McGovern Institute for Brain Research

The McGovern Institute for Brain Research at MIT is led by a team of world-renowned neuroscientists committed to meeting two great challenges of modern science: understanding how the brain works and discovering new ways to prevent or treat brain disorders. Patrick J. McGovern and Lore Harp McGovern, committed to improving human welfare, communication, and understanding through their support for neuroscience research, established the McGovern Institute in 2000. Patrick McGovern passed away in March 2014.

Faculty Changes

The McGovern Institute welcomed one new faculty member in FY2015. Mark T. Harnett joined the institute as an investigator and as an assistant professor in MIT's Department of Brain and Cognitive Sciences. Mark received a BA in biology from Reed College in Oregon and a PhD in neuroscience from the University of Texas at Austin. He then joined the lab of Jeffrey McGee for a postdoctoral appointment at Janelia Farm, where he had been since 2009. Dr. Harnett's scientific interests focus on the synaptic and cellular substrates for information processing in central mammalian circuits. Specifically, he works on the computations carried out within neurons embedded in neural circuits.

Guoping Feng was appointed as an associate member of the Broad Institute, joining the Broad core faculty in shaping the scientific priorities of the institute.

Resource Development

Fundraising from individuals and private foundations remains a priority at the McGovern Institute. McGovern Institute staff hosted multiple donor cultivation events during the fiscal year, and faculty and staff met with more than 50 donors and prospects in Cambridge, New York, Florida, and California.

We raised $1.9 million in cash gifts and pledge payments from individuals, companies, and small family foundations in FY2015.

Symposia

Resting State Connectivity Conference

In September 2014 the McGovern Institute, together with the Martinos Center at Massachusetts General Hospital, hosted the Fourth Biennial Conference on Resting State/Brain Connectivity. More than 500 researchers attended from around the world, and the McGovern Institute sponsored a reception on the Kresge Oval. Susan Gabrieli was the primary conference organizer, and talks were held in Kresge Auditorium. By all accounts, it was a very successful event.

McGovern Institute Spring Symposium

The McGovern Institute held its spring symposium on April 27, 2015. The symposium, organized by assistant professor Mehrdad Jazayeri, featured 10 talks followed by a panel

discussion. Speakers were Amy Bastian, Kathy Cullen, Jorn Diedrichsen, Thomas Jessell, Richard Mooney, Nate Sawtell, Marc Sommer, Josh Tenenbaum, Daniel Wolpert, and Byron Yu.

Chinese Institutes/McGovern Institute Symposium

On May 19, 2015, several McGovern Institute investigators traveled to Peking University in Beijing to hold a one-day symposium for faculty, postdocs, and students.

Other Major Events

The annual Phillip A. Sharp Lecture in Neural Circuits (endowed by Biogen Idec in honor of the McGovern Institute's founding director, Phillip Sharp) was given by Cori Bargmann from the Howard Hughes Medical Institute and The Rockefeller University on March 2, 2015, and was titled "Themes and Variations in Circuits and Behavior."

The 2015 Scolnick Prize was awarded to Charles Gilbert of The Rockefeller University. His work addresses fundamental questions about visual perception, and he has provided important insights into how the brain recovers from injury and degenerative disease. His lecture, given on March 20, 2015, was titled "The Dynamic Brain."

The Poitras Center and Stanley Center jointly sponsored a monthly seminar series held in our building that featured leading researchers in the area of psychiatric disorders. Speakers were as follows: Raquel Gur, University of Pennsylvania; Stephan Heckers, Vanderbilt University; Sophia Vinogradov, University of California, San Francisco; and Ricardo Dolmetsch, Novartis. All talks were held in Singleton Auditorium and followed by a reception.

Annual Retreat

The McGovern Institute held its annual retreat at the Sea Crest Beach Hotel in Falmouth, MA. The two-day event, held on May 31 and June 1, 2015, was attended by over 140 people studying brain science. It provided a tremendous opportunity for scientists to share highlights of their work and get to know fellow researchers they may not have met before. There were 12 talks, a very large poster session, and many opportunities to interact.

McGovern Institutes in China

The McGovern Institute at MIT continues to collaborate and interact with the three International Data Group/McGovern Institutes in China at Tsinghua University, Beijing Normal University, and Peking University.

Board of Directors

The McGovern Board of Directors meets quarterly, in July, October, January, and April. Membership of the board for FY2015 is as follows: Lore McGovern; Elizabeth McGovern; Michelle Bethel; Michael Sipser, MIT; Robert Langer, MIT; Edward Scolnick, Broad Institute; Sheila Widnall, MIT; and James Poitras, Avalon Mining Inc. Pat McGovern's seat is being filled by his stepdaughter, Michelle Bethel.

McGovern Leadership Board

The McGovern Leadership Board meets once per year. The board participates in programming at the McGovern Institute and interacts with the director and faculty members throughout the year, providing critical funding and strategic advice to the institute.

Core Laboratories

The McGovern Institute operates several core laboratories that serve the local neuroscience community, including but not confined to members of the institute.

Martinos Imaging Center at MIT

The Martinos Center provides access to neuroimaging technologies, including two 3T magnetic resonance imaging (MRI) scanners for human brain imaging, a 9.4T MRI scanner for small animal imaging, a magnetoencephalography scanner, and an electroencephalography system. There is also a coil fabrication lab and a mock MRI scanner to help subjects (especially children) adapt to the scanning environment.

Viral Gene Transfer Core

The viral core is a joint project of the McGovern and Picower Institutes. It operates on a fee-for-service basis to provide viral vector technologies to neuroscience researchers inside and outside MIT.

Two-Photon Microscopy Core

This core features a sophisticated two-photon system with four lasers to support two-color imaging and uncaging. The system includes two workstations, configured for slice physiology and whole animal work. It has recently been upgraded to include an electrophysiology system.

McGovern Institute Neurotechnology Program

The McGovern Institute Neurotechnology Program (MINT) provides seed funding for collaborations between McGovern labs and researchers from other disciplines within and beyond MIT, with a focus on developing new technologies for brain research. Since its establishment in 2006, MINT has supported over 35 projects. Collaborating principal investigators are from multiple departments and schools at MIT and from other institutions, including the Broad Institute, Massachusetts General Hospital, and McLean Hospital.

Awards and Honors

Mehrdad Jazayeri and Gloria Choi were among nine MIT researchers to be named 2014 Sloan Research Fellows. These fellowships are awarded each year to early-career scientists “in recognition of distinguished performance and a unique potential to make substantial contributions to their field.”

Rebecca Saxe received a Troland Research Award from the National Academy of Sciences. The Troland Award “recognizes unusual achievements and further empirical research in psychology regarding the relationships of consciousness and the physical world”.

Zeynep Saygin, a postdoc in Nancy Kanwisher's lab, has been named a winner of the 2014 Wellcome Image Awards for her work visualizing connections in the human brain. The awards recognize the "most informative, striking and technically excellent images" recently acquired by the Wellcome Image Gallery."

Feng Zhang was named the winner of the 2014 National Science Foundation (NSF) Alan T. Waterman Award. This award is NSF's highest honor for outstanding researchers under the age of 35 across all areas of science and engineering. The Waterman Award was presented to Dr. Zhang during a ceremony held at the US Department of State in Washington, DC. Zhang was also listed by Technology Review as a key player in the field of genome editing, one of the magazine's "10 Breakthrough Technologies" for 2014.

In addition, Dr. Zhang received one of six new awards from the Paul G. Allen Family Foundation to study brain cell growth and development. He was awarded $1 million to "develop a highly scalable genomic engineering system that can reliably evaluate the genetic activity that leads to differentiated and mature cells." Dr. Zhang was also one of two winners of the Society for Neuroscience 2014 Young Investigator Award and one of six scientists to receive a Robertson Investigator Award from the New York Stem Cell Foundation. Finally, Zhang was the cowinner of the 2014 Gabbay Award in biotechnology and medicine from Brandeis University.

Gloria Choi and Feng Zhang were named among Cell's "40 Under 40." Also, Choi and Yingxi Lin were the first individual recipients of the Paul and Lilah Newton Brain Science Award. The award funds "innovative new basic science research projects" in MIT's Department of Brain and Cognitive Sciences.

Mehrdad Jazayeri was presented the Klingenstein-Simons Fellowship Award in the Neurosciences. This award funds young investigators engaged in basic or clinical research that may lead to a better understanding of neurological and psychiatric disorders.

Six of the first recipients of National Institutes of Health BRAIN Initiative awards were from MIT, more than any other institution. Of those, four were from the McGovern Institute (Robert Desimone, Edward Boyden, Alan Jasanoff, and Ian Wickersham).

Tomaso Poggio received the Society for Neuroscience's 2014 Swartz Prize for Theoretical and Computational Neuroscience.

Ed Boyden has been named the 2015 recipient of the Carnegie Prize in Mind and Brain Sciences.

Patrick Hsu, a postdoc in Feng Zhang's lab, has been named to the 2015 Forbes 30 Under 30 List for his work with the CRISPR-Cas9 genome editing system

Major Research Publications

In collaboration with colleagues in the MIT Center for Biomedical Engineering, Feng Zhang showed that CRISPR can be used to edit the genome of the malaria parasite Plasmodium falciparum. This protozoan parasite is among the leading causes of

mortality in the developing world and has until now been very difficult to study genetically. (Nature Methods, September 2014)

Ann Graybiel, collaborating with colleagues in Germany, has studied a gene called FoxP2 that is implicated in human language and that evolved rapidly in the lineage leading to modern humans. When the human version of this gene is expressed in mice, the researchers found that the animals more rapidly acquire procedural memories, an effect that might also be relevant to humans' unique ability to learn language. (*Proceedings of the National Academy of Sciences*, September 30, 2014)

Feng Zhang and his collaborators from MIT and the Broad Institute engineered a strain of transgenic mice in which the CRISPR system can be activated in any cell type of choice. The path from a healthy cell to a cancer involves multiple mutations, and the authors show that their new system allows this multistep process to be modeled for lung cancer. The new mouse strain is likely to find widespread use in cancer, brain research, and many other fields. (*Cell*, October 9, 2014)

Feng Zhang has published several papers illustrating the wide applicability of the CRISPR genome editing technology. One study, a collaboration with colleagues at the Koch Institute for Integrative Cancer Research, used CRISPR to generate mice susceptible to liver cancer. (*Nature*, October 16, 2014)

Feng Zhang and colleagues demonstrated that the CRISPR gene editing system works efficiently in the adult nervous system. (*Nature Biotechnology*, January 2015)

In a collaboration funded by the McGovern Institute Neurotechnology Program, Emilio Bizzi and Polina Anikeeva (Department of Materials Science and Engineering) were able to test a novel type of flexible probe that can simultaneously record neural activity and deliver light for optogenetic stimulation. Using this method, they were able to stimulate and record from the spinal cord, a technically challenging task given that the spine moves much more than the brain. These electrodes can be used both for basic research and as part of a neuroprosthesis for paralysis. (*Advanced Functional Materials*, November 7, 2014)

Rebecca Saxe's group identified a brain region that is involved in recognizing emotions independently of how they are conveyed. This region is activated both by viewing emotional human faces and by viewing emotionally charged stories presented using graphical narratives that do not include faces. (*Journal of Neuroscience*, November 26, 2014)

Feng Zhang, collaborating with colleagues at the University of Tokyo, described a new application of the CRISPR-Cas9 system in which the Cas9 protein is engineered to switch genes on rather than off. In a proof-of-concept experiment, the authors used this method to screen for genes that may cause resistance to chemotherapy drugs in cancer cells. (*Nature*, January 29, 2015)

Jim Di
Carlo and colleagues compared the behavior of a "deep neural network" computer vision model with that of the primate visual system and showed that the two systems achieve similar performance on object recognition tasks. (*PLoS Computational Biology*, December 18, 2014)

January 9, 2014
John Gabrieli and colleagues reviewed neuroimaging findings in which initial brain measures (neuromarkers) were correlated with or predicted future education, learning, and performance in children and adults; criminality; health-related behaviors; and responses to pharmacological or behavioral treatments. (*Neuron*, January 7, 2015)

A team led by Ed Boyden has invented a new way to visualize the microscopic structure of brain and other tissues. Unlike traditional microscopy, which involves magnifying the image, the new method works by physically enlarging the specimen itself, in some cases more than 100 times. The expansion is achieved by infusing the tissue with polyacrylate, the same substance used in baby diapers, which expands dramatically on addition of water. (*Science*, January 30, 2015)

How do primates, including humans, tell faces apart? Scientists have long attributed this ability to so-called "face-detector" (FD) neurons, thought to be responsible for distinguishing faces, among other objects. But no direct evidence supported this idea. Now, using optogenetics, Arash Afraz, working with Ed Boyden and Jim DiCarlo, has provided the first evidence that directly links FD neurons to face discrimination in primates—specifically, differentiating between males and females. By deactivating just a few FD neurons, Afraz found that face discrimination in the primates was impaired. (*Proceedings of the National Academy of Sciences*, May 26, 2015)

Among the hardest decisions are those that involve weighing benefits against costs, such as choosing to take a higher-paying job in a city far from family and friends versus choosing to stay put with less pay. Researchers in Ann Graybiel's lab have now identified a neural circuit that appears to underlie decision making in this type of situation, which is known as approach-avoidance conflict. The findings could help researchers discover new ways to treat psychiatric disorders that feature impaired decision making, such as depression, schizophrenia, and borderline personality disorder. (*Cell*, June 4, 2015)

Rebecca Saxe has previously identified a brain region (known as the rTPJ) specialized in terms of understanding the thoughts and beliefs of other people. Beliefs can derive from different sources (e.g., seeing something, hearing something), and Saxe's group has now identified unique patterns of brain activity within the rTPJ that represent these different possible sources of beliefs. (*Cognition*, October 2014)

Robert Desimone
Director
Doris and Don Berkey Professor of Brain and Cognitive Sciences