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The **Quest** for Intelligence



**brain+cognitive
sciences**

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A Message from the Department Head

Jim DiCarlo



In this issue, you will learn about the MIT Quest for Intelligence, an ambitious, Institute-wide effort to advance the science and engineering of human intelligence. MIT has long been a leader in the field of intelligence research through entities like the Center for Brains, Minds and Machines (CBMM), headquartered in building 46, and the Computer Science and Artificial Intelligence Laboratory (CSAIL). The Quest is a natural next step to bring together talent and ideas from across MIT to spark new collaborations and advance innovative moonshot research. The BCS community is incredibly exciting to be a key part of this quest, as understanding intelligence in engineering terms will profoundly change and improve the world.

You will also learn about the BCS Clinical Connection Training Module (page 3) led by Dr. Thomas Byrne, Professor of Neurology at Harvard Medical School and Senior Lecturer in BCS. The week-long program enables BCS graduate and undergraduate students to participate in professionally guided clinical experiences and small meetings in collaboration with Massachusetts General Hospital, and it connects these experiences with coursework on the neurobiology of disease. It touches on a range of clinical topics, and it aims to spark new potential collaborations with clinical researchers while graduate students are early in their training. In my time as an early graduate student and a physician in training, my interactions with patients, families, and primary care givers still to this day remind me of why our department's basic science research is so desperately needed, and how many lives it can potentially improve. I hope that the department's Clinical Connection Module will, at the very least, provide at least a glimpse of that same perspective for our students working here in the research trenches.

We are pleased to welcome Alexander "Sasha" Rakhlin, who joins us from Wharton School at the University of Pennsylvania, as a tenured faculty member in BCS and a core member of MIT's Institute for Data, Systems and Society (IDSS). Sasha will join BCS Prof. Emery Brown in adding to our department's important faculty connection to IDSS. Sasha is a leader in the fields of learning theory, statistical analysis and machine learning, and his addition to BCS will help fulfill some of our long-standing teaching needs in computation, and will develop novel research collaborations with experimental BCS faculty members in the areas of data analysis and mechanisms of biological learning. Please join me in welcoming Sasha!

In this issue, we also highlight the Margaret Bidwell Memorial Lecture. It is one of the hallmarks of the spring MIT Colloquium series on the Brain and Cognition, which we host along with the McGovern Institute for Brain Research (MIBR) and the Picower Institute for Learning and Memory (PILM). The Bidwell Lecture demonstrates the enormous impact that donations of any size can have on our community, and how a love of learning can create a lasting legacy to memorialize a loved one.

Lastly, you will notice that we have included a new regular feature, Research Bytes (page 6-8) to capture a snapshot of the amazing science done by BCS faculty and their research teams. I am so very proud of everything that the BCS community has accomplished and what I know we still will accomplish.

James J. DiCarlo MD, PhD
 Peter de Florez Professor of Neuroscience
 Head, Department of Brain and Cognitive Sciences

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A New Perspective on the Whole Brain

Clinical Connection Training Module brings BCS students out of the lab and into the hospital

By Sara Cody

On a Friday morning, a crowd gathers in the morgue in the basement of Massachusetts General Hospital (MGH). Moments before, the audience had learned the case history of a deceased patient, reading notes from the attending physician, exploring MRI images projected on the wall and discussing possible diagnoses and treatment options. Now they form a semicircle around the neuropathologist as they watch him carefully dissect the patient's preserved brain. He confirms the diagnosis of Alzheimer's disease, pointing out its catastrophic effects as he passes brain slices around the crowd for a closer look. Among the audience are doctors, medical students, residents, and thanks to the BCS Clinical Connection Training Module, a BCS graduate student.

"MIT and MGH have a long and storied history of collaboration, and I wanted to continue that tradition while opening up new opportunities for BCS graduate and undergraduate students to gain first-hand experience in a clinical setting," says Dr. Thomas N. Byrne, Professor of Neurology at Harvard Medical School, Neurologist at MGH and Senior Lecturer in the Department of Brain and Cognitive Sciences at MIT, who leads the program. "A physical bridge connects both MGH and MIT across the Charles River. My hope is that this program does the same for learning opportunities between the institutions."

The program is a week-long rotation, where participants coordinate directly with Byrne to attend a variety of seminars, conferences, discussions and other experiences throughout the week based on their interests, whether it's spending time in a clinic, sitting in on a radiology consult, attending neurology and psychiatry grand rounds, or even the Friday morning brain cuttings. Students have the opportunity to learn about the pathogenesis, diagnosis, management and therapeutic clinical trials of diseases of the nervous system. Seminars range in relevant topics such as Alzheimer's disease, functional neurosurgery, movement disorders, epilepsy, neuro-oncology and neuropsychiatry.

"One thing I try to stress to the students is that this experience lets you see neuroscience in action through the clinical perspective," says Byrne. "When it comes to making a diagnosis, sometimes you have the whole story, as when you are looking at the case history in the brain cutting. Sometimes you only have part of the story if you are seeing a new patient in the clinic who is presenting with the initial symptoms of a disease. Knowledge of the basic science coupled with clinical experience enables us to establish a diagnosis and therapeutic intervention. This experience allows students to understand the potential impact of their research in a real-world setting."

Jenna Aronson, a BCS graduate student, participated in the rotation in December 2017. Aronson's research interests focus on neurodegenerative brain disorders and aging, so she felt particularly drawn to participate in the program. The ability to work closely with Byrne to tailor the rotation to fit her interests made for a deeply impactful experience. She even accompanied Byrne in the exam room as he saw his own patients in the memory loss clinic, where she interacted with patients and their caregivers and gained a deeper understanding of the physical and emotional toll of the people affected by a neurodegenerative diagnosis.

"The reason I came to BCS is to learn more about neurodegenerative disease, and with that understanding, find ways to give back to both patients and their caregivers affected by it," says Aronson. "As a doctoral student, I think it's important to understand the point of research, and this clinical rotation is a meaningful way of gaining firsthand perspective in the clinic in addition to simply studying it in the lab. For me, it really solidifies my resolve to move forward in my research."

In addition to the brain cutting and memory disorders clinic, Aronson attended conferences on functional neurosurgery, radiation neuro-oncology, Alzheimer's disease and neurodegeneration. According to Aronson, one of the most impactful parts of the experience was the one-on-one time with Byrne, who is a "wealth of information in and of himself."

"I would definitely recommend this experience to anyone, even if their research interests don't seem directly clinically relevant," says Aronson. "In the lab, you typically only work with small areas of the brain, but this is an incredible opportunity to look at the whole brain from a different perspective. It just shows you what a mystery the brain really is, and how much work there is still to be done!"

To learn more about the Clinical Connection Training Module, visit bcs.mit.edu/graduate/research-programs

Photo credit: Shutterstock



MIT Launches the Quest for Intelligence

Institute-wide initiative will advance intelligence research

Edited by: Sara Cody and Rachel Donahue Photo credits: Kris Brewer | CBMM



Jim DiCarlo

Imagine if the next breakthrough in artificial intelligence came from a deeper understanding of the root of intelligence itself: the human brain. Since the launch of the MIT Quest for Intelligence (The Quest) this spring, BCS faculty have been brainstorming moonshot projects that approach this grand vision. With big questions focused on recognition, perception, learning, language, emotion, and creativity, each moonshot project will seek to address scientific and engineering goals to achieve true progress in understanding intelligence. And this is just the beginning.

The Quest is comprised of two linked entities: “The Core and The Bridge.” Working within “The Core,” BCS faculty aim to advance the science and engineering of both human and machine intelligence. A key output of this work will be machine-learning algorithms. The second entity, “The Bridge” will be dedicated to the application of MIT discoveries in natural and artificial intelligence to all disciplines, and it will host state-of-the-art tools from industry and research labs worldwide.

“Discovering how the human brain works in the language of engineers will not only lead to transformative A.I.,” said BCS Department Head Jim DiCarlo in an opinion article published in *WIRED*. “It will also illuminate new approaches to helping those who are blind, deaf, autistic, schizophrenic, or who have learning disabilities or age-related memory loss. Armed with an engineering description of the brain, scientists will see new ways to repair, educate, and augment our own minds.”

Interested in learning more about the moonshot projects? Email bc_s_news@mit.edu

MIT has been on the frontier of intelligence research since the 1950s, when pioneers Marvin Minsky and John McCarthy helped establish the field of artificial intelligence. MIT now has over 200 principal investigators whose research bears directly on intelligence. Researchers at MIT’s Computer Science and Artificial Intelligence Laboratory (CSAIL) and the MIT Department of Brain and Cognitive Sciences (BCS) collaborate on a range of projects. MIT is also home to the National Science Foundation-funded center for Brains, Minds and Machines (CBMM) — the foundation of the Quest Core.

Other researchers participating in The Quest include members of the Media Lab, the Operations Research Center, the Sloan School of Management, the School of Architecture and Planning, and the School of Humanities, Arts, and Social Sciences. Four years ago, MIT launched the Institute for Data, Systems, and Society (IDSS) with a mission promoting data science, particularly in the context of social systems. It is anticipated that faculty and students from IDSS will play a critical role in this initiative as well. The Quest will continue to provide resources to facilitate the interdisciplinary collaboration of MIT researchers as they work together to advance our understanding of human and machine intelligence.

This article was adapted from a story written by Peter Dizikes for the MIT News Office. ■■



Josh Tenenbaum



Laura Schulz

Core Quotes from the Quest

On March 1, MIT celebrated the official launch of the Quest by hosting a day-long symposium. The morning sessions showcased the principal entities that will make up the Quest itself: the Core and the Bridge. The Core will advance the science and engineering of both human and machine intelligence. The Bridge will be dedicated to the application of MIT discoveries in natural and artificial intelligence to all disciplines.

BCS faculty members, a few of which are mentioned here, addressed the audience about their research in understanding intelligence, and their vision for the Core.

“The human brain can do what AI systems cannot yet do. If harnessed, the science of human intelligence provides incredible opportunity to replenish the well of AI algorithms. Past successes have shown us that when engineers guide their algorithm-building efforts with measurements and discoveries from brain science, you get transformative progress [in artificial intelligence].”

Jim DiCarlo

Head, of the Department of Brain and Cognitive Sciences and Peter de Florez Professor of Neuroscience

“Success stories are based on two key algorithms in modern artificial intelligence, or machine learning: one is reinforcement learning and the other is deep learning. Both of them come from neuroscience. Mathematical theories are important to satisfy our basic curiosity for scientific understanding and for opening the way to better engineering. Both of which are what the Quest is about.”

Tomaso Poggio

Director of the Center for Brains, Minds, and Machines (CBMM) and the Eugene McDermott Professor of Brain and Cognitive Sciences

“Children are the only system in the known universe that demonstrably, reliably, reproducibly, builds human-level intelligence. So why not build AI this way? Why haven’t we yet? I think the reason is that only now do we have a scientific field studying how children learn and think that is mature enough to offer guidance for AI.”

Josh Tenenbaum

Professor of Computational Cognitive Science and CBMM Investigator

“The ways that children learn go far beyond pattern detection and prediction right from the start.

Advances in [our technology to collect this kind of data] will teach us about the how children learn in a

way that will tell us what kind of learning is possible for us and for the machines we might try to build. The Quest will take us to remarkable places and enable us to build remarkable things. But I hope it’s also the kind of quest that will bring us back to ourselves and a deeper understanding of who we are and who our children might become.”

Laura Schulz

Professor of Brain and Cognitive Sciences



Rebecca Saxe



Tomaso Poggio

“Babies start with expectations and with preferences. Babies brains prioritize images that look like faces, and babies look at faces in order to engage in contingent, meaningful social interactions. The connections between baby’s brains are already set up expecting this pattern of experience. These connections are how the brain uses its expectations, to interpret its sensations and to seek the information that it needs. If you want AI that starts like a baby, you want AI that not only learns from the input it gets, but also knows what kind of input it is looking for and can select what it learns from whom. The architecture of a baby’s brain is social right from the start.”

Rebecca Saxe

Professor of Brain and Cognitive Sciences, Associate Member of MIBR

Visit bcs.mit.edu/newsletter to watch the full presentations from the Intelligence Quest launch.

Research Bytes

Here is a snapshot of the latest research discoveries from BCS faculty and their research teams. To read the stories in full and to get the latest research news, visit bcs.mit.edu.

Distinct brain rhythms and regions help us reason about categories

In a study published in *Neuron*, BCS Prof Earl Miller (PILM), and his research team show that the ability to categorize items based on straightforward resemblance or abstract similarity arises from the brain's use of distinct rhythms, at distinct times, in distinct parts of the prefrontal cortex (PFC). Humans have this capability whether the items look patently similar — such as Fuji and McIntosh apples — or they share a more abstract similarity — such as a screwdriver and a drill. Miller says their findings suggest a model of how the brain achieves category abstractions. By precisely describing the frequencies, locations, and timing of brain rhythms that govern categorization, the findings could advance our understanding of some aspects of autism spectrum disorders (ASD), says Miller.

— **David Orenstein | Picower Institute for Learning and Memory**

Distinctive brain pattern helps habits form

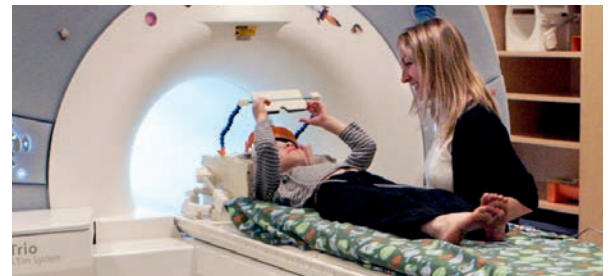
Although we may think of routines as a single task, they are usually made up of many smaller actions. For example, brushing your teeth entails picking up our toothbrush, squeezing toothpaste onto it, and then lifting the brush to our mouth. This process of grouping behaviors together into a single routine is known as “chunking,” but little is known about how the brain groups these behaviors together. Institute Professor and BCS Prof Ann Graybiel (MIBR) and her research team have now found that certain neurons in the brain are responsible for marking the beginning and end of these chunked units of behavior. These neurons, located in the striatum, a brain region highly involved in habit formation, fire at the outset of a learned routine, go quiet while it is carried out, then fire again once the routine has ended.

— **Anne Trafton | MIT News Office**

Back-and-forth exchanges boost children's brain response to language

A landmark 1995 study found that children from higher-income families hear about 30 million more words during

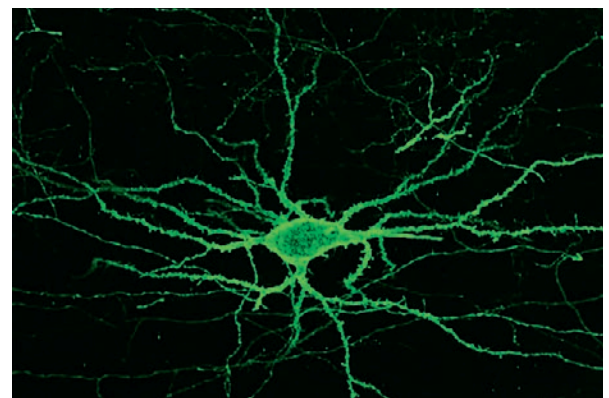
their first three years of life than children from lower-income families. This “30-million-word gap” correlates with significant differences in tests of vocabulary, language development, and reading comprehension. A study from the laboratory of BCS Prof. John Gabrieli (MIBR), the Grover M. Hermann Professor in Health Sciences and Technology, found that back-and-forth conversations between adults and children are more critical to language development than the word gap. In a study of children between the ages of 4 and 6, they found that differences in the number of “conversational turns” accounted for a large portion of the differences in brain physiology and language skills that they found among the children. This finding applied to children regardless of parental income or education. — **Anne Trafton | MIT News Office**



Seeing the brain's electrical activity

Neurons in the brain communicate via rapid electrical impulses that enable the brain to coordinate behavior, sensation, thoughts, and emotion. Scientists who study this electrical activity usually measure these signals with electrodes inserted into the brain, a task that is notoriously difficult and time-consuming. BCS Prof Edward Boyden (MIBR) and his research group have developed a new approach: a light-sensitive protein that can be embedded into neuron membranes, where it emits a fluorescent signal that indicates how much voltage a particular cell is experiencing. This could allow scientists to study how neurons behave, millisecond by millisecond, as the brain performs a particular function.

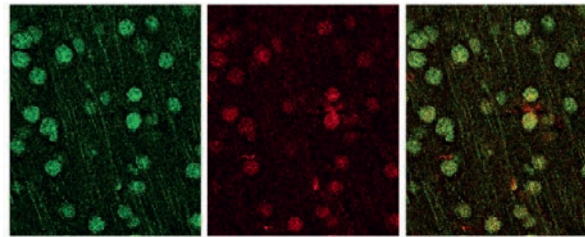
— **Anne Trafton | MIT News Office**



Study reveals how the brain tracks objects in motion

Catching a bouncing ball or hitting a ball with a racket requires estimating when the ball will arrive. Neuroscientists have long thought that the brain does this by calculating the speed of the moving object. However, a new study from the laboratory of Mehrdad Jazayeri (MIBR), the Robert A. Swanson Career Development Professor of Life Sciences, shows that the brain's approach is more complex. The new findings suggest that in addition to tracking speed, the brain incorporates information about the rhythmic patterns of an object's movement: for example, how long it takes a ball to complete one bounce. They found that people make much more accurate estimates when they have access to information about both the speed of a moving object and the timing of its rhythmic patterns. — Anne Trafton | MIT News Office

consequential in people with 16p11.2 deletion syndrome. Accounting for up to 1 percent of autism cases, 16p11.2 deletion occurs in people who are missing a small region of DNA near the center of one copy of chromosome 16. For years, scientists have been working to determine exactly how the reduced presence of 29 protein-encoding genes leads to clinical symptoms of the syndrome, such as autism-like behaviors, developmental delay, and intellectual disability. — David Orenstein | Picower Institute for Learning and Memory



Study finds early signatures of the social brain

Humans use an ability known as theory of mind every time they make inferences about someone else's mental state — what the other person believes, what they want, or why they are feeling happy, angry, or scared. Behavioral studies have suggested that children begin succeeding at a key measure of this ability, known as the false-belief task, around age 4. However, a new study from BCS Prof Rebecca Saxe and her research group has found that the brain network that controls theory of mind is already formed in children as young as 3. The MIT study is the first to use functional magnetic resonance imaging (fMRI) to scan the brains of young children as they perform a task requiring theory of mind — in this case, watching a short animated movie involving social interactions between two characters. — Anne Trafton | MIT News Office

Machine-learning system processes sounds like humans do

Using a machine-learning system known as a deep neural network, Josh McDermott, the Frederick A. and Carole J. Middleton Assistant Professor of Neuroscience, and his research group have created the first model that can replicate human performance on auditory tasks such as identifying a musical genre. This model, which consists of many layers of information-processing units that can be trained on huge volumes of data to perform specific tasks, was used by the researchers to shed light on how the human brain may be performing the same tasks. The study also offers evidence that the human auditory cortex is arranged in a hierarchical organization, much like the visual cortex. In this type of arrangement, sensory information passes through successive stages of processing, with basic information processed earlier and more advanced features such as word meaning extracted in later stages. — Anne Trafton | MIT News Office

Researchers identify important role for gene in 16p11.2 deletion autism

In a new study of one of the most common genetic causes of autism, MIT researchers, led by Mriganka Sur (PILM), the Newton Professor of Neuroscience and director of the Simons Center for the Social Brain at MIT, have identified a molecular mechanism that appears to undermine the ability of neurons in affected mice to properly incorporate changes driven by experience. The findings suggest that a particular gene, MVP, is likely



Cognitive scientists define critical period for learning language

A great deal of evidence suggests that it is more difficult to learn a new language as an adult than as a child, which has led scientists to propose that there is a “critical period” for language learning. However, the length of this period and its underlying causes remain unknown. A new study out of BCS Prof. Josh Tenenbaum’s lab suggests that children remain very skilled at learning the grammar of a new language much longer than expected — up to the age of 17 or 18. However, the study also found that it is nearly impossible for people to achieve proficiency similar to that of a native speaker unless they start learning a language by the age of 10. The findings are based on an analysis of a grammar quiz taken by nearly 670,000 people, which is by far the largest dataset that anyone has assembled for studying language-learning ability. — **Anne Trafton | MIT News Office**

Calcium-based MRI sensor enables more sensitive brain imaging

BCS and BE Prof Alan Jasanoff (MIBR) and his research group have developed a new magnetic resonance imaging (MRI) sensor that for monitoring neural activity deep within the brain by tracking calcium ions. Because calcium ions are directly linked to neuronal firing — unlike the changes in blood flow detected by other types of MRI, which provide an indirect signal — this new type of sensing could allow researchers to link specific brain functions to their pattern of neuron activity, and to determine how distant brain regions communicate with each other during particular tasks. In tests in rats, the researchers showed that their calcium sensor can accurately detect changes in neural activity induced by chemical or electrical stimulation, deep within a part of the brain called the striatum. — **Anne Trafton | MIT News Office**

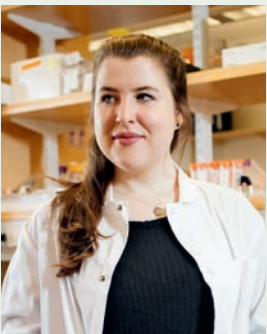
In Their Own Words



“Computational neuroscience is a lot about modeling the actual neurons themselves. ... In the future, I want to do research in cognitive neuroscience. I think it’s very important to have a very solid statistical and mathematical background, and I hope that studying computational neuroscience will give me that.”

Liang Zhu’18

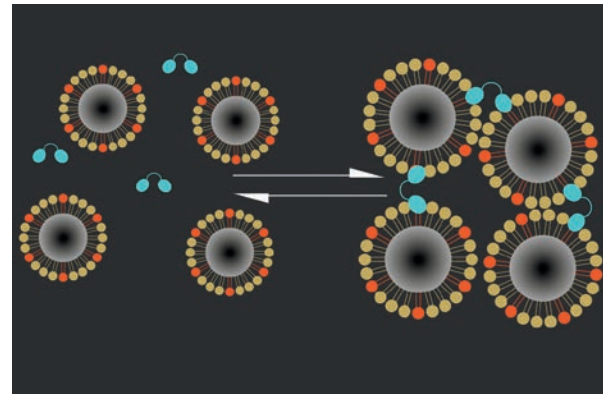
On his experience working in Prof. Josh Tenenbaum’s lab
Photo credit: Ian MacLellan | MIT



“It can often take months or even years to produce results you want in research. I’m really appreciative of the opportunity to understand what goes on behind the scenes and to know that the work I’m doing today, no matter how small a part, can possibly help someone in the future. That’s what really drives me.”

Isabella Pecorari’18

On her experience working in Profs. Ann Graybiel and Guoping Feng’s labs
Photo Credit: Jake Belcher | MIT



Brain circuit helps us learn by watching others

It’s often said that experience is the best teacher, but the experiences of other people may be even better. If you saw a friend get chased by a neighborhood dog, for instance, you would learn to stay away from the dog without having to undergo that experience yourself. This kind of learning, known as observational learning, offers a major evolutionary advantage, says BCS Prof Kay Tye (PILM). Tye and her colleagues at MIT have now identified the brain circuit that is required for this kind of learning: the anterior cingulate cortex (ACC) transmits socially-derived information to the basolateral amygdala (BLA), where it assigns predictive value to enable social cognition. — **Anne Trafton | MIT News Office**

A Lecture, A Love Story

The annual Margaret Bidwell Memorial Lecture brings BCS community together to learn more about brain diseases and disorders

Standing before a packed auditorium filled with members of the BCS community, György Buzsáki, Professor of Neuroscience at NYU School of Medicine, addressed the crowd about his research on neural syntax, or how the brain processes and organizes sensory information to support cognitive function. Buzsáki was this year's distinguished guest speaker for the Margaret Bidwell Memorial Lecture. The lecture, part of the MIT Colloquium on the Brain and Cognition series, was made possible by a gift established in 1997 by John B. Bidwell (MIT SB 1963, MCP 1966), in honor of his late wife.

"John was very connected to the educational mission of the Institute," says Prof. Mriganka Sur, Newton Professor of Neuroscience and Director of the Simons Center for the Social Brain, who oversaw the gift during his time as Department Head of BCS. "He tapped into his life savings to establish this lecture as a heartfelt way to remember his beloved wife's legacy. It is a shining example of the impact that gifts of all sizes can have on the department."

In the early 1950s, Margaret was a widowed single mother of two young children working at the Hingham Ammunitions Depot, a local naval base. John was stationed there as an active member in the Navy, where he eventually attained the rank of captain. According to John's stepchildren Edward Donlon and Mary Gegler, the couple "balanced each other beautifully." Margaret and John married in 1960.

Throughout his life, John fostered a deep connection to MIT and a lifelong love of learning. He had earned his first Bachelor's degree from Harvard University in 1954, and later attended MIT, earning a second Bachelor's degree in economics and a Master's degree in urban planning. John stayed on at MIT after his graduate studies, working in the urban planning department until his retirement in 1998.

"My mother was so supportive of John's desire to further his education," remembers Gegler. "Sometimes he would lose track of time, studying on campus until late into the night. My mother would drive to Cambridge from our home in Milton to pick him up, no matter how late it was."

In 1981, Margaret was diagnosed with amyotrophic lateral sclerosis (ALS), a progressive neurodegenerative disease that impacts the neurons that control muscle movement. As her health declined, John became her primary caretaker and advocate until her death in 1983. After years of careful research, John decided how he wanted to memorialize his wife as he neared retirement. John and his family had witnessed the cognitive impact that ALS had on Margaret. John wanted his gift to support basic science research in the area of brain disorders, which is



John B. Bidwell
Photo provided by Bidwell family

how he ultimately selected BCS to receive his gift. And that's when he approached Sur in BCS.

"We discussed options for his gift to the department, and I suggested a lecture series centered on brain disorders and diseases endowed in his wife's name," says Sur. "We don't have a medical school at MIT, but we are basic scientists with a deep connection to these diseases, and this was our first focused effort to bring our faculty and students together with experts in the field of brain disorders. It paved the way for some of our most successful initiatives, like the Simons Center for the Social Brain and the MIT Aging Brain Initiative."

John attended the lectures until his death in 2017. Donlon and Gegler have continued the family tradition by attending the lecture as their schedules allow, and each year they are blown away by the scope of the event, noting their appreciation that John created a meaningful lasting memory of their mother.

"John's love for MIT was boundless, and he felt confident that the research and community and that it was the best way to establish a lasting legacy in our mother's legacy," says Donlon. "While we aren't scientists ourselves and may not understand the topics of the lectures, the important thing is that someone in the audience does, and the impact of that is enormous. It really was a perfect act of love for our family that upholds John's belief that you could enrich your life through education." ■■

To learn more about making a gift to BCS, visit bcs.mit.edu/give-bcs

Community Highlights



1. BCS Department Head Jim DiCarlo presented the 2017 BCS Teaching and Mentorship Awards at the the 2018 Hans-Lukas Teuber Memorial Lecture. Faculty recipients of BCS Teaching and Mentorship with their awards. Awards include (l to r) Kay Tye, Bob Desimone, Myriam Heiman, Elly Nedivi, Josh McDermott and Earl Miller (not pictured).



2. Graduate student recipients include (l to r) Top Row: Julia Leonard, Amanda Vernon, Dustin Hayden, Luke Hewitt, Tobias Kaiser, Maddie Pelz, Matthias Hofer, Daniel Estandian and Joyce Wang Bottom Row: Rachel Magid, Anthony Martorell, Maddie Cusimano, Rosa Lafer-Sousa. Not pictured: Kelsey Allen



3. At the Academic Expo, Course 9 undergrads Katie O'Neil'19, Nathan Munet'19, Amy Zhang'19, Habiba Noamany'20, and Jeremy Lin'19 were on-hand to chat with prospective majors about their experiences at MIT.

Noteworthy News

Prof. **Josh McDermott** received a Troland Research Award from the National Academy of Science, citing his “groundbreaking discoveries about how people hear and interpret information from sound in order to make sense of the world around them.”

Prof. **Feng Zhang** was a recipient of the 2018 Vilcek Prize, which honors the contributions of immigrants to the United States and to foster appreciation of the arts and sciences. Zhang was also elected to the American Academy of Arts and Sciences and the National Academy of Sciences.

Prof. **Ed Boyden** received the 2018 Gairdner International Award, Canada’s most prestigious scientific prize, for his role in the discovery of light-gated ion channels and optogenetics, a technology to control brain activity with light.

Prof. **Rebecca Saxe** was a recipient of the MIT Committed to Caring Award, which recognizes faculty members who are nominated by graduate students as outstanding mentors.

Prof. **Nancy Kanwisher** received the 2018 Heineken Prize, the Netherlands’ most prestigious scientific prize — for her work on the functional organization of the human brain. Kanwisher also received the 2018 Davida Teller Award, established to honor women vision scientists who have made exceptional contributions to the field of vision science and also have a strong history of mentoring.

Prof. **Emery Brown** was inducted into the Florida Inventors Hall of Fame in recognition of his research that has advanced anesthesiology.

Prof. **Ann Graybiel** was a recipient of the 2018 Gruber Neuroscience Prize in recognition of her pioneering work in the structure, organization and functions of the basal ganglia.

The recipients of the Angus MacDonald Award for Excellence in Undergraduate Teaching by a Graduate Student include **Joyce Wang, Luke Hewitt, Matthias Hofer, Maddie Cusimano, Kelsey Allen, Rosa Lafer-Sousa, Tobias Kaiser, Dustin Hayden** and **Madeline Pelz**.

The recipients of the Walle Nauta Award for Excellence in Graduate Teaching by a Graduate Student are **Anthony Martorell** and **Daniel Estandian**.

The recipients of the Walle Nauta Award for Continuing Dedication to Teaching by a Graduate Student are **Amanda Vernon, Julia Leonard** and **Rachel Magid**.

Josh McDermott received the BCS Award for Excellence in Undergraduate Advising.

Elly Nedivi received the BCS Award for Excellence in Undergraduate Teaching.

Bob Desimone and **Earl Miller** received the BCS Award for Excellence in Graduate Teaching.

Myriam Heiman received the BCS Award for Excellence in Graduate Mentoring.

Kay Tye received the BCS Award for Excellence in Postdoctoral Mentoring.

To view the full list of noteworthy news, view the newsletter online at bcs.mit.edu

BCS Welcomes New Associate Professor

Alexander "Sasha" Rakhlin studies models of learning and decision-making

By Sara Cody

For Prof. Alexander "Sasha" Rakhlin, mathematics is so much more than numbers and equations on a page. Growing up in Russia, he attended one of the top math schools in the country, but it wasn't until he studied computer science and statistics as an undergraduate at Cornell University when he realized its true potential to have a direct impact on the world.

"I became fascinated with the idea that one can mathematically model the process of learning from data or from experience in the outside world, write a computer program based on the model, and observe the learning process in front of your eyes" says Rakhlin. "That led to my interest in the brain. I was interested in the mechanisms of how learning can be implemented, and in understanding it in computational terms so we can build models to replicate that phenomena in man-made systems."

Rakhlin's interest in the brain and statistical expertise drew him to MIT, where he completed his graduate studies with Prof. Tomaso Poggio, who is currently the director of the Center for Brains, Minds and Machines (CBMM), founded in 2005. Rakhlin joined the predecessor of CBMM, the Center for Biological & Computational Learning, which was founded in 1992 and combined mathematics, engineering, and neuroscience to better understand biological and artificial intelligence. According to Rakhlin, statistics is an important tool in computational neuroscience, particularly when trying to understand how learning works in an intelligent system.

"Statistics plays a huge role in neural research because it provides the necessary tools for extracting signal from noise, for finding structure in the data. In fact, a lot of progress in areas like machine learning came in a large part from theoreticians suggesting new methods based on their analyses," says Rakhlin. "In addition to classical statistical approaches, I think that our research should focus on building models that learn sequentially from data since that is how a person learns. We can see what works, what doesn't work, and update the models as we learn from experience."

Post-graduate school, Rakhlin honed his research program at the University of California at Berkeley for his postdoctoral training and as a faculty member in the Department of Statistics at the University of Pennsylvania. Today, his research focuses on models of learning and decision-making. He has devoted a large part of his research to developing the theoretical and algorithmic foundations of online (sequential) learning in dynamic environments. He began this research by



Professor Alexander "Sasha" Rakhlin
Photo credit: The Wharton School

studying extensions of classical statistical techniques for independent data and later switched to the more realistic and challenging problem of modeling dependent data.

His work has resulted in a range of new methods for making online predictions that show excellent performance on real-world data. Most notably, his active research in online learning is pointed at one of the most important open questions at the intersection of the brain sciences and artificial intelligence — how does the brain learn so efficiently relative to current machines? Rakhlin is currently setting up his teaching program here, where he hopes to focus on the statistical analysis of neural data, machine learning, and more.

With the Department's commitment to intelligence research through CBMM and the newly-formed MIT Intelligence Quest initiative, Rakhlin looks forward to expanding and strengthening the connections between BCS and other MIT centers, such as IDSS, CSAIL and more.

"For me, the most exciting thing is how math has a real impact on the world. IDSS will coach students in mathematical and applied statistics and ensure that it has real-world applications, including economics, computer science, and of course, brain and cognitive sciences," says Rakhlin. "I see a lot of opportunity for natural synergy between BCS and IDSS, particularly when incorporating computational approaches in neuroscience research, and I'm excited to help build that bridge to the benefit of the wider MIT community." ■

Making Preventive Medicine More Accessible

MIT senior Anjali Misra is drawn to health care problems that don't have easy answers.

By Fatima Husain | MIT News Office

Anjali Misra spends a lot of time attending to those who need help the most. On a typical day, the MIT senior and certified emergency medical technician can be found behind the wheel of the MIT ambulance or leading training sessions in CPR and first aid across campus. So far, Misra has helped facilitate the training of more than 1,000 MIT community members.

"I like the idea of being the kind of person who can help in a crisis," she says. "I think that getting to do something similar as a career would be ideal."

Misra, who is majoring in brain and cognitive sciences and minoring in music, has her eyes set on medicine: "I knew for my entire life that I wanted to be a doctor. I was one of those strange kids who from 2 years old had a vision."

That vision brought Misra from Cedar Rapids, Iowa, to Cambridge, Massachusetts, though she admits that "the idea of trying to pursue medicine at an institute of technology seemed a bit incongruous" at first. She turns to her career role model, physician and author Atul Gawande, to explain how her MIT education has been crucial to her approach to medicine.

"He said that science is a commitment to a systematic way of thinking," she says. By approaching medicine systematically, Misra hopes to "solve problems that don't really seem to have answers on the surface."

She's referring in large part to problems that span both public health and medicine: preventable diseases, which are exacerbated by disparities in access to health care. During her high school years in Cedar Rapids, Misra witnessed firsthand the inaccessibility of health care in rural communities.

When she volunteered at her local hospital, she began to notice that some of the patients visiting the emergency room suffered from chronic, unchecked medical conditions — and that the visits could have been avoided if the patients had access to regular care. "To me, that is an area for great improvement in health care," Misra says.

To best equip herself with the tools to tackle preventable disease, Misra, a 2018 Mitchell Scholar, will pursue a master's degree in public health at University College Cork in Ireland before returning to the U.S. to pursue medicine.

"Having a chance to see how a different country addresses similar [public health] problems," she says, "hopefully sets me up to keep an open mind as I try to pursue all of these things in my own career." She hopes to use her undergraduate and graduate education to become an effective physician who helps improve her patients' lives. "As soon as I become comfortable [as a practicing physician], then I can start to incorporate advocacy from a really early part of my career," she says. "I don't want to wait until the very end to do that." ■■

Anjali Misra
Photo credit:
Jake Belcher | MIT

