



Massachusetts
Institute of
Technology

spring / summer 2014

bcsnews

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brain+cognitive sciences

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A Message from the Department Head

Jim DiCarlo

As department head I am often asked to present highlights of our faculty's work at events or in print. I consider it a privilege to represent such an extraordinary pool of talent aiming to reverse engineer the mind from many different angles.

In this issue of our newsletter I am excited to introduce one of our newest additions, Dr. Gloria Choi, who became an assistant professor in BCS and an investigator in the McGovern Institute last year. Her lab studies the brain's ability to attach positive or negative associations to stimuli in our environments, particularly smells. Perceptual systems have always been a strength of our department, especially vision. Along with recent addition Dr. Josh McDermott (audition), Gloria represents a new avenue by which we might understand the fundamental workings of the brain.

This issue also contains many reminders that BCS is not just our 48 faculty-members. Our Building 46 community also includes 102 graduate students, 116 undergraduates, 121 postdoctoral researchers, and over 200 staff-members. This summer we brought together representatives of all of those groups for the first-ever joint retreat with BCS, Picower, and McGovern on Cape Cod. We also held a special event to honor our administrative staff who have gone above and beyond.

If you follow neuroscience research, you have probably heard a lot in recent years about optogenetics, an exciting new set of techniques that allow researchers to turn genes on and off in a living animal using light. In this issue you'll get an introduction to an exciting application of those techniques from Christine Eckhardt, a graduate student in Dr. Kay Tye's lab. This is a great reminder that our students are not just students — they are also researchers using cutting-edge techniques on a daily basis.

For that reason, one of my top priorities as department head has been to insure that our graduate students have the support they need to continue that work. This year we created a new society, the Champions of the Brain Fellows, to bring together friends of the department who support our graduate students through fellowships. In this way they contribute to both the student's education and the research that the student performs. This evening gave them an opportunity to meet their student fellows and to be among the first to hear about their exciting on going work.

The society is one of many efforts we are making to strengthen our community at all levels. In this issue I hope you will enjoy learning about our fabulous BCS community.

On the Cover

The brain learns to anticipate sequences and can recreate meaning from limited, or noisy, information. Although each individual word of the text is garbled, the sentence can be easily read because the brain has learned to anticipate the correct sequence of letters based on prior experience. It is unknown where and how experience drives the neural plasticity that enables this ability. MIT researchers have now shown that this learning can occur in primary visual cortex, V1, where it can be studied in mice. The pseudocolor plots show patterns of cortical activation. The left half of the image shows the pattern evoked in V1 by the first element of a visual sequence, while the right half shows a similar response generated when the second element, based on the training, was expected but not presented. This surprising result suggests that the mechanistic bases of high-order cognitive spatiotemporal sequence learning can be studied in experimentally accessible sensory regions of the cortex.

Cover image courtesy of Jeffrey Gavornik and the Bear Laboratory

Editorial Board
Rachel Traugher
Pia Handsom

**Please keep
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Champions of the Brain Fellows

A new society launches celebrating graduate student fellowship support

By Rachel Traugher, BCS

MIT's graduate program in Brain and Cognitive Sciences is consistently recognized as one of the best in the world. We attract outstanding students with the discipline and creativity to make major contributions to our understanding of the brain and how it works in sickness and health. From the nature of intelligence to understanding the diseases of development and aging, we are closing in on answers to some of the most challenging problems faced by human beings.

With the federal government sequester in effect, support for these students faces grave challenges.

"Our ability to enroll graduate students in our program is contingent on whether or not we have the financial capacity to support them while they are here," says BCS Department Head Jim DiCarlo. "We are entering a golden age of brain and cognitive science research and discoveries. Now more than ever, this is a critical time to be sure we keep attracting the best minds to MIT's Department of Brain and Cognitive Sciences."

The **Champions of the Brain Fellows** was created to address this need. Launched during the summer of 2013, the society's purpose is twofold: to recognize the generosity of those friends and alumni who make it possible for BCS graduate students to explore their scientific dreams, and to encourage those who are considering supporting the graduate students of the Department.

Champion of the Champions

Among the Department's longtime supporters who answered this call are Barrie HM and AI 51' Zesiger. In 2009, when Barrie and AI learned that BCS would only be able to admit eleven students due to funding concerns, they pledged one million dollars to endow a fellowship for the Department. As the Department explored ways to recognize and encourage philanthropic support for graduate students, reaching out to them was a natural choice.

"Barrie and AI are wonderful advocates of graduate students in the Department," says DiCarlo, "I am so pleased that they are willing to help us take on this new challenge."

To inaugurate the Champions of the Brain Fellows, the Zesigers have pledged an additional one million dollars to match new fellowship donations. It is their hope that this commitment will inspire others.



BCS Department Head Jim DiCarlo with Zesiger fellow Christine Eckhardt and Barrie Zesiger

"Now is the time to invest in brain research," says Barrie Zesiger, "and MIT is the place. Together, we can make a difference."

Springtime event

On March 5, 2014, the Department hosted its first Champions of the Brain Fellows celebration. Featuring presentations by BCS graduate students Becky Canter, Barbara Weedon Fellow and Tsai lab member, Stephen Allsop, Jeffrey Halis Fellow and Tye lab member and Pedro Tsvividis, Norman B. Leventhal Fellow and Tenenbaum / Schulz lab member, the evening kicked off with a reception followed by an intimate dinner with students, faculty and fellowship supporters.



Weedon Fellow Rebecca Canter

Interested in becoming a Champion, or finding out more about the society?

Contact

Elizabeth Chadis,

Assistant Dean at
(617) 253-8903 or
echadis@mit.edu

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Brain technology at BCS

Tye laboratory graduate student and Zesiger fellow Christine Eckhardt demonstrates the techniques behind optogenetics

By Rachel Traugher, BCS

Activating neurons with light may sound like something out of a science fiction novel, but it's business as usual in the Tye laboratory. Graduate student Christine Eckhardt knows this firsthand. An MD PhD joint student with Harvard and MIT, Eckhardt uses optogenetics to study the role of the locus coeruleus in cognitive flexibility and reversal learning.

"Let's imagine that you love ice cream. The sight of a Ben & Jerry's or the sound of an ice cream truck fills you with happiness and immediately motivates you to buy your own cone. However, perhaps you develop lactose intolerance as you grow older, such that a bowl of ice cream never ends well. Being the flexible human being you are, you switch your behavior—perhaps avoiding the dessert when you see the Baskin Robbins (or in all likelihood, taking Lactaid pills). Cues that previously predicted a positive outcome now predict a negative one, and you change your behavior accordingly. I think that the locus coeruleus might play a significant role in that process," says Eckhardt.

Before implanting an optical fiber, Eckhardt must first wait for the cell bodies treated with the virus to express Channelrhodopsin in the cell membrane. The virus is a key component in the optogenetic process, making it possible to activate the neurons below the fiber with light.

"Channelrhodopsin is commonly used by many scientists working with optogenetics. This particular virus and type of Channelrhodopsin has been characterized – e.g., someone recorded at different time points using patching, or extracellular recording, and histology to see how the channel responds to light and when full expression of the virus occurs. With the virus I am using, it usually takes three to four weeks to fully express," explains Eckhardt.

After the three to four week period, it's time to implant the optrode—a combination of an electrode and an optic fiber. Eckhardt chose an electrode shaped in a very specific way to ensure maximum contact with the locus coeruleus.



BCS graduate student Christine Eckhardt hard at work in the laboratory

"If you look really closely, you can see the electrode and the top where the optic fiber goes. This is a particular type that is well suited for the locus coeruleus—it's shaped like an oblong. The electrode has the contacts going vertically, which is optimal for the shape of the LC," she says.

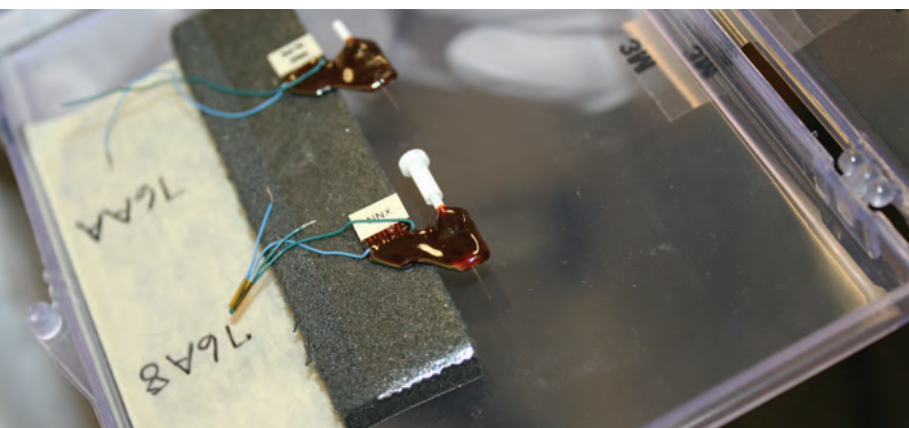
Knowing whether or not she implanted the electrode correctly and that the Channelrhodopsin has expressed is simple – when she shines light on the cells, she is able to pick up the neurons firing in a time locked manner.

As shown by the optrode, optogenetics isn't the only technology at use in Eckhardt's work. She also uses electrophysiology.

"There are a couple of techniques that fall under the umbrella of electrophysiology, but generally it means that you're picking up electrical signals from the neurons. In some cases, I may implant an electrode to pick up the change in membrane potential of the neurons. I also use patching, or taking slices from the brain and recording from individual neurons intracellularly."

Eckhardt learned these techniques on the job.

"One of the fortunate things about the Tye lab, in addition to our PI, is the experience of the postdocs and researchers who work here. They have been an invaluable resource whenever I have a question about a particular procedure or experiment I'd like to run, and they have really helped me nail down techniques and expand my intellectual framework surrounding neuroscience." ■■



Electrodes and fibers used in optogenetics research

Want to learn more about Eckhardt's work in Tye laboratory? Check out their website www.tyelab.org

BCS Community News

Community news: Sun, sand, cognition and neuroscience on Cape Cod



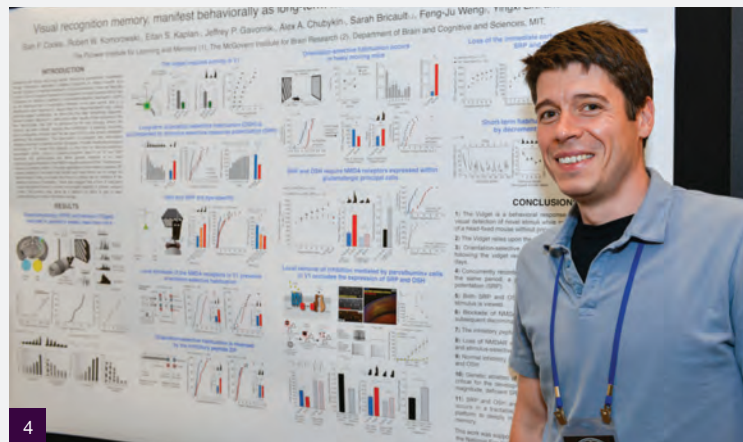
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The first ever BCS, Picower and McGovern Institute joint retreat was held on June 1-2 2014. Featuring talks from members of the three units, the two day event also included a poster session, New England clam bake and a dance party! Awards, judged by the faculty present, were given for the best talk, (Dr. Matthias Heidenreich, Zhang lab) and best posters (Dr. Ram Madabhushi, Tsai Lab and Dr. Sam Cooke, Bear Lab).

1. **Retreat attendees 2014**
2. **Attendees learning about each other's research at the poster session**
3. **Members of the McGovern Institute's headquarters staff enjoying the dance party!**
4. **Picower postdoc Sam Cooke with award winning poster**

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BCS Welcomes New Faculty

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BCS Assistant Professor
Gloria Choi

BCS Assistant Professor Gloria Choi studies how we process scent through emotion.

BCSN: Tell us a bit about what your lab studies.

Choi: People attach special meaning to the smell of coffee, a perfume, or a great white wine because they inhaled them off of a loved one or shared them with a special friend. Learning is that potential to process neutral external stimuli—like these odors—into meaningful representations that evoke emotions and behavioral responses. Thus, my lab uses olfaction as a model to understand fundamental concepts of learning and cognition. How can an odor drive behavioral responses and internal emotional states depending on one's past experiences? How and where in the brain is that learning imposed? What modulates it?

BCSN: What drew you to this field?

Choi: As a graduate student, I studied innate, stereotyped responses, focusing specifically on how they are served by subcortical structures. Rodent olfaction was a natural model as responses to certain primal scents are hardwired to allow them to find mates and food, and avoid predators. The vast majority of external stimuli, however, do not have inherent valence or behavioral significance. Instead those qualities are imposed on the stimuli through experience. This process of learning may be as important to survival and reproduction as innately wired behaviors, because it allows animals to adapt to changing environments. Thus, as a postdoc, and now as an independent researcher, I am using the olfactory system to study learning in the context of cortical processing. I find this work fascinating because the olfactory system, with its condensed pathways from sensory perception to behavior, may offer an ideal system to understand learning: that is, how interactions between innately wired and neutral stimuli shape and generate appropriate behavioral responses.

BCSN: Why did you come to MIT?

Choi: There are exciting, fundamental questions about the brain that scientists all around the world are trying to answer. To answer these questions, we need cutting edge technologies and enriching environments. With that in mind, MIT is the perfect place: being here allows me to access the most innovative tools and interact with brilliant colleagues from a multitude of domains. ■■

Interested in learning
more about the
Choi Lab?
Check out their website
www.gloriachoi.org/



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- Attendees listen attentively as BCS graduate student Jorie Koster Hale presents her research during the talk portion of the day at headquarters
- Winners of the 2014 building 46 staff awards pose with BCS Dept Head Jim DiCarlo. From left to right: Margo O'Leary, Katie Mulroy, Jim DiCarlo, Aggie Fernandes, Kate White

Noteworthy News

Faculty

Professor Emery Brown was elected to the National Academy of Sciences.

Assistant Prof. Gloria Choi was awarded the Jephtha H. and Emily V. Wade Award by MIT in support of her proposal titled *Investigating the Piriform Circuitry Underlying Learned Behaviors*.

Prof. Yingxi Lin and **Josh Tenenbaum** received BCS Awards for Excellence in Undergraduate Teaching

Prof. Molly Potter received the Davida Teller Award from the Vision Sciences Society. The award is given each year to an outstanding woman vision scientist with a strong history of mentoring.

Associate Professor Rebecca Saxe received a Troland Research Award from the National Academy of Sciences.

Lighthouse Guild Selects **Professor Pawan Sinha** as their 2014 Pisart Vision Award Winner for his research on vision and blindness.

Assistant Prof. Kay Tye is being honored this month by the Office of the Dean for Graduate Education as part of their "Commitment to Caring" program. She was nominated by her grad students for creating a lab environment in which members support and mentor each other.

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

Professors Kay Tye, Mehrdad Jazayeri, and **Gloria Choi** have each been awarded Sloan Research Fellowships. Of nine MIT researchers who received this award, three are from BCS.

The National Science Foundation names **Assistant Professor Feng Zhang** its Alan T. Waterman Awardee for 2014.

Staff

BCS Administrative Assistant for the Graduate Program **Robert Cummings** received a Spot Award from the School of Science. He was nominated by BCS Administrative Officer Pia Handsom for his work on Interview Day/Weekend.

Administrative assistant **Julianne Gale** was nominated for a Spot Award from the School of Science for her work by Kate White.

Administrative assistant **Josh Kastorf** was nominated for a Spot Award from the School of Science for his work by Pia Handsom.

BCS Undergraduate Administrator **Susan Lanza** received a Spot appreciation award from the McGovern Institute for helping students and staff to use and troubleshoot the poster printer.

BCS Financial Assistant **Toni Oliver** also received a Spot Award. She was also nominated by Pia for her work on the redesign of the BCS lobby.

Postdocs and students

Course 9 junior **Sofia Essayan-Perez** was selected as MIT's official nominee for the Barry Goldwater Scholarship.

Postdoc **Rob Komorowski** will receive the Infinite Kilometer award from the MIT School of Science or his service to the Building 46 Postdoc Committee.

Recent MIT grad and Kanwisher Lab-member **John Mikhael** has the received the Rhodes Scholarship, which will allow him to continue his study of neuroscience at Oxford University.

Congratulations to BCS class of 2014 graduates!

Ruth Abrams
Eloho Fidelia Akpovi
George H. Bailey
Zuzanna Z. Balewski
Sean Batir
Sebastian K. Begg
Mika Braginsky
Luke A. Chellis
Emily K. Chen
Nora A. Darago
Christopher M. Delgado
Aliya P. Dincer
Salvador Esparza
Ashley Gilmore
Emilio A. Gonzales
Heath P. Gould
David S. Han
Stephanie S. Holden
Da Sul Jim
Jaes C. Jones
Jared T. Katz
Nathaniel L. Kim
Jaclyn A. Konopka
Jiahao Liang
Jiayi K. Lin
Sarah R. Lund
Rebecca A. MacRae
Tomer R. Mangoubi
Christine J. Park
Joseph P. Perricone
Aviana L. Polsky
Lauren C. Quisenberry
Laya Rajan
Christine K. Rogers
Elisabeth L. Rosen
Elise L. Ruan
Hannah F. Schiller
Katalina J. Sher
Harrison R. Siegel
Emad Taliep
Samuel B. Thacker
Victoria Vega
Natalia A. Velez-Alicea
William G. Watkins
Yijing Xin

Interested in joining Champions?

\$70,000
Name one student for one year

\$325,000
Support one student a year each
year for five years

\$1 million
Support one student every year
in perpetuity

Champions

Gerald Burnett
Mark Gorenberg
Nancy and Jeffrey Halis
Anne and Paul Marcus
William McClelland
Janet and Shelly Razin
Mrs. Hubert Schoemaker
Caroline and Henry Singleton*
Eugene Stark
Barbara Weedon*
Barrie HM and AI '51 Zesiger

**deceased*

continued from p.03

“We hope this event becomes a highlight of our academic year,” says DiCarlo. “It’s our opportunity to say thank you to our donors, while creating space for them to engage with the students, learn more about their research and meet others who care about the Department’s mission.”

The Department plans to hold this event annually. Other benefits of membership include updates from students on their research and progress through their academic career at MIT. ■■

Interested in becoming a Champion, or finding out more about the society? Contact Elizabeth Chadis, Assistant Dean at (617) 253-8903 or echadis@mit.edu

Dean Mike Sipser greets BCS supporter Gene Stark, with Elizabeth Chadis and BCS graduate student Melissa Kline at the Champions dinner.

BCS Assistant Professor Kay Tye with BCS supporter Larry Hillbrand and Dean Mike Sipser at the Champions reception.

