HEALTHY BRAINS FOR HEALTHY LIVES

Town Hall
January 30, 2017

Rose Goldstein, Vice-Principal (Research and Innovation)
Our Vision and Goals

- Within 10 years, transform many brain disorders from terminal or life-long afflictions to treatable, or even curable, conditions.

- Reduce the human and socio-economic burden of psychiatric and neurological illnesses.

- Improve the mental health, quality of life, and productivity of people around the world.
## Overall 7-year budget plan

<table>
<thead>
<tr>
<th>In millions $</th>
<th>Quebec Research (direct costs)</th>
<th>HBHL Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>64.8</td>
<td>9.5</td>
</tr>
<tr>
<td>Indirect cost</td>
<td>14.1</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>84.0</td>
<td>18.0</td>
</tr>
</tbody>
</table>
Healthy Brains for Healthy Lives

AI and the Brain

CFREF

Brain research and Training CIFAR

IVADO: Artificial Intelligence/Machine Learning

BrainsCAN

Université de Montréal

Western

$84M

$93M

$66M
Implementation milestones

- Sep-Dec 2016: Governance
- Feb 2017: Funding Agreement with federal government
- Winter: HBHL program development & Fund distribution
- Winter: Thematic workshops
- Winter: HBHL Admin office
HBHL Board
Chair: VP-Research & Innovation

Scientific Director: A. Evans
Associate Scientific Director: D. Precup

Research Management Committee (RMC)
Chair: A. Evans
Vice-Chair: A. McKinney

Managing Director

Operations & Management Committee
(Director, VP-RI, Strategic initiatives, AVP Finance, Comm’s)

International Advisory Council (IAC)
Partnership & Innovation Council (PIC)

Innovation and Entrepreneurship Platform
(AVP Innovation, Business Dev. Team)

HBHL Research Themes

Theme 1: Neuroinformatics
Theme 2: Mechanistic models of neuro-degenerative diseases
Theme 3: Applied cognitive neuroscience of brain plasticity
Theme 4: Population Neuroscience and Brain Health
Key governance bodies

- Board
- Research Management Committee
- International Advisory Council
- Partnership and Innovation Council
HBHL Board

- Oversight of HBHL
- Resource allocation fair/transparent
- Expenditures aligned with HBHL goals
- Appropriate governance, management and personnel structures, policies, procedures and strategies

- Rose Goldstein (Chair)
- Christopher Manfredi
- Yves Beauchamp
- David Eidelman
- Antonia Maioni
- Bruce Lennox
- Alan Evans (Non-voting)
- Guy Rouleau (Non-voting)
- John Capone, VPR Western (External)
- 2-4 members at large
Scientific Leadership

- Scientific oversight
- Planning of research activities
- Implementation of research programs
- Delivery of HBHL mandate

Alan Evans
Scientific Director

Doina Precup
Associate Scientific Director
For more information:

Questions?

www.mcgill.ca/hbhl

hbhl@mcgill.ca
HBHL Sub-committees

- Functions that cut across the four themes
- Tasks/tools/mechanisms supporting HBHL deliverables
- Promote interdisciplinarity

Laurence Kirmayer
Social Sciences

Doina Precup
Neurohub

Lesley Fellows
Clinical and Knowledge Translation

Gustavo Turecki

Brigitte Kieffer
Animal Models

Edward Fon
Cell and Tissue Mechanisms
Research Management Committee

- Research activities
- Advise on all aspects of HBHL
- Scientific leadership
- Resource allocation

- Alan Evans (Chair)
- Anne McKinney (Vice-Chair)
- Doina Precup
- Guy Rouleau
- Brigitte Kieffer
- Laurence Kirmayer
- Robert Zatorre
- Michael Meaney
- Gustavo Turecki
- Lesley Fellows
- Ted Fon
- Julien Doyon (UdeM)
- Ravi Menon (Western)
HBHL Approach & Deliverables

- Understand the *individual* brain
- Integrate genetic, epigenetic, physiological, imaging, behavioral, environmental, clinical and social aspects
- NeuroHub - Advanced analytic platform for brain data
- By 2022: Canadian Framework for Brain Health
Healthy Brains for Healthy Lives
Canada First Research Excellence Fund (CFREF)

Population neuroscience and brain health

Neuroinformatics and modelling

Models of neurodegenerative diseases

Cognitive neuroscience of brain plasticity
HBHL Theme 1

Neuroinformatics and Modelling
A) Rather than link a gene (or genes) with a multi-factorial syndrome
B) Link genes to specific mechanisms/circuits that can be targeted and modified

Animal model: Powerful way to decipher causes of gene-syndrome association
Epidemic Spreading Model (ESM) of Aβ propagation (A) measure Aβ deposition pattern (B). Normal anatomical connectivity (C) is used to generate multiple hypothetical lifetime Aβ propagation/deposition courses (D). Each hypothetical course corresponds to a set $i$ of seed ROIs and model parameters $\theta_i = [\beta_i, \delta_i, \sigma_i]$.

ESM iteratively estimates, per subject, the $\theta_i$ that maximizes similarity between estimated and observed Aβ deposition pattern. ESM also models onset age of Aβ binding and propagation.

Aβ Production and Clearance Rates from ESM model

Clinical group

APOE ε4 alleles

Iturria-Medina Y, Sotero RC, Toussaint PJ, Evans AC, ADNI

Basic mechanisms of brain disease are complex and poorly understood.
Access to tissue is limited.
Not clear what new drugs should target > widespread testing, high failure rate.
Closed, proprietary approach create redundancy. Many centres test same compound.

Working with human tissue/neurons is the next stage in drug discovery
“Stem cells” make this possible.
Disease modelling in a dish
“Precision-Personalized medicine”

Drug Development
Clinical trials: MNI CRU

Assay development
Small molecule screening

NeurO C-BIGR
Neuro OpenScience
Clinical Biologic Imaging and Genetic Repository

Patient Samples:
- Blood and skin cells
- Genetic data
- Imaging data
- Clinical data

CRISPR-Genome editing
- Correction of disease mutations
- Introduction of disease associated mutation

Patient

iPSCs

Neurons

- Parkinson’s Disease
- ALS
- Multiple Sclerosis
- Leukodystrophies
- Intellectual disabilities
HBHL Theme 3

Applied Cognitive Neuroscience of Brain Plasticity
TETRIS (CT)

Haier et al. (2009) BMC Res Not

Juggling (VBM)

Cortical plasticity

Navigation (VBM)

Musicianship (DBM)
HBHL Theme 4

Population Neuroscience and Brain Health

- Neuroscience - Social Science - Population Mental Health
Social determinants of brain health

- **Workshop**: Capturing “Context”: Refining the sciences of Mind, Brain and Culture by including the Social environment

- Panel of social indicators, integrated in HBHL online platforms

- Examples of emerging projects
  - effects of migration and urban environments on mental health
  - mediators of mental health effects of microaggression and discrimination
  - interaction of social, developmental and neurobiological determinants of suicide, depression and dysphoria among Indigenous youth
Welcome to the MMHRC
Responding to Cultural Diversity in Mental Health

The MMHRC provides resources to support culturally safe and competent mental health care for Canada’s diverse population. Please join us to build a community of practice.

Join Our Listserv

Recent Posts
MHCC Report: Supporting the Mental Health of Refugees to Canada
Culture, context and mental health of Somali refugees
Woori Maum: Korean Canadian Mental Health Association
Catalyst – October 2016 – Case for Diversity Paints Opportunity for Service Improvement | Mental Health Commission of Canada
The European Psychiatric Association Guidelines on Cultural Competency – Summary
Here’s Why Black People in Canada Are Healthier Than Those in the U.S. | TakePart
Improving Cultural Competence to Reduce Health Disparities

New in the Literature
Medical Student Mental Health: Culture, Environment, and the Need for Change.
Determinants of subjective well-being in people with psychosis referred for psychological therapy in South London.
Developing family interventions for adolescent HIV prevention in South Africa.

Upcoming Events
Refugee Mental Health Course: Focus on Syrian Refugees
January 18 - February 14
Webinar: Group therapy programs for Syrian refugees
January 25 @ 1:00 PM - 2:00 PM
Promoting Healthy Relationships for Youth
February 15 - February 17
Action Table: Improving Mental Health Service Planning for IRER Populations
March 28 @ 8:30 AM - March 29 @ 4:30 PM
Society for the Study of Psychiatry and Culture, Annual Meeting: “Family Matters”
April 27 - April 29

View All Events
HBHL Platform
Animal Models

- Manipulate endogenous systems
- Test therapeutic interventions

- Measure causal effects on behaviour

- Emphasis on COGNITION
- Cuts across themes
- Synergy with Western U

Genes & Molecular pathways
Brain Circuits
Neuroinformatics
Phenotype

Neurological disorders (Theme 2)
Development & Environment (Theme 3)
Psychiatric disorders (Theme 4)
Animal data

- Invasive: optogenetics & Ca imaging
- Invasive & translatable: DBS
- Non-invasive & translatable: MRI
- Behavioral phenotyping
- Deep learning & prediction
- Longitudinal
- Heterogeneity
- Big data
HBHL Platform
NeuroHub
CBRAIN National HPC Integration
(200,000 processors)

Orcinus - Westgrid
(3072 cores)

Kraken - SHARCNET
(3774 cores)

GPC - SciNET
(30240 cores)

Guillimin - CLUMEQ & Local Servers
(16000 cores)

JUROPA & JUDGE – Julich, GER
(30000 cores)

Colosse - CLUMEQ
(7616 cores)

Mammouth II - RQCHP
(2464 cores)

Canadien Consortium on Neurodegeneration in Aging.
Data Types

Imaging
Behaviour
Genetics
Epigenetics
Tissue samples
The ability to simulate the brain in enough detail to carry out vital scientific research will grow with computer power. A digital facsimile of a cylindrical piece of tissue in the rat cortex became a reality in 2008, when speed was clocked in teraflops. As computers climb to the peta and exa scales, the Human Brain Project envisions full-brain simulations of a mouse and of the same species that conceived Hamlet and Einstein’s general theory of relativity.

<table>
<thead>
<tr>
<th>Computing Memory</th>
<th>2005 Single-neuron model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exabyte (10^18 bytes)</td>
<td>2008 Column in neocortex (10,000 neurons)</td>
</tr>
<tr>
<td>Petabyte (10^15 bytes)</td>
<td>2011 Cortical mesocircuit (100 necortical columns)</td>
</tr>
<tr>
<td>Terabyte (10^12 bytes)</td>
<td>2014 Complete rodent brain (100 mesocircuits)</td>
</tr>
<tr>
<td>Gigabyte (10^9 bytes)</td>
<td>2023 Complete human brain (1,000 times rodent brain)</td>
</tr>
<tr>
<td>Megabyte (10^6 bytes)</td>
<td></td>
</tr>
<tr>
<td>Gigaflop (10^9 flops)</td>
<td>Teraflop (10^12 flops)</td>
</tr>
<tr>
<td>Petaflop (10^15 flops)</td>
<td>Exaflop (10^18 flops)</td>
</tr>
</tbody>
</table>

More Computer = More Brain
Since President Obama announced the BRAIN Initiative in April 2013, dozens of leading technology firms, academic institutions, scientists and other key contributors to the field of neuroscience have answered his call and made significant commitments to advancing the Initiative.

**FEDERAL COMMITMENTS**

**NIH**
National Institutes of Health

NIH is announcing $46 million in new BRAIN-related grant awards, focusing on new tools and techniques.

**FDA**
Food and Drug Administration

FDA is joining the BRAIN Initiative, with the goal to enhance the transparency of the regulatory landscape for neuroscientific medical devices.

**DARPA**
Defense Advanced Research Projects Agency

DARPA is building on four existing programs and is planning new investments in the BRAIN Initiative, with the ultimate goal of relieving and rehabilitating warriors and civilians suffering from traumatic injury and neuro-psychiatric illness.

**NSF**
National Science Foundation

NSF is continuing to make investments to support BRAIN Initiative by accelerating fundamental research and the development of new technologies for neuroscience and neuroengineering.

**FEDERAL COMMITMENTS**

**NIH**
National Institutes of Health

NIH is announcing $46 million in new BRAIN-related grant awards, focusing on new tools and techniques.

**FDA**
Food and Drug Administration

FDA is joining the BRAIN Initiative, with the goal to enhance the transparency of the regulatory landscape for neuroscientific medical devices.

**DARPA**
Defense Advanced Research Projects Agency

DARPA is building on four existing programs and is planning new investments in the BRAIN Initiative, with the ultimate goal of relieving and rehabilitating warriors and civilians suffering from traumatic injury and neuro-psychiatric illness.

**NSF**
National Science Foundation

NSF is continuing to make investments to support BRAIN Initiative by accelerating fundamental research and the development of new technologies for neuroscience and neuroengineering.

**PRIVATE SECTOR COMMITMENTS**

**$30 MILLION**
US PHOTONICS INDUSTRY

GOALS
To develop new optics and photonics technologies to tackle challenges of the BRAIN Initiative.

**$5 MILLION**
GLAXOSMITHKLINE

To fund innovative peripheral neurotechnologies and provide unrestricted, royalty-free access for research purposes to all intellectual property developed through this challenge.

**PRIVATE RESEARCH EFFORTS**

**$65 MILLION**
UNIVERSITY OF PITTSBURGH

Creating a new University of Pittsburgh Brain Institute focused on unlocking the mysteries of normal and abnormal brain function.

**$12 MILLION**
UNIVERSITY OF CALIFORNIA, BERKELEY AND CARL ZEISS MICROSCOPY

Infrastructure for neurotechnology development.

**$40 MILLION**
THE CARNEGIE MELLON UNIVERSITY

Commitment to support the goals of the BRAIN Initiative.

**$62 MILLION**
THE SIMONS FOUNDATION

To uncover patterns of the neural activity that produce cognition by combining analyses of internal mental states with studies of sensory and motor processing.

**ONGOING COMMITMENTS**

Continuing Progress from Existing Partners

**$60 MILLION**
ANNUALLY
THE ALLEN INSTITUTE FOR BRAIN SCIENCE

Understand how brain activity leads to perception, decision making and ultimately action.

**$70 MILLION**
HOWARD HUGhes MEDICAL INSTITUTE

Develop new imaging technologies and understand how information is stored and processed in neural networks.

**$40 MILLION**
OVER THE NEXT 10 YEARS
KAVLI FOUNDATION

Provide the knowledge for addressing debilitating diseases and conditions.

**THE BRAIN INITIATIVE**
National Institutes of Health

**POSSIBLE LONG-TERM OUTCOMES**

The BRAIN Initiative has the potential to do for neuroscience what the Human Genome Project did for genomics by supporting the development and application of innovative technologies that can create a dynamic understanding of brain function. It aims to help researchers uncover the mysteries of brain disorders, such as Alzheimer’s and Parkinson’s diseases, depression, Post-Traumatic Stress Disorder (PTSD), and traumatic brain injury (TBI).

**NOW IS THE TIME TO INVEST IN BRAIN RESEARCH**

The Human Genome Project demonstrates the potential impact that ambitious research programs like the BRAIN Initiative can have. From 1988-2003, the Federal Government invested $3.8 billion in the Human Genome Project, which has since generated an economic output of $796 billion — a return of $141 for every $1 invested.
Canadian Brain Initiative

Translational focus a Canadian strength

Large enough for global impact, small enough to be “organizable”

Mature national neuroinformatics infrastructure

Potentiate not dictate

Provide analytic infrastructure

Foster open, collaborative projects at different levels

Cross-disciplinary training and career paths
## Research Programs – Direct Costs

<table>
<thead>
<tr>
<th>Research ($20.4M)</th>
<th>Talent ($17.8M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovery Fund interdisciplinary research</td>
<td>Student and Postdoctoral Fellowships</td>
</tr>
<tr>
<td>Research Transition Awards</td>
<td>New Investigators start-up grants</td>
</tr>
<tr>
<td>Innovative Ideas</td>
<td>Visiting Fellows</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation ($11.2M)</th>
<th>Infrastructure ($15.4M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Collaboration Platform</td>
<td>Technology Development</td>
</tr>
<tr>
<td>Neuro-Innovation Fund (1:1 matched)</td>
<td>Core facilities Operations</td>
</tr>
<tr>
<td>Knowledge Mobilization</td>
<td></td>
</tr>
</tbody>
</table>
**Interdisciplinary Discovery Fund:** Strategic and long-term research for interdisciplinary teams:
- Up to 400K/year x 3 year (2-4 awards per year)

**Innovative Ideas:** Exploration of novel and innovative ideas with the potential for breakthrough science.
- Seed ($25K x 1 year)
- Vision ($100K x 2 years)
- 5 per year (each)
Talent

- **Support for graduate students** (MA and PhD, 20 per year) & *Postdoctoral Fellows* (10 per year): Interdisciplinary training

- **New Investigators Start-up**: for recruitment of new faculty: equipment and direct research costs ($250K-500K/HBHL hire ~3 per year)

- **Visiting Fellows**: Academic exchange. Fellowships and travel ($50K x 4 per year)
Innovation

- **International Collaboration Platform:** Respond quickly to emerging international opportunities. Link with partners. (~$500k per year, total)

- **Neuro-Innovation Fund:** Matched by Quebec Gov., in collaboration with industry and other partners (~$500k per year, total)

- **Knowledge Mobilization:** Research and Innovation Chairs, Knowledge Translation (KT) policy, products, or processes. ($100K/year, 1 year, 6 awards per year)
Infrastructure

- **Technology Development**: Specialized professionals for technology development of tools and processes e.g. programmers, statisticians, mathematicians, $400k \times 3$ awards per year, multi-year duration

- **Core Facilities Operations**: Operations, maintenance, upgrades, expansions of existing HBHL platforms. ~$1M per year total
# Projected Rollout

<table>
<thead>
<tr>
<th>Program</th>
<th>Launch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme Development Workshops (&quot;Road map&quot;)</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>International Collaboration</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>Core Platforms</td>
<td>Dec 2016</td>
</tr>
<tr>
<td>Innovative ideas (Pilot)</td>
<td>Spring</td>
</tr>
<tr>
<td>Visiting Fellows (Pilot)</td>
<td>Spring</td>
</tr>
<tr>
<td>Technology Development (Pilot)</td>
<td>Spring</td>
</tr>
<tr>
<td>Student Scholarships &amp; Fellowships</td>
<td>Spring</td>
</tr>
<tr>
<td>Neuro-Innovation Fund</td>
<td>Spring</td>
</tr>
<tr>
<td>Knowledge Mobilization</td>
<td>Summer</td>
</tr>
<tr>
<td>Interdisciplinary Discovery Research Teams</td>
<td>Summer</td>
</tr>
</tbody>
</table>
Questions?

www.mcgill.ca/hbhl

hbhl@mcgill.ca