRAIN RESEARCH STRATEGY

Researchers Roundtable Summaries

Meeting Dates: October 2021 – May 2022

OVERVIEW

The Canadian Brain Research Strategy (CBRS) is a pan-Canadian community-led initiative that unites the leaders of more than 30 neuroscience and mental health institutes and programs across the country. Together with early career researchers, Indigenous Peoples, and patients – we are building a collective nation-wide vision for brain research and societal impact that will inspire the government to invest in a major brain research initiative for Canada.

Canada is a world leader in many fields of neuroscience and mental health research. National-level resources, infrastructure and policy are needed to build on Canada's uniquely collaborative, transdisciplinary and open approach to brain research that will amplify the impact of current investments and allow us to be a leader and role model on the international stage.

The emerging national strategy for brain research will be initially guided by work on six Strategic Focus Areas - Diversity & Team Science, Open Neuroscience, Neuroethics, Neuroscience-AI Interface, Platform Science, and Transdisciplinary Training - that reflect Canada's distinction in *how* we approach brain research[1]. These initiatives cross boundaries of research approaches, including biological, environmental, behavioural and social perspectives.

Working with CBRS, we convened more than 150 researchers from across the country in a series of roundtables in October 2021 and May 2022 around each of the six strategic focus areas, participating researchers were engaged in small group brainstorming sessions. The summary below captures the abundance and diversity of ideas attendees brainstormed. These ideas outline how we may inspire, guide, and forecast the opportunities that each strategic priority has and could have on the Canadian and global scene.

The output from these roundtables will be used to craft a series of position papers on each strategic priority. The aim is to inspire and guide the government and other funders to further invest in programs that foster collaborative, transdisciplinary and open approaches to brain research.

Discussion Outline

1. Inspire

Inspire by painting an exciting future and highlighting the urgent and unique opportunity we have with each Strategic Focus Area to advance brain research in Canada.

- Why are these initiatives critical to brain research (compared to other fields)
- Why must we invest in these initiatives now to advance brain research?
- Why Canada? What is the unique opportunity for Canada to lead through these initiatives?

2. Guide

Guide what an investment in a Canadian brain research initiative looks like by specifying the priority national-level resources and activities that are needed for each Strategic Focus Areas.

- How are we held back? Why can't the resources and activities happen without greater government support?

- What government support do we need? What national-level resources and activities are needed to advance brain research through this initiative? What barriers and challenges do they address?
- What non-government support do we need? (e.g., funding or partnerships to bring in patient groups, Indigenous perspectives, partnerships beyond Canada).

3. Forecast

Forecast the impact of investing in these Strategic Focus Areas on the neurological and mental health of Canadians.

- What does success in these initiatives look like for the neurological and mental health of Canadians?
- What positive impact on brain research will come from these initiatives? For example, impact on how we conduct brain research, on advancing knowledge on the brain, on Canada's standing in brain research on the international stage.
- Considering multiple interconnected dimensions on a national and international scale, what positive impact beyond brain research will come from these initiatives? For example, impact on other scientific fields, patient care, the economy, health of Canadians, other areas of society.

OPEN NEUROSCIENCE ROUNDTABLE SUMMARY

Open science is idea that all data and knowledge from brain research should be shared and publicly available for others to use and build on. An open approach to neuroscience and mental health research improves the speed of discovery and pushes for better patient and community engagement.

On October 14th, 2021, the Open science taskforce champion, Guy Rouleau, led a roundtable of 31 researchers from 13 academic institutions across the country gathered to discuss a framework for open science in a national strategy for brain research. Researchers came from a range of neuroscience and mental health research backgrounds and from a range of career stages.

Inspire

Why Canada? How is this an opportunity for Canada to Lead?

- Canadian neuroscience is a relatively small tight-knit and collaborative community, which facilitates cultural change
- Canada has unique concentrations of neuroscience researchers looking at same questions (leading to excellent research across a variety of fields), but also willingness to collaborate - we need to capitalize on this
    - for example, Canadian Consortium on Neurodegeneration in Aging is a group of 300+ researchers and trainees from basic to clinical approaches, funded by an array of organizations, including CIHR
- Canada has existing open science programs with excellent track records which we can build upon (TOSI; Databases for single cell recordings, structural biology, genomic data).
- While we have the beginnings of Open science, this may be a chance to bring Canadian neuroscience even further to the forefront.
- We need to make advances for Canada to compete and to lead internationally
    - Other countries and pan-national entities are seeing the importance of open science approaches – for example, NIH has a date for enforcing data management plans, programs in UK are also more advanced in their support for national open science initiatives. We do not want to fall behind other nations.

Why is this approach critical for brain research (compared to other fields)?

- Brain disorders are complex with heterogeneity in progression and symptoms. Open data approaches allow sharing of large datasets and helps us move towards precision healthcare.
- Neurological/mental health conditions affect diverse populations and have complex trajectories across the lifespan and no one research group/centre can cover all of this; aggregating data scales up the impact of what we can do
- Much more is not known in neuroscience than other fields; meaning the potential importance of discoveries is far greater.
- The brain crosses scales of complexity – from cellular/molecular, to systems and behaviour and society. Allowing data to be used for different projects and approaches offers potential for meta-data and re-analysis and further fosters a diversity of ideas.
- Lightens the burden on research participants with brain related conditions and further motivates them to participate.
- Neuroscience will continue to get more expensive and technology driven. There needs to be an "international space station" collaborative approach. Every lab/country should not be doing it alone - not possible.

Untapped potential - With a bigger commitment to open science, how would brain science be uniquely positioned to make key discoveries, serve as a model for other fields, or address pressing health issues?

- Neuroscience is already very relatively advanced and organized internationally on many fronts; so ideal foundation for ambitious new open science approaches and opportunity for Canada to lead internationally.
- More efficient use of resources, neuroscientific approaches can generate data that can easily be combined across labs and institutions
    - Government has already invested huge money into equipment (e.g., scanners) and generating data – these investments need to be fully leveraged with open science approaches; A lot of data (and meta-data) already exists that can be shared and re-used/re-analyzed from these investments
- With greater investments in open science, smaller institutions will be empowered to conduct research with previously inaccessible data that they do not have the local resources to collect. Tapping into their expertise and ideas will further propel progress in neuroscience.
- COVID-19 illustrated the potential for science to progress faster than ever before with open collaboration and higher transparency. With the impact of brain disorders projected to grow and pressing need for treatments and scientific/clinical advances, we need to prepare now in pursuing FAIR principles to avoid pitfalls experienced with COVID-19 research (e.g., excessive reliance on unvalidated pre-prints)

Guide

What resources and activities are needed to advance brain research through this initiative?

- Training a new generation of scientists well-versed in open science
    - Training/education on open science tools, how data re-use plays out in different domains, clear standards and protocols.
- Investment in support staff and infrastructure (pipelines, hardware, data security, legal)

- Standardization and development of best practices – we need a common language
- Change in culture of academic research and evaluation – recognizing data sharing as a valued research output
    - High value placed on replication and validation to address reproducibility crisis
    - Career incentives, awards and prizes to recognize OS practices

What governmental support do we need?

- National mandates and ethics guidelines at federal level to facilitate open science implementation
- National strategies for ensuring common measures and interoperability of data across institutions
- Sustainable long-term infrastructure for data repositories that spans institutions and isn't reliant on grants.
- Leadership by influential federal funding agencies – e.g., mandatory open access to data generated by tri-agency funding (a la NIMH data archive) would necessitate significant investment in a national infrastructure

What non-governmental support do we need? e.g., funding or partnerships to bring in patient groups, Indigenous perspectives, partnerships beyond Canada

- Culture shift reassessing criteria for evaluating scientific merit (outreach, education, carrot, and stick)
- Support for open publishing and elimination of paywalls in journals, publication
- More fellowships and student scholarship grants with OS as a component
- Support from various funders to enable international repositories
- Support the creation of more diverse and inclusive datasets
- Better support for patients/patient organizations to connect with researchers
    - Increased public understanding of what OS of their data actually means; building trust

Forecast

What does success look like?

- Open, reproducible publications, where analyses can be recreated from original data source
- Success also includes removal of obstacles to data sharing
- Young scientists with strong open science training, such as in being able to make solid research data management plans, will ultimately strengthen the rigour, validity, and reproducibility of future neuroscience research
- Researchers being recognized for open science activities (e.g., in grant applications and researcher evaluation)
- 'Data will be available on request' statements are a thing of the past. All data and analysis code is a mandatory part of paper submission / acceptance, and this is rigorously checked for functionality.
- Open science will enable discoveries that will help a broad range of neurological and mental health conditions;

What positive impact on brain research will come from this initiative?

- Better access to data for junior researchers and trainees
- Harmonization of ethics, training, data repositories
- More reproducible research findings, reducing dark data
- Synergizing similar research and pooling data to reduce duplication of effort

- Canada could become a model for other countries to adopt open science and government policy to support it, can begin to integrate data internationally
- Can diversify where data comes from, can collect from regions across Canada, not limited to specific homogenous regions or groups. Greater representation in the data
- With open science & increased power we are better positioned to look at the intersection of social determinants of health with biological/genetic factors

What positive impact beyond brain research will come from this initiative? Consider multiple, interconnected dimensions on a national and international scale

- Improved public perception of science and relationship between patients, researchers and clinicians (transparency, reliability, trustworthiness); Better scientific literacy among the public – reduced misinformation
- Allows more engagement of patients and citizens in science
- Enables discoveries that will help a broad range of neurological and mental health conditions (better able to tackle rare diseases with more diverse and larger N's)
- A shift in the way the research community evaluates the merit of research
- Opportunity to scale OS practices up into other sciences; Open science tools available for other fields, and international research community
- More efficient use of funding resources

NEUROETHICS ROUNDTABLE SUMMARY

Neuroethics entails the understanding of the ethical, legal, and social issues raised by our continuously advancing knowledge of the brain. In order to make the best use of neuroscience and mental health research, it is important to look at the potential benefits, risks, and broader social impact.

On May 4th, 2022, the Neuroethics taskforce champion, Judy Illes, led a roundtable of 23 researchers from 14 academic institutions across the country to discuss a framework for Neuroethics in a national strategy for brain research. Researchers came from a range of neuroscience and mental health research backgrounds and from a range of career stages.

Inspire

How is this an opportunity for Canada to Lead? Why is this approach critical for brain research (compared to other fields)?

- Staying connected to societal needs: Brain science does not exist outside of social context. It is important to inform research with real world health issues and Indigenous worldviews on brain wellness. We need to ensure that vulnerable populations have a voice in brain research and have access to new technologies.
- Guiding rapid scientific development: Neurotechnology and AI are rapidly advancing and opening new areas of brain research exploration and clinical applications. At the same time, there is exciting development towards open science and the democratization of science. To ensure equity, privacy, and long-term sustainability, we need to catch up and become anticipatory rather than reactive in the incorporation of neuroethics. We need to train our scientists and clinicians now.
- Guiding equitable funding distribution: Clearer frameworks for risk assessment and classification, as well as ethical valuation frameworks, could really help to guide the distribution of funding. For example, should we commit the majority of funding to the most common ailments, or the most severe? Neuroethics could inform this decision.

- Defining and amplifying impact: Impact is often difficult to measure in mental health and social interventions, but problems in neuroethics may be easier to define and serve as a good starting point for eventually helping to validate and promote investments in these important areas.

Guide

What resources and activities are needed to advance brain research through this initiative?

- Breaking down silos and bridging basic and clinical science so that we have more integrated worldviews on brain and mental health. Basic science could benefit from clinical research which has more integrated neuroethics. This will be building on existing Canadian leadership in interactions between scientists and clinicians and in interdisciplinary engagement.
- Further strengthening collaboration: (1) Shared platforms for reagents, methodologies, and funding; (2) Incorporation of ethical principles into the community practices of neuroscience platforms; () Restructure multi-team funding models (e.g., a priori agreed upon milestones, deliverables, funding cutoffs and reallocation processes, enforced regular interactions like NDR Inc, competing to become part of a funded group rather than to get funding as a group).
- Exchange between researchers and non-researchers: (1) Clearly articulating the complex idea of neuroethics and work from a shared understanding of neuroethics; (2) Developing channels that connect researchers to research participants, policymakers, and potential users of knowledge and their interests and needs; (3) Creating ways to bring technologies to the public instead of the other way around to ensure equitable access.
- Democratization of science: Vulnerable populations within Canada and around the world have historically faced data extraction. We need to continue to make research processes and data sharing more ethical, engage in co-creation, and support vulnerable populations in conducting their own research.
- Reimaging neuroethics training: Current ethics training and requirements are not sufficient and effective. We need to identify shared priority topics within neuroethics and include training on effective practices to engage in neuroethics, particularly beyond the academy (e.g., how researchers can contribute to public policy and engage the public). We also need to consider various audiences and tailor the training accordingly.
- National standards for neuroethics: (1) A national bioethics body to create guidelines; (2) Integrated requirement in grant proposals for brain researchers to incorporate ethics in their research ideation and planning, meaningfully reflect on neuroethical implications, and consider engagement with stakeholders beyond the academy to advance neuroethics; (3) A harmonized ethics review process.
- National neuroethics resources: (1) National training and certification modules; (2) Funding for neuroethics awareness in addition to training; (3) National surveys on Canadian health (e.g., building on Statistics Canada's Canadian Health Measures survey); (4) Funding for administrative support.

Overall considerations: (1) Equity is a priority for all investments. Investments should be distributed to provide equal social opportunities. In particular, healthcare resources we invest in should be accessible for all people regardless of their backgrounds and transcending geographical limitations; (2) To truly achieve our vision with governmental support, we must have champions in the government in addition to funding from the government; (3) There must be coordination across local, provincial, and federal levels in addressing neuroethics.

Forecast

What does success look like?

- Neuroethics is widely recognized. Built upon shared priorities and standards, we have high-quality national resources on neuroethics to support diverse stakeholders in the brain research ecosystem.
- Diverse stakeholders are part of the discourse and practice of neuroethics. There is meaningful and respectful exchange between scientists and clinicians and between researchers and non-researchers. As a result, neuroethics is informed by the latest research discoveries and diverse lived experiences and integrates diverse worldviews on the brain and mental health.
- Brain researchers go beyond checking a box. Rather than an ad-hoc requirement, neuroethics is an embedded guiding principle upheld by the brain research ecosystem. Brain researchers truly change the way they conduct and communicate research. In addition, there is close collaboration between brain researchers and policymakers. For example, how the brain affects behavior can inform the criminal justice system.
- Health care is significantly advanced and equitable. As diverse stakeholders work together towards a better understanding of the brain and mental health, we can translate new findings to new medical advances in prevention, diagnosis, and therapy. For these medical advances, we ensure that equity guides both their design and access.

TRANSDISCIPLINARY TRAINING ROUNDTABLE SUMMARY

Transdisciplinary training entails combining the efforts of scientists from different "disciplines" or fields such as biology, physics, computer science, social science, and the humanities, as well as non-academic groups such as people from government and the public. Training and support for transdisciplinary research is needed to make sure people across fields and areas learn to work well together.

On May 5th, 2022, the Transdisciplinary training taskforce champion, Caroline Ménard, led a roundtable of 18 researchers from 15 academic institutions across the country to discuss a framework for Transdisciplinary Training in a national strategy for brain research. Researchers came from a range of neuroscience and mental health research backgrounds and from a range of career stages.

Inspire

How is this an opportunity for Canada to Lead? Why is this approach critical for brain research (compared to other fields)?

- Truly understand the brain: Our brains define who we are, how we behave, what we strive for, and how we interact with each other and our environments. Integral to our capacities to live good lives, our brains do not differentiate between disciplines and inevitably require transdisciplinary research to gain a holistic understanding.
- Reap the benefits of current advances: Rapid technological advances have enabled collection of massive and novel information about the brain and associated behaviors. To leverage this critical mass of information and tackle novel, groundbreaking questions in brain research, we must synergize and harmonize computational and engineering expertise with biological and clinical expertise.

- Build on increased virtual capabilities: Our resilience through the pandemic has further increased our ability to communicate and learn virtually, opening new opportunities for researchers to access transdisciplinary training.
- Stay connected to societal needs: As we transform the scale and scope of brain research, we will increase our capabilities to address society's biggest health challenges. As we do so, we must remain connected to societal needs, which medical and social science can help inform. With the rise of neurotechnology, we must also remain focused on incorporating ethics rather than addressing ethics ad hoc.

Guide

What resources and activities are needed to advance brain research through this initiative?

- Diverse forms of transdisciplinary training: We need to invest in developing transdisciplinary training that crosses departments at the college, graduate, and postdoctoral levels. We need to strengthen technical abilities while remaining grounded in biological and health contexts throughout the entire research process from data collection to analysis to interpretation and application. The training could take on different forms such as degree programs, curricula, short-term research exchanges, rotations, and co-mentorship. Instead of each institution reinventing the wheel, we can also build channels to share successful models of transdisciplinary training.
- Structural shifts in training: As training extends beyond single disciplines, we must complement this shift with different ways of structuring training:
    1. Flexibility on timelines given that increased complexity of transdisciplinary work could lead to extended time for research projects and degree completion
    2. Flexibility in travel funding where funds are available for conferences and experiential and engagement activities outside of the primary discipline
    3. Training in communication and collaboration is key to cultivate a collaborative mindset and facilitate the day-to-day working across disciplinary boundaries; such soft skills training would also bolster brain researchers' capacity to contribute beyond the academy.
- Support for transdisciplinary research: At the investigator level, we must reimagine funding to support a cultural shift towards transdisciplinary work so that transdisciplinary training can bear fruit. There are four ideas to reimagine funding:
    1. Availability of operational funding to support supervision of transdisciplinary or interdisciplinary trainees
    2. Long-term funding to enable cultivation of transdisciplinary collaborations
    3. Transdisciplinary expertise on grant review panels to increase capacity to evaluate transdisciplinary proposals
    4. Modification of grant expenditure requirements that encourage collaborations.
- National resource sharing: To scale the impact of our investments and ensure equitable access to transdisciplinary resources, we must also invest in national resource sharing:
    1. Bridging existing national training among different networks and consortia
    2. Scaling up existing training or develop new training such that more diverse training are accessible online and recognized across institutions and programs

3. Platforms that allow researchers to access physical and virtual resources from other disciplines.

Forecast

What does success look like?

- Brain researchers are more empowered to transition and build bridges between academic fields as well as to pursue opportunities to create social impact beyond the academy. Overall, we will have a more flexible and creative talent pool in Canada.
- Brain research models a collaborative and open culture that leverages the power of transdisciplinary research. This culture will develop as brain researchers from institutions of all sizes and expertise become better communicators and collaborators and are supported to work together.
- Brain research effectively contributes to societal wellbeing. With researchers becoming better communicators, public engagement efforts around brain research will be more effective. Brain research will be more deeply connected to people's lived experiences, and there will be increased translation of innovative ideas from the academy to industry in Canada.
- A virtuous cycle for Canadian brain research to flourish where more exciting stories, discoveries, and applications in Canadian brain research retain and attract more diverse talents, who in turn open new vistas of exploration and new perspectives on existing complex problems.

DIVERSITY & TEAM SCIENCE ROUNDTABLE SUMMARY

Diversity & Team Science ensures fair treatment and opportunity for all those who work and participate in research. Diversity involves having a range of identities, perspectives, and lived experiences throughout the research process and leads to better quality research.

On May 6th, 2022, the Diversity & Team Science taskforce champion Lisa Saksida and co-lead Tabrez Khokhar led a roundtable involving 23 researchers from 19 academic institutions across the country to discuss a framework for Diversity and Team Science in a national strategy for brain research. Researchers came from a range of neuroscience and mental health research backgrounds and from a range of career stages.

Inspire

How is this an opportunity for Canada to Lead? Why is this approach critical for brain research (compared to other fields)?

- Address systemic racism: Canada is a highly multicultural nation well positioned to leverage diversity and team science. We can build on existing efforts in EDI at both institutional and national levels. Importantly, we must specifically address the historical role of systemic anti-black and anti-Indigenous racism in the country.
- Enhance research excellence with diversity: The big questions in neuroscience require interdisciplinary thinking and team approaches. In this way, brain science is uniquely poised to benefit from high-quality team science initiatives. However, we must ensure that team science promotes rather than detracts from diversity. Team science means that one has to be invited to the team in the first place, so we must address gate keeping in brain research now.

- Support our young diverse talents to thrive: The challenge for diverse talents to be included in research teams begins early.
    - Young underrepresented talents do not get the same opportunity to work in research labs or attend conferences due to various barriers such as lack of outreach, biased selection processes, and financial burdens. As a result, they are at a disadvantage for competitive opportunities in the future.
    - Even when young underrepresented talents are able to access research opportunities and develop as researchers, they often face non inclusive environments. They are often *not* invited to teams, whether those are research groups or grant review panels and committees, because those in positions of power tend to come from overrepresented backgrounds and draw from their existing network who tend to be of similar backgrounds.
    - Even when underrepresented researchers are invited, they are often tokenized and not given meaningful roles or platforms to contribute fully and thrive. Without diverse researchers, incoming trainees will lack role models with whom they can identify. The time to break the vicious cycle is now.
- Learn about the diversity of human brains: In addition to diversity in research teams, we need diversity in research content. We are missing out on learning about the diversity of human brains which can greatly advance precision medicine. The majority of research, particularly in psychology, studies white and often highly educated populations.
- Build on increased virtual capabilities: Online communication has greatly improved our ability to work across geographic distances and also disciplines. We can leverage this capacity to build bigger support networks for diverse researchers and research.

Guide

What resources and activities are needed to advance brain research through this initiative?

- Opportunities for young, underrepresented talents:
    1. Scale up successful models of science outreach, science fairs, summer research programs, and research administration support (e.g., Canada Summer Research Opportunities Programme (SROP), Manulife Kids Science & Technology, Strengthening the Administration of Research (STAR))
    2. Lowering financial barriers: removal of graduate application costs, increased availability of Tri-agency graduate scholarships, increased pay for graduate and postdoctoral training
    3. Broader application timelines to create better access
- Reimagining scientific excellence and how we measure it:
    - Recognition of various types of life experience that are highly valuable in research teamwork and ideation but are not traditionally part of academic training
    - Embedding EDI metrics around both research team composition and study population composition into grant and journal submission and review processes
    - Accountability for teamwork and team member contribution to avoid tokenism
    - Structuring grants to focus more on diverse teams including ECRs rather than individual PIs

    - Open calls and transparent processes for selecting who gets to review grants
    - Making sure minorities hold leadership positions in grant bodies and review committees and in research teams
    - More faculty hires on EDI initiatives
    - Collection of more statistics to quantify current EDI problems and future successes. For diversity in research teams, an example would be success rates for grant applications from underrepresented groups. For diversity in research content, an example would be collecting demographic data on research participants.
- Dedicated research funds to increase diversity:
    1. Funds dedicated to research in diverse populations
    2. Funds dedicated to Black and Indigenous trainees
    3. Fellowships that support the transition to independence for a cohort of trainees, providing both training and lab start-up funding and a community
    4. Development of additional systemic incentivization to promote diversity and inclusion
- Supporting allyships: We can develop resources to encourage allyships. Resources can cover topics such as how to avoid burdening underrepresented members with administrative and EDI work, how to recruit more majority group members to become active allies, how to support intersectional identities, etc.
- Accessible shared resources: Shared resources can take advantage of our enhanced virtual capabilities and take the form of borderless consortia, listservs, datasets, etc. This would be particularly helpful for researchers who may experience isolation whether geographically or socially.

Overall consideration: We must address systemic anti-black and anti-Indigenous racism.

Forecast

What resources and activities are needed to advance brain research through this initiative?

- Every Canadian can receive the healthcare they deserve because we would no longer have to extrapolate limited research findings and would instead be able to leverage studies on diverse populations to make good on precision medicine for everyone
- Diverse talents are supported to join and stay in the Canadian brain research ecosystem. The composition of brain researchers reflect the diverse composition of Canada as a whole, and we have diversity in senior researchers. This would contribute to studies on diverse populations as diverse scientists are known to do research on more diverse populations.
- Everyone in the brain research ecosystem actively works to improve diversity among scientists. The population of people working to promote diversity should itself more closely reflect the population of Canada - meaning, more majority group members! This would alleviate the burden and tokenism currently placed on underrepresented members.
- EDI is widely recognized as a driver of scientific excellence. We proactively seek EDI in both research focus and personnel, and our institutions embed metrics to assess EDI in funding and recruitment.

- We hold a more diversified and nuanced concept of diversity. We recognize intersectionality and consider low-income and first-generation backgrounds who are most affected by poor postdoctoral job security, for example.

PLATFORM SCIENCE ROUNDTABLE SUMMARY

Platform Science entails creating dedicated physical or virtual space across institutions and across Canada to share resources such as major research facilities, equipment, tools, data, and expertise. Platforms allow research to be more equitable, collaborative, innovative, and productive.

On May 9th, 2022, the Platform Science taskforce champion Yves De Koninck and co-lead Marie-Eve Paquet led a roundtable of 15 researchers from 13 academic institutions across the country gathered to discuss a framework for Platform Science in a national strategy for brain research. Researchers came from a range of neuroscience and mental health research backgrounds and from a range of career stages.

Inspire

How is this an opportunity for Canada to Lead? Why is this approach critical for brain research (compared to other fields)?

- Maximize return on investment: Given Canada's relatively small funding size and pool of brain researchers, we need to efficiently use our funding to maximize what we can achieve together.
- Truly understand the brain: Brain is the most complex organ, and brain research spans a vast range of scales from molecular to cellular to circuit to behavioral to societal. We need to share, collaborate, and harmonize across disciplines in order to reach a holistic understanding of the brain.
- Tap into the potential of state-of-the-art techniques: There are a lot of exciting techniques with broad utility in neuroscience. However, their potential is not realized due to lack of access and expertise. As seen in physics and astronomy, the tools in brain research are rapidly increasing in complexity and cost. Complex imaging in particular is approaching this condition. We need to move towards a model in which tools are managed by a group of tool experts and used for experiments by other researchers from around the world.
- Promote equitable access: We have an opportunity to uplift all researchers across geography, institution size, and seniority. It is currently challenging for geographically isolated/more rural labs, smaller universities, and early career investigators who have fewer resources in terms of money, cutting-edge equipment, and staff. To ensure that we support and retain talents, we must ensure equitable access.
- Ensure research excellence and avoid reinventing the wheel: We are capturing gigantic datasets. We need platforms to share both data and data analysis software efficiently. As our approaches become increasingly diverse, complex, and specialized, we need to make sure that expertise to correctly acquire and analyze datasets are available to and standardized among all.
- Maximize social impact: To leverage brain research for the development of novel applications in medicine and artificial intelligence, brain researchers must work with clinicians and people with lived experience and industry partners. These large-scale efforts will benefit from platforms that connect diverse stakeholders.

Guide

What resources and activities are needed to advance brain research through this initiative?

- Physical platforms such as a collection of core-like centers across the country that implement complex techniques with broad utility.
- Virtual platforms where datasets and open source software are shared for researchers to perform analysis regardless of where they are from. One successful example is the Allen Institute's Brain Observatory.
- An important part of our investment in virtual platforms would be infrastructure that enables fast, feasible information transfer.
- Linkages and liaising between platforms to help researchers utilize multiple research components in synergy (e.g. high throughput molecular phenotyping to molecular perturbation for behavior).
- Training is needed to help ensure that researchers can utilize resources shared on platforms. As we have to compete for talent with industry and other countries, we need to provide competitive compensation to experts. To scale up access to expertise, we can also develop training courses.
- Metrics of success need to be developed so that we can track the utilization and impact of platforms and iterate on platforms to maximize success. For instance, we can track the number and diversity of users and citations. We can also develop better measures of collaborative work and data sharing.

Overall considerations as we develop platforms: (1) Support needs to span the research process from data generation to analysis to the development of new tools and applications; (2) Cultural shifts toward team science are needed to alleviate attribution concerns; (3) We need to ensure sustainability for platforms beyond initial investments, and industry collaboration could be part of the solution; (4) "Few sizes fit all" models to ensure lower barriers of entry.

Forecast

What does success look like?

- Brain researchers across provincial and national borders and across sectors engage meaningfully to tackle novel, groundbreaking questions together.
- Translation towards clinical applications is faster. We can apply existing techniques to translational contexts and support academy-industry collaboration for platforms. We can speed up moving beyond animal models and the discovery of clinically relevant biomarkers, targets, and treatments.
- Tool development is more robust and sustainable due to platform structures and systems in place, in contrast to one-off individual efforts.
- Canada is able to retain and recruit talents from around the world by offering powerful platforms.
- Canadian brain researchers further their international influence as their research productivity per unit of research funding is enhanced by platforms.
- Canada has a more skilled workforce that excels in collaborating across disciplines.
- All brain researchers can access cutting-edge techniques and cross-disciplinary expertise affordably and efficiently.

- Approaches and data are more standardized. This will enable researchers to work more efficiently and synergistically.

NEUROSCIENCE-AI ROUNDTABLE SUMMARY

Artificial intelligence (AI) was initially developed from our understanding of the brain. Using AI tools helps us better understand how the brain works, and new knowledge about the brain can also be applied to improve AI. Progress in neuroscience and AI can benefit each other and all the other fields that rely on them.

On May 10th, 2022, the Neuro-AI taskforce champions, Karim Jerbi and Yoshua Bengio, led a roundtable of 35 researchers from 17 academic institutions across the country to discuss a framework for Neuro-AI in a national strategy for brain research. Researchers came from a range of neuroscience and mental health research backgrounds and from a range of career stages.

Inspire

How is this an opportunity for Canada to Lead? Why is this approach critical for brain research (compared to other fields)?

- Revolutionize treatment: Neuro-AI approaches could help streamline data processing, expedite biomarker discovery, and refine current diagnostic and therapeutic tools. Together, these advances could facilitate a shift towards prevention and early treatment, as well as an increase in treatment effectiveness. One example of success we can build on is the AI-enhanced data processing and decision support systems in neuroimaging.
- Maximize existing investments: We have the opportunity to harmonize research data, particularly multimodal data, and identify reproducible and robust features for the broader neuro-AI community. This will enable the community to fully take advantage of AI systems' analytical capabilities and to develop effective precision medicine.
- Enhance research productivity and innovation:
    - Existing AI/ML can help accelerate brain research by facilitating data collection and processing. For instance, physical ML approaches can complement and augment biological datasets.
    - Leveraging AI in data analysis is crucial given the increasingly large data sets collected by brain research teams. We also have an opportunity to unify datasets across teams to further take advantage of AI's analytical capabilities, rising above inconsistent standards and silos. This approach could particularly benefit complex topics like mental health.
    - With AI, we can also build learning tools. Trainees can learn by manipulating AI models of tangible data-processing systems. For certain brain contexts, we can also build starter models for studying complex brain functions.
    - Brain research has historically had a huge impact on the development of AI systems and will be critical to achieve the next breakthroughs in AI. Brain research can help overcome current AI shortcomings in generalization and flexibility which the brain excels at. In addition, brain research will inform the development of more relevant, helpful AI grounded in biological and health contexts. For instance, we can help AI move

beyond affective computing towards processes like how the brain incorporates emotion into cognitive processes. This is especially relevant for mental health.

- Build on existing successes: Compute Canada, datasets funded by CIHR/NSERC, CIFAR Learning in Machines & Brains (LMB) program, CIFAR reinforcement learning summer school, Mothers and Machine Learning program, current efforts classifying disorders and diseases, Allen Brain Institute platforms, UK biobank data, Human Connectome Project, and Human Brain Project.

Guide

What resources and activities are needed to advance brain research through this initiative?

- Cultural and structural transformation: (1) to support longer research timelines as transdisciplinary training and collaboration, as well as large-scale data collection for AI model, take longer and (2) to reimagine research excellence (e.g., diverse researchers to generate diverse neuro-AI, different metrics of success, publication beyond traditional journals or departments divided by traditional disciplines).
- Transdisciplinary training can encourage young researchers to explore novel fields and questions and ensure that brain research leverages both biological expertise and mathematical and AI expertise. More transdisciplinary training programs and paths into brain research training programs from other subject areas can be developed. In addition to degree programs, short-term training opportunities can add flexibility in promoting breadth in academic training across career stages. Example opportunities include summer schools, workshops, visiting experts, and lab exchanges. To ensure fruitful transdisciplinary exchange and collaboration, training in cross-disciplinary communication is also key. As transdisciplinary training could be more costly and time-intensive, funds can also be made available for salary awards targeted toward young interdisciplinary researchers.
- National resources for transdisciplinary research:
    1. Funding for transdisciplinary work and team grants
    2. National convenings to facilitate research exchange, including exchange with clinicians, nonprofits or industry to impact patient care (example success story: Aifred)
    3. Transdisciplinary ambassadors who liaise between neuro and AI
    4. Funding for mathematical and theoretical projects (e.g., BRAIN initiative's theories, models and methods for analysis of complex data from the brain).
- Resources to increase data and algorithm sharing could expedite research and promote collaboration, overcoming resource constraints of individual labs. National platforms could be complemented with dedicated support personnel on data management and computational and engineering support. Academia could collaborate with industry on the development of infrastructures. There could also be mandates on data sharing and awards to recognize researchers who have significantly enhanced the research community through data sharing efforts and uplifting other researchers.
- Developing standardization builds on data sharing and includes developing shared benchmarks, language, and principles.

- Resources on deploying AI tools: (1) Infrastructures for deploying decision support systems; (2) Regulation on commercial deployment of AI.

Forecast

What does success look like?

- We have increased trust among stakeholders in the brain research ecosystem. With more open practices and transdisciplinary exchanges, neuro-AI researchers can better connect and co-construct with people with lived experiences, Indigenous communities, and industry (particularly those working in digital health). The establishment of shared guidelines and resources on deploying AI tools will further reinforce trust.
- Neuro-AI research advances translate to patient care advances, particularly with collaborations between the academy and other stakeholders in the brain research ecosystem. Patient care will advance in precision and effectiveness and shift towards preventative care via measurement-based care-derived data, AI-assisted clinical decision making, patient education, and new therapies from neuro-AI synergy.
- AI achieves transformative breakthroughs with strengthened ability to generalize, multi-task, and learn continuously. At the same time, AI tools will be better positioned for social good as they are grounded in biological and health contexts. The next-gen AI will benefit brain research and beyond, leading to improved health outcomes and economic growth in Canada.
- Brain researchers are able to collectively elucidate novel, complex topics that were previously not possible to address without shared standards, large datasets, and AI-powered analyses. Mental health is one such topic.
- We develop, attract and retain more AI and transdisciplinary talent in Canada. More transdisciplinary thinkers would galvanize innovative work, especially at the neuro-AI intersection, and lead to a robust startup ecosystem with good networking and collaboration
- There are AI tools serving novel and more diverse needs because of an increase in the diversity in AI scholars. We will have more AI scholars from Black and Indigenous communities, adjacent fields, and latent talent (e.g., stay-at-home caregivers and parents on parental leave).

AI also inspires brain research. Studying artificial cognition may reveal novel ways of thinking about cognition and consciousness in humans.