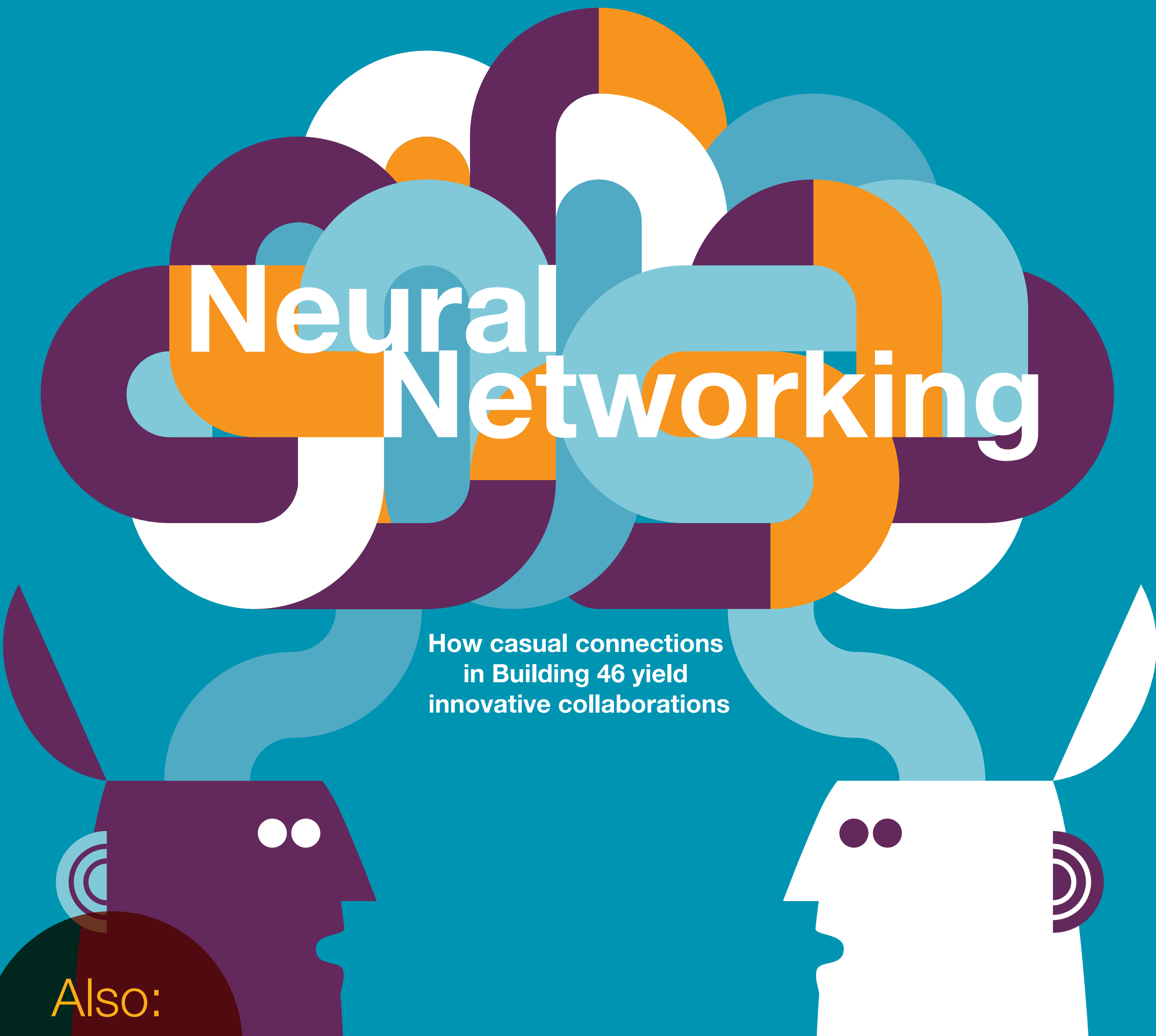
Fall 2020

bcs news



Neural Networking

How casual connections in Building 46 yield innovative collaborations

Also:

BCS during the pandemic

New momentum for equity and justice

MIT | brain+cognitive sciences

From the Department Head

Dear Friends,

Six months ago, the arrival of Covid-19 upended normal daily life. Since then, we have made unprecedented adjustments in how we learn, teach, and conduct research. Amid these circumstances, our community continues to be both remarkably productive and resilient.

Following the sudden halt to most on-campus work in March, MIT has gradually ramped up lab-based research and other essential on-campus work. Through the downs and ups we have been able to maintain the vital collaborative and collegial relationships that make the Building 46 community unique in scope and impact. This issue of BCS News highlights some of those collaborations (page 7) and the way they arise organically.

On the academic front, this fall the department welcomed nearly double the number of undergraduate majors than last year, thanks to the rapid growth in Course 6-9 (Computation and Cognition), a partnership with the Department of Electrical Engineering and Computer Science. Our new class of graduate students is exceptionally strong, bolstered by an increase in women and traditionally underrepresented communities.

Our community has also come together with renewed energy on addressing anti-Black racism (see page 16). Urged on by graduate students and others in our community, building leadership has committed to identify and understand the impact of systemic racism and to make measurable progress on building a more equitable and inclusive community.

I am continually impressed by our community's dedication, resourcefulness, and creativity. I believe we will come through these experiences stronger, more resilient, and more supportive. I hope you and your loved ones are safe and healthy, and that this challenging time has set the stage for a better year to come.

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

BCS Leadership

Rebecca Saxe, PhD
John W. Jarve (1978) Professor in Brain and Cognitive Sciences
Associate Department Head

Michale Fee, PhD
Glen V. and Phyllis F. Dorflinger Professor of Neuroscience
Associate Department Head of Education

On the Cover

Sharing the physical space of MIT's Building 46 triggers a unique sharing of ideas, approaches, and techniques—mind melds that often lead to innovative new research.
Illustration credit: ©Getty Images

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New Faculty

Evelina Fedorenko
Image credit: Caitlin Cunningham/McGovern Institute

Evelina Fedorenko pioneers *in-vivo* imaging and analysis in humans to study how language is generated, processed, and understood.

"Most of the work that I've done is trying to understand how we take an utterance and decode meaning from it." But as she points out, language is a two-way street. While there has been much work on how language is received, processed, and understood, much less is known about how a thought becomes an expression. "Half of the time we use language, we use it to produce something. Just in the last year, we've started doing a lot of work on production even though it's much, much harder to study."

Ev is no stranger to BCS; she earned her PhD here in 2007 and remained as a postdoc and research scientist, retaining her BCS affiliation when she became an assistant professor at Harvard Medical School and an associate researcher at Mass General. She "returned" to BCS last summer, joining the faculty as Assistant Professor of Cognitive Sciences and Associate Member of the McGovern Institute; in January she was promoted to associate professor. @ev_fedorenko

Morgan Sheng

Another familiar face in BCS, **Morgan Sheng** returned to the department last fall as professor of neuroscience, a position he also held from 2001–08; the years in between were spent as vice president for neuroscience at Genentech. Morgan is author of more than 200 peer-reviewed publications focused on the molecular mechanisms underlying the structure and plasticity of synapses and the molecular-cell biology of neurodegeneration. Now a core member of the Broad Institute, Morgan co-directs their Stanley Center for Psychiatric Research; he is also affiliated with the McGovern Institute and the Picower Institute.

David Rand
Image credit: M. Scott Brauer

David Rand has gained new visibility in recent months as an expert on Covid-19 misinformation in social media, one facet of a research thrust that uses cognitive science to study human decision-making in areas such as cooperation and political preference. Rand was named last year as the Erwin H. Schell Professor and an associate professor of management science and brain and cognitive sciences in a joint appointment with MIT Sloan. As noted in an April profile by MIT News, David also spent many years as a guitarist. "Being an academic is like being in a punk-rock band," he says. "In both cases, you start by trying to come up with a new idea that nobody's used before. In academia, it's a good research idea, and in music it's a cool riff or melody. Then you take that kernel and spend a lot of time developing it into this cohesive whole that you try to make a perfect as possible." @DG_Rand

Tenure and Promotion

Associate Professor Michael Halassa was named a Class of 1958 Career Development Professor.

Elly Nedivi was named the inaugural William R. (1964) And Linda R. Young Professor.

Feng Zhang was promoted to Full Professor.

Virtually Engaged

Adjusting to online courses, BCS makes the most of the new environment

by Tristan Davies

Call it *terra semi-cognita*: Students and faculty returned this fall to a world of online classes, a continuation of the remote learning that began unexpectedly in March when the pandemic arrived and students were sent home. The difference this time is that there was a summer to work on adjusting courses to suit the online platform.

While most faculty didn't have to drastically change course material, Academic Administrator Sierra Vallin notes, "They have altered the delivery to keep students engaged, pausing to ask for questions frequently."

Another change was rethinking how to assess progress. "We completely threw out exams in 9.01 [Introduction to Neuroscience,] and replaced them with frequent, low-stakes quizzes—almost weekly," adds Laura Frawley, PhD, course coordinator and teaching lab supervisor. "We believe this has encouraged students to stay on top of the material more than they would have if we had fewer, higher-stakes, exams."

Jade Daher, a fourth-year Course 9 student, noticed the effort. "I've really appreciated how much care the faculty have put into making sure that lectures and labs continue to be as engaging and informative for us as they would be in person, and that they are encouraging us to participate and stay connected with our peers while still being accommodating of everyone's situations."

Other improvements from the spring include:

- A new learning platform, Canvas, which replaced the homegrown Stellar system in June and has "gotten great reviews thus far," says Vallin.

- Technologies such as Panopto and sli.do which extend the capability of Canvas and Zoom and make teaching more interactive.

Jade Daher

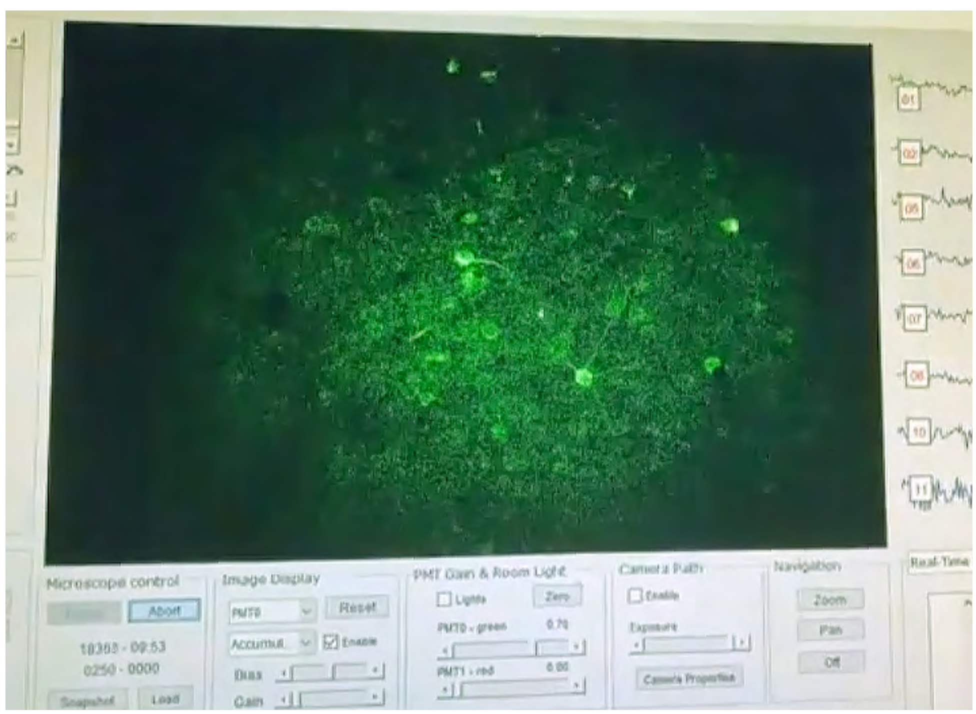
- Better awareness of each student's situation—for example, scheduling recitations so that students can attend even if they're in time zones on the other side of the world.

Vallin and Frawley agree the greatest challenge was 9.17, Systems Neuroscience Laboratory. When taught in person, the class is one of students' first opportunities for hands-on design, research, and analysis. How to translate this to remote learning? "We are doing this by incorporating avatar-style labs in which an experimenter performs an experiment at MIT live while responding to our students' input. This method also enables students to be involved in complicated and advanced experiments they otherwise would not have access to," says Frawley. "Students in 9.17 seem to really enjoy the course and are very engaged."

While faculty and instructors deeply miss seeing their students in person, the shift online has not been as much of a setback as was feared. "Although I absolutely miss attending lectures in person, I actually like that so many classes are recording synchronous lectures to be available to students again for later use," says Daher.

"I am pleasantly surprised by how well both 9.01 and 9.17 are going," says Frawley, "far better than I anticipated."

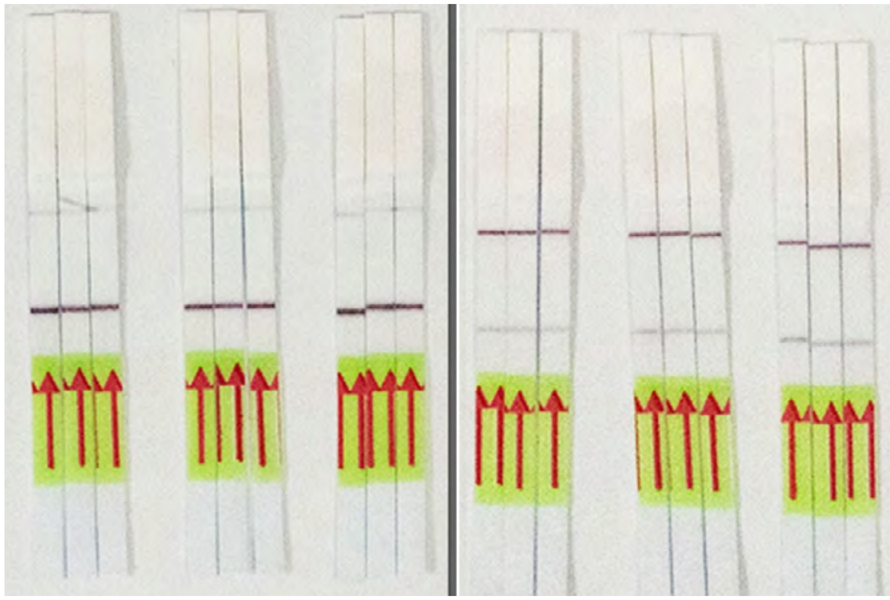
Says Vallin, "It seems as though learning virtually has in some way lowered the barrier between students and instructors. I think the instructors have done a great job of minimizing student stress which in turn humanized them. That is a great thing.



Even remotely, students in 9.17, Systems Neuroscience Lab, are able to get an up-close look at live data collection, in this case neuronal activity (brighter green spots and peaks on the recording traces) visualized during the class session in an awake and behaving mouse.

BCS Investigates Covid-19

When the SARS-CoV-2 coronavirus emerged as a global threat in early 2020, numerous investigators in the Department of Brain and Cognitive Sciences and Building 46 quickly turned their attention to understanding the virus and its effects. From novel test methods to organismal and social effects of Covid-19 infection, these investigators are making vital contributions.



On STOPCovid test strips, a negative result is indicated by a single line (left panel) and a positive test by two lines (right panel)
Image credit: Abudayyeh-Gootenberg lab, McGovern Institute, and Zhang lab, McGovern Institute/Broad Institute

One-step test provides rapid and sensitive Covid-19 detection

A team of researchers at the McGovern Institute for Brain Research at MIT, the Broad Institute of MIT and Harvard, the Ragon Institute, and the Howard Hughes Medical Institute (HHMI) has developed a new diagnostics platform called STOP (SHERLOCK Testing in One Pot). The test can be run in an hour as a single-step reaction with minimal handling, advancing the CRISPR-based SHERLOCK diagnostic technology closer to a point-of-care or at-home testing tool. The test has not been reviewed or approved by the FDA and is currently for research purposes only.

Our itch to share helps spread Covid-19 misinformation

When people are consuming news on social media, their inclination to share that news with others interferes with their ability to assess its accuracy. The study presented the same false news headlines about Covid-19 to two groups of people: One group was asked if they would share those stories on social media, and the other evaluated their accuracy. The participants were 32.4 percent more likely to say they would share the headlines than they were to say those headlines were accurate. “There does appear to be a disconnect between accuracy judgments and sharing intentions,” says Professor David Rand, co-author of a paper detailing the findings. “People are much more discerning when you ask them to judge the accuracy, compared to when you ask them whether they would share something or not.”

Gloria Choi
Image credit: Justin Knight/McGovern Institute

How could Covid-19 and the body’s immune response affect the brain?

To get ahead of the possible long-term neurological problems from infection, multiple labs in The Picower Institute for Learning and Memory at MIT have begun pursuing research to determine whether and how it affects the brain, either directly or via the body’s heightened immune response. For example, Picower Institute Member Gloria Choi and Harvard University immunologist Jun Huh have meticulously traced the pathway by which infection in a pregnant mother can lead to autism-like symptoms in her child and how, counterintuitively, infection in people with some autism spectrum disorders can temporarily mitigate behavioral symptoms.

Examining the social impact of Covid-19

After being forced to relocate from their MIT dorms during the Covid-19 crisis, two members of Professor Rebecca Saxe’s lab at the McGovern Institute are now applying their psychology skills to study the impact of mandatory relocation and social isolation on mental health. Graduate student Heather Kosakowski and undergraduate Michelle Hung developed a survey to measure how the social behavior of MIT students, postdocs, and staff is changing over the course of the pandemic. Survey questions were designed to measure loneliness and other aspects of mental health.

Building Cognitive Computing Bridges

MIT Schwarzman College of Computing joins to key campus partners to boost distinctive computational approaches

By Rachel Donahue

Construction begins on Vassar St. for the new MIT Stephen A. Schwarzman College of Computing.
Image credit: Rachel Donahue

"Alexa, tell me a joke."

"Why shouldn't you arm-wrestle a T. rex? He's a sore loser, and he will eat you."

Artificial intelligence is more widespread than ever, but in even the most commercially successful cases such as Amazon's Alexa assistant, it's pretty easy to tell you're not dealing with a real human. Natural intelligence has a flexibility and adaptability that we are just beginning to understand and are far from replicating in machines. Learning more about the computational underpinnings of the brain and mind might help make a better Alexa. But a more enduring value of such research would be illuminating the biological processes that underlie sensation and perception, decision-making, learning, memory, language, and other cognitive processes.

"Computational approaches are central to achieving our vision of reverse engineering the brain," says department head Jim DiCarlo, the Peter de Florez Professor of Neuroscience. "There is a real need to build formal, testable bridges that integrate across multiple levels of analysis, from molecules to systems to cognition." DiCarlo's lab, for example, has developed an iterative approach where models of visual processing and empirical electrophysiological data play off each other, resulting in computational models optimized to replicate—and thereby better understand—brain processes.

Bridging computational and biological approaches is one of BCS's most distinctive features, made even stronger when the bridges cross to other departments and disciplines at MIT.
Over the past two years, the department has launched the 6-9 Computation and Cognition major in cooperation with the Department of Electrical Engineering and Computer Science; secured a major graduate student training grant from NIH to help train the next generation of leaders in these integrative methods; expanded computational core services within BCS; and formed meaningful connections to the MIT Stephen A. Schwarzman College of Computing (SCC).

The rapid development of the SCC presents exciting opportunities for BCS through both intellectual and physical proximity. The college is creating 25 new faculty positions spanning six strategic areas, that aim to connect computing with other disciplines across MIT. One of those areas, "Computing and Natural Intelligence: Cognition, Perception, and Language," aims to close the gap between the science and engineering of intelligence, a natural fit for programmatic connections with BCS. Construction of the new SCC building began this summer next door to Building 46, and current plans are for there to be a connection between the two: a physical bridge to complement the strategic one.

Literal or figurative, the connections are vital, says DiCarlo. "Computation is essential to the future of the field of brain and cognitive science; BCS is already a world leader because this is part of our DNA. Building bridges between BCS and other parts of campus help connect us to the best resources and expertise in the world so we can create the meaningful collaborations needed to drive the field forward."

Tenenbaum Puts MacArthur Funds to Good Use

Seeding creative new projects and improving access are top priorities

By Anne Trafton, MIT News

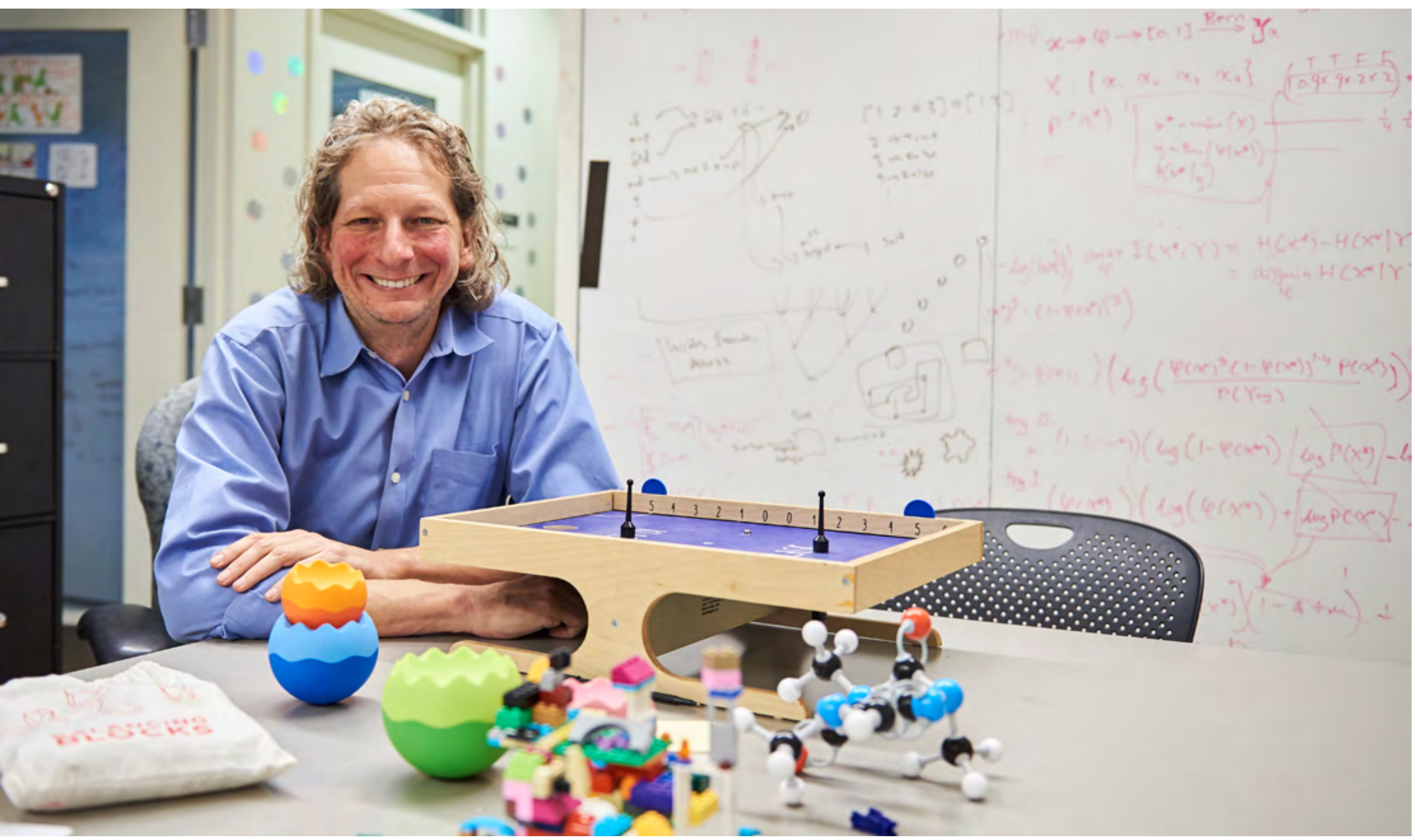
Cognitive neuroscientist Josh Tenenbaum is now well into the first year of his MacArthur Fellowship, which was announced last autumn.

The fellowships, often nicknamed "genius grants," come with a five-year, $625,000 prize, which recipients are free to use as they see fit. Tenenbaum, a professor of computational cognitive science, investigator in the Computer Science and Artificial Intelligence Laboratory (CSAIL), and Research Thrust Leader in the Center for Brains, Minds, and Machines, says he would like to use the grant money to fund some of the more creative student projects in his lab, which are harder to get funding for, as well as collaborations with MIT colleagues that he sees as key partners in studying various aspects of cognition. He also hopes to use some of the funding to support efforts to increase research participation of under-represented minority students.

Using computer modeling and behavioral experiments, Tenenbaum seeks to understand a key aspect of human intelligence: how people are able to rapidly learn new concepts and tasks based on very little information. This phenomenon is particularly noticeable in babies and young children, who can quickly learn meanings of new words, or how objects behave in the physical world, after minimal exposure to them.

"One thing we're trying to understand is how are these basic ways of understanding the world built, in very young children? What are babies born with? How do children really learn and how can we describe those ideas in engineering terms?" Tenenbaum says.

Including Tenenbaum, 24 MIT faculty members and three staff members have won the MacArthur Fellowship.



Professor Joshua Tenenbaum, now in the second year of his MacArthur "genius grant," told The Tech, "one of the things I might use the grant for is to seed new, far-out, crazy projects. The other thing is to support programs that increase access to and participation in our field for people from underrepresented groups."
Image credit: John D. & Catherine T. MacArthur Foundation

Neural Networking

How casual connections in Building 46 yield innovative collaborations

By M.R. O'Connor

Molecular biologist Elly Nedivi was looking for a microscope. Specifically, she wanted an instrument capable of taking high resolution images of entire neurons with all their dendrites and synapses in the brain of a living mouse, something no one had done before. Newly arrived at MIT as an assistant professor, Nedivi found herself at a talk given by Peter So, an associate professor of mechanical and biological engineering, and optics expert. So's openness to new ideas struck Nedivi and she approached him afterwards. "It was clear to me that he was the person," she said. So had never considered the applications of his research in microscopy to neuroscience before then. "I knew almost next to nothing about the brain," he said. "When Elly comes up to ask if I'm interested in working together to do neuroimaging, I said, 'I haven't done any, why don't we try something?'"

Since then, Nedivi, now the William R. (1964) and Linda R. Young Professor of Neuroscience, and So, now a professor of mechanical and biological engineering, have initiated a long-standing collaboration using multi-photon microscopy, a technique that can visualize fluorescent structures deep in living tissue, to track dendrites and neurons in mouse brains. Their early research supported the view

Elly Nedivi
William R. (1964) and Linda R. Young
Professor of Neuroscience
Image credit: Joshua Sarinana

that neurons in adult brains aren't hard-wired, as previously believed, but are actually remarkably plastic and capable of remodeling structurally, even growing new branch tips. They have continued to expand imaging capabilities with a microscope that uses fluorophores that can be co-excited and easily separated. This two-color synaptic imaging enabled simultaneous visualization of inhibitory synapses and dendritic spine remodeling *in vivo*. They are now working to develop the first three-color imaging techniques. It's been 20 years since their first conversation and Nedivi and So are still pioneering new instruments and insights into the plasticity of the brain, publishing some 12 papers together. Their labs are a four-minute walk apart, and their students and postdocs regularly cross the street to collaborate with one another. It's been a remarkably smooth partnership, according to So. "After many years, there is a trust personally between Elly and me," he says. As for Nedivi, she's reminded of a similar partnership in rock 'n' roll. "Elton John and his songwriter, Bernie Taupin" she says, with a laugh.

Building 46, which houses the Department of Brain and Cognitive Sciences as well as the McGovern Institute for Brain Research, Picower Institute for Learning and Memory, and several other high-profile research centers, is home to 45 faculty researchers, all dedicated to working on fundamental questions about the brain and mind. In search of answers, many of them routinely reach outside the scope of their own disciplines to work with scientists in other fields of inquiry, often with colleagues within the building. Some of these collaborations have become partnerships lasting for decades, resulting in influential publications and new ideas. For the last 18 years, Walter A Rosenblith Professor of Cognitive Science Nancy Kanwisher on the fourth floor has worked on and off with Jim DiCarlo, Peter de Florez Professor of Neuroscience and department head, on the second floor to develop and improve computational models of how the brain recognizes objects. Professor of Cognitive Science Laura Schulz on the second floor has partnered with Professor of Computational Cognitive Science Josh Tenenbaum on the fourth floor for 19 years to understand early childhood learning and the nature of memory. Since 2010, Associate Professor Mike Halassa on the fifth floor has worked with Guoping Feng, James W (1963) and Patricia T Poitras Professor of Neuroscience, on the third floor to understand how specific brain circuits relate to autism and schizophrenia. "We are lucky to have amazing colleagues here," said Kanwisher. "Many of the people I want to collaborate with most in the world are in my department."

When the complex at 43 Vassar Street was completed in 2005, it was touted as the largest neuroscience center in the world, built to bring together different disciplines in one place. The lead architect, Charles Correa (1930-2015), studied at MIT and designed the central atrium and surrounding balconies as common areas where people and ideas could commingle, creating opportunities for serendipitous discovery. Fifteen years later, Building 46 seems to have succeeded in fomenting collaborations. "The physical proximity is really important," said DiCarlo. "I see Nancy all the time. You get to know someone and you speak their language and understand where they are coming from and you are not afraid to challenge them."

Peter So
Professor of Mechanical Engineering
and Biological Engineering
Image credit: John Freidah

For Mike Halassa, who also holds a Class of 1958 Career Development Professorship, Building 46 created the opportunity for an unexpected encounter that resulted in a rich partnership with Guoping Feng. In 2010, Halassa was a postdoc studying the thalamus and its cortical interactions. As it turned out, Feng had created a new transgenic mouse, the first that would give Halassa the ability to study the thalamic reticular nucleus and its role in generating cortical rhythms. "It was so unusual because he gave it to me before he published his own paper on generating the mouse," said Halassa. This work resulted in a *Nature Neuroscience* paper published in 2011 where Halassa and Feng provided the first causal demonstration for the role of the thalamic reticular nucleus in cortical spindles, rhythms relevant to sleep function and known to be perturbed in both schizophrenia and Autism Spectrum Disorder. Three years later, Halassa was walking down a hallway when Feng saw him and said: "You wouldn't believe this but I have this amazing finding that I think you would be interested in." Feng had discovered a gene, *Ptchd1*, that seemed linked to altered sensory processing in Autism Spectrum Disorder and was specifically expressed in the thalamic reticular nucleus of the mouse during development. "What are the odds that there is this one brain region that I've established some expertise on and now one form of autism is linked to it?" said

Josh Tenenbaum
Professor of Computational Cognitive Science
Image credit: John D. & Catherine T. MacArthur Foundation

"We bring different perspectives to what we are talking about but I would say there is unlimited respect."

– Laura Schulz

Halassa. The resulting study, co-authored by both researchers, was published in *Nature* in 2016.

Other collaborations at Building 46 originated in disagreements that evolved into ongoing debates that continue to inform the research and ideas of both collaborators. Two decades ago, Josh Tenenbaum was demonstrating an experiment that showed how humans might learn the relationship between a cause and effect by separately analyzing the structure or existence of a cause and its strength. Most of the people in the room agreed with his results, but Laura Schulz strongly dissented. "She exclaimed, 'I don't see it at all,'" said Tenenbaum. "We went back and changed the experiment based on her feedback. It was tough but she was right. It worked much better, it was much more interesting. And now it's one of my most cited papers. It laid the foundation for much of my research." In Schulz's recollection, this initial disagreement transformed her understanding of the work she was doing in the field. "Learning about Josh's ideas is like walking with a naturalist: you're going up a mountain and someone points to a wildflower," says Schulz, "and then points out that it's connected to the entire geology of the landscape and to the Ice Age." The ability to challenge each other works because, according to Schulz, they share a huge amount of common ground. "We bring different perspectives to what we are talking about but I would say there is unlimited respect," she said. "It's made my work much more far reaching and vigorous."

Laura Schulz
Professor of Cognitive Science

Today, Tenanbaum and Schulz's collaboration extends beyond co-authoring papers and collaborating on specific projects. Tenenbaum says some of their most significant work is co-mentoring students. "It's a super additive benefit, being mentored by the two of us," he says. "They get to learn from our creative, productive interplay." One of their mentees was Julian Jara-Ettinger, whose doctoral dissertation won the Robert J. Glushko Prize in 2017. Now an assistant professor of psychology at Yale University, Jara-Ettinger studies how children use mental representations and computations to navigate the social and physical world. Tenenbaum proudly describes Jara-Ettinger as someone whose work "bears the stamp of what he learned and how he was trained, which was in the nature of this collaboration." Jara-Ettinger said that he felt privileged to work with Schulz and Tenenbaum because their approaches complement one another so well. "Laura sees the field from a birds-eye view, identifying and solving problems long before others have even realized that a problem is looming over our theories," he said. "And Josh has a way of taking foundational century-old problems and making their vagueness and intractability disappear."

There is also a personal aspect when it comes to sustaining a partnership, a natural inclination towards friendship. "I feel like I couldn't collaborate with someone if I didn't like them and trust them, as a human being as well as a scientist," says Kanwisher. Fifteen years ago, she describes meeting with DiCarlo so they could create a graduate seminar course and being struck by his ambition. "We would come up with a list of topics and then Jim would say, 'I want to know *how* object recognition works.' I would laugh and say, 'Well, we're not going to answer that.' Now, 15 years later, I feel like he has done more to answer that question than pretty much anyone else." DiCarlo describes Kanwisher as someone has he looked up to since the

Mike Halassa
Class of 1958 Career Development Associate Professor

beginning of his career who has now also become his friend and colleague down the hall. “It’s not just her amazing scientific mind that I learn from, but how she mentors students, and asks hard questions without offending people,” he says. “It’s an art and those are skills that I try to model from her.”

Rather than exhausting themselves, long collaborations seem to generate productivity. “We’re in the same building and space, I see him maybe once a week and we have these brainstorm meetings once a month,” said Halassa of his relationship with Feng. “I feel like we are just getting started.” Indeed, there is a sense that the longer the collaboration, the more fruitful it becomes. “I would emphasize the long-term nature of it,” said Tenenbaum. “In order to nurture students, you have to have a really long-term collaborative relationship and build ideas together.” According to DiCarlo, working with Kanwisher “feels so much more scientifically productive at this moment. This is the most exciting work that we are doing together, and it just gets more exciting because we now have working computational models to pull our previously separate lines of work together and activate totally new questions.”

In recent months, these collaborations have been put to a new test. Nearly all research stopped when the Covid-19 pandemic arose, and the comeback has been slow; labs only returned to full occupancy in mid-October. Under the mantra “work that can be done remotely, should be,” many whose work focuses on computational modeling and machine learning continued to work remotely when wet-lab research ramped up.

Within weeks of the wind-down, however, it was evident the collaborations wouldn’t be stopped. Earl Miller, the Picower Professor of Neuroscience, and Professor Ila Fiete have moved ahead on a project to study how neural rhythms move around the cortex and what that means for brain function, holding a joint lab meeting on Zoom recently where graduate student Mikail Khona presented models of how timing relationships affect those waves. While this kind of an interaction between labs would normally have taken place in person in Building 46, neither lab let the pandemic get in the way.

The habit—the desire—the need—to forge new paths continues to be as strong as ever across the Building 46 community.

M. R. O’Connor is a journalist who writes about the politics and ethics of science, technology and conservation. Her work has appeared online in The Atavist, Slate, Foreign Policy, The New Yorker, Nautilus, UnDark and Harper’s. Her most recent book is Wayfinding: The Science and Mystery of How Humans Navigate the World.

David Orenstein, Director of Communications for the Picower Institute for Learning and Memory, also contributed to this article.

Nancy Kanwisher
Walter A. Rosenblith Professor of Cognitive Science

From Collaboration to Clinic

GENUS takes the next step

A $1.8 million grant from the Part the Cloud-Gates Partnership Grant Program of the Alzheimer’s Association is funding a new clinical trial to test a revolutionary idea for slowing Alzheimer’s disease.

The light and sound stimulation technique, called Gamma ENtrainment Using Sensory Stimuli (GENUS), was developed in the labs of Picower Professor of Neuroscience Li-Huei Tsai, director of the Picower Institute; Emery Brown, Edward Hood Taplin Professor of Computational Neuroscience and Health Sciences and Technology; and Ed Boyden, Y. Eva Tan Professor in Neurotechnology, collaborating as part of the Aging Brain Initiative at MIT.

The technique originated in the observation that gamma frequency (40Hz) brain wave power and synchrony is weaker in Alzheimer’s model mice and may also be in patients. Instilling the gamma rhythms with non-invasive 40Hz flashes of visible light or 40Hz sound stimuli improved cognition and memory, prevented neurodegeneration, and reduced amyloid and tau protein buildups in animal models of the disease. Early results from human testing at MIT show that GENUS is well tolerated and increases 40Hz power and synchrony.

The clinical study, conducted in collaboration with neurologist Dr. Keith Johnson at MGH, will enroll 50 volunteers aged 55 or older who show signs of amyloid protein plaque buildup in PET scans but who remain cognitively normal. Enrollment is expected to begin soon. For more information contact Clinical Research Coordinator Danielle Stark at dstark@mit.edu.

David Orenstein, Picower Institute

Research in Brief

How the Brain Learned to Read

Reading is a uniquely human behavior that has only arisen in the last few thousand years—too quickly for the evolution of newly-specialized areas of the brain. A collaboration between the labs of Jim DiCarlo (BCS/CBMM) and Stanislas Dehaene, a professor of experimental cognitive psychology at the Collège de France, supports the idea that that parts of the brain that originally evolved for other purposes have been "recycled" for reading. As one example, they suggest that the inferotemporal (IT) cortex, a part of the visual system that is specialized to perform object recognition, has been repurposed for orthographic processing—the ability to recognize written letters and words.

Lead author on the study, which was published in *Nature Communications*, was Rishi Rajalingham, a postdoc in the DiCarlo lab.

Anne Trafton, MIT News Office

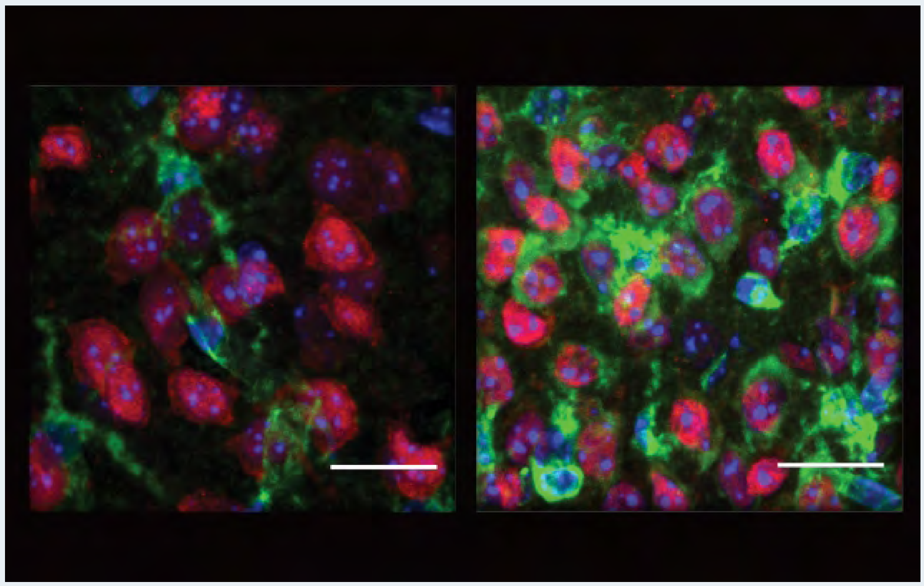
Mitochondrial RNA Release Linked to Huntington's Pathology

In the first study to comprehensively track how different types of brain cells respond to the mutation that causes Huntington's disease, researchers in Myriam Heiman's lab (PILM/Broad) found that a significant cause of death for spiny projection neurons (SPNs), a class of basal ganglia neurons that are ravaged by the disease, might be an immune response triggered by the errant release of RNA from SPN mitochondria.

"When these RNAs are released from the mitochondria, to the cell they can look just like viral RNAs, and this triggers innate immunity and can lead to cell death," said Heiman.

The research team included Heiman lab postdoc Hyeseung Lee and Robert Fenster, now at McLean Hospital, who were lead authors of the paper published in *Neuron*.

David Orenstein, PILM



MIT neuroscientists have linked the vulnerability of neurons in Huntington's disease to the release of mitochondrial RNA and an associated immune system response. In this image, on the right are neurons from a Huntington's model mouse showing much more PKR (a marker of immune response to mitochondrial RNA) in green than neurons on the left, which are from a healthy mouse.
Image credit: Hyeseung Lee

Affiliation Abbreviations

BCS: Department of Brain and Cognitive Sciences
CBMM: MIT Center for Brains, Minds, and Machines
MIBR: McGovern Institute for Brain Research
PILM: Picower Institute for Learning and Memory
SCSB: Simons Center for the Social Brain
Broad: Broad Institute of MIT and Harvard
ChemE: Department of Chemical Engineering
CSAIL: Computer Science and Artificial Intelligence Laboratory
MSE: Department of Materials Science and Engineering
Koch: Koch Institute for Integrative Cancer Research

A set of images documents one participant through multiple interactions with MIT's "Your Baby the Physicist" study. The study is one of many now made more easily accessible to participants through the new Children Helping Science collaborative. Image credit: Courtesy of the MIT Early Childhood Cognition Laboratory.

Serious Science at Home

The impact of the Covid-19 pandemic on mobility and contact prompted a group of researchers to accelerate development and launch of a website that could transform the field of cognitive development. Children Helping Science (childrenhelpingscience.com) is a massive project connecting families to hundreds of online studies of developmental psychology and cognition that they can do from home.

"It's like the Hubble telescope of child development," says Laura Schulz (BCS), who is one of six lead partners on the project. "By aggregating participants, we can ask and answer questions that would be impossible given just the resources of individual labs."

Children Helping Science aims to greatly increase the number of people who participate in studies. Schulz anticipates that having studies more easily accessible also will boost participation by families who might not have time or resources to travel for studies in person, leading to study populations that more closely represent the population as a whole.

Tristan Davies, BCS

ThreeDWorld Boosts Environmental Modeling

Computer-generated environments, and the physical interactions simulated in them, have become key tools in studies of cognition, but to date no single platform has combined high-fidelity physical and sensory rendering in a range of settings.

ThreeDWorld (TDW) does just that. Developed in a partnership with the MIT-IBM Watson AI Lab and Stanford University, TDW allows researchers to easily program and run highly realistic simulations under a wide range of conditions and with believable and realistic physical interactions for materials including solids, cloths, liquids, and deformable objects, along with real-time sound simulation, which is especially rare.

The controller code and object and environment libraries are freely available through threedworld.org. The software was largely developed by Jeremy Schwarz and Seth Alter of CBMM, and the project leaders include Josh McDermott, Jim DiCarlo, and Josh Tenenbaum in BCS and Dan Yamins at Stanford.

Tristan Davies, BCS

Mapping the Brain's Sensory Gatekeeper

The thalamic reticular nucleus (TRN) is believed to act as a gatekeeper for sensory information flowing to the cortex. A new map reveals that the region contains two distinct subnetworks of neurons with different functions.

One of these cell populations is located in the core of the TRN, while the other forms a very thin layer surrounding the core. These two populations, initially identified from patterns of messenger RNA expression, also form connections to different parts of the thalamus, researchers found. Based on those connections, the researchers hypothesize that cells in the core are involved in relaying sensory information to the brain's cortex, while cells in the outer layer appear to help coordinate information that comes in through different senses, such as vision and hearing.

The findings could offer researchers more specific targets for designing drugs that could alleviate some of the sensory, sleep, and attention symptoms of autism. "The idea is that you could very specifically target one group of neurons, without affecting the whole brain and other cognitive functions," said Guoping Feng (MIBR), one of the leaders of the research team.

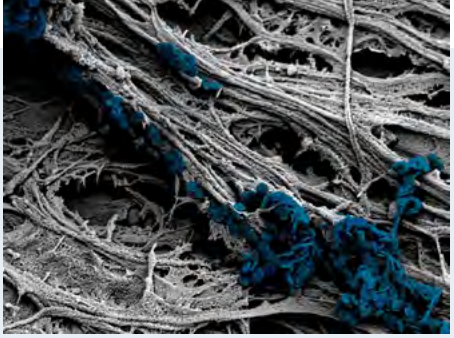
Anne Trafton, MIT News

Competition and Cooperation Revealed at Neuromuscular Junction

New work from the lab of Troy Littleton (PILM/Biology) has revealed a curious combination of cooperation and competition between two types of glutaminergic neurons innervating the same *Drosophila* muscle. The "tonic" neuron, which connects only to a single muscle, emits its glutamate at a constant but low rate while the muscle is active. Meanwhile, the "phasic" neuron connects to a group of muscles and jumps in with a strong quick pulse of activity to spring the muscles into action.

Using newly-developed tools to genetically alter the activity of each type, Biology graduate student Nicole Aponte-Santiago found that when the phasic neuron was disabled, the tonic neuron would increase activity and attempt to compensate for lost function. But the opposite was not true: the phasic neuron didn't respond to the loss of tonic input. "Even though a muscle has two distinct inputs, it can sort of uniquely control those two," Littleton says. "When the muscle is getting glutamate, does it know whether it is coming from the tonic or the phasic neuron, and does it care? It appears that it does care, that it really needs the tonic more than the phasic."

David Orenstein, PILM



A scanning electron microscope image of cultured neural cells shows newly developed nanodiscs (colored area) arrayed along the cell surface, where they can exert enough force to trigger a response. Image credit: Image courtesy of the researchers

Nanoscale Mechanical Stimulation of Neurons

In addition to responding to electrical and chemical stimuli, many neurons respond to mechanical effects, such as pressure or vibration. These responses have been more difficult for researchers to study because there has been no easily controllable method for inducing such mechanical stimulation of the cells. A team including postdoc Danijela Gregurec and Polina Anikeeva and others from MIT, Brigham and Women's Hospital, and Bunker Hill Community College have found a new method for doing just that.

The key was developing minuscule magnetic discs which flutter when subjected to a certain kind of varying magnetic field. This allows the nanodiscs to act as levers, wiggling up and down with the direction of the field.

This "opens an entire field of possibilities," said Gregurec. "This means that anywhere in the nervous system where cells are sensitive to mechanical forces, and that's essentially any organ, we can now modulate the function of that organ," bringing science a step closer to the goal of bioelectronic medicine that can provide stimulation at the level of individual organs or parts of the body, without the need for drugs or electrodes.

David Chandler, MIT News

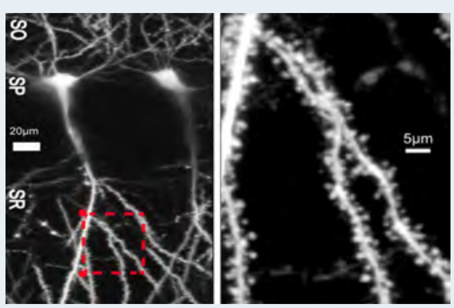
For Synapses, Size May Not Equal Strength

Synaptic plasticity—the strengthening or weakening of synapses—has been studied for decades as a mechanism of learning and adaptation. For a long time, the field's working assumption has been that functional and structural changes were closely associated: strengthening went along with an increase in synaptic spine size and weakening preceded spine shrinkage. But a study from the lab of Mark Bear (PILM) published in *Molecular Psychiatry* adds specific evidence to support a more recent view, backed by other recent studies, that those correlations are not always true.

The researchers found that activating the mGluR5 receptor in mice led to weakening of synapses in the hippocampus, but spine size did not decrease for at least an hour. In other studies, they found that blocking ion flow through another receptor, NMDAR, the synapses again weakened but did not shrink. Extending these studies to compare normal mice with mice engineered with a mutation linked to Fragile X syndrome, the study also suggested that the NMDAR pathway may provide new hope for treating Fragile X.

The study's lead authors are former lab members Aurore Thomazeau and Miquel Bosch.

David Orenstein, PILM



Within a microscope image of neurons from the hippocampus region of a rodent brain (left), a zoomed-in section (red square) of a neuron's dendrites shows spines (right) where many synaptic connections with other neurons reside. Image credit: Stephanie Barnes

Robot Plug and Play

There have been several approaches to the surprisingly tricky job of designing robots that can handle slippery and flexible materials such as cables, which constantly change shape as they are manipulated. Recently, a group of researchers from CSAIL and from the MIT Department of Mechanical Engineering pursued the task from a different angle, in a manner that more closely mimics us humans. The team's new system uses a pair of soft robotic grippers with high-resolution tactile sensors to successfully manipulate freely moving cables.

"Manipulating soft objects is so common in our daily lives, like cable manipulation, cloth folding, and string knotting," says Yu She, a postdoc in the lab of Ted Adelson (BCS/CSAIL) and lead author on a new paper about the system. "In many cases, we would like to have robots help humans do this kind of work, especially when the tasks are repetitive, dull, or unsafe."

Rachel Gordon, CSAIL

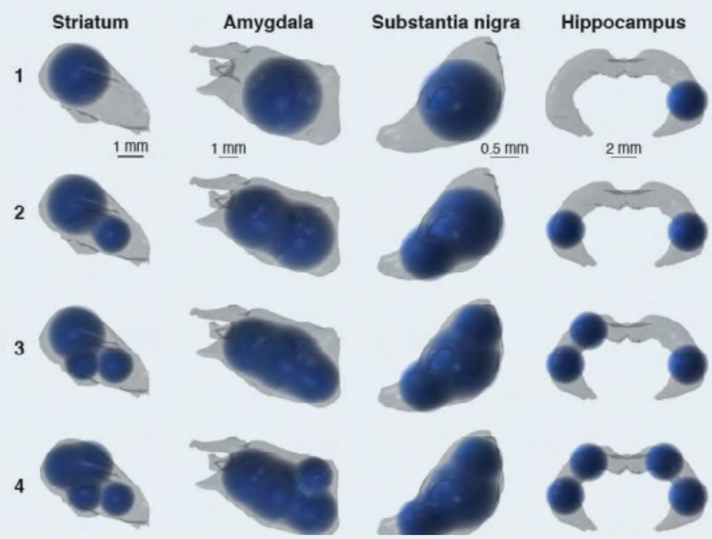
Accompanying video:
http://bit.ly/bcsnewstactile

COMMAND and Control of Drug Delivery

A team including researchers from the labs of Institute Professor Ann Graybiel (MIBR), Michael Cima (MSE/Koch) and Robert Langer (ChemE/Koch) have developed a new technique for targeting the delivery of treatments to specific areas of the brain.

"Identifying therapeutic molecules that can treat neural disorders is just the first step," says Graybiel. "There is still a formidable challenge when it comes to precisely delivering the therapeutic to the cells most affected in the disorder. Because the brain is so structurally complex, and subregions are irregular in shape, new delivery approaches are urgently needed."

COMMAND (computational mapping algorithms for neural drug delivery) is



3D renderings of simulated multi-bolus delivery to various brain structures (striatum, amygdala, substantia nigra, and hippocampus) show one to four boluses.
Image credit: Courtesy of the Graybiel, Cima, and Langer labs.

designed to help target a drug to a specific brain region with carefully calibrated injections at multiple sites. The algorithm maximizes on-target drug delivery and minimizing off-target delivery. The work was published in *Cell Reports.*

Sabbi Lall, MIBR

When Perceptions Don't Match

When your mother calls your name, you know it's her voice even over a poor phone connection. And when you see her face, you know it's hers even if she is far away. This persistence of recognition despite variability is a hallmark of human perception.

Are the invariances learned by AI models similar to the invariances learned by human perceptual systems? Graduate student Janelle Feather and Josh McDermott (BCS/CBMM) discovered that they are different—that pairs of sounds the model says are the same do not sound alike to human listeners.

The importance of this work, which was presented at the 2019 Conference on Neural Information Processing Systems (NeurIPS), lies in improving models of perception. Says Feather, "We hope that this work will provide a useful behavioral measuring stick to improve model representations and create better models of human sensory systems."

Anne Trafton, MIT News

Accompanying video:
bit.ly/bcsnewsperceptions

Study may explain how infections reduce autism symptoms

For many years, some parents have noticed that their autistic children's behavioral symptoms diminished when they had a fever. While this phenomenon is well documented, it has been unclear why fever would have such an effect.

In a study of mice, the researchers found that in some cases of infection, an immune molecule, interleukin 17A, is released and suppresses a small region of the brain's cortex that has previously been linked to social behavioral deficits in mice.

Senior authors of the study, which was published in *Nature*, were Gloria Choi (PILM) and Jun Huh (Harvard Medical School). The lead authors were MIT graduate student Michael Douglas Reed and MIT postdoc Yeong Shin Yim.

Although findings in mice do not always translate into human treatments, the study may help to guide the development of strategies that could help to reduce some behavioral symptoms of autism or other neurological disorders, says senior author Choi.

Anne Trafton, MIT News

Going to the Rain Forest to Understand Music

How does culture shape perception? A study led by researchers from MIT and the Max Planck Institute for Empirical Aesthetics in Frankfurt, Germany, found that unlike residents of the United States, where music based on octaves is prevalent, people of the Tsimane' tribe living in a remote area of the Bolivian rainforest usually do not perceive the similarities between two versions of the same note played in different registers (high or low).

"The relative pitch was preserved (between notes in the series), but the absolute pitch produced by the Tsimane' didn't have any relationship to the absolute pitch of the stimulus," says lead author Nori Jacoby, now at the Max Planck Institute for Empirical Aesthetics. "That's consistent with the idea that perceptual similarity is something that we acquire from exposure to Western music, where the octave is structurally very important."

The study, published in *Current Biology*, included authors from Harvard and the Pontifical Catholic University of Chile, as well as senior author Josh McDermott (BCS/CBMM).

Anne Trafton, MIT News

Awards and Honors

Faculty

Polina Anikeeva: 2020 MacVicar Faculty Fellow

Ed Boyden: 2020 Wilhelm Exner Medal

Emery Brown: 2020 Swartz Prize for Theoretical and Computational Neuroscience, Society for Neuroscience; Elected Member of the Board of Directors, Simons Foundation

Gloria Choi: Nancy Lurie Marks Family Foundation (NLMFF) Career Development Award; Walter B. Brewer Fund for Science Innovation

Kwanghun Chung: Presidential Early Career Award for Scientists and Engineers

Steven Flavell: McKnight Scholars Award

Mehrdad Jayazeri: MIT School of Science Teaching Prize for Graduate Education

Nancy Kanwisher: 2019 George A. Miller Prize in Cognitive Neuroscience

Earl Miller: Doctor of Science (Honoris Causa), Kent State University

Elly Nedivi: Elected Member of the Dana Alliance for Brain Initiatives

Rebecca Saxe: 2020 Guggenheim Fellowship

Morgan Sheng: 2020 Julius Axelrod Prize, Society for Neuroscience

Joshua Tenenbaum: MacArthur Award; elected to the American Academy of Arts and Sciences

Li-Huei Tsai: Elected Fellow of the National Academy of Inventors

Graduate students

Lou Beaulieu-Laroche (Harnett Lab): Harold M. Weintraub Graduate Student Award from Fred Hutch

Meredith Mahnke (Miller Lab): Covid-19 Hero

Gwyneth Margaret Welch (Tsai Lab): Ruth L. Kirschstein National Research Service Award Individual Predoctoral Fellowship

Sandya Subramanian (Brown Lab): 2020-2021 Collamore-Rogers Fellowship

Postdocs

Cassi Estrem (Flavell Lab): Ruth L. Kirschstein Postdoctoral Individual National Research Service Award

Héctor De Jesús-Cortés (Bear Lab): El Mundo Boston Latino 30 under 30 Award

Sam Rodriques (Boyden Lab) and Jonathan Strecker (Zhang Lab): 2019 STAT Wunderkind

Rachel Ryskin (Fedorenko/Gibson Labs) and Grayson Sipe (Sur Lab): School of Science Infinite Kilometer Award

Undergraduates

Katie Collins: Barry Goldwater Scholar

Vaibhavi Shah (Sur Lab UROP): 2020-2021 Barry Goldwater Scholarship

Staff

Rachel Donahue: School of Science Infinite Mile Award

Gerald Hughes: Covid-19 Hero

Taylor Johns (Sur Laboratory Manager): Infinite Mile Award, School of Science

Catherine Nunziata (McGovern Institute HQ): MIT Infinite Mile Award

Eleanor Ricci-MacPhail (Sur Lab SCSB Administrative Manager): 2020 MIT Excellence Award

BCS Departmental Awards

Mark Harnett: Excellence in Graduate Mentoring

Myriam Heiman: Excellence in Undergraduate Teaching

Roger Levy: Postdoc Award to an Outstanding Postdoctoral Mentor

Troy Littleton: Excellence in Undergraduate Advising

Sasha Rakhlin: Excellence in Graduate Teaching

Lupe Cruz, Maddie Cusimano, Mark Saddler: Angus MacDonald Award for Excellence in Undergraduate Teaching by a Graduate Student

Victoria Beja-Glasser, Mahdi Ramadan: Walle Nauta Award for Excellence in Graduate Teaching by a Graduate Student

Mika Braginsky, Tobias Kaiser, Halie Olson: Walle Nauta Award for Continuing Dedication to Teaching by a Graduate Student

Robert Ajemian: BCS Award for Excellence in Teaching

Mariana Gomez del Campo ’20: Pioneering a New Course

In only its second year, Course 6-9, Computation and Cognition has attracted more than a hundred students—one of the main reasons the number of BCS majors doubled between fall 2019 and fall 2020.

One of the first students to graduate from the program this spring was Mariana Gomez del Campo. Mariana was born in Mexico City but has lived most of her life in the U.S. She first declared a major in Brain and Cognitive Sciences with a minor in Computer Science, so when the new 6-9 major was announced she found it a better fit with her interests. We asked her about the experience.

Q. What are you interested in and why? How did that lead to you choosing 6-9?
A. I’m fascinated by the human brain. It’s an incredibly powerful and complex organ, and yet it’s so poorly understood. Intrigued by this mystery, and by the fact that every single human on this planet has one of these supercomputers inside their skull, I was drawn into MIT’s Department of Brain and Cognitive Sciences.

But as a student at MIT, it’s impossible to not feel a sense of curiosity for computer science. The interaction between these two fields is multidirectional. We can build computer systems inspired by the human brain and these neural networks are capable of solving all sorts of problems. But we can also use tools from computer science to find out more about the brain. And the more we know about how the human brain functions, the closer we’ll be to building machines that can think, sense, and act as humans do. That’s what led me to choose 6-9, rather than just studying cognitive science on its own.

Q. How does it feel to be one of the first 6-9 graduates?
A. I always say I’ve had the best time of my life at MIT. I’ve encountered a lot of challenges for sure, and it hasn’t been easy, but I’ve loved my experience here. It feels unreal to be one of the first students to receive receiving a degree in such an exciting and evolving field from an institution that is a leader in advancing human and machine intelligence research.

In August, Mariana began her first post-graduation job remotely, as a data scientist for the Advanced Analytics and Artificial Intelligence team at General Motors.

At home over the summer, Mariana Gomez del Campo ’20 (left) enjoyed improving her culinary skills, learning Mexican recipes such as tortilla soup from her mother.

> “the more we know about how the human brain functions, the closer we’ll be to building machines that can think, sense, and act as humans do.”

BCS Takes on Systemic Racism

By Tristan Davies

Like much of MIT and the nation, the Building 46 community was horrified by the killing of George Floyd, and stirred by the protest and social action movement that swelled in response. BCS and Building 46 leadership, faculty, postdocs, graduate students and staff are collaborating on actions and commitments to recognize, understand, and address systemic racism in our own community, the brain and cognitive sciences field, and society at large.

Graduate students, represented by the Gradvocates, a departmental organization that had already been formed to advance the interests of students in BCS, galvanized the BCS community, which led to a community town hall in early June. Since then, departmental administration has worked closely with community representatives to gather feedback and develop a comprehensive plan of action.

By the end of June, graduate students, staff, and postdocs had volunteered to serve on an expanded BCS Diversity Committee, and the BCS Graduate Admissions Committee had removed the requirement that applicants take the GRE. Soon after, the department brought on the Raben Group as consultants to help evaluate the current situation and plan the way forward.

Some longer-term commitments include increasing the number of participants in existing programs which already target underrepresented minorities.

The Post-Baccalaureate Research Scholars Program, a two-year program designed to prepare students to become competitive PhD applicants and successful graduate students, will grow from two students a year to six. Also targeted for growth in both size and diversity:

- The MIT Summer Research Program, which brings talented sophomores and juniors from other colleges to MIT.
- The Quantitative Methods Workshop, hosted by the Center for Brains, Minds, and Machines, which invites students from select partner institutions for a seven-day workshop on computational tools and techniques used in neuroscience.

A number of BCS labs are also working at the grassroots level to foster a more inclusive culture and build partnerships with minority-serving institutions in the Boston area and nationally.

"The pledge to take action was the easy part," says DiCarlo. "To make real and lasting change, this coordinated set of efforts must be at the very core of what we do—we must live and breathe this work every day just as we live and breathe research and education every day. To do that, we will need the power of the entire BCS community, but I know that we are each ready to join the fight."

"...To do that, we will need the power of the entire BCS community."

Image credit: Bill Montgomery/Unsplash

Rediscovering the Lure of Brain Science: Gene Stark and support for young scientists

By Rachel Donahue, PhD

"I was very disappointed with high school biology," recalls Gene Stark '68, SM '69, EE '70, SCD '72. "I had a teacher who couldn't stand the sight of blood, therefore we did no lab work. We just read the book and memorized the names for all these things."

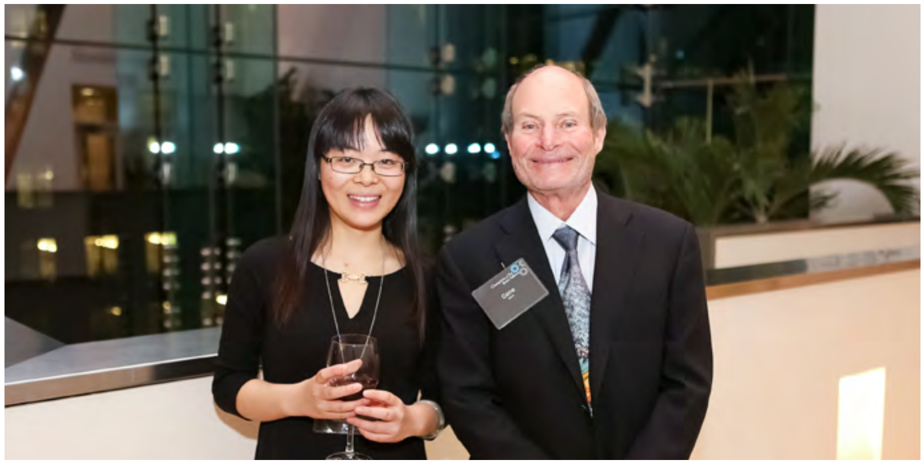
Despite this, Gene still had a kernel of interest in the mind and brain. "I had always been fascinated by the concept of psychology, so I took 9.00 from Hans-Lukas Teuber," the legendary founder of the Department of Psychology, which later became Brain and Cognitive Sciences. "I didn't know what I was getting into. Everybody said it was an easy B, but a tough A. So I said, I'm going for the tough A."

The course was indeed memorable, but Gene's interests led him in another direction. He went on to earn a BS, MS, and SciD In Electrical Engineering, spending one week shy of eight years at MIT. He went on to a long tenure as a business liaison, coordinating partnerships and helping transfer technology for commercialization, at Los Alamos National Laboratory in New Mexico. Gene is now Corporate Secretary for Arlington Industries in Scranton, Penn., an industry leader in the development of unique and innovative electrical and communications products.

Support for students

A serendipitous invitation to connect with BCS gave Gene a new way to engage with his interest in brain science. An invitation to BCS's 2013 "Brains on Brains" symposium coincided with business travel, and Gene happily accepted an invitation to the day-long event featuring faculty talks and breakout sessions.

"It was a real mind opener, very interesting. I spoke with [department head] Jim DiCarlo and other faculty at the luncheon, and immediately asked, 'what do you need?' I heard about the need for graduate student support and committed to an annual fellowship the next day."



Gene Stark, right, with inaugural Stark Fellow Yang Wu in 2014.
Image credit: Bryce Vickmark

A few years later, he endowed a fellowship. "In part it's the people, in part it's the work. You have brilliant people working on the unknown, and it's so cool to meet graduate students." Gene returns to campus often, and has opportunities to meet with his fellows, learn about their research, and hear updates on project progress. Every year, those who support graduate fellowships and research are also invited to an annual Champions of the Brain Fellows celebration.

The Stark graduate fellowship has provided support to eight students so far; the impact of this gift on helping train the next generation of scientists and innovators will be felt for many years to come.

Improving the pipeline

More recently, Gene has become an early supporter of the BCS Research Scholars Program, which was created in 2017 to provide recent college graduates from under-represented groups with additional research and academic training in neuroscience in order to prepare them for the most competitive PhD programs, including BCS's. The program is small but successful: of the six students who have completed it, four are now in doctoral programs at MIT, Princeton, and Stanford. Building on this foundation, the aim is now to enlarge the program to ten students a year.

"I am so glad to hear about its expansion. It's about helping those who are hardworking, smart, and just need a little extra time and experience to get into a great graduate school," says Gene, who recognizes that improving access to and equity in the sciences will also bring an important diversity of experiences and perspectives to research.

Gene enjoys his special connections to the research happening in BCS—not just for the science, but also because he gets to know students, "what they're doing and why and where they want to take the work in the future. Each one is different. Each one has a compelling story and is doing compelling research under outstanding faculty."

By focusing his support on scientists in the earliest stages of their careers, Gene has shown his commitment to the future. "I know it may take 10 or 20 years to, let's say, produce a Nobel Prize winner, but it's a long-term investment to fix the pipeline.

"I won't live to see many breakthroughs, but in the future it will happen and it's very important."

brain+cognitive sciences

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Fall 2020
bcs news

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BCS News is produced twice a year by the MIT Department of Brain and Cognitive Sciences, 77 Massachusetts Avenue #46-2005, Cambridge MA 02139, and distributed without charge to alumni, donors, and other BCS community members. Opinions expressed in BCS News are those of the authors and subjects, and do not necessarily represent the views of the department. Address correspondence to bcs-info@mit.edu.

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