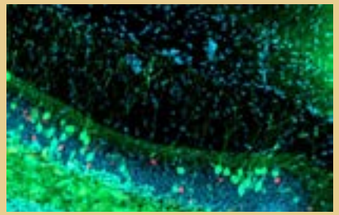
BOSTON UNIVERSITY
CENTER FOR SYSTEMS NEUROSCIENCE

Annual Report | 2022

Boston University
Center for Systems Neuroscience
Annual Report

2022

Research Spotlights



Front cover photo: *The Center for Systems Neuroscience occupies several floors of the Rajen Kilachand Center for Integrated Life Sciences and Engineering located on the Charles River Campus at Boston University*

LETTER FROM THE DIRECTOR

WELCOME TO THE ANNUAL REPORT of the Boston University Center for Systems Neuroscience (CSN). Our center brings together investigators from multiple different departments at Boston University on both the Charles River Campus and the School of Medicine, facilitating discoveries in neuroscience based on innovative interdisciplinary interactions.

The Center builds on important successes of systems neuroscience at Boston University to foster collaborations and enhance recruitment of new researchers. The Center for Systems Neuroscience has contributed to hiring of many vibrant new junior faculty members. In addition, to further support development of innovative new techniques at Boston University the CSN executive committee selects CSN Distinguished post-doctoral fellows supported by Center funding.

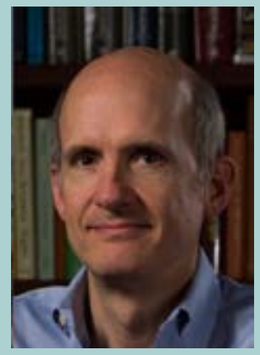
The Center for Systems Neuroscience has played an active role in obtaining and administering large scale grant support, including an Office of Naval Research MURI award which provided $7.5 million for interdisciplinary projects as well as an ONR DURIP grant. The Center also assisted in an NSF instrumentation grant obtained by Prof. Chantal Stern for a scanner for functional magnetic resonance imaging (fMRI) in the Center for Cognitive Neuroimaging.

The Center also helped obtain a second ONR MURI grant with principal investigator Prof. Yannis Paschalidis which also received a supplemental DURIP award. The Center also obtained a Boston University Kilachand Fund Award that supports work on circuit mechanisms for cognitive function and supports further interdisciplinary grant applications. The Center has done extensive work to publicize neuroscience at Boston University with an official CSN twitter account with over 1200 followers (@buCSNneuro) and a Center Director account with over 2000 followers (@HasselmoMichael).

The Center for Systems Neuroscience brings together researchers in numerous events described in detail in this annual report. These events include a lunchtime series of virtual and hybrid seminars that bring together 60-190 attendees for each seminar. The Center also organized a symposium on October 5-6, 2021 focused on recent advances in systems and computational neuroscience and has organized an upcoming symposium on October 3-4, 2022.

The materials in this annual report illustrate the success of the faculty affiliated with the Boston University Center for Systems Neuroscience. We appreciate the support of the Boston University administration, and in particular the support of Vice President and Associate Provost for Research Gloria Waters.

Prof. Michael Hasselmo
Director
BU Center for Systems Neuroscience



"Our center brings together investigators from multiple different departments at Boston University... facilitating discoveries in neuroscience based on innovative interdisciplinary interactions."

FROM THE ASSOCIATE DIRECTORS

WE HAVE CONTINUED TO EXPAND our unique strength in computational neuroscience, including multiple new tenure-track faculty with research focus in the field. Opportunities for continued growth in computational neuroscience exist within the FCDS, facilitated by co-occupancy with Mathematics and Statistics in the new Center for Computing and Data Sciences.

To that end, we intend to organize a proposal to hire an interdisciplinary computational neuroscience faculty within FCDS; the CSN is well-positioned to coordinate and advocate for such a joint proposal, involving one or more departments associated with the CSN. Through continued growth and collaboration with CSN, an opportunity exists to establish BU as Boston's hub for computational neuroscience research and education, and thereby a world leader in computational neuroscience.

As Associate Director, I organized with other CSN members proposals for the Kilachand Fund Award and two R01s. We subsequently withdrew the Kilachand Fund proposal after the project was funded by NIH (R01NS119483, 01/01/2021-11/30/2025, Total Award to BU: $1,796,072). A recent R01 proposal (Total Funds Requested: $5,699,290) was favorably scored (Impact Score 35, Percentile 21); we resubmitted in 07/2022.

As CSN members continue to advance technology for measuring neural activity, we continue to support educational resources for training in neural data analysis, including an online resource which attracts approximately 1500 users/month. We applied for NIH funding to continue development of this resource. The proposal was scored favorably (Impact score 25); we will resubmit the proposal in 10/2022.

Computational neuroscience continues to grow with the CSN. We appreciate the efforts of Provost Jean Morrison, and the Vice President and Associate Provost for Research Gloria Waters in support of this growth.

With best wishes,

Prof. Mark Kramer
Associate Director
BU Center for Systems Neuroscience

IN FY22, I HAD THE PLEASURE of joining and chairing the 2021 Boston Area Neuro Group Planning Committee, acting as the local host/organizer for our virtual meeting featuring CSN's Professor Benjamin Scott. I'll serve the same role in the fall, when our meeting will be held at BU and will highlight CSN faculty and other BU neuroscience institutes, programs, and departments.

As President of the International and Behavioural Neural Genetics Society, I helped organize program content for the 2022 meeting in Memphis, TN, including workshops on single cell RNA-seq, spatial transcriptomics, and single cell eQTL analysis.

Profs. Jerry Chen, Ryan Logan, and I applied for two grants: an internal Kilachand grant and an NSF grant to study the genetic basis of cognition, learning, and memory. Also, Professor Kathleen Kantak (MPI) and I (PI) were awarded a U01 grant (U01DA055299) to study the genetic basis of cocaine addiction model traits in rats.

I continued my involvement in Diversity, Equity, Inclusion, and Justice (DEIJ) efforts, including serving as a faculty member on the DEIJ Committee for the Graduate Program for Neuroscience (GPN). I continued my mentorship efforts, serving on CSN student committees for Jenna Libera (PI: Benjamin Wolozin), Jennifer Freire (PI: Xue Han), and Jonique George (PI: Shelley Russek), and reviewed CSN post-doctoral fellowship applications.

I represented the CSN at NIH/NIDA events, including invitations from the Division of Neuroscience and Behavior to discuss the importance of controlling for genetic drift in rodent colonies, and from NIDA Genetics, Epigenetics, and Developmental Neuroscience to lead a grant writing workshop.

I look forward to continuing to serve as Associate Director for the CSN on the MED campus and welcome suggestions for future outreach activities.

Sincerely,

Prof. Camron Bryant
Associate Director
BU Center for Systems Neuroscience

HIGHLIGHTS OF FY2022

- Administration of funding for the ONR MURI grant N00014-16-1-2832 to the Center for Systems Neuroscience, providing $7.5 million for research by Center members Profs. Michael Hasselmo, Chantal Stern, and Marc Howard, as well as administration of an ONR Defense University Research Instrumentation Program (DURIP) grant to supplement our ONR MURI grant
- Successful third year renewal based on ONR reviews for ONR MURI grant N00014-19-1-2571 obtained by Center members Profs. Yannis Paschalidis, Michael Hasselmo, Chantal Stern, John Baillieul, and Roberto Tron, providing $7.5 million for five years of research funding. The grant was supplemented with an additional DURIP award N00014-21-1-2844 for $497,047
- Funding of five Center for Systems Neuroscience Distinguished Fellows: Dr. Vicky Moya (who successfully obtained NIH F32 NRSA funding), Dr. Brenna Fearey, Dr. Cristina Delgado Sallent, Dr. Gary Kane, and Caitlin Lienkaemper
- Successful application for Kilachand Type A/B Funding by a group organized by Prof. Michael Hasselmo, including Profs. Chantal Stern, Xue Han, Yannis Paschalidis, David Boas, Joseph McGuire, Jerry Chen, and Marc Howard
- Director participation on the executive committee of the NSF research training grant (NRT) obtained by Prof. Thomas Bifano and led by Prof. David Boas
- Participation in successful search and recruitment for Neuroengineering faculty in the Department of Biomedical Engineering, Prof. Brian DePasquale.
- Maintenance of Center webpage and Twitter accounts with over 1200 followers for the Center (@buCSNneuro) and over 2000 followers for the Center Director (@HasselmoMichael) with posting of notices on Twitter as well as Facebook to publicize Center events and the accomplishments of Center faculty
- Appointment of Center Director Prof. Michael Hasselmo as Editor-in-Chief of the journal Hippocampus
- Series of lunchtime seminars organized by the Center for Systems Neuroscience
- Successful presentation of a CSN workshop on Advances in Systems and Computational Neuroscience on Oct. 5-6, 2021 organized by Profs. Chand Chandrasekaran, Benjamin Scott, and Michael Hasselmo

CENTER FOR SYSTEMS NEUROSCIENCE AT A GLANCE

88
Faculty Members

5
Staff Members

165
Currently Funded R&D Projects

$67.8M
Funding for R&D

5
CSN Distinguished Fellows

319
Peer-reviewed Publications

14
Center Events

MISSION STATEMENT & STRATEGIC PLAN

THE CENTER FOR SYSTEMS NEUROSCIENCE (CSN) at Boston University was established to provide a unifying collaborative and administrative structure designed to further enhance research, foster collaboration, and enhance recruitment of new researchers in multiple Colleges and Departments on both the Charles River Campus and Medical Campus in the field of systems neuroscience.

The Center is interdisciplinary and interdepartmental in nature and University-wide in scope. The mission of the Center is to advance research in Systems Neuroscience at Boston University with the following specific goals:

- **To enhance the profile and reputation of Boston University** for research in Systems Neuroscience, establishing an internationally recognized academic center of excellence that will attract talented young investigators for training in the experimental techniques and mathematical theories of systems neuroscience.

- **To foster collaborative research.** The Center will foster collaborations from different fields of research to make experimental and conceptual breakthroughs in our understanding of the function of brain circuits, including analysis of neural phenomena in experiments at the system level and testing of computational theories of neural function. This will include fostering collaborations between researchers in the College of Arts and Sciences, the College of Engineering, the College of Health and Rehabilitation Sciences: Sargent College, the School of Medicine and others as appropriate. The Center will be synergistic and will work collaboratively with other centers at Boston University including the Neurophotonics Center, the Photonics Center, the Center for Information and Systems Engineering, the Biological Design Center and the Cognitive Neuroimaging Center.

- **To support cutting-edge research.** The primary research goal of the Center is to examine how systems of interacting neurons mediate behavioral function. This includes investigating the brain systems underlying functions such as perception and attention, learning and memory, speech and hearing, decision-making, movement and planning. The Center will support research including the study of population function within individual regions, as well as systems of interacting regions, spanning from recordings of single neurons within individual brain regions to functional imaging of large scale activity within interacting brain regions. Understanding brain systems is also relevant to furthering our understanding of the etiologies of neurological and psychiatric diseases and impairments.

- **To generate and provide access to technical innovations** appropriate for enhancing understanding of neural systems. The recent federal BRAIN initiative has highlighted the need for the generation of novel techniques for studying the brain. These techniques will include techniques for large-scale network recording capabilities, to observe the selective activity of individual neurons within large populations using voltage recording or voltage and calcium imaging. Techniques will also include elucidating the role of populations of neurons using circuit manipulations such as optogenetic interventions that increase or decrease neural activity in identified populations during behavior.

- **To link neural mechanisms to human behavior.** The Center for Systems Neuroscience will foster collaborative research linking human behavior to neural mechanisms by improving access to imaging techniques through a new Cognitive Neuroimaging Center. Work in the Center will enhance understanding of the large-scale macroscopic activity within human brain structures associated with cognitive functions such as memory, spatial navigation, attention and perception, and speech and language, using state-of-the-art functional magnetic resonance imaging techniques.

- **To develop new computational models** that account for current experimental data and generate predictions to guide new experiments. The Center will build upon current strengths at Boston University in the development of theoretical and computational models as well as statistical techniques for data analysis to foster collaborations between experimentalists in departments such as Biology, Psychological & Brain Sciences, and Speech, Language and Hearing Sciences with faculty from Mathematics and Statistics, Biomedical Engineering, Physics and the Data Science Center.

The CSN will promote interdisciplinary research in the field of Systems Neuroscience and play an active role in research training in this area. These activities will include:

1. Bringing together students, researchers and faculty in an open, interactive environment with the goal of developing new collaborations to address specific questions in systems neuroscience. These events may take the form of weekly seminars, colloquia, external speaker series, mini-symposia, or more extensive conferences and workshops.
2. Fostering collaboration among researchers via shared mentoring of graduate students and post-doctoral fellows.
3. Providing seed funding whose aim is to foster collaborations between different faculty members in the Center.
4. Developing and supporting large-scale collaborative projects that bring together researchers across schools and colleges to focus on problems in systems neuroscience with the goal of obtaining external funding.
5. Facilitating mentoring relationships between junior and senior faculty to support research and career development.
6. Outreach and Education. The Center will design and hold educational events focusing on the brain that are open to the larger community, including students and alumni. ■

A view of CSN lab space in the foreground and graduate student and post-doc offices beyond.

CSN Director Prof. Michael Hasselmo addresses faculty at CSN retreat.

RESEARCH SPOTLIGHTS

SPOTLIGHT: STEVE RAMIREZ

How Do Social Interactions Conjure Up Memories and Emotional Responses in the Brain?

HAS A SONG EVER REMINDED you of the past and unexpectedly surfaced emotions associated with that specific experience or person from your memory? Does walking into Staples remind you of back-to-school shopping, even years after graduating? Or, have you ever been introduced to a new employee, and as you exchange names and shake hands, you can't help but think back to your first day on the job?

Experiences can unlock vivid memories — transporting us back in time and triggering emotional responses. Dr. Steve Ramirez, Assistant Professor of Psychological & Brain Sciences at Boston University, is the principal investigator of The Ramirez Group, where he leads NIH-supported research on how memory works and how to hijack it to treat disorders of the brain.

His latest research, published in PNAS, uncovers how memories and fear-responses can be transmitted through social interactions. How exactly did his team make this discovery, and what are the future implications? Read below for a Q&A with Ramirez and lead author Abby Finkelstein to learn about the motivation behind this work, the findings, and what the team hopes to study next.

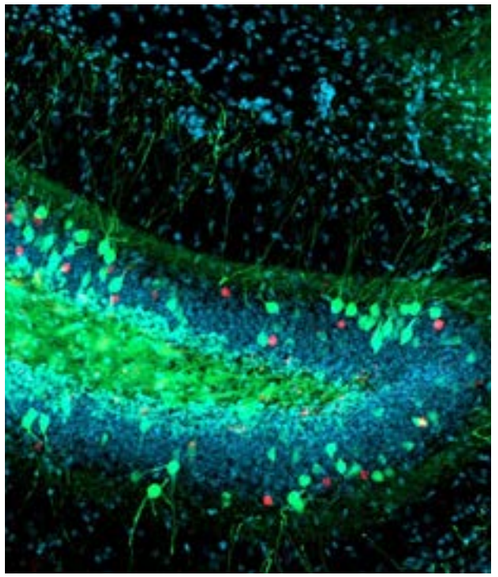


Photo courtesy of the Ramirez Lab

What did you aim to study with your research? What made you want to examine this issue?

Our research studies what memory looks like in the brain (i.e. its physical basis) as well as how to artificially manipulate memories to restore the brain. Memory is one of the most fundamental processes of the brain and we can even artificially tinker with the brain to restore memories, enhance positive memories or suppress negative ones. Our work could one day be harnessed for future therapeutic techniques to treat a variety of conditions including depression, anxiety, and post-traumatic stress disorder (PTSD).

In this study, we specifically wanted to examine how previously acquired memories were modulated when animals socialized. More specifically, we wanted to study how social interactions can conjure up memories of the past. As humans, we do this all the time — we tell stories (i.e. "remember when…"), we visit some of our most cherished moments of the past, and we learn from some of the hardest experiences through this process of recollection. Rodents also socially interact with one another — and we wanted to study how socialization tapped into and triggered previously acquired memories within their brains as well.

Walk us through your experiments. What did the findings reveal?

Our experiments examined the effect of different social and non-social experiences on an individual's memory of a past negative event. These social experiences can include having an animal, which we call the "observer" or "stressed familiar individual," interact with its cage mates either directly, behind an opaque wall, or behind a one-way mirror. The non-social experiences can include access to the opaque wall itself

without a cage-mate on the other side. The behavioral experiments revealed that two types of socially-transmitted stressors enhanced fear memory, while non-socially transmitted stressors and our control experiences had no effect on fear memory strength.

We hypothesize that this enhancement was due to socially-stimulated stress reactivating neurons encoding the fear memory, and showed that such neuronal ensembles were indeed reactivated only by the social stressors in a brain region called the hippocampus.

Next, we hypothesized that if fear memory neurons were being reactivated during the social experience, tagging these neurons as active during the social experience and then artificially turning them on in a neutral context would cause fearful behaviors only in mice that also had the fear memory from a past, independently learned experience. In other words, an animal that had previously acquired a fear memory may have this memory inadvertently activated under certain conditions when a stressed cage mate was present. If so, then reactivating these cells artificially should also produce the fear responses. This is exactly what our optogenetic experiment showed, bolstering our proposal that social stress reactivates hippocampal traces of fear memories and thus amplifies fear recall.

> "We show that individually acquired memories can be enhanced by another animal's stress more so than by one's own, revealing a new intersection of individual history and sociality."

What was the most surprising finding?

We were surprised by the counterintuitive finding that direct physical interaction with a stressed familiar individual did not have a fear recall effect on the mice — while experiencing ambient stress cues indirectly (presumably through their vocalizations and scents, for instance) from the stressed familiar individual had such a strong enhancing effect on fear memory in the mice. The team brainstormed possible explanations, and tested the hypothesis that this phenomenon might be due to the physical interaction impacting not only the cage-mates, but actually reducing the distress signals put out by the stressed familiar individual. We put a "social buffering" mouse on the same side of the wall as the stressed mouse and were able to show that this direct interaction did indeed block the fear memory enhancing signals — and therefore blocked the fear memory recall effect on the entire group.

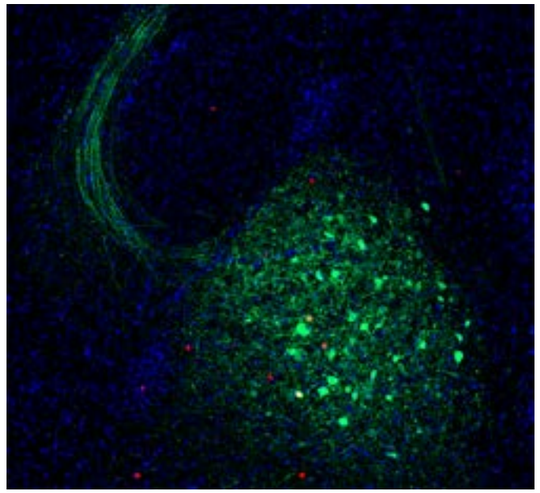


Photo courtesy of the Ramirez Lab

What is the significance of these findings?

We show that individually acquired memories can be enhanced by another animal's stress more so than by one's own, revealing a new intersection of individual history and sociality.

The data suggests that socially-transmitted stress signals themselves may more powerfully access particular memories whereas having full on physical interaction with an individual may either leave the memories untouched — or perhaps even buffer their negativity in some instances. Something about the indirect stress cues tilts the scales in favor of fear memory recall and enhancement, but once we add the physical dimension of socialization, we don't see these effects.

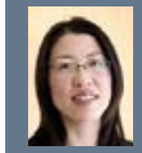
These results are exciting to us because they point to the social dimension as a mechanism by which memories can be enhanced among animals.

* * *

This excerpted article and interview, authored by Molly Gluck, originally appeared in the **BU *Experts blog*** on March 15, 2022.

To read the full interview visit: tinyurl.com/5n7zbxuz

This work was supported by an NIH Early Independence Award (DP5 OD023106–01), an NIH Transformative R01 Award, a Young Investigator Grant from the Brain and Behavior Research Foundation, a Ludwig Family Foundation grant, the McKnight Foundation Memory and Cognitive Disorders Award, and the Center for Systems Neuroscience and Neurophotonics Center at Boston University. ■



SPOTLIGHT: XUE HAN

Learning to Forget

A FEW RUSTY NAILS LITTERED the path near the home of Midnight. A smart black Labrador, she knew the way was dangerous, and she avoided it.

Then the path was cleared. Still, it took Midnight six months before she could bring herself to set paw on the path. "There was nothing I could do to convince her," says Associate Professor Bobak Nazer (ECE, SE), the dog's owner. "She just remembered, 'not safe.'"

In a way, military veterans and others suffering from post-traumatic stress disorder (PTSD) struggle with the same problem: It can be hard to dissociate certain settings or sounds—say, a large, wide-open space or fireworks—from certain dangers they've experienced—say, sniper fire

Nazer is one of several ENG researchers collaborating on studies of the hippocampus, the region of the brain that is critical for learning and memory in both animals and humans. Their work has implications not only for PTSD, but also dementia and Alzheimer's disease, which are associated with hippocampal atrophy.

From left, Xue Han (BME), grad students Rebecca Mount and Sudiksha Sridhar, and Bobak Nazer (ECE, SE). Photo by Ciara Crocker

In recent years, Associate Professor Xue Han (BME) has made a name for herself as a pioneer in optogenetics and optical imaging. Using pulses of light to control and observe the behavior of different neurons, she has discovered new types of brain signals.

"We image hundreds and hundreds of neurons simultaneously," says Han, "and that actually creates a huge problem on the data analysis front."

That problem led Han to link up with Nazer, an expert in data science and high-dimensional statistics.

"For me," says Nazer, "dealing with information and data processing, what's interesting is trying to ground a mathematical problem in some kind of useful engineering scenario."

Along with Professor Venkatesh Saligrama (ECE, SE), the pair earned a Dean's Catalyst Award, and two National Science Foundation grants aimed at leveraging strides in biomedicine and machine learning to advance knowledge of how the brain works.

This year, Han and Nazer and ENG colleagues published a study that documents mice learning and unlearning a behavior. First, the mice heard a tone that was soon followed by an annoying puff of air in the eye. Using a technique called calcium imaging, the researchers identified the group of neurons in the hippocampus that was involved in learning to associate the tone with the puff.

After several days of this training, the mice spent one additional day listening to the tone followed by nothing—no more puff. At first, the mice continued to blink, bracing themselves for the air puff. But, fairly quickly, they got used to the tone having no particular meaning. "They learned to forget," says Han. "And that involved a different population of cells."

The study was the first to visualize a large-scale neural network to provide detailed, real-time evidence that two distinct populations of neurons are activated when the brain learns something, then learns to disregard it. A greater understanding of how that process works might eventually benefit patients with PTSD and anxiety disorders, as well as those with diseases related to memory loss and cognitive decline.

* * *

This piece was excerpted from a larger article titled "ENG researchers from across disciplines are joining forces to produce images and insights into how neurons and other cells work." It was authored by Patrick L. Kennedy and originally appeared in the fall 2021 issue of ***ENGineer***, the Boston University College of Engineering alumni magazine.

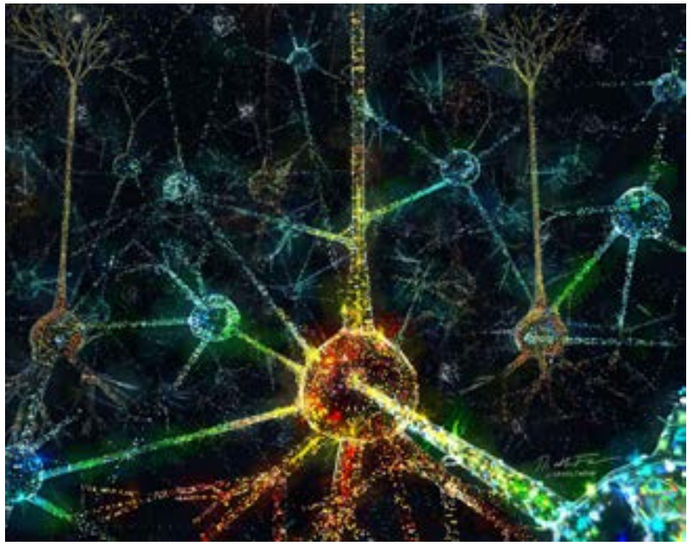
To read the full article visit: tinyurl.com/bdd5a74j. ■

SPOTLIGHT: JERRY CHEN

Why Do We All Feel Touch Differently?

NEW RESEARCH FROM BOSTON UNIVERSITY neurobiologist Jerry Chen could help scientists understand, for example, how to better treat strokes and autism spectrum disorder

When you touch something, whether stepping onto a sandy beach or stroking the back of a dog, sensations fly into your brain. You feel the coarse grain of the sand under your feet, the fluffiness of the fur on your hand. But you also bring a bit of yourself into the feeling: Along with the external stimulation from the beach or pup, there's the memory of past moments—toweling sand from your toes during a summer vacation, snuggling with a much-missed family pet. We all agree that something feels abrasive or soft, but interpret that sensation slightly differently.



Neurobiologist Jerry Chen is studying how different brain cells connect to form what he calls "circuit hubs" that allow animals to utilize their senses, particularly touch. Image courtesy of Nicolle Fuller/Sayo Studios

"When we perceive our environment, we're actually doing two things," says Boston University neurobiologist Jerry Chen, an expert on cognitive function. "We're taking in all the senses, all the physical elements of the world; at the same time, we are applying our own types of inference, subjective interpretation of what we think we're perceiving."

In a new study published in Science, Chen illuminates that process, showing how the brain combines external information and internal memory to build a sense of touch. Looking at mouse brains, Chen and a team of researchers from BU and the Allen Institute for Brain Science discovered a circuit in the primary somatosensory cortex—the part of the brain that receives signals related to touch, temperature, and pain—that's dedicated to computing tactile information. He says the circuit helps the brain figure out how to balance the stimulation coming from outside the body with existing knowledge. The study may be significant for our understanding of a range of neurological disorders and neuropsychiatric diseases that can alter sensory perception, from strokes to autism spectrum disorder. Improved knowledge of the brain's circuits, says Chen, a BU College of Arts & Sciences assistant professor of biology, may pave the way for more targeted treatments and interventions.

As part of their dive into the brain's workings, the team developed a new method for surveying and watching cells: a platform that generates activity in the brain, shows the molecular composition of the firing cells, and helps compute all of the data. It allowed Chen to look at how different neurons in the cortex reacted and communicated when an animal touched an object—and how those neurons adapted when something in the environment shifted.

Chen and his team used the Allen Institute's atlas of the mouse brain—a catalog of the different types of brain cells—as a starting point for the project. Chen, a former Allen Institute Next Generation Leader, says the atlas is great for pinpointing the location and category of a neuron, but it doesn't really tell researchers much about the neuron's functions. His findings bring that detail and color. "It's another level of understanding for how everything fits together," says Chen, who's also a BU College of Engineering assistant professor of biomedical engineering. "The biggest thing is that we've married the catalog with the functional definition—that's really going to open up a lot of ways for us to understand the brain."

The Brink spoke with Chen about his findings and their potential for improving our knowledge and care of the brain:

What do your findings reveal?

When you're perceiving the world around you, your brain does a combination of processing the stimuli that make up the scene, but it also tries to fill information based on what you've learned in the past to help you interpret what you're sensing. For example, let's say you're rummaging through a bag feeling around for your car keys. Your brain has learned what keys feel like, so it's filling in information as you are feeling objects of different textures or shapes to guide your search. However, there are times when you feel something, like a sharp edge, that really jumps out and tells you that you're on the right track and that you've maybe found your keys. Our findings essentially uncover that there is a dedicated circuit composed of specific cells in the catalog that we call hub cells. These cells help to alert the brain that you've come across a salient feature that needs to be investigated further.

> "Rather than viewing the brain as a homogenous piece of tissue, understanding which specific cell types are the most relevant will allow us to develop treatments that can be highly targeted."

Did anything about those hub cells surprise you?

The hub cells, which we identified to be important for feature detection, also respond in interesting ways when your environment changes. There are a certain set of genes that are known to be important for learning and adaptability and that can go up or down depending on changing environments. We found that those genes are always on in hub cells, which goes against some current principles. When environments change, these cells respond by trying to compensate for these changes.

Photo of Jerry Chen courtesy of Jackie Ricciardi

What's the significance of your findings?

Our findings have relevance for a range of neurological disorders, such as stroke, and neuropsychiatric diseases, such as autism spectrum disorder, where an individual's sense of perception can be altered. Rather than viewing the brain as a homogenous piece of tissue, understanding which specific cell types are the most relevant will allow us to develop treatments that can be highly targeted.

This marks exciting progress toward directly treating the underlying cause of specific symptoms, while also potentially avoiding unwanted side effects from other therapeutics and interventions. One big complication of therapies these days with brain disorders is they're not only affecting the circuit of interest, but they're affecting other circuits that you don't want to necessarily mess with. The fact that we have a genetic handle on these specific circuits means that one could potentially design target therapies that will affect only those circuits.

* * *

This excerpted article and interview, authored by Molly Gluck and Andrew Thurston, originally appeared in ***The Brink*** on January 6, 2022.

To read the full article and interview visit: tinyurl.com/2hev2ya7

This research was supported with funding from a National Institutes of Health New Innovator Award, the Brain Research Through Advancing Innovative Neurotechnologies (BRAIN) Initiative, and the National Institute of Mental Health. ■

Members of the CSN community gathered in the courtyard for a social event

Center retreat participants exiting Howard Eichenbaum Colloquium Room where CSN events are often hosted.: Pictured (left to right) are Michael Hasselmo, Anna Devor, Maria Medalla, and Jerry Chen

LEADERSHIP & STAFF

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THE CENTER FOR SYSTEMS NEUROSCIENCE has a small staff that includes partial support for the Center Director, Professor Michael Hasselmo, and the Associate Directors, Professors Mark Kramer and Camron Bryant, as well as part-time funding for the Center Manager, Dr. Jun Shen, and full-time funding for the Center Administrator, Jessie Priestley.

The director and associate directors oversee preparation of grant applications and presentations for grant reviews, participate in search committee meetings and seminars, and oversee pilot funds and Center seminars.

Together, the director and two administrators oversee the Center budget and annual reports, the organization of grant review materials, the organization of Center seminars and symposia, and numerous other administrative tasks.

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Pictured (from right to left) are Chantal Stern, Mark Kramer, Robert Joseph, and Benjamin Scott

Center for Systems Neuroscience

Organizational Chart

Vice President and Associate Provost for Research
Gloria Waters

Director
Michael Hasselmo

Executive Committee
Michael Hasselmo
David Boas
Jerry Chen
Angela Ho
Nancy Kopell
Tyler Perrachione
Douglas Rosene
Shelley Russek
David Somers
Chantal Stern
John White

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FACULTY COMMITTEES

The Center charter states that the Director of CSN shall be advised by an Executive Committee and a Scientific Advisory Board.

Membership in the ***Executive Committee*** is determined jointly by the Vice President for Research and the CSN Director. The Committee advises the Director on strategic initiatives, scientific programs and operational activities and cognate Center affiliations. The Executive Committee has been formed and updated with the following members (including the Director and Associate Directors):

Professor Michael Hasselmo
Professor David Boas
Professor Camron Bryant
Professor Jerry Chen
Professor Angela Ho
Professor Nancy Kopell
Professor Mark Kramer
Professor Tyler Perrachione
Professor Doug Rosene
Professor Shelley Russek
Professor David Somers
Professor Chantal Stern
Professor John White

Members of the ***Scientific Advisory Board*** were chosen by the CSN Director and VP for Research in consultation with the Executive Committee. The Board advises the Director as needed on strategic planning and research programs and on initiatives to enhance national visibility of CSN and support multi-institutional initiatives. The Board is comprised of distinguished scientists and leaders of university or government organizations in systems neuroscience. Those who accepted board positions include:

Professor David Badre *(Brown University)*
Professor Bradford Dickerson *(Harvard University)*
Professor Ila Fiete *(MIT)*
Professor Earl Miller *(MIT)*

DISTINGUISHED FELLOWS

THE CENTER HAS A BUDGET for supporting potential pilot projects and innovative new techniques for research. On the recommendation of the Center executive committee, in FY22 these funds were used to support post-doctoral fellows with expertise in techniques that are central to development of new research areas and associated grant applications. These researchers were designated the Center for Systems Neuroscience Distinguished Fellows.

FY22 FELLOWS

Dr. Maria Victoria Moya
(with Prof. Michael Economo)
Developing new optical technology for measuring connections between brain cells (manuscript currently under review); obtained an NIH NRSA F32 post-doctoral fellowship

Dr. Gary Kane
(with Prof. Benjamin Scott)
Using wide field imaging to analyze neural mechanisms underlying the optimization of decision-making

Dr. Brenna Fearey
(with Prof. Mark Howe)
Studying the rules of computation at single neurons across dendritic arbors in the direct and indirect pathways of striatum

Dr. Cristina Delgado Sallent
(with Profs. Steve Ramirez and Benjamin Scott)
Characterizing brain regions and cell populations essential to ketamine's therapeutic effects

Caitlin Lienkaemper
(with Prof. Gabriel Ocker)
Building a principled, biologically motivated random model for neural activity

PREVIOUS FELLOWS

Dr. Leah Bakst
(with Prof. Joseph McGuire)
Awarded both an NSF SPRF fellowship (SMA-1809071; 7/1/18-6/30/19) and an NIH F32 fellowship (F32-EY029134)

Dr. Tashauna Blankenship
(with Prof. Melissa Kibbe and Prof. Chantal Stern)
Awarded an NIH NRSA post-doctoral fellowship

Dr. Eric Lowet
(with Prof. Jerry Chen and Prof. Xue Han)
Co-authored a Neuron paper with Prof. Jerry Chen; currently publishing voltage-imaging research with Prof. Xue Han

Dr. Joshua Foster
(with Prof. Sam Ling)
Co-authored paper in Journal of Neuroscience forthcoming

Pictured are Professor Laura Lewis (left) and graduate student Jessica Yee

ACHIEVEMENTS & AWARDS

CENTER FACULTY EARNED VARIOUS AWARDS and achievements over the course of the past fiscal year. These include:

John Baillieul, Professor, Mechanical Engineering
- Co-editor (with Tariq Samad) of Springer Encyclopedia of Systems and Control, 2nd Edition

David Boas, Professor, Biomedical Engineering
- BME Service Award
- Distinguished Professor of Engineering, Boston University College of Engineering

Camron Bryant, Associate Professor, Pharmacology & Experimental Therapeutics
- President, International Behavioural and Neural Genetics Society (IBANGS), the official society for the journal, Genes, Brain and Behavior
- Chair of Planning Committee, Boston Area Neuro Group (BANG)

Chandramouli Chandrasekaran, Assistant Professor, Psychological & Brain Sciences
- Honorable mention, 2022 Daniel X. Freedman Award for outstanding basic research achievement by a Brain and Behavior Research Foundation Young Investigator

Jerry Chen, Assistant Professor, Biology
- NIH U01 NS128665 BRAIN Initiative Award

Alice Cronin-Golomb, Professor, Psychological & Brain Sciences
- Senior editor, Psychological Science
- Editorial board, Behavioral Neuroscience

Stephen Grossberg, Professor, Mathematics and Psychology
- Author, Conscious Mind, Resonant Brain: How Each Brain Makes a Mind, Oxford University Press

Xue Han, Professor, Biomedical Engineering
- Elected to the College of Fellows of the American Institute for Medical and Biological Engineering
- Promoted to Full Professor

Michael E. Hasselmo, Director, Center for Systems Neuroscience; Professor, Psychological & Brain Sciences
- Named Editor-in-Chief, Hippocampus
- Elected member - Memory Disorders Research Society
- Elected member - American Academy of Arts and Sciences

Stefan G. Hofmann, Professor, Psychological & Brain Sciences
- Humboldt Professorship, University of Marburg, Germany
- President, Academy of Cognitive Therapy

Mark Howe, Assistant Professor, Psychological & Brain Sciences
- NIH R01MH125835
- Aligning Science Across Parkinson's Award
- Stanley Fahn Junior Faculty Award

Laura Lewis, Assistant Professor, Biomedical Engineering
- Sloan Research Fellow
- McKnight Scholar Award
- Pew Scholar Award
- Associate Editor, PLoS Biology

Ryan Logan, Associate Professor, Pharmacology & Experimental Therapeutics
- Elected Associate Member in American College of Neuropsychopharmacology

Yannis Paschalidis, Professor, Electrical & Computer Engineering, Computing & Data Sciences
- Distinguished Professor of Engineering
- Appointed Director of the Hariri Institute for Computing and Computational Science and Engineering
- Charles DeLisi Award, College of Engineering, Boston University
- Vice President for Publication Activities, IEEE Control Systems Society

Siddharth Ramachandran, Professor, Electrical & Computer Engineering
- Appointed Deputy Editor of Optica

Steve Ramirez, Assistant Professor, Psychological & Brain Sciences
- Matthew Pecot Fellowship from the McKnight Foundation
- Pew Foundation Biomedical Scholars
- Metcalf Cup and Prize for Excellence in Teaching
- Quad-L Early Career Award from the University of New Mexico
- HHMI Gilliam Fellowship

Shelley Russek, Professor, Pharmacology & Experimental Therapeutics
- Editorial Board, Journal of Neurochemistry

Benjamin Scott, Assistant Professor, Psychological & Brain Sciences
- 2021 SFARI Investigator
- Whitehall Foundation Award

Kamal Sen, Associate Professor, Biomedical Engineering
- Ignition Award, Boston University

Chantal Stern, Professor, Psychological & Brain Sciences
- Elected member, Memory Disorders Research Society
- Section editor, Hippocampus
- Consulting editor, Behavioral Neuroscience

Tuan Leng Tay, Assistant Professor, Biology; Anatomy & Neurobiology
- Frontiers in Immunology Research Topic Lead Editor, "Understanding the Roles of Glia and Circulating Leukocytes in Neurodegenerative Diseases"

Julia TCW, Assistant Professor, Pharmacology & Experimental Therapeutics
- BrightFocus Foundation Alzheimer's Disease Research Award
- Toffler Scholar Award

Michael Wallace, Assistant Professor, Anatomy & Neurobiology
- Peter Paul Career Development Professorship, Boston University
- Brain Behavior Research Foundation Young Investigator Grant
- Whitehall Foundation Research Award

Meg Younger, Assistant Professor, Biology
- Searle Scholar ■

The lobby of the Rajen Kilachand building features an art installation titled Blue-Green Brainbow, *produced by Brooklyn-based sculptor and printmaker Carson Fox, which was inspired by a neuroimaging technique that distinguishes individual neurons in the brain using fluorescent proteins.*

EVENTS

THE CENTER HOSTED A SYMPOSIUM and a number of seminars at Boston University featuring both BU speakers and external speakers as well as candidates for faculty positions in relevant departments. These events, promoted internally via departmental email lists and to the public via Twitter, attracted audiences of 60-500 researchers from a wide range of fields including: the CAS departments of Psychological and Brain Sciences, Biology, Physics, and Mathematics and Statistics; the Sargent School departments of Health Sciences and Speech, Language and Hearing Sciences; the School of Medicine departments of Anatomy and Neurobiology and Pharmacology and Experimental Therapeutics; and the School of Engineering departments of Biomedical Engineering and Electrical and Computer Engineering.

FALL 2021

September 8th
Early Career Workshop
- For junior faculty and post-doctoral fellows affiliated with the CSN; information on grant funding from the BU Federal Relations Office and Foundation Relations Office
- Organized with Vice President of Federal Relations Jennifer Grodsky

September 22nd
Prof. Benjamin Scott
- Boston University, Department of Psychological and Brain Sciences
- Title: Neural mechanisms for inference and decision making
- Hosted by Prof. Michael Hasselmo

October 5th – 6th
SYMPOSIUM: Advances in Systems and Computational Neuroscience
- Nancy Kopell, Boston University - "How does deep brain stimulation work for Parkinson's disease?"
- Brent Doiron, University of Chicago - "Cellular mechanisms for quenching neuronal variability"
- Sam Gershman, Harvard University - "Dopamine prediction errors are dead, long live dopamine prediction errors!"
- Xue Han, Boston University - "Calcium and voltage imaging analysis of neural network across spatiotemporal scales during behavior"
- Tatiana Engel, CSHL - "Latent circuits in recurrent neural networks"
- Jennifer Luebke, Boston University - "Diversity and selective vulnerability of cortical pyramidal neurons"
- Kanaka Rajan, Mount Sinai - "How brain circuits function in health and disease: Understanding brain-wide current flow"
- Stefano Fusi, Columbia University - "The role of hippocampus in memory compression"
- Ila Fiete, MIT - "Place cells: capacity, volatility, and predetermined scaffolds"
- Demba Ba, Harvard University - "Sparse coding, artificial neural networks, and the brain: Toward 'Substantive Intelligence'"
- Jerry Chen, Boston University - "CRACKing neural circuits underlying behavior"

Faculty participating in the CSN symposium (from left to right): Stefano Fusi, Tatiana Engel, Jerry Chen, Benjamin Scott, Ila Fiete, Brent Doiron, Michael Hasselmo, Sam Gershman, Camron Bryant, and Chandramouli Chandrasekaran

October 27th
Prof. Michael Yartsev
- University of California, Berkeley, Department of Bioengineering
- Title: Neural mechanisms of complex spatial, social and acoustic behaviors in bat
- Hosted by Prof. Jerry Chen

November 3rd
Prof. Scott Linderman
- Stanford University, Department of Statistics
- Title: Discovering structure in neural and behavioral data
- Hosted by Prof. Benjamin Scott

A panel discussion at the CSN retreat. Pictured (from right to left) are Mark Kramer, Tyler Perrachione, Nancy Kopell, Shelley Russek, and Michael Hasselmo

Tyler Perrachione offering insights during a CSN retreat panel discussion

SPRING 2022

February 9th
Prof. Keri Martinowich
- Johns Hopkins University, Department of Neuroscience
- Title: Cell-type and spatially resolved molecular signatures in human brain disorders
- VIRTUAL event hosted by Dr. Madelyn Ray

February 23rd
Prof. Gordon Fishell
- Harvard University, HMS Neurobiology
- Title: The intimate dependence and remarkable precision of cortical interneuron-pyramidal cell connectivity
- IN-PERSON and VIRTUAL event hosted by Profs. Shelley Russek and Heidi Meyer

March 30th
Prof. Meyer Jackson
- University of Wisconsin-Madison, Department of Neuroscience
- Title: Revealing neural circuit mechanisms with voltage imaging
- IN-PERSON and VIRTUAL event hosted by Prof. Xue Han

A break between sessions at the CSN retreat: Pictured (from left to right) are John White, Mark Kramer, and Uri Eden

April 6th
Prof. Alain Destexhe
- CNRS and Paris-Saclay University, France
- Title: Multiscale modeling of brain states, from spiking networks to the whole brain
- VIRTUAL event hosted by Prof. Emily Stephen

April 13th
Prof. Andreas Nieder
- University of Tübingen, Germany, Institute of Neurobiology
- Title: Neuronal code for numbers in humans, monkeys and crows
- VIRTUAL event hosted by Prof. Benjamin Scott

April 27th
CSN Post-Doc and Faculty Social
- An opportunity for CSN postdoctoral researchers and faculty members to engage beyond the lab

May 4th
Prof. Liset M. de la Prida
- Instituto Cajal – CSIC, Spain
- Title: Dissecting subcircuits underlying hippocampal function
- VIRTUAL event hosted by Dr. Andy Alexander

May 18th
Dr. Alex Mathis
- DeepLabCut, EPFL
- Title: Measuring and modeling behavior with deep learning
- IN-PERSON event hosted by Prof. Steve Ramirez

June 28th
Tutorial and Joint Social
- Opportunity for CSN-affiliated graduate students, post-doctoral researchers, and faculty to learn about novel techniques and build community. ■

A breakout discussion at the CSN retreat: Pictured (from left to right) are Joseph McGuire, Jennifer Luebke, Maya Medalla

Gathered in the courtyard for a CSN social: Pictured (from left to right) are Anna Cattani, Luca Posa, and Michael Hasselmo

RESEARCH PROJECTS

THE FACULTY CONDUCT RESEARCH in a number of different areas. These include:

1. Learning and memory function
2. Speech and hearing
3. Attention and perception
4. Developmental and degenerative disorders
5. Decision and action
6. Neurophotonics and circuit mapping
7. Computational neuroscience

There are numerous research projects within these areas that are described in the publications listed in this annual report and funded by an extensive range of research grants. This annual report will not provide details about all of the research projects, focusing instead on the projects directly related to funds from the Center for Systems Neuroscience.

List of Current Grants and Pending Applications

The Center for Systems Neuroscience was directly involved in obtaining several grants over the past several years: 1) An ONR MURI grant worth $7.5 Million to Prof. Michael Hasselmo, 2) An ONR DURIP grant associated with the ONR MURI worth $557,580 to Prof. Chantal Stern, 3) An NSF MRI grant worth $1,582,077 to Prof. Chantal Stern, 4) A second ONR MURI grant obtained by Prof. Yannis Paschalidis with assistance from Profs. Michael Hasselmo and Chantal Stern worth $7.5 Million, 5) An ONR DURIP grant obtained in summer 2021 as a supplement to this second MURI grant. In addition, as listed in the Supplemental Spreadsheet, the faculty affiliated with the Center for Systems Neuroscience have obtained numerous grants, including a number of additional grants obtained by faculty who received support from start-up funds or post-doctoral fellowships provided by the Center.

ONR MURI *grant* 2016-2022, $7,500,000. Center Director Michael Hasselmo is the principal investigator on an Office of Naval Research MURI grant that was awarded in 2016 entitled: Neural Circuits Underlying Symbolic Processing in Primate Cortex and Basal Ganglia (PI: Michael Hasselmo, Program officer: Tom McKenna) - 07/01/16-05/31/21, with no-cost extension to Nov. 30, 2022, ONR MURI N00014-16-1-2832. This grant provides five years of support totaling $7,500,000. The ONR program officer is Dr. Tom McKenna. The projects on this MURI grant support research in the laboratories of Prof. Hasselmo, Prof. Marc Howard and Prof. Chantal Stern at Boston University in collaboration with Prof. Earl Miller at MIT and Prof. David Badre at Brown University. The grants administration included presentations in the ONR meeting on June 8, 2022 and preparation of an annual report due Nov. 1, 2022.

***ONR DURIP grant*, $557,580.** In affiliation with this ONR MURI grant, Prof. Chantal Stern submitted an application for an Office of Naval Research DURIP grant that was awarded in 2017: ONR Defense University Research Instrumentation Program (DURIP) grant: High-performance computing cluster for cognitive neuroscience analysis and modeling. (PI: Chantal Stern, PO: Tom McKenna) 6/01/2017-6/30/2018. ONR DURIP N00014-17-1-2304. This grant provides $557,580 for purchase of computational resources for data analysis and modeling by neuroscience faculty including Chantal Stern, Marc Howard, Michael Hasselmo, Sam Ling, Joseph McGuire, Chandramouli Chandrasekaran and Karin Schon.

***NSF MRI grant*, $1,582,077.** The director of the Center for Cognitive Neuroimaging Chantal Stern submitted a grant that supports neuroimaging work that is an integral part of systems neuroscience research at Boston University. She obtained an NSF Major Research Instrumentation grant (PI: Chantal Stern, Program officer: John Yellen) Title: MRI: Acquisition of a 3-Tesla Magnetic Resonance Imaging (MRI) Scanner for Cognitive and Systems Neuroscience 9/1/2017-8/31/2018, NSF BCS 1625552. This grant provided $1,582,077 for 70% of the purchase of a Siemens fMRI scanner that has been installed in the Kilachand Center.

ONR MURI *grant* 2019-2024, $7,500,000. The CSN director worked with Profs. Yannis Paschalidis, John Ballieul and Chantal Stern to organize a research team based on multiple discussions with ONR program officer Dr. Marc Steinberg. This grant was selected for funding and started in the fall of 2019. We organized a research team that included Yannis Paschalidis as PI, Michael Hasselmo, John Baillieul, Chantal Stern, Margrit Betke and Roberto Tron from Boston University, and John Leonard and Nick Roy from MIT. Four members were previously members of an earlier MURI run by Michael Hasselmo. This ONR MURI award is entitled: Neuro-Autonomy: Neuroscience-inspired perception, navigation, and spatial awareness for autonomous robots. This provides $7,500,000 over five years to the 2 researchers at MIT and the 6 researchers at BU. This grant involves ongoing weekly meetings of MURI researchers in full team meetings or in sub-group meetings, as well as ONR third year review presentations on April 11-12, 2022 and as part of an ONR review meeting on August 3-13, 2021.

ONR DURIP GRANT 2021, $497,047. The BU members of the 2019 MURI N00014-19-1-2571 (Profs. Tron, Paschalidis, Baillieul, Stern, Betke and Hasselmo) participated in an application for an additional ONR DURIP award to supplement this research. On August 18, 2021, this grant was awarded as DURIP N00014-21-1-2844 for $497,047 headed by principal investigator Prof. Roberto Tron to support researchers at Boston University affiliated with the ONR MURI grant.

NSF training grant in Neurophotonics. Center Director Michael Hasselmo participated as an executive committee member for a grant obtained by Principal Investigator Prof. Thomas Bifano for an NSF Research Traineeship (NRT) grant entitled: “NRT: Neurophotonics.” The Center Director has participated on the Executive committee for this grant to select trainees. This grant provides training in neurophotonics for graduate students in multiple programs. Related to this grant, Prof. Chantal Stern and Neurophotonics Center Director Prof. David Boas submitted another NST training grant in 2021 entitled “NRT: Neuroscience in the Everyday World” (NSF2125829).

NIH R01 grants. During the period of running the CSN, the Center director was also principal investigator on multiple NIH R01 grants. This included his own grants NIMH R01 MH060013 and MH061492, and two grants transferred from Prof. Howard Eichenbaum after he passed away in the summer of 2017, with grant numbers MH051570 and MH052090. In fall 2019, the Center director also obtained the new funding for another R01 grant MH120073 for five years of support. These grants are administered through the Dept. of Psychological & Brain Sciences.

The Center also obtained and administered support to a Kilachand Type A/B Project awarded by the Office of the Vice President for Research. The CSN director Prof. Michael Hasselmo worked with Prof. Chantal Stern, Prof. Xue Han, Prof. Yannis Paschalidis, Prof. David Boas, Prof. Joseph McGuire, Prof. Jerry Chen, and Prof. Marc Howard to organize a research team, and prepare a preliminary proposal that was submitted on December 19, 2019. Subsequently a full proposal was submitted on June 8, 2020 for a Kilachand Type A/B Project to the Office of the Vice President for Research. This proposal was updated for reconsideration in June 2021 and was selected for funding in October 2022. This team focuses on understanding circuit mechanisms in the neocortex underlying general cognitive function, with the aim of developing innovative approaches to computational modeling of neural circuits and new experimental voltage and calcium techniques to analyze circuit dynamics. The Center members regularly participate in meetings of this grant by the Center.

This Kilachand Fund Award led to the organization of an NSF STC preliminary proposal submitted early this year. The CSN director Prof. Michael Hasselmo worked with Profs. Thomas Bifano, Emery Brown, Jerry Chen, Adam Cohen, Anna Devor, Xue Han, Mark Harnett, Stephanie Jones, Nancy Kopell, Jerome Mertz, Vincent Peiribone, Steve Ramirez, Robert Stackman, and Carmen Varela to organize a research team, and prepare a preliminary proposal that was submitted on February 1, 2022.

The Kilachand Fund Award also led to the submission in April 2022 of an NIH R01 collaborative grant by Prof. Hasselmo and Prof. Xue Han proposing the use of voltage imaging techniques to analyze circuit dynamics in the hippocampal formation that could contribute to the higher level processing of spatial trajectories that is relevant to the coding of trajectories in problem solving as described in the awarded Kilachand Fund grant.

Affiliated faculty. The Center for Systems Neuroscience faculty have a number of ongoing research grants. For quantifying the overall support of neuroscience researchers affiliated with the Center, the expenditure and grant figures have been obtained from OSP and edited to avoid overlap with other centers such as the Photonics Center. Please note that this grant information is not included in this external report. ■

PUBLICATIONS

CSN Faculty published the following articles in peer-reviewed journals. Articles published by two or more Center-affiliated faculty are indicated by an asterisk "*".

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FACILITIES & EQUIPMENT

THE CENTER HOUSES FACULTY in various locations on the Charles River Campus and the School of Medicine Campus. The Rajen Kilachand Center building provides a central location for meetings and Center administration, as well as research facilities for some Center faculty.

Rajen Kilachand Center Building

A number of CSN members are housed on the 7th, 8th and 9th floors of the Rajen Kilachand Center for Integrated Life Sciences and Engineering building at Boston University. Administrative offices for the Center are also housed on the 7th floor of this new building. The building includes space for social gatherings, seminars, and laboratory meetings. The first floor also houses facilities for the Cognitive Neuroimaging Center, as well as testing rooms for behavioral studies. The building provides research space for several CSN faculty performing research using systems neuroscience techniques in animals or functional imaging in human subjects. This is the primary new space available at Boston University for these techniques. Space allocation for the centers housed in the Rajen Kilachand building is controlled by the Provost, the Vice President, and the Associate Provost for Research. Allocation of space takes into consideration the research productivity and external research funding of the investigators and research teams.

Core resources provided by university

Housing for animals used in systems neuroscience research:

- Laboratory Animal Care Facility (LACF)

Shared resources for microscopy used in systems neuroscience research:

- Proteomics and Imaging Core Facility

Existing laboratories

Multiple laboratories support systems neuroscience research:

The Atema Lab – Professor Jelle Atema

Intelligent Mechatronics Laboratory – Professor John Baillieul

Neural Systems Laboratory – Professor Helen Barbas

Artificial Intelligence and Emerging Media Group – Professor Margrit Betke

Bifano Laboratory – Professor Thomas Bifano

Bio Optical and Acoustic Spectroscopy Lab – Professor David Boas

Laboratory of Addiction Genetics – Associate Professor Camron Bryant

Neural Dynamics of Cognition Laboratory – Assistant Professor Chandramouli Chandrasekaran

Chen Lab – Assistant Professor Jerry Chen

Binaural Hearing Laboratory – Professor H. Steven Colburn

Vision and Cognition Laboratory – Professor Alice Cronin-Golomb

Cruz-Martín Lab – Assistant Professor Alberto Cruz-Martín

Davison Lab – Associate Professor Ian Davison

Denison Lab – Assistant Professor Rachel Denison

Neurovascular Imaging Laboratory – Associate Professor Anna Devor

Economo Laboratory – Assistant Professor Michael Economo

Eden Group – Professor Uri Eden

Laboratory of Molecular Neurobiology – Professor David H. Farb

Gabel Lab – Associate Professor Christopher V. Gabel

Laboratory for Learned Neural Dynamics and Cortical Prediction - Assistant Professor Jeffrey Gavornik

Cortical and Computational Decoding of Speech Lab – Professor Oded Ghitza

Motor Development Lab – Associate Professor Simone Gill

The Guenther Lab – Professor Frank Guenther

Han Lab – Professor Xue Han

Harris Lab – Professor David A. Harris

Laboratory for Computational Neurophysiology – Professor Michael Hasselmo

Ho Laboratory – Associate Professor Angela Ho

Psychotherapy and Emotion Research Laboratory – Professor Stefan Hofmann

Theoretical Cognitive Neuroscience Laboratory – Professor Marc Howard

Howe Lab - Assistant Professor Mark Howe

Keck Laboratory for Network Physiology – Professor Plamen Ivanov

Joseph Lab – Associate Professor Robert Joseph

Laboratory of Behavioral Neuroscience – Professor Kathleen M. Kantak

Developing Minds Lab – Associate Professor Mellisa Kibbe

Laboratory of Cognitive Neurobiology – Professor Ronald Killiany, Associate Professor Tara Moore, Professor Mark Moss, Professor Douglas Rosene

Aphasia Research Laboratory – Professor Swathi Kiran

Kolaczyk Group – Professor Eric Kolaczyk

Cognitive Rhythms Collaborative – Professor Nancy Kopell

Neural Dynamics and Data Analysis Laboratory – Associate Professor Mark Kramer

Imaging Brain Dynamics Group – Assistant Professor Laura Lewis

Lin Lab – Associate Professor Jen-Wei Lin

The Ling Lab – Associate Professor Sam Ling

Logan Lab – Associate Professor Ryan Logan

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Glia Engineering Lab – Assistant Professor Tim O'Shea

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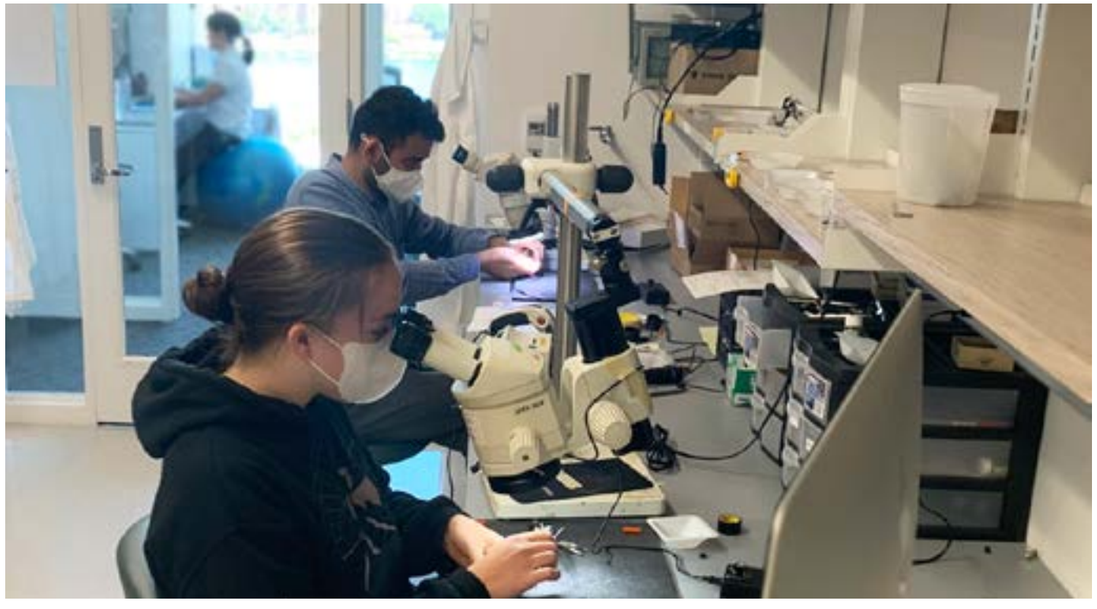
Communication Neuroscience Research Laboratory – Associate Professor Tyler Perrachione

Nanostructured Fibers and Nonlinear Optics Laboratory – Professor Siddharth Ramachandran

Ramirez Group - Assistant Professor Steve Ramirez



In the Howe Lab intern Lydia Mroz (foreground) and post-doc Amil Joshi use stereo microscopes to build optical devices that will record neural activity

Intern Emily Martin synthesizes a fluorescent dye

Cognitive and Clinical Neuroscience Laboratory – Assistant Professor Robert M. G. Reinhart

The Roussarie Lab – Assistant Professor Jean-Pierre Roussarie

Laboratory of Translational Epilepsy – Professor Shelley J. Russek

Laboratory of Addictive Disorders – Professor Valentina Sabino

Brain Plasticity and Neuroimaging Laboratory – Assistant Professor Karin Schon

Laboratory of Comparative Cognition Lab – Assistant Professor Benjamin Scott

Natural Sounds and Neural Coding Lab – Professor Kamal Sen

Laboratory of Cellular Biology of the Basal Ganglia – Professor Jean-Jacques Soghomonian

Neuroimaging, Perception, and Attention Laboratory – Professor David Somers

Stephen Lab – Assistant Professor Emily Stephen

Cognitive Neuroimaging Laboratory – Professor Chantal Stern

The Stern Lab – Professor Robert Stern

Center for Autism Research Excellence – Professor Helen Tager-Flusberg

Brain and Early Experiences Laboratory – Associate Professor Amanda Tarullo

Tay Lab – Assistant Professor Tuan Leng Tay

The Laboratory of Human Induced Pluripotent Stem Cell Therapeutics – Assistant Professor Julia TCW

Tron Group – Assistant Professor Roberto Tron

Brain and Vision Laboratory – Professor Lucia Vaina

Wallace Lab – Assistant Professor Michael Wallace

Neuronal Dynamics Lab – Professor John White

Laboratory of Neurodegeneration – Professor Benjamin Wolozin

Computational Neuroscience and Vision Laboratory – Research Assistant Professor Arash Yazdanbakhsh

Younger Lab – Assistant Professor Meg Younger

Zhou Lab – Professor Lan Zhou

Human Systems Neuroscience Laboratory – Associate Professor Basilis Zikopoulos

Communication and Neurodevelopment Lab – Assistant Professor Jennifer Zuk

LOOKING AHEAD

The offices of the director and the administrators for the Center for Systems Neuroscience are located at 610 Commonwealth Ave. on the 7th floor.

The seminars for the Center for Systems Neuroscience typically take place in the Eichenbaum Colloquium Room on the 1st floor of the Rajen Kilachand Center for Integrated Life Sciences & Engineering, 610 Commonwealth Avenue, Boston, MA.

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Back cover photo: *Faculty and staff at the CSN Retreat. Pictured (from left to right) are David Farb, Jun Shen, Chandramouli Chandrasekaran, Allison Kunze, Uri Eden, Jerry Chen, Swathi Kiran, Ian Davison, Mark Kramer, Alberto Cruz-Martin, Maya Medalla, Xue Han, Chantal Stern, Marc Howard, Ron Killiany, Jean-Jacques Soghomonian, Michael Hasselmo, Kat Kantak, John White, Tara Moore, Nancy Kopell, Shelley Russek, Anna Devor (kneeling), Doug Rosene, Karin Schon, Michael Economo, Jen-Wei Lin, Alice Cronin-Golomb, Steve Ramirez, Robert Joseph, Jenny Luebke, Benjamin Scott, Tyler Perrachione, David Boas, Amanda Tarullo, Jeff Gavornik, and Joseph McGuire*

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