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. The McGovern Institute was established in 2000 by Patrick J. McGovern and Lore Harp McGovern, who are committed to improving human welfare, communication, and understanding through their support for neuroscience research.

Faculty and Administrative Changes

Rebecca Saxe, a faculty member in the Department of Brain and Cognitive Sciences (BCS), joined the McGovern Institute as an associate member in January 2012. Professor Saxe obtained her PhD from MIT and returned to the Institute as a faculty member in 2006; she was awarded tenure in 2011. She is widely recognized for her research on social cognition, including the neural basis of "theory of mind," the ability to understand the mental states of other individuals. With the addition of Professor Saxe, the McGovern Institute now has 15 full members and two associate members.

James DiCarlo was named chair of BCS, and his five-year term began on March 1, 2012.

The McGovern Institute's new development officer, Kara Flyg, joined the institute in August 2011.

Resource Development

Fundraising from individuals and private foundations remains a priority at the McGovern Institute. McGovern Institute staff hosted four donor cultivation events during the fiscal year, and faculty and staff met with more than 60 donors and prospects in Cambridge, New York, Florida, and California.

More than $3.3M in cash from 190 individuals and companies was donated to the McGovern Institute in FY2012. Highlights of new grants from private foundations included a $2M renewal grant from the Ellison Medical Foundation, several grants from the Simons Foundation, $200,000 from the McKnight Endowment Fund for Neuroscience, $98,000 from Autism Speaks, and $65,000 from the Bachmann-Strauss Dystonia and Parkinson Foundation.

Annual Symposium

The McGovern Institute's 2012 symposium, held on April 27, 2012, was entitled Magnetoencephalography [MEG]: Applications to Cognitive Neuroscience. The organizers were Robert Desimone, Charles Jennings, and Dimitrios Pantazis from the McGovern Institute, along with Matti Hamalainen of Massachusetts General Hospital (MGH). The nine speakers discussed how MEG is contributing to the understanding of human brain function and disease, including language, movement control, and the basis of psychiatric disease. The symposium also marked the opening of the new MEG laboratory at MIT, and the anniversary of the 1972 paper by David Cohen describing

his pioneering work—much of it conducted at MIT—on the development of MEG technology. Professor Cohen, now a faculty member at MGH, spoke at the symposium and was presented with a commemorative plaque in honor of the occasion.

Joint Symposium with the Picower and Broad Institutes

On September 22–23, 2011, the McGovern Institute joined with the Picower Institute and the Broad Institute's Stanley Center for Psychiatric Research to host a joint symposium on the genetics and biology of severe mental illnesss. The organizers were Guoping Feng (McGovern Institute), Li-Huei Tsai (Picower Institute), and Edward Scolnick (Stanley Center).

Scolnick Prize

The 2012 Scolnick Prize winner was Roger Nicoll, of the University of California, San Francisco (UCSF), a leading expert on synaptic plasticity. His lecture, given on April 19, 2012, was entitled "Deconstructing and Reconstructing a Synapse."

Sharp Lecture

Okihide Hikosaka, of the National Institutes of Health (NIH), gave the inaugural Phillip A. Sharp Lecture in Neural Circuits, on March 1, 2012. His lecture was entitled "Choosing Good Objects—A Basal Ganglia Mechanism." The Sharp Lecture is endowed by a gift from Biogen-Idec Inc., in honor of Institute Professor Phillip Sharp, a cofounder of Biogen and the founding director of the McGovern Institute.

Annual Retreat

The McGovern Institute's annual retreat was held once again at the American Academy of Arts and Sciences, in Cambridge, MA. The event, on April 18, 2012, featured 13 talks and numerous poster presentations from McGovern Institute laboratories, followed by dinner at the academy.

Simons Center for the Social Brain

McGovern Institute members are among the beneficiaries of the newly established Simons Center for the Social Brain. The center was established through a $26.5M gift to MIT from the Simons Foundation Autism Research Initiative. Ann Graybiel and Guoping Feng from the McGovern Institute were among those supported through the first round of seed grants from the center, which were announced in spring 2012.

McGovern Institutes in China

Following the April 2011 announcement of the International Data Group/McGovern Institute for Brain Research at Tsinghua University, two more such institutes have been initiated, at Peking University and Beijing Normal University.

Board of Directors and Leadership Board

The McGovern Institute board of directors meets quarterly—in July, October, January, and April. The membership of the board remains unchanged since last year, and

includes Patrick McGovern; Lore McGovern; Elizabeth McGovern; Marc Kastner; Robert Langer; Edward Scolnick (Broad Institute); Sheila Widnall; and James Poitras (Avalon Mining, Inc.).

The McGovern Institute Leadership Board meets twice a year. The Leadership 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 McGovern Institute.

Core Laboratories

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

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

The 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.

The 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.

McGovern Institute Neurotechnology Program

The McGovern Institute Neurotechnology Program provides seed funding for collaborations between McGovern Institute laboratories and researchers from other disciplines within and beyond MIT, with a focus on developing new technologies for brain research. Seven new projects have been funded this year, in areas ranging from MRI imaging to the use of genomics tools in neuroscience to the development of new types of electrodes for chronic neural recordings.

Awards and Honors

Ann Graybiel was awarded the Kavli Prize in Neuroscience, along with Cornelia Bargmann of UCSF and Winfried Denk of the Max Planck Institute. The $1M prize is awarded every two years for outstanding achievement in advancing the knowledge and understanding of the brain and nervous system.

Edward Boyden and Feng Zhang were awarded the Perl–University of North Carolina Neuroscience Prize, along with Karl Deisseroth of Stanford University. The prize is

given annually to recognize a seminal achievement in neuroscience. Four of the 12 past recipients of the Perl Prize were subsequently awarded the Nobel Prize.

Edward Boyden was the first winner of the newly established A. F. Harvey Prize, awarded by the UK-based Institute of Engineering and Technology to recognize outstanding contributions to medical engineering.

Edward Boyden, Robert Horvitz, Nancy Kanwisher, and Tomaso Poggio were among 12 MIT faculty invited to speak at the 2012 World Economic Forum, in Davos, Switzerland.

Rebecca Saxe was named a Young Global Leader by the World Economic Forum.

Michale Fee received Duke University's Katz Prize, named for neuroscientist Lawrence Katz, which is given annually to a neuroscientist "whose work reflects Katz's openness to new ideas, creativity, and enthusiasm for technical and conceptual innovation."

Tomaso Poggio was a guest speaker at the Fourth Israeli Presidential Conference, Facing Tomorrow 2012. President Shimon Peres hosted the event, held in June 2012.

Alan Jasanoff was among 17 scientists nationwide to receive the NIH Director's Transformative R01 (T-R01) Award, designed to encourage scientists to explore high-risk projects with the potential to dramatically transform their field.

Guoping Feng and Feng Zhang both received the 2011–2012 McKnight Technological Innovations in Neuroscience Award for using new technologies to monitor, manipulate, analyze, and model brain function.

Feng Zhang received the Damon Runyon–Rachleff Innovation Award, which supports the "next generation of exceptionally creative thinkers with high risk/high reward ideas."

Major Research Publications

John Gabrieli's group reported that people with dyslexia are impaired in their ability to recognize individual voices. This effect, which is specific to speech in the listener's native language, supports the idea that dyslexia reflects a deficit in phonological processing. *Science*. July 29, 2011.

Nancy Kanwisher and colleagues examined how the human visual system responds to symmetry, identifying brain regions that either distinguish or fail to distinguish between mirror-image reversals of visual scenes. This distinction is crucial for navigation but irrelevant for other aspects of visual processing, such as object recognition. The results support the existence of distinct pathways for recognition and action within the visual system. *Journal of Neuroscience.* August 3, 2011.

Martha Constantine-Paton's laboratory identified a molecular pathway by which the brain-derived neurotrophic factor promotes the targeting of new proteins to developing synapses. The mechanism is important for the increase in synaptic strength that occurs

during visual cortex development as a result of eye-opening. *Journal of Neuroscience.* August 17, 2011.

Martha Constantine-Paton and colleagues studied the mechanism by which maps of the visual world become correctly aligned in the developing brain as a result of visual experience. *Neuron.* August 25, 2011.

Nancy Kanwisher and colleagues provided evidence that the human brain has areas that are specialized for language. Using functional MRI (fMRI) to map activity in individual subjects, they showed that most language-responsive areas are activated only by language and not by other cognitive tasks that have been proposed to overlap with language. *Proceedings of the National Academy of Sciences USA.* September 27, 2011.

Ann Graybiel's group described changes in the brain's rhythmic activity as animals learn new habits. The effects were seen by measuring neural activity within the striatum, a brain structure previously associated with habit formation, as rats gradually learned to navigate a maze. *Proceedings of the National Academy of Sciences USA.* October 4, 2011.

Edward Boyden, Ann Graybiel, and collaborators, including former McGovern Institute member Christopher Moore, used a combination of optogenetics and high-field fMRI to measure the relationship between brain activity and the blood-oxygen-level-dependent (BOLD) signal that is widely used in human neuroimaging. The results confirm a critical assumption in the field, namely that the BOLD signal scales in proportion to local neural activity. *Journal of Neuroscience.* October 19, 2011.

Michale Fee's laboratory examined the neural basis of variability in the immature songs of juvenile birds. Variation in the timing of individual syllables can be characterized as a combination of two components: one stereotypic, the other random. These components are driven by distinct brain structures, whose relative contributions change over time as the bird learns to produce a mature song. *Journal of Neuroscience.* November 9, 2011.

Yingxi Lin and colleagues showed that the immediate-early transcription factor neuronal Pas domain 4 protein (NPas4) is a key regulator of memory formation within the mouse hippocampus. Through a combination of genetic and behavioral methods, they showed that NPas4 acts specifically in hippocampal area CA3 to promote retention of newly formed memories. *Science.* December 23, 2011.

Robert Horvitz studied the molecular mechanism by which asymmetry arises within the developing nervous system of the worm *C. elegans*. A specific cell division gives rise to non-identical left and right daughter cells, only one of which becomes a neuron. This asymmetry depends on an epigenetic regulatory mechanism involving a specific histone complex that is deposited asymmetrically onto DNA at the time of replication. *Cell.* December 23, 2011.

John Gabrieli, Rebecca Saxe, and colleagues used diffusion tractography to test the idea that functional brain activation is correlated with differences in anatomical connectivity.

Their results confirm that this is the case for the fusiform gyrus, a brain region that is implicated in recognizing faces. *Nature Neuroscience.* December 25, 2011.

John Gabrieli and colleagues used fMRI to manipulate learning. By measuring fluctuations in brain activity, they identified patterns of activity during learning that were associated with better subsequent recall. Using real-time fMRI, they were then able to time the presentation of each stimulus to manipulate the likelihood that it would be remembered. *NeuroImage.* January 2, 2012.

Robert Desimone and colleagues showed that eye movements and shifts in visual attention depend on different populations of neurons within the frontal eye fields, a cortical area that provides "top-down" signals to control visual behavior. *Neuron.* February 9, 2012.

Rebecca Saxe's laboratory studied the neural responses to the suffering of other people and found that emotional or physical pain leads to activation of distinct sets of brain regions. In a related study, with implications for understanding intergroup conflicts, the same laboratory found that these brain responses differ according to whether the victim is a member of the same cultural group or of a hostile outgroup. Neuropsychologia. January 2012, and *Philosophical Transactions of the Royal Society of London B: Biological Sciences.* March 5, 2012.

Michale Fee and postdoctoral fellow Jesse Goldberg examined how the basal ganglia signal via the thalamus to the cortex, a pathway that is disrupted in Parkinson's disease. *Nature Neuroscience.* February 12, 2012.

Ann Graybiel and postdoctoral researcher Kenichi Amemori examined the representation of positive and negative values within the anterior cingulate cortex. By microstimulating this region, they could bias monkeys' decisions in an approach-avoid task, causing animals to give greater weight to negative values—a possible model for human depression. *Nature Neuroscience.* May 2012.

Edward Boyden and collaborators at the Georgia Institute of Technology developed a robotic device that can automate the otherwise challenging manual task of patch clamping individual neurons within the living brain. *Nature Methods.* May 6, 2012.

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