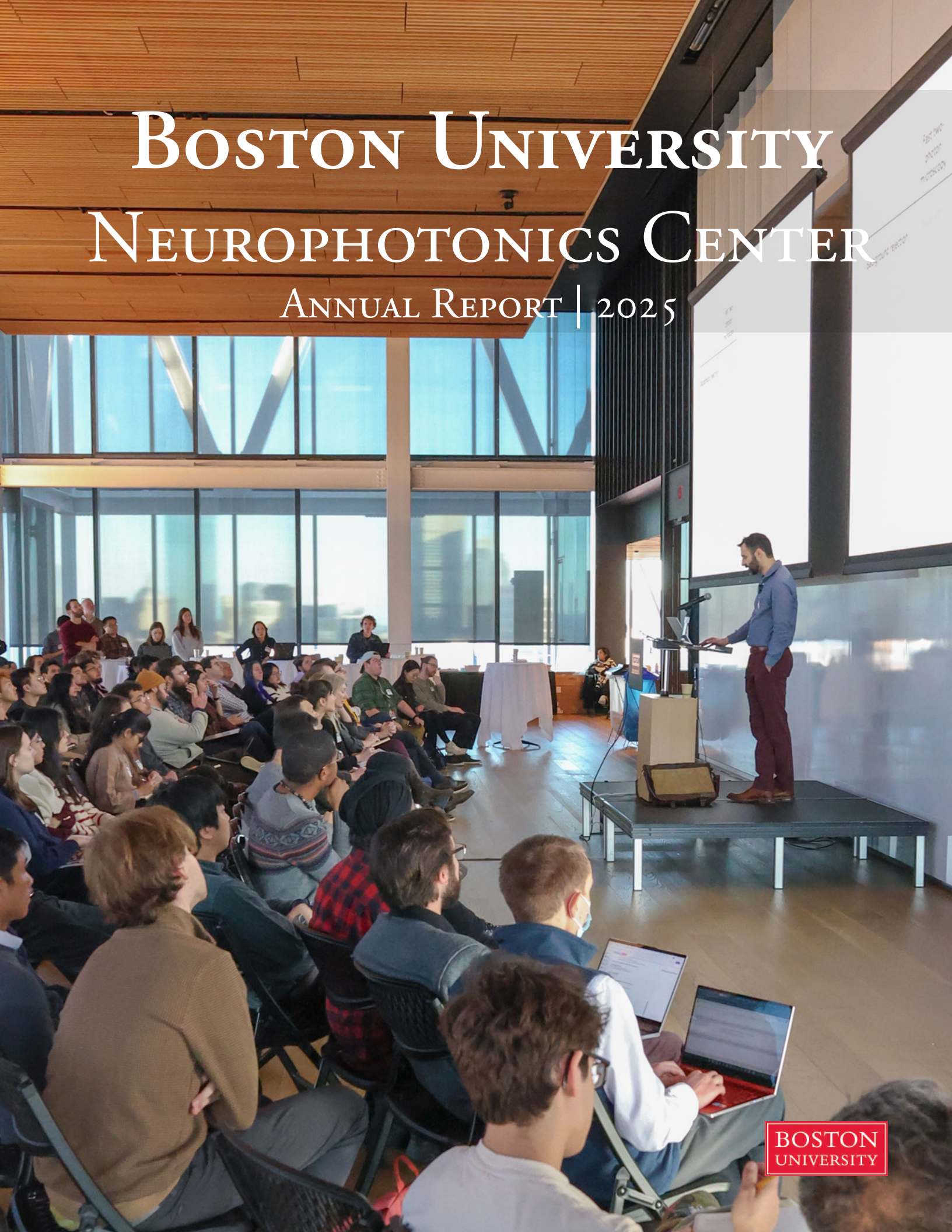
Boston University
Neurophotonics Center
Annual Report | 2025



BOSTON UNIVERSITY

Center Leadership & Staff

David Boas, Ph.D.
Director

Jerry Chen, Ph.D.
Associate Director

Anna Devor, Ph.D.
Associate Director

Christopher Gabel, Ph.D.
Associate Director

Parya Farzam,
fNIRS Specialist and Administrative Director

Danny Giancioppo,
Assistant Director of Communications

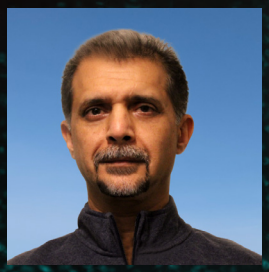
John Giblin, Ph.D.
Scientist

John Jiang,
Lab Manager

Kıvılcım Kılıç, Ph.D.
Scientist

Martin Thunemann, Ph.D.
Scientist

Meryem Yücel, Ph.D.
Technical Director



Zahid Yaqoob, Ph.D.
Technical Director

Letter from the Director

THIS PAST YEAR WAS A PIVOTAL ONE FOR THE BOSTON UNIVERSITY NEUROPHOTONICS CENTER (NPC), with the launch of our NIH-funded T32 Training Program, designed to strengthen and expand our growing community of trainees. This new funding allows us to enhance our established "Introduction to Neurophotonics" bootcamp for rising second-year PhD students with a complementary "Data Science" bootcamp for rising third-year students. The response from trainees has been overwhelmingly enthusiastic as they are eager to adopt best practices in advanced data analysis, coding, and software management that will serve them well throughout their research careers.

We have also introduced a new element to the training activities: a three-day quantitative skills workshop offered each semester. In Fall 2024, Ryan Raut led a session on quantitative reasoning for neurophotonics time-series data, combining a conceptual overview with hands-on Python exercises. In Spring 2025, Stefan Mihalas from the Allen Institute guided trainees through neural dimensionality analysis, subspace comparisons, and cross-session neural data evaluation, again paired with interactive exercises using real datasets. These sessions have been met with strong engagement and have set a high bar for future NIH T32 supported Quantitative Skills Workshops.

Perhaps most exciting is the launch of the Neurophotonics Trainee Organization (NTO), an entirely trainee-led initiative that has rapidly become a hub for community building and professional development. The NTO now coordinates a variety of committees and events, including regular Neuroethics Discussions with invited experts, monthly Neurotechnology Tutorials followed by our Neurophotonics Social, and, as of this year, the new Neurophotonics Podcast—five episodes and counting in its inaugural year. NTO plans for the coming year include engaging alumni and industry leaders, organizing journal clubs, and expanding career development activities. I encourage all members of our community to support and participate in these efforts.

Our 8th Annual Neurophotonics Symposium in January 2025, organized by Meg Younger and Chris Gabel, took on the theme "Neurophotonics Across the Animal Kingdom." The program featured sessions spanning invertebrates, small mammals, and clinical translation, creating a uniquely broad perspective that kept the room filled with an engaged audience from across Boston all day long. This continued growth in attendance and diversity of topics reflects both the strength of our community and the appeal of the symposium as a gathering place for the regional neurophotonics field.

On the research and technology front, we have much to look forward to. Prof. Anna Devor, with support from many in the NPC community, secured an NIH Shared Instrument Grant to install a state-of-the-art three-photon microscope by the end of 2025. I encourage you to start planning experiments now to take full advantage of this capability. Meanwhile, our work in functional near-infrared spectroscopy (fNIRS) continues to expand, with whole-head, high-density systems enabling 200-optode coverage now in regular use. These systems are opening new opportunities for studying neurorehabilitation in Parkinson's disease, post-stroke gait recovery, and aphasia, among other areas. Efforts are also underway to miniaturize and simplify the technology for independent home use by patients, extending its reach into real-world and clinical environments.

The momentum in neurophotonics at BU remains strong, driven by new resources, an increasingly vibrant training ecosystem, and the energy and creativity of our faculty, trainees, and staff. I look forward to seeing how our community leverages these opportunities in the year ahead.

Dr. David Boas,
Center Director

At a Glance

62
Faculty Members

97
PhD Students

$725K
In Grants/Faculty Member

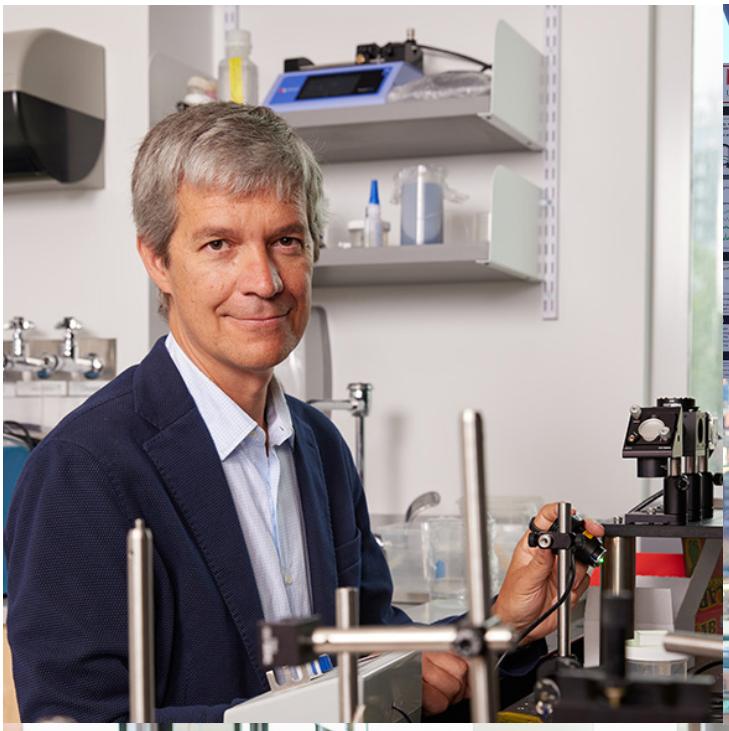
$17M
In Collaborative Grant Funding

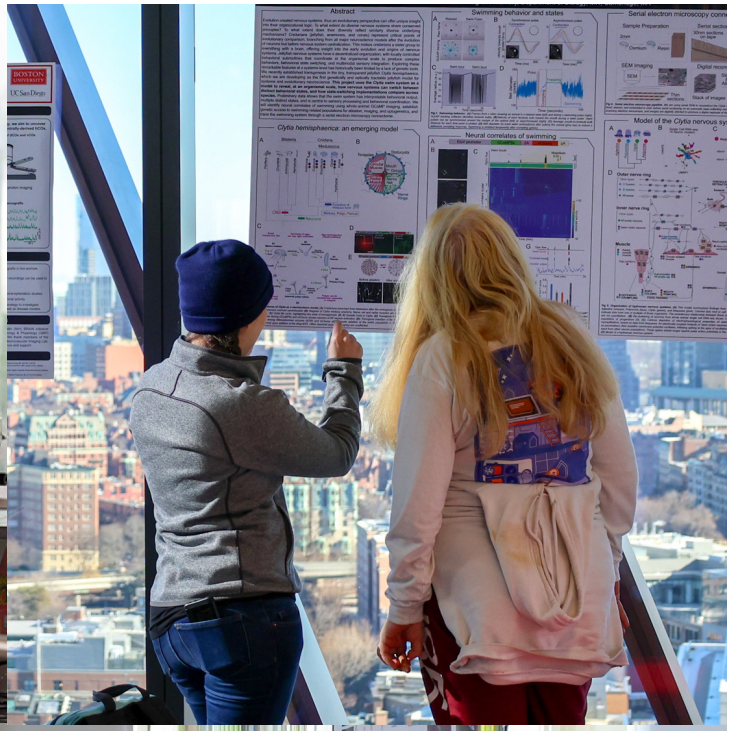
48
Publications from NPC Faculty Collaborations

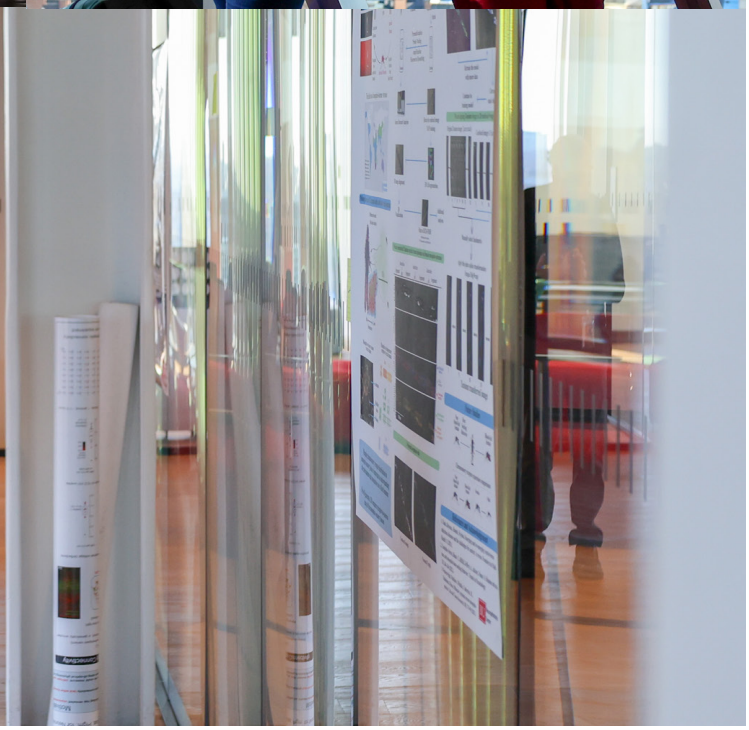
32
Collaborative Grants Funded

Who We Are

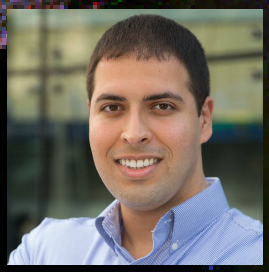
THE MISSION OF THE BU NEUROPHOTONICS CENTER is to build and support an interdisciplinary community that can develop and broadly deploy impactful photonics technologies in the neurosciences to advance our understanding of how the brain works in health and in disease.







Neurophotonics Center Faculty



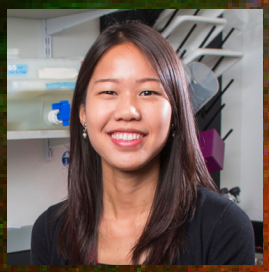
Lou Awad
Associate Professor
Health & Rehabilitation

Thomas Bifano
Professor
ME, MSE, BME, ECE

Irving Bigio
Professor
BME, ECE, PHYS, MED

Jan K. Blusztajn
Professor
Pathology

David Boas
Professor, NPC Director
BME, ECE



Lynne Chantranupong
Assistant Professor
Biology

Jerry Chen
Associate Professor
Biology

Ji-Xin Cheng
Professor
ECE, BME, MSE

Xiaojun Cheng
Assistant Professor
BME

David Chung
Professor
Medicine

Alice Cronin-Golomb
Professor
PBS

Ian Davison
Associate Professor
Biology

Jeffrey Demas
Assistant Professor
ECE

Brian DePasquale
Assistant Professor
BME

Anna Devor
Professor
BME

Michael Economo
Assistant Professor
BME

Terry Ellis
Professor
Physical Therapy

Claudio Ferre
Assistant Professor
Occupational Therapy

Chris Gabel
Associate Professor
Physiology & Biophysics

Jefferey Gavornik
Assistant Professor
Biology

Simone Gill
Associate Professor
Medicine

Lee Goldstein
Associate Professor
Neurology, MED

David Greer
Professor
Neurology

Xue Han
Professor
BME

Michael Hasselmo
Professor
Neuroscience

Mark Howe
Assistant Professor
PBS

Swathi Kiran
Professor
Speech, Language, and Hearing Sciences

Deepak Kumar
Associate Professor
Physical Therapy

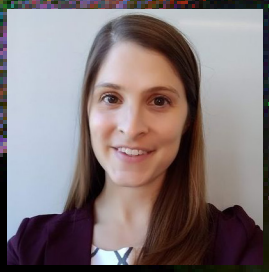
Sam Ling
Associate Professor
PBS

Jennifer Luebke
Professor
Anatomy & Neurobiology

Maria Medalla
Associate Professor
Anatomy & Neurobiology

Jerome Mertz
Professor
BME, ECE, Physics

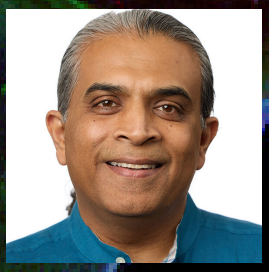
Neurophotonics Center Faculty



Heidi Meyer
Assistant Professor
Neuroscience

Hadi Nia
Assistant Professor
BME, MSE

Timothy O'Shea
Assistant Professor
BME, MSE



Siddharth Ramachandran
Professor
ECE, MSE, Physics

Steve Ramirez
Associate Professor
PBS

Darren Roblyer
Professor
BME, ECE

Douglas Rosene
Professor
Anatomy & Neurobiology

Travis Rotterman
Assistant Professor
Pharmacology, Physiology & Biophysics

Jean-Pierre Roussarie
Assistant Professor
Anatomy & Neurobiology

Shelly Russek
Professor
Neuroscience

Michelle Sander
Associate Professor
ECE, BME, MSE

Benjamin Scott
Assistant Professor
PBS

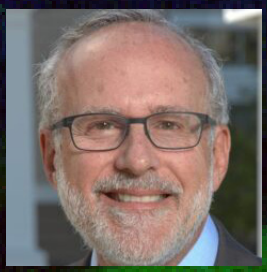
Kamal Sen
Associate Professor
BME

David Somers
Professor
PBS

Matthias Stangl
Assistant Professor
BME, PBS, Neurosurgery

Emily Stephen
Assistant Professor
Neuroscience

Chantal Stern
Professor
PBS



Robert Stern
Professor
Neurology

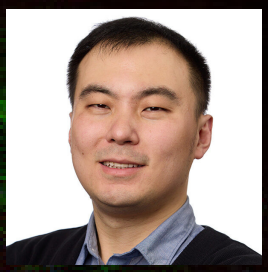
Helen Tager-Flusberg
Professor
PBS

Julia TCW
Assistant Professor
Pharmacology & Experimental Therapy

Martin Thunemann
Assistant Professor
BME

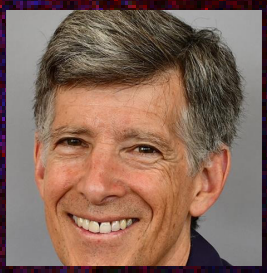
Lei Tian
Associate Professor
ECE, BME

Michael Wallace
Assistant Professor
Anatomy & Neurobiology



Tianyu Wang
Assistant Professor
ECE

John White
Professor
BME, Pharmacology and Experimental Therapeutics, Neuroscience



Ben Wolozin
Professor
Anatomy & Neurobiology

Chen Yang
Professor
Chem, ECE, MSE

Meg Younger
Assistant Professor
Biology

Meryem Yücel
Associate Professor
BME

Ella Zeldich
Professor
Anatomy & Neurobiology

Neurophotonics Center 2025 Fellows

Tushar Arora

WITH SUPPORT FROM THE NIH T32 GRANT, Tushar Arora will continue his work with Dr. Brian DePasquale—focusing on neural data analysis and developing machine learning models to understand neural dynamics underlying motor control and decision-making. This work aims to improve our ability to decode behavior, forecast neural activity, and understand how different brain areas communicate. Tushar's research will integrate advanced machine learning techniques with multimodal experimental datasets consisting of electrophysiological recordings, optogenetic stimulation, and mechanical perturbations. He also plans to extend these methods to brain-computer interface applications, ultimately striving to develop better neural prosthetics. A robust and generalizable model for interpreting neural dynamics will not only advance closed-loop experiments but also offer new approaches for analyzing discrete time series data and can be deployed in BCI devices.

Anne Curtis

WITH SUPPORT FROM THE NIH T32 GRANT, Anne Curtis will continue her work with Dr. Lynne Chantranupong studying neuromelanin, a byproduct of dopamine metabolism. By generating neuromelanin in stem cell derived organoids, Anne is able to investigate the function of this pigment and how it influences vulnerability during Parkinson's Disease. Furthermore, she plans to utilize Interference Differential Absorbance Confocal (IDAC) Microscopy, developed by the Mertz Lab, to track neuromelanin with improved resolution. Anne hopes to elucidate the function of this poorly understood pigment and uncover new therapeutic strategies for treating Parkinson's Disease.

Negar Rahmani

WITH SUPPORT FROM THE NIH T32 GRANT, Negar Rahmani will investigate how Reelin-expressing neurons in the entorhinal cortex communicate with the hippocampus to support memory formation, and how this signaling is modulated by alternative splicing of Reelin's receptor, Apoer2. Working in the lab of Professor Angela Ho, and co-sponsored by Professor Steve Ramirez, she integrates molecular genetics, circuit-level manipulations, and two-photon calcium imaging to examine how distinct Apoer2 splice variants influence Reelin signaling, synaptic plasticity, and neural circuit dynamics. Her research seeks to identify early disruptions in memory-related pathways that contribute to Alzheimer's disease and to advance the application of neurophotonics tools in systems neuroscience.

Neurophotonics Center's 8th Annual Symposium | *"Neurophotonics Across the Animal Kingdom"*

On January 15, 2025, the Neurophotonics Center co-hosted its 8th annual symposium event alongside the Hariri Institute, in an event organized by NPC faculty Meg Younger and Christopher Gabel. The symposium topic, "Neurophotonics Across the Animal Kingdom," included studies on schooling fish, C. elegans., songbirds, and more.

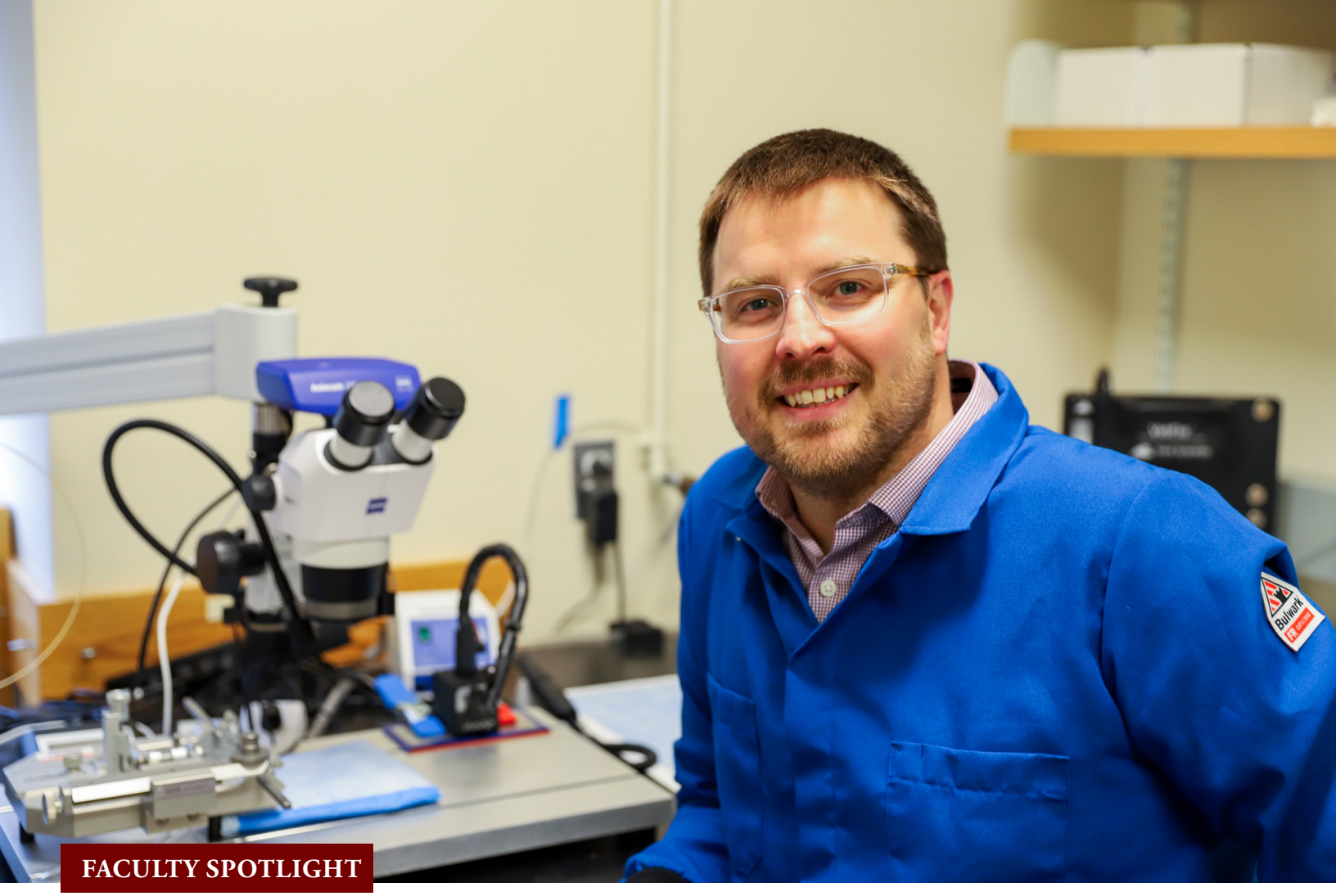
Following opening remarks from Center Director **David Boas**, co-ogranizer **Meg Younger** kicked off the first round of presentations, chaired by Assistant Professor **Brian DePasquale**: Neuronal Circuits for Navigation and Movement. Presenters included Matthew Lovett-Barron and Rachel Wilson From U.C. San Diego and Harvard University, respectively. Following their presentations was a coffee break and the first opportunity to check out some of the many amazing posters submitted by Neurophotonics Center students, showcasing their relevant neurophotonics research to experts in the field.

The second session of presentations,"Combining Neurophotonics and Connectomics to Study Neuronal Function," was chaired by Associate Professor **Jerry Chen**, and featured talks from Boston University Assistant Professor Benjamin Scott and Stanford University's Professor Thomas Clandinin, covering songbird research and connectomics as related to the drosophila visual system.

The penultimate session, "Novel Techniques: Pushing the Limits of Neurophotonics," chaired by Mike Wallace, featured talks from BU Assistant Professor **Michael Economo** and Harvard University's Aravi Samuel, where they shared presentations concerning voltage imaging and optogenetic biochemistry.

Lastly, "Neurophotonics: Bridging Molecules, Circuits, and Behavior," chaired by Associate Professor **Ian Davison**, featured the last three speakers: Zoe Donaldson, from the University of Colorado, Boulder; Silke Sachse, from the Max Planck Institute; and Cori Bargmann of the Rockefeller University. Closing out the symposium, these presenters shared research on pair bonding, olfactory processing in transgenic locusts, and neuronal function in C. elegans.

The event could not have been made possible without the help of the Hariri Institute, as well as NPC faculty members across the board. Thank you to everyone who participated in the organizing, as well as all of our guests. We already can't wait for next year!



FACULTY SPOTLIGHT

TIM O'SHEA'S LAB IS FINDING AVENUES TO REPAIR NEUROTRAUMA

by Danny Giancioppo

Although Assistant Professor Tim O'Shea (BME, MSE) was always interested in STEM, it wasn't until his junior year of high school that his interest evolved into a personal mission.

Growing up in Brisbane, Australia, there was a surplus of mining and mechanical engineering opportunities in the state, lending itself to a vibrant engineering community. However, when his best friend suffered a spinal cord injury playing rugby, O'Shea knew he wanted to study the Central Nervous System (CNS) to improve methods of rehabilitation and repair.

"He was an in-patient for almost a year," O'Shea recalls. He would work with his friend in the process of rehabilitation, and was confronted at a young age with the harsh reality of living with a spinal cord injury. "[Later,] I had this serendipitous interaction with a professor at the university I ended up going to for undergraduate, who told me about medical engineering and the idea of developing exoskeletons and various prosthetic-type devices to help people walk again." From there the mission was simple: O'Shea would go to university and pursue a degree in medical engineering, seeking to help people like his best friend following various neurotrauma.

During his time as an undergraduate, O'Shea was introduced to the widespread capability of cellular-molecular manipulations in biomedical engineering. Where he once sought to help with the treatment of spinal cord injuries, he now found there were methods of research which began carving a path toward tissue regeneration and ultimately recovery of spinal cord function. This led O'Shea to the U.S. for his PhD, where he's continued

his research ever since—for the last several years, at Boston University.

"We work in three main initiatives. CNS injury, neural interfaces, and glial drug delivery."

In the O'Shea lab, researchers advance the opportunity for spinal cord repair through biomedical engineering and research. "Not purely on spinal cord injury," O'Shea adds, but other neurotrauma. "We work on stroke as well as neurodegenerative diseases such as Parkinson's Disease," primarily through their research on glial cells.

Glia literally means "glue," and it's an apt name for the cell-type's purpose in neural tissue function. Glial cells, which are commonly subcategorized as astrocytes, microglia and oligodendroglia, were once considered merely there to contribute to the mechanical integrity of the central nervous system, allowing the main functional cells, neurons, to direct movement and sensation. But this was an oversimplified understanding.

"[Glia] are critical to regulating neural circuit functions and ensuring the brain and spinal cord remain healthy," O'Shea explains. "You can't have brain or spinal cord tissue without glia." Without glial cells, O'Shea goes on, the neurons are either doomed to die or functionally fail within the context of their role. "They're critical to maintaining the viability of circuits, but not only do they do that, they essentially are the gatekeepers of the outside world to the CNS."

Glial cells are responsible for regulating other cells and molecules that may enter the CNS and partition the CNS apart from other cells and tissues. In this way, O'Shea views them as one of the most integral cell types in the brain—and this is within a healthy context. When it comes to perturbations, such as brain trauma or neurodegenerative disease, they are second-to-none. The glial cells will respond to these perturbations by undergoing adaptations to regulate repair and functionality of the brain, more so than neurons. This is why, in the O'Shea lab, they primarily focus on glial cells—a form of research that lends itself to convergent projects across the Neurophotonics Center, and University at large, which they break down into three categories of work.

Assistant Professor Tim O'Shea showing off the rotary evaporator, used to volatilize and collect organic solvents from chemical reactions during work-up

"We work in three main initiatives," O'Shea says. "CNS injury, neural interfaces, and glial drug delivery."

"We have projects focused on developing ways to better deliver therapies that have relevance for neurodegeneration—like Parkinson's disease and Alzhemier's disease. Obviously, our work in CNS injury is relevant to stroke, spinal cord injury, traumatic brain injury. And then the neural interface work—there's more and more interest in putting electrodes into the brain without really thinking about the ramifications of that long-term for people's brain health. If we can develop better ways to interface with the CNS, we can develop safer electrodes. All of those are really important for furthering potential clinical treatments."

In their CNS injury work, the research leans toward modulating the function of endogenous glia for wound repair—using material systems to manipulate key features of wound responses such as metabolism or proliferative programs—to augment a neonatal-like recovery.

"In very young animals, they have these kind of 'super' glial cells that are able to mount a wound response more effectively. As a result, certain CNS injuries in very young mammals will naturally regenerate […]

The Gel permeation chromatography (GPC) unit, used to measure the molecular weight of new olymers the O'Shea Lab synthesizes

We lose that competency over the first couple weeks of postnatal development, and we instead rely on fibrotic wound healing." Much of the lab's efforts therefore aim to replicate neonate wound repair responses, while simultaneously hampering the adult wound responses, which are less effective.

"That's endogenous cells—cells that are already in the brain and spinal cord," O'Shea continues. "Another aspect of CNS injury work is in transplantation. How can we use an exogenous source of cells to do wound repair? We transplant cells that turn into glial cells, and we develop ways to enhance their survival and their function to do better wound repair in the context of these CNS injuries."

One active example concerns organoid research, one of the widest cross-convergent research projects currently ongoing at Boston University. Organoids are literally "mini organs," small, healthier cells placed onto a correspondingly damaged organ—such as the brain, through any number of neurodevelopmental or -degenerative ailments. When regulated properly, these miniature cells showed signs of reintegration with the damaged organ, providing it with new, functioning cells which could, in the best of cases, lead to organ repair and renewed functionality.

"The organoid project is kind of interesting," O'Shea says. "We're essentially using these material films that we can load with molecular regulators. We can place [them] on the surface of the brain, or over the top of the implanted organoid, to provide the developmental morphogens that direct the patterning of the organoid." A consistent problem with organoid implantation is the aimless development process of the new cells. With no instruction, there can be a heterogeneous mass of cells—sometimes leading to tumor growth. The use of material films thus serves an "engineering approach," substituting the developmental morphogen gradients which otherwise take place during development.

Ironically, this was only a byproduct of the original material goal. "We were trying to use [material films] to modulate the foreign body response around devices," O'Shea says. The material was not only a film, then, but a coating around the perceived interface of electrodes and devices implanted into the CNS.

This serendipitous result has led to multiple collaborations across Boston University's campus with other researchers forwarding organoid research, but it isn't the only field that promotes convergence. Like many

"IF WE CAN DEVELOP BETTER WAYS TO INTERFACE WITH THE CNS, WE CAN DEVELOP SAFER ELECTRODES. ALL OF THOSE ARE REALLY IMPORTANT FOR FURTHERING POTENTIAL CLINICAL TREATMENTS"

– Tim O'Shea

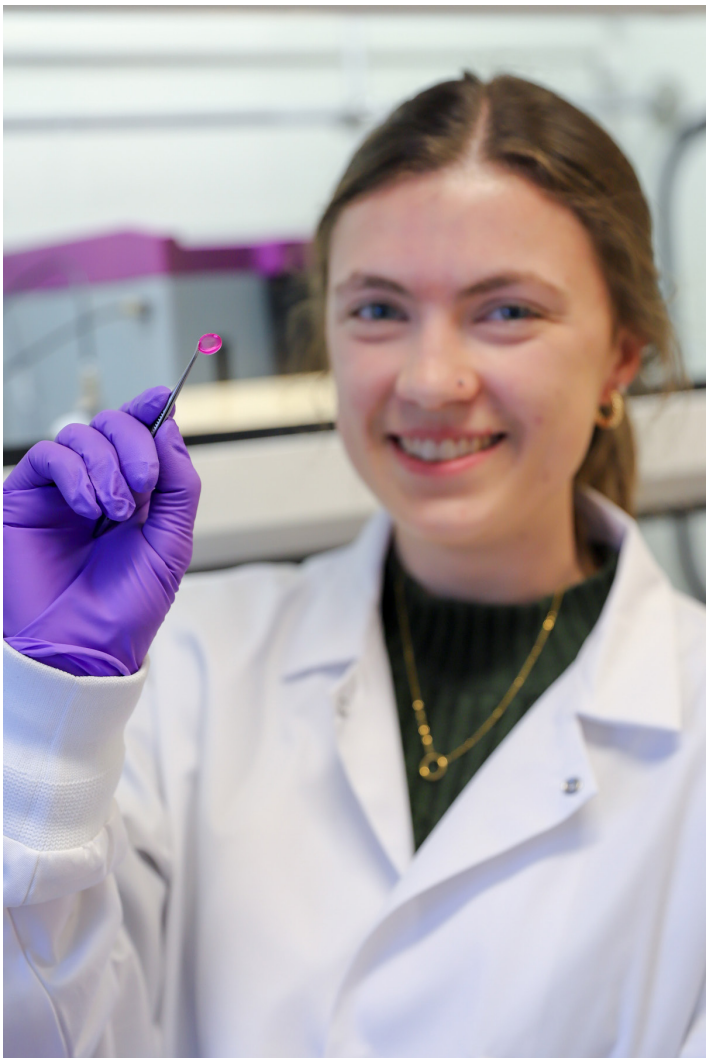
Neurophotonics Center labs, O'Shea's group is an inherently interdisciplinary collection of scientists with several multifaceted projects. This has led to such collaborations as with the Boas lab, in their research on modulating glial function in strokes, and implanted device projects with the Economo lab—who have developed microprism models for neuron imaging—and integrating their materials onto the prism to make them optically transparent for imaging purposes.

"We see ourselves as both a group that makes new material tools to do interesting biological studies," O'Shea explains. "And we bring [faculty] along who have expertise in complementary areas—mostly optical tools—to be able to elevate the kind of studies that we can do."

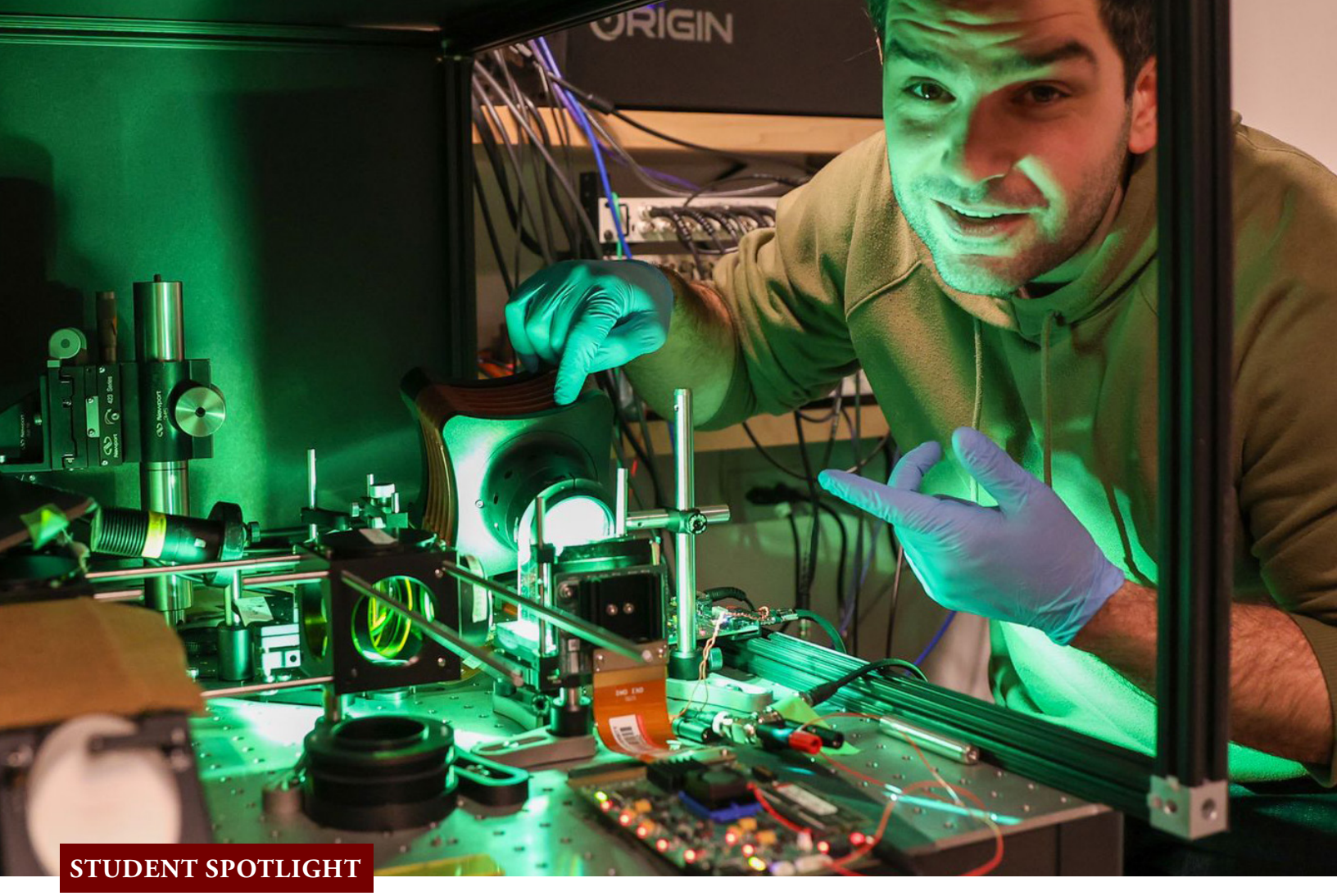
The same rule applies for his students, both new and returning: innovate first, and then apply widely. To O'Shea, a varied pool of expertise determines a successful lab space. "It's not like we just have students that purely make new materials, although that is an aspect of people's projects." O'Shea explains that "those same people who are [making materials] are also studying their materials in vitro cell culture models, in in vivo animal models," and that some students also have the complement of the optics element— intravital imaging.

Many of the projects that the O'Shea lab works on are largely supported by the NIH, spinal cord injury research foundations such as the Craig H Neilsen, Byron Riesch, Paralyzed Veterans of America, and Wings for Life, as well as the Neurophotonics Center. Currently, three R21 grants and an R35 MIRA, all from NIH, are providing the funding and resources necessary for the O'Shea lab to continue its research at a high level. In the current political environment, O'Shea feels it's particularly vital to acknowledge and thank the US tax payers and the federal government workers for their assistance in enabling such important work. "That support is crucial to do the work. It doesn't just happen in a vacuum. We can't do our work without that kind of support."

And the support of such institutions doesn't only help fund the research, O'Shea adds. It also helps to improve the research itself. "A lot of these grants don't get awarded the first time. So the process of going through peer reviews and study sections—it helps cement the idea, focus the idea, refine the idea to really hone in on what's most important to go after. And these projects are tackling a really important question that is addressing a really important need."



PhD Student Kate Herrema (O'Shea Lab, Devor Lab) holds a biomaterial film loaded with morphogens, which gets applied onto the brain surface over implanted organoids to create morphogen gradients



STUDENT SPOTLIGHT

WILL CUNNINGHAM MAKES MOVES ON NPC GRADUATE STUDENT ORGNAIZATION AND NEURONAL CIRCUITRY RESEARCH

by Danny Giancioppo

Will Cunningham doesn't just study how neuronal circuits control systems of movement—he's making several moves of his own. While pursuing his PhD at Boston University, he's serving as a member of the Economo lab group, and simultaneously helping to found the Neurophotonics Training Organization (NTO), a student chapter that will house individual student groups under one umbrella.

For being such a leader in the neurophotonics community, it's a surprise he wasn't initially heading down that path. "My STEM journey has been a little winding," Cunningham says. "Historically, when you think about names that transcend across all borders, scientists are the ones doing the things that transform the world in positive ways."

Growing up in a house of scientists, Cunningham always had an interest in STEM subjects, but was unsure about his own career path. He studied Mathematics and Computational Science in his undergraduate career, and later worked as a software developer at Epic Systems, where he yearned for a return to academia.

"It was not for me," Cunningham jokes. "I enjoy learning, and I enjoy interacting with people who are really smart and continuing to grow."

Deciding to pursue intellectual curiosities that might

"EVERYONE AS A GRAD STUDENT KNOWS SOMETHING THAT YOU DON'T. THAT'S PART OF THE POINT OF GRAD SCHOOL."

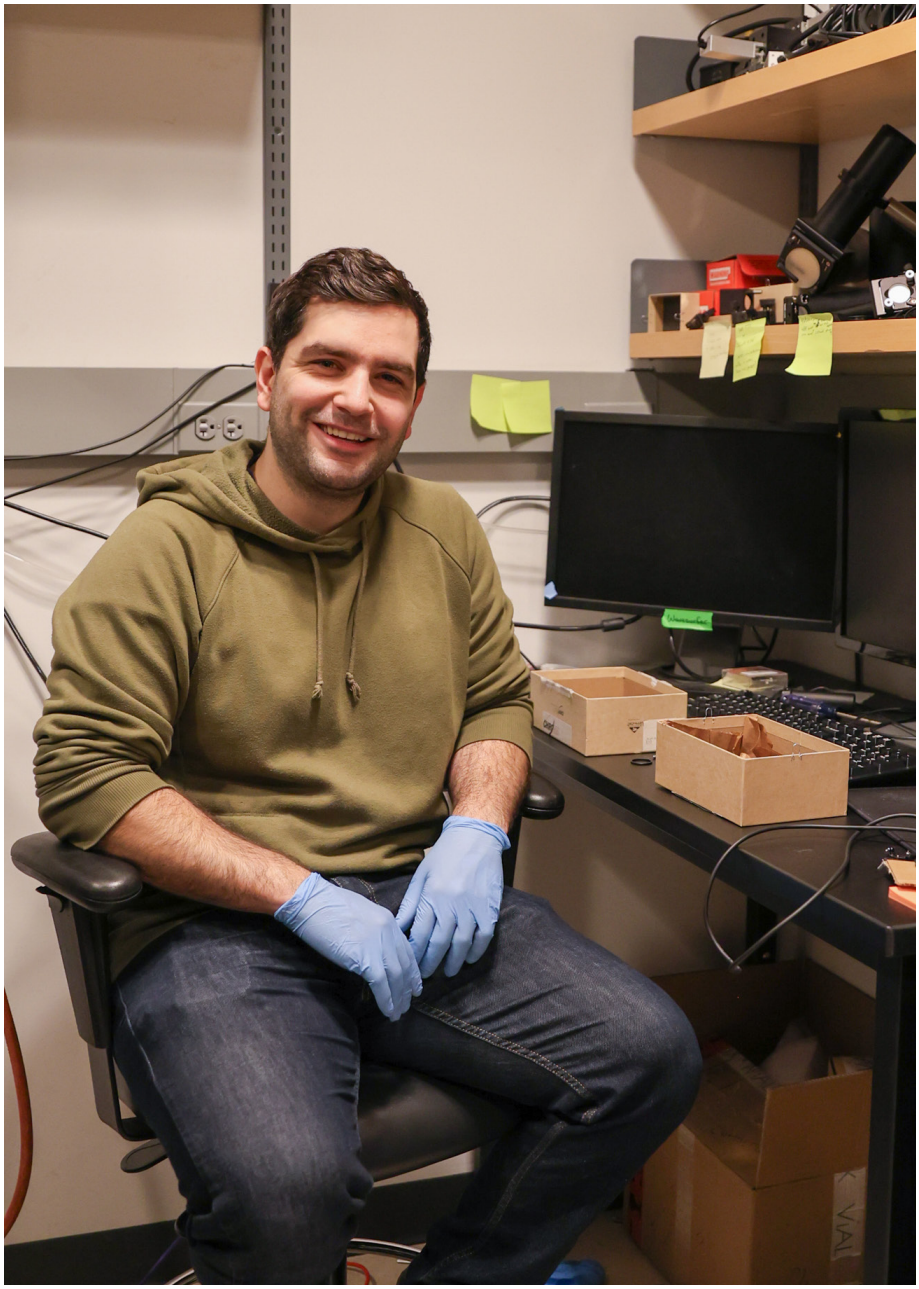
– Will Cunningham

help better the world, he began studying through the Graduate Program for Neuroscience, following in the footsteps of his mother, a fellow neuroscientist. He even found a way to bring his undergraduate interests into the fold, as he found plenty of space for math and computer science in a number of neuroscience studies. Joining the Economo lab, therefore, was a perfect convergence of his interests.

"The Economo lab as a whole is pretty interested in motor control," Cunningham says. It's something most people take for granted. The underlying structure—or "building blocks," as Cunningham puts it—of what dictates the body's ability to move and control said movement, made up of neuronal circuits and cell types. By gaining a greater understanding of their function, the Economo lab hopes to provide a deep understanding of how these circuits typically function, providing a baseline for brain-computer interface development or for comparison when things go awry, such as in neurodegenerative diseases.

Cunningham's role within the group currently involves imaging transcriptomic markers—the things that determine which genes are expressed in each type of cell—via slice work to see how variable the cell types are, and how they work together. "Within a brain region you have a hundred or so building blocks, maybe," he says. "What are the motifs or themes about the way those building blocks are connected to each other to create ways of doing computation?"

The answer lies in his optical research, studying mice brain cells and keeping them activated to investigate how one activated cell affects the other cells within a single "slice" of a mouse brain. By using proteins—some which activate the cells when exposed to light, some which change in response to cellular activity—Cunningham is able to record the responses of each cell and map out how they talk to each other. Combining this with imaging which proteins each cell expresses allows the lab group to identify cell types and determine what sort of building



blocks they are, and thus what function they play in overall movement.

"A lot of what I'm doing is working on the tools for other neuroscientists to get at the things that they're interested in," Cunningham explains. Other lab members work to similar ends; for example, one lab member is studying the neuronal circuit for facial movements, gaining a more developed understanding of the brain regions and cells to help specify treatments. "If [scientists] have a good understanding of the underlying connectivity and the way these building blocks are put together, eventually [they] can target individual cell types—because right now a lot of therapies target the whole brain."

The long-term goal of the Economo lab builds upon the opportunity to advance the understanding of underlying neuronal connectivity, spreading to larger research projects both at BU and beyond. And assisting a larger community of research doesn't stop for Cunningham in the lab. He's also working with Neurophotonics Center faculty and staff to create a student-led organization.

With the assistance of professors David Boas and Michelle Sander over the course of the last six or seven years, several student groups have emerged in the effort to bolster community among graduate students. However, there has been no concerted effort to house these groups under one umbrella, giving grad students not only a voice in the community, but easy access to all of their goings-on.

"There's a symposia group, there's a neuroethics group," Cunningham says, listing some of the many committees within the NPC, "more recently there's even a BCI (Brain and Computer Imaging) group—there's a podcast group. And so all of these were very disparate committees. They weren't really talking to each other."

As the NTO comes together, Cunningham is hoping to unify these groups, making socialization and collaboration more fluid and frequent. "When Neuroethics has a speaker over, it would be potentially beneficial to have the podcast committee invite that speaker to be interviewed," he explains, providing further examples of convergent planning. "It might make sense for the BCI committee to have a joint event with the neuroethics committee… It really makes sense for people to talk together and have a community."

The NTO brought together the committees at the end of the 2024 fall semester to discuss each committee's current responsibilities and impact, with the goal of building up the structure of shared resources.

"How do we order food? How do we submit receipts? What rooms should we reserve for our events?" These are some of the shared concerns of the many committees the NTO hopes to create a baseline of assistance for, promoting further engagement and an easier production process for community events.

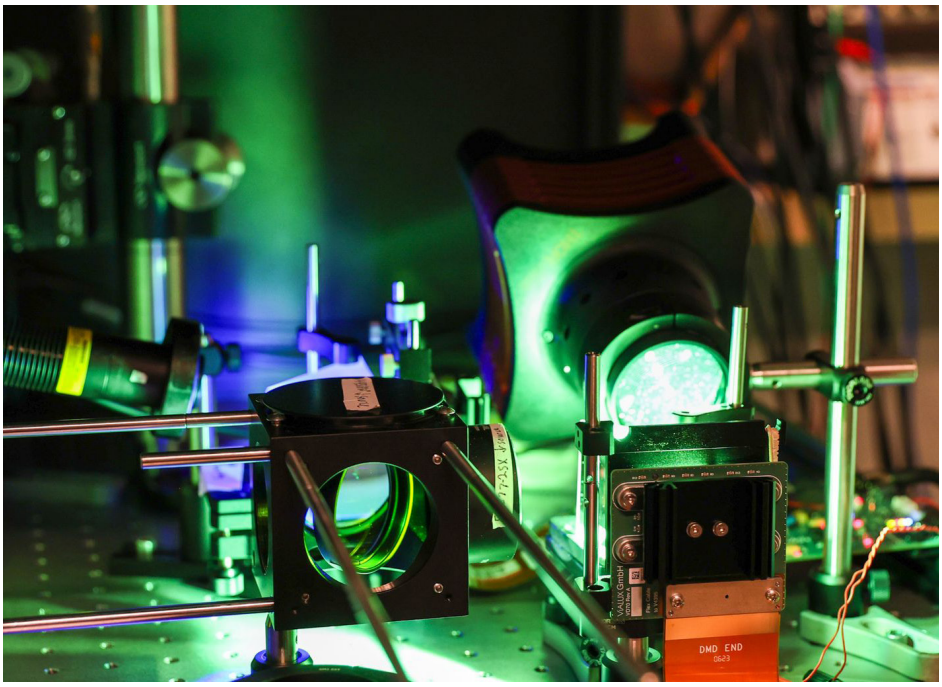
At the end of the day, the goal is to create a community for NPC trainees. Promoting their own growth and interests, in Cunningham's opinion, is the best way to not only forge a sense of collaboration, but to teach.

"Everyone as a grad student knows something that you don't. That's part of the point of grad school—everyone's reading and doing their own research."

While searching for the strongest leadership and structure of the committees going forward, Cunningham hopes that students who are part of the organization feel that they are getting the most out of their membership, and that their voices are being heard.

"The first thing I did before [our first meeting] was set up a Slack for all of these different groups so that there was one place where the committees could talk about upcoming events and create a Google calendar and a Google Drive for sharing all of those resources." The NTO is also planning to begin a newsletter to send out events on a regular basis and create a stream of "familiar faces" as the organization forms a more cohesive structure.

"There is a place for all of these committees to advertise their events, and [Neurophotonics Center students] can expect to become more engaged and involved."



MANIPULATING MEMORIES TO HEAL THE BRAIN

Steve Ramirez

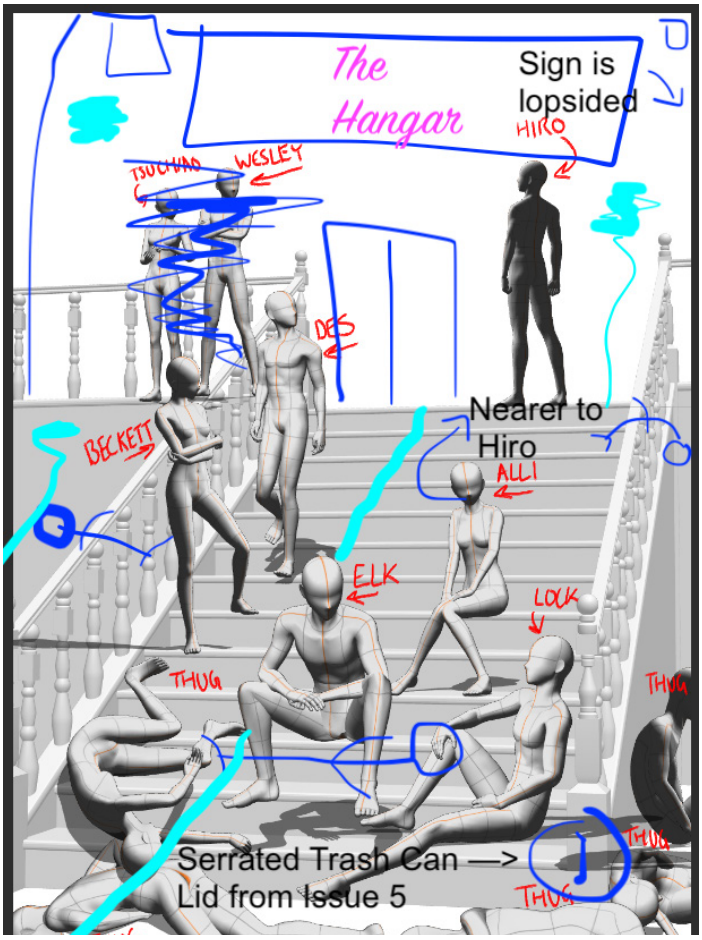
Steve Ramirez's lab at Boston University sits within the Neurophotonics Center, where his team leverages a suite of cutting-edge neurophotonic tools—particularly optogenetics and *in vivo* calcium imaging—to image and manipulate memories in the mammalian brain. They genetically access specific neuronal populations in several areas important for memory including the hippocampus, amygdala, and prefrontal cortex, which are active during learning experiences, rendering them visible under specialized microscopes in the Neurophotonics Center.

By inserting viruses that drive light-sensitive proteins and calcium sensors into these cells, the lab then uses precise pulses of light delivered through implanted optic fibers to activate or suppress memory-bearing neurons during behavioral tasks. When combined with the Center's 2-photon microscopes, these methodologies enable real-time control and observation of how genetically defined neuron ensembles encode, retrieve, and modify memories in freely behaving mice.

The Ramirez Group's research advances beyond fundamental circuit mapping; they use these technologies to intentionally alter memory traces for therapeutic ends. By optogenetically reactivating engrams linked to positive experiences or silencing those associated with fear, for instance, they've demonstrated the ability to modulate depression- or PTSD-like symptoms in animal models. Furthermore, they've explored how social interactions can rekindle dormant memories and how particulate environments can bias which memories are recalled, offering insights into how real-world environments influence neural circuitry loss and recovery.

Using 2-photon approaches, the lab is now studying how to predict which cells will become memory-bearing cells days in advance, how the heterogeneous landscape of cell-types in the brain process learning and memory, how the physical basis of memory changes with time and experience, as well as how disorders of the brain (e.g. cancer) alter local and brain-wide circuit dynamics.

Collectively, the lab's use of neurophotonics is steering memory research toward interventions that could one day treat psychiatric disorders by precisely editing and harnessing our own memory networks.



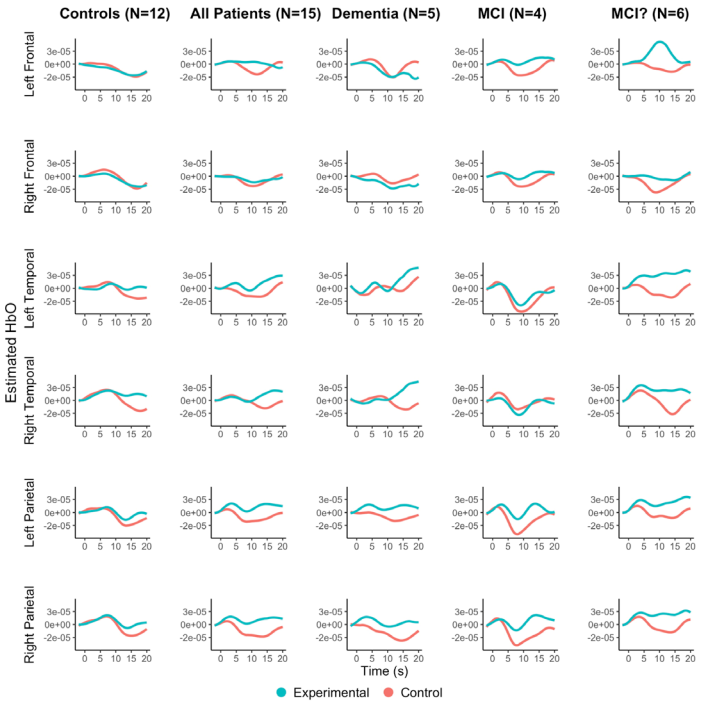
fNIRS Across the Clinical Spectrum of Alzheimer's Disease to Heal the Brain

Shalom Henderson and Swathi Kiran

Dementia affects over 55 million people globally, with projections reaching 78 million by 2030. Alzheimer's disease (AD), the most common form of dementia, accounts for 60 – 80% of cases and represents a global health challenge. Two major breakthroughs have shaped AD diagnosis and treatment. First, validated pathophysiological biomarkers including amyloid and tau PET imaging, cerebrospinal fluid analyses, and emerging blood-based markers have revolutionized early detection and monitoring. Second, FDA-approved anti-amyloid therapies such as lecanemab offer the first disease-modifying options shown to slow cognitive decline in early-stage AD. These advances highlight the critical importance of early and accurate diagnosis to enable timely intervention and improve patient outcomes.

Identifying AD in its earliest stages, however, remains a persistent difficulty. Preclinical individuals often lack noticeable symptoms, and subtle cognitive changes may resemble normal aging. While lumbar punctures and PET imaging are constrained by cost, invasiveness, and limited access, blood-based biomarkers are not yet fully implemented in routine clinical practice. Could functional near-infrared spectroscopy (fNIRS) offer a non-invasive, accessible solution for detecting early cognitive decline spanning both prodromal and preclinical stages of AD? This is the question driving the work of Shalom Henderson and her team at the Center for Brain Recovery and Neurophotonics Center.

A growing body of research has identified distinct fNIRS signatures associated with AD. Vascular dysregulation is among the earliest pathological events in AD and is closely linked to cognitive decline. Disruption of the neurovascular unit reduces cerebral blood flow, particularly in regions critical for cognition, even in the preclinical stages. fNIRS studies in AD and related conditions, such as amnestic mild cognitive impairment (aMCI), reveal consistent hemodynamic alterations including reduced task-evoked oxyhemoglobin (HbO) responses



and diminished resting-state connectivity. Studies also suggest that compensatory hyperactivation may reflect neural inefficiencies in MCI, serving as a potential early biomarker of cognitive dysfunction.

The team's ongoing research leverages naturalistic discourse tasks, which may more effectively reveal neural changes than traditional structured assessments (e.g., confrontation naming, verbal fluency), as they better reflect the demands of real-world communication. This approach is applied across a spectrum of clinical presentations, including individuals with confirmed AD dementia, MCI, and those with questionable or subjective cognitive concerns (denoted as "MCI?" in the figure). Active recruitment and data collection are ongoing to further examine differences in cortical activity between these groups and age-matched healthy controls.

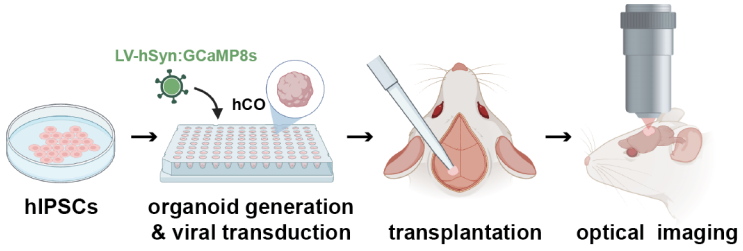
Longitudinal, In Vivo Imaging of Human Brain Organoids Transplanted into Mice

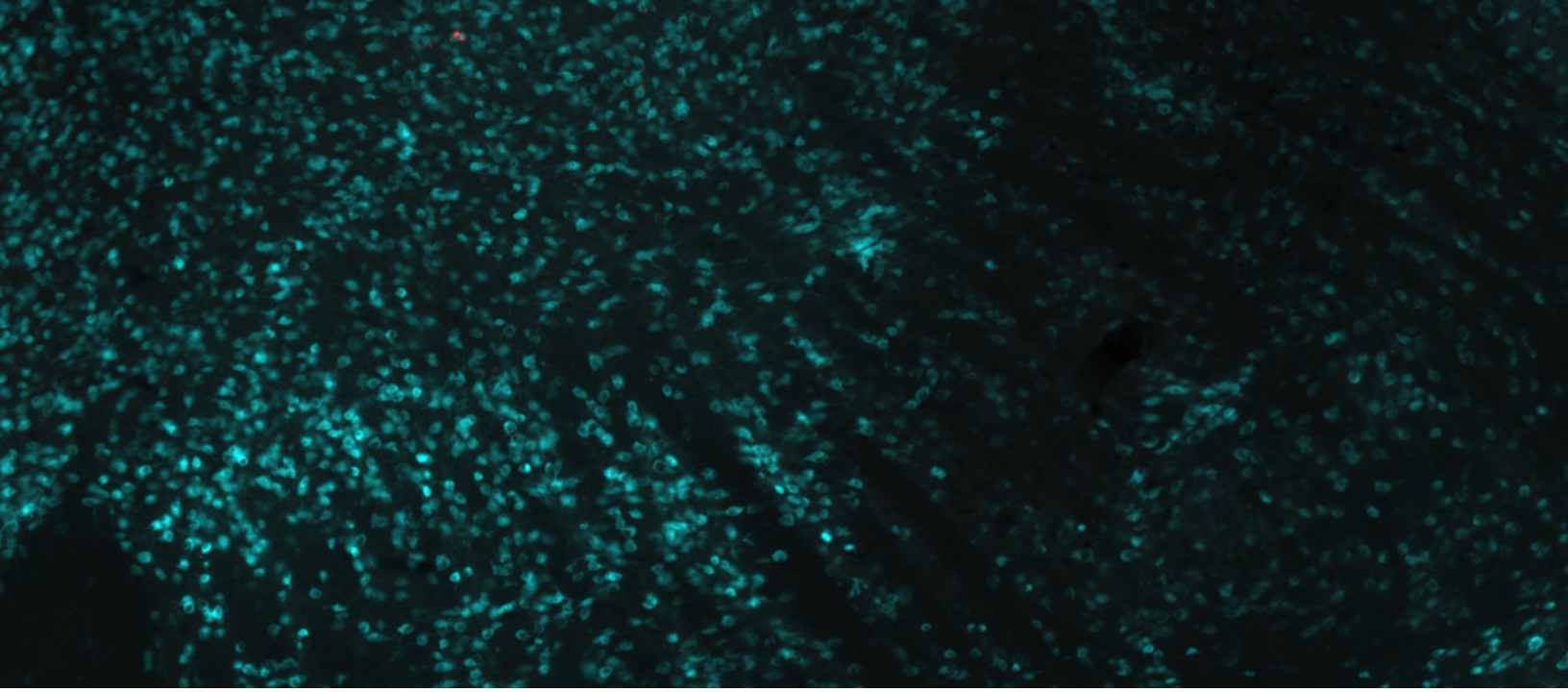
Kate Herrema, Anna Devor, Tim O'Shea, Martin Thunemann, and Ella Zeldich

Human induced pluripotent stem cell (iPSC)-derived cortical organoids (hCOs) are three-dimensional neural cell aggregates that resemble the developing human cortex and have emerged as an avenue to study pathological processes in a human-centric experimental context. They have been used for a variety of applications including disease modeling, drug screening, and regenerative medicine. However, insufficient oxygen and nutrient supply causes the formation of a necrotic core during extended hCO culture which restricts their growth and ultimately limits neuronal maturation. Furthermore, hCOs cultured in vitro lack key cell types present in the native brain microenvironment as well as functionally relevant neuronal circuitry. To address these shortcomings, many researchers now turn to xenotransplantation – the implantation of a human organoid into the rodent brain. Previous work from our group and others has shown that xenotransplantation of hCOs facilitates vascularization by the host, increased neuronal maturation, and the integration of human neurons into host neuronal circuits. However, there is a need for strategies to monitor structural and functional changes in these models throughout in vivo maturation.

NPC fellow Kate Herrema, with her advisors Martin Thunemann, Anna Devor, and Timothy O'Shea, and her collaborator Ella Zeldich (Boston University Chobanian & Avedisian School of Medicine) is developing a multimodal neurophotonics toolkit for longitudinal, in vivo monitoring of xenografted hCOs. Recently, Kate optimized the use of optical coherence tomography (OCT) imaging for label-free assessment of graft vascularization and delineation of the host-graft interface. This work has yielded promising insight into how hCO xenografts integrate structurally with host tissue over time. Additionally, the team has been using two-photon imaging to monitor maturation-related changes in neuronal activity in human neurons labeled with genetically-encoded calcium indicators. These data revealed trends in xenograft neuronal network maturation including the emergence of large, synchronized calcium events at 3 months after implantation. These results provide valuable insight into the developmental trajectory of hCO xenografts and give context to future xenotransplantation studies aimed at investigating neurodevelopmental disorders. Ongoing studies led by Dr. Thunemann and Dr. Zeldich are using this approach to investigate neurodevelopmental defects caused by Trisomy 21, the underlying genetic cause of Down Syndrome.

One limitation of this work is considerable graft-to-graft variability with respect to cytoarchitecture and neuronal network dynamics, potentially limiting the ability to draw biologically meaningful conclusions using this model. To permit widespread use of xenotransplantation technology requires additional tools to direct the neuronal maturation of hCOs in vivo after xenotransplantation. Kate and her co-advisor Timothy O'Shea aim to address this problem with engineered biomaterials, en-





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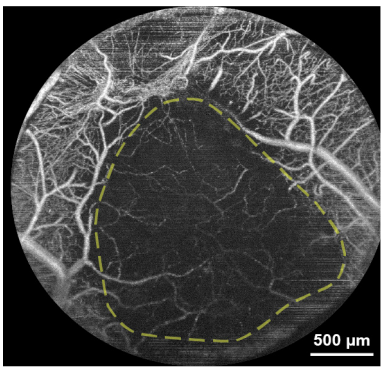
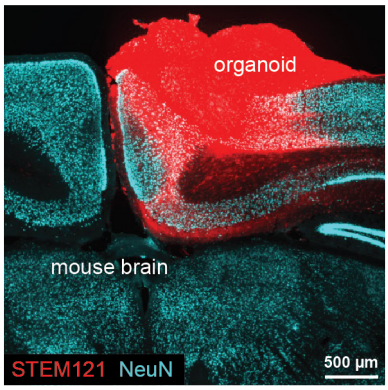


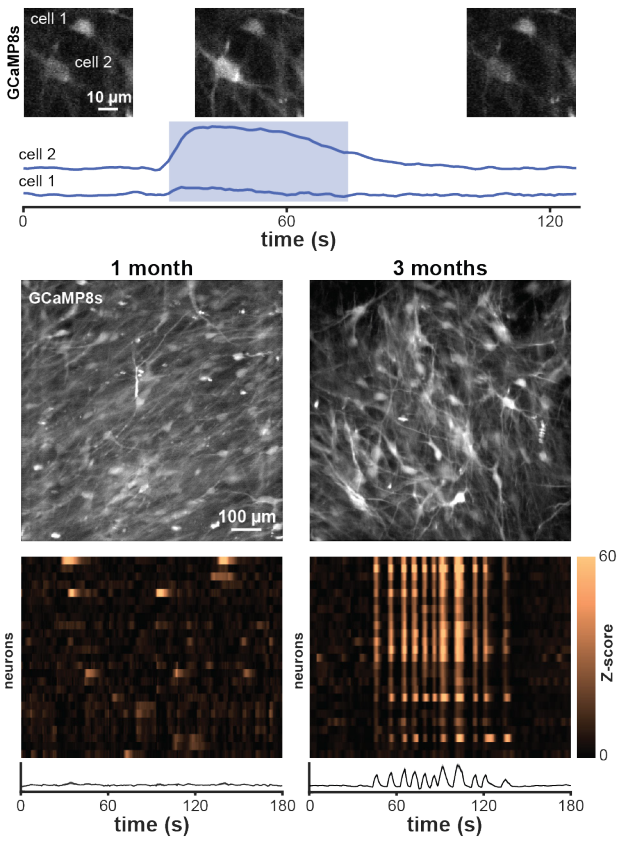
Immunostaining



abling the controlled delivery of small molecules guiding neurodevelopment, so-called "morphogens", in vivo. Importantly, their approach aims to expose hCO xenografts to morphogen concentration gradients, resembling neurodevelopmental processes in the developing brain. Preliminary results have shown that retinoic acid, a potent morphogen, can be delivered via biomaterial films to transplanted hCOs. One month after transplantation, two-photon calcium imaging indicated increased neuronal activity adjacent to the biomaterial compared to cells at further distances as well as an overall increase in neuronal activity compared to xenografts not exposed to retinoic acid. These results show that prolonged delivery of retinoic acid spatially regulates neuronal fate and advances the neuronal maturation of hCOs in vivo.

Taken together, efforts driven by this interdisciplinary team are delivering new protocols and technologies that will enable more widespread and impactful research in the rapidly growing field of organoid xenotransplantation. Insights gained from these studies promise to advance our understanding of neurodevelopmental pathologies, informing therapeutic strategies and improving clinical outcomes.

Two-photon



TRACKING BLOOD FLOW AND PRESSURE WITH LIGHT

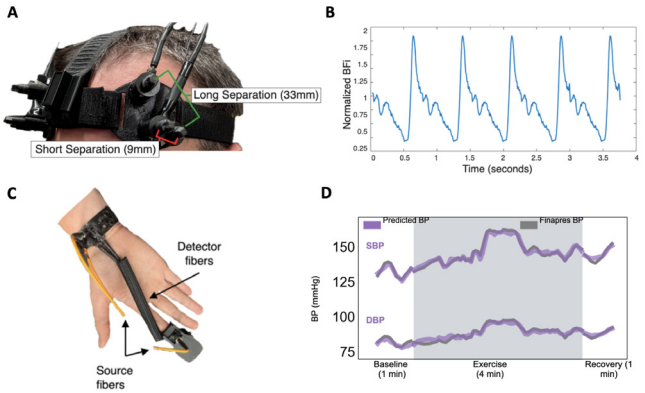
Darren Roblyer, Ariane Garrett, and Kyle Bohl

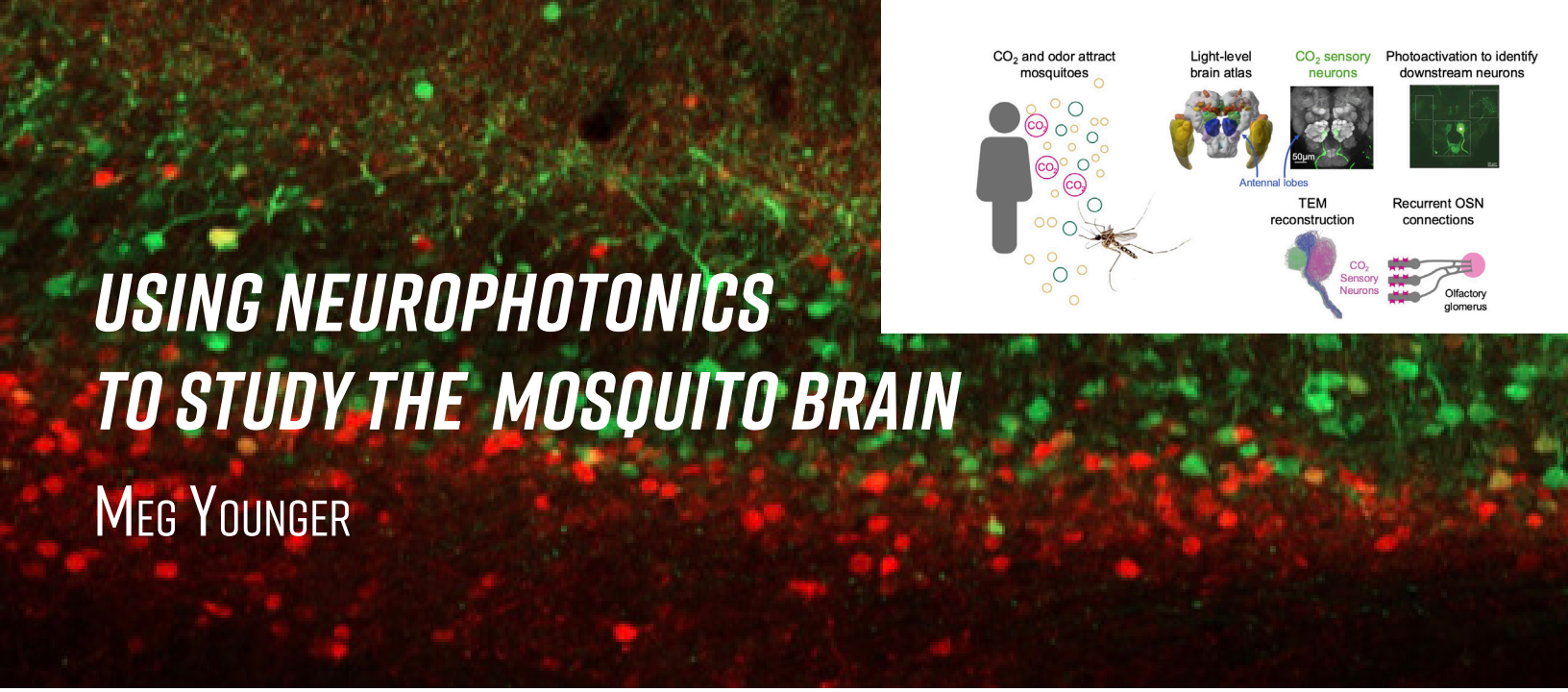
Hemodialysis, a life-sustaining therapy for kidney failure, has been linked to a high incidence of cognitive decline. While this connection is well recognized, the underlying mechanisms remain unclear. One promising avenue of investigation is the role of cerebral blood flow changes during dialysis.

The Biomedical Optical Technologies Laboratory (BOTLab), helmed by Darren Roblyer, are addressing the technical challenges of recording cerebral blood flow measurements throughout hemodialysis sessions. To do this, the team built a mobile, fiber-based laser system that uses Speckle Contrast Optical Spectroscopy (SCOS) to capture the Blood Flow Index (BFi). SCOS utilizes long coherence laser illumination at wavelengths sensitive to red blood cells scattering and hemoglobin absorption to measure changes in blood flow. The custom device measures blood flow at two source-detector separations (9 mm and 33 mm) on both sides of the forehead, capturing data from each of its four detectors at a high sampling rate of 100 Hz. Consideration for patient comfort and software flexibility enable long duration measurements of cerebral hemodynamics in a clinical setting.

We also investigated the utility of SCOS for cardiovascular monitoring at peripheral sites, with a focus on estimating blood pressure (BP). Hypertension (elevated BP) is the leading cause of cardiovascular disease (CVD), affecting nearly half of adults in the Unites States (US) and over 1 billion adults globally. There is a large body of evidence indicating that frequent BP measurements outside of the clinic provide a more robust assessment of a person's "usual" BP compared with a single measurement acquired in the clinician's office. However, frequent monitoring is challenging with current cuff-based sphygmomanometers.

To address this, we developed a high speed SCOS system that acquired blood flow and volume waveforms on the wrist and finger. We extracted a wide array of temporal, shape-based, and frequency-domain features from each high-resolution waveform, as well as features that characterize the temporal relationships between these features. These features and their inter-relationships are determined by the dynamic biomechanical properties of peripheral microvasculature, including vascular compliance and resistance. We then used these features to estimate BP without the use of an arm cuff. We found that SCOS waveforms could estimate BP with low errors, and offered a significant (31%) improvement compared to other optical cuffless BP estimation strategies.





USING NEUROPHOTONICS TO STUDY THE MOSQUITO BRAIN

MEG YOUNGER

Mosquito-borne disease is one of the greatest threats to human life, claiming over half a million victims each year. The Younger lab has pioneered the study of neural circuits in the Aedes aegypti mosquito, which transmits Yellow Fever, Dengue, Zika, and other pathogens. The Younger lab adapts genetic methods and imaging approaches from model organisms for use in this deadly non-model insect. The lab uses the NPCs two-photon system to conduct in vivo calcium imaging in live mosquitoes. They combine these measurements or neural activity with anatomical measurements that are also collected using the NPCs two-photon system. The lab uses genetically encoded photoactivatable fluorophores to visualize and map neurons that project to different areas of the brain at the light level and genetically encoded calcium indicators to measure neural activity in the mosquito.

Detection of humans by mosquitoes relies heavily on olfaction. The Younger lab studies the olfactory system by presenting mosquitoes with chemosensory cues while two-photon calcium imaging is conducted on the olfactory areas of the brain. Chemicals that are found in human body odor are used as stimuli, as well as carbon dioxide (CO2), which is found in human breath and is a potent cue that sensitizes mosquitoes to the presence of other odorants. The NPC Staff Scientist, Jack Giblin, played a major role in setting up this method at BU.

In addition to light-level imaging, the Younger lab collaborates with Wei-Chung Allen Lee's lab at Harvard Medical School. Together they are generating a wiring diagram of the Aedes aegypti mosquito olfactory system. They have imaged and aligned a 3D-electron microscopy volume of an entire female mosquito brain using an automated tape-based transmission electron microscopy pipeline developed by the Lee lab. Working with Gregory Jefferis and Elizabeth Marin at Cambridge University, these labs are reconstructing the anatomical organization of circuits in the mosquito antennal lobe, the first site of olfactory processing in the mosquito brain, work that is supported by a Wellcome Trust Discovery Award. The Younger lab uses the two-photon system at the NPC to study neurons and circuits that we identify in the new mosquito connectome.

Using this approach, we found strong recurrent network connectivity between sensory neurons that detects the important host cue, CO2. This is not seen in the orthologous circuit in the fruit fly, Drosophila melanogaster. Recurrent connections are not common in olfactory sensory neurons in general, and this may be novel to the mosquito. In collaboration with Brian DePasquale's lab, we are using this new wiring diagram to generate artificial neural circuit models of the mosquito olfactory circuit to test predictions about functional importance of these connections. This work is supported by the NPC-CAN-DO award and was recently preprinted on BioRxiv. The labs are using in vivo two-photon calcium imaging in live mosquitoes to both inform our constructed model and to test model predictions about the impact of these recurrent synapses on the activity of the CO2 circuit of both mosquitoes and fruit flies. When combined, these anatomical and physiological measurements offer mechanistic insight into the neural circuits that underlie carbon dioxide sensitization in the mosquito, and will also provide a launchpad for future research in the neural circuit models that support olfaction.

The mosquito provides a rare opportunity to study fundamental questions about olfaction while solving an urgent biomedical question. How the nervous system of any species encodes the vast array of possible odorants, in isolation and natural blends, remains a mystery. Understanding the mechanisms through which the mosquito olfactory system detects human odor is an inroad to eliminating mosquito biting behavior.

INVESTIGATING THE COCKTAIL PARTY PROBLEM IN HUMANS USING FNIRS

Sudan Duwadi, Meryem Yucel, David Boas, and Kamal Sen

The challenging problem of attending to a speaker in the presence of multiple speakers, commonly referred to as the "cocktail party problem", is a longstanding problem in diverse areas, e.g., neuroscience and computer science. Humans with normal hearing can solve this problem, indicating the existence of a solution in the brain. However, many humans, e.g., those with hearing loss, ADHD and autism, struggle with this problem. Currently, little remains known about brain regions that contribute to solving this problem in the normal brain.

In a Neurophotonics Center project funded by the NSF NCS-Frontiers Award (PI: Sen, Co-PI: Boas), we used functional Near-Infrared Spectroscopy (fNIRS) to investigate the cocktail party problem in humans.

Our experimental design replicates an ecologically valid cocktail party scenario in both overt and covert contexts. In the overt scenario, 3-second audiovisual movie clips are presented simultaneously at 30 degrees to the left and right. Prior to each clip, a 2-second spatialized white noise cue is paired with a white crosshair on the corresponding screen, guiding subjects on which direction to focus, with eye movements allowed. In the covert scenario, subjects are exposed solely to spatialized audio from the same set of movies. Here, the 2-second spatialized white noise serves as the cue, directing their attention, while they maintain a gaze on a central screen displaying a static white crosshair. fNIRS data were collected from 15 subjects using the NinjaNIRS22 system with a whole head, high density cap. We analyzed whole-brain evoked responses in both scenarios and used machine learning methods to decode the attended spatial location.

Our preliminary group results revealed evoked responses in Dorsal and Ventral Attention networks, and somatomotor network, among others, in both overt and covert conditions. Our classification results show that it is possible to classify attend left vs attend right conditions in the overt condition with above chance accuracy in 13 out of 15 subjects. These results are promising for brain-computer interface applications, e.g., enhancing hearing aid algorithms to selectively focus on specific sound sources in cocktail party-like settings.

GAIT UNDER COGNITIVE LOAD AND ACROSS CONTEXTS

Courtney Guida

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by the cardinal symptoms of resting tremor, bradykinesia, rigidity, and postural instability. Gait impairments are a hallmark feature of PD, with persons with PD (PwPD) demonstrating subtle gait alterations early in the disease course. Maintenance of mobility requires continuous integration of sensory, motor, and cognitive information in real time. As a result of this degeneration of the basal ganglia and subsequent loss of automaticity, PwPD appear to increase reliance on cortical control to regulate their gait, transforming walking from solely a motor process to a more cognitively demanding task. Evidence suggests that support of adaptive coordination of movement may primarily depend upon the prefrontal cortex. Specifically, in PwPD an increased dependence on higher-order cognitive processes, such as attention and executive functioning, has been proposed as a potential mechanism for reducing functional motor deficits. Evidence to this effect comes from work revealing significant cognitive-motor dual-task costs when PwPD engage in an attentionally-demanding task.

Functional near-infrared spectroscopy (fNIRS) provides a non-invasive method of assessing prefrontal cortical activation during walking, providing insight into the neural mechanisms supporting maintenance of gait under varying contexts. Elevated activation can be interpreted as an indicator of increased compensatory cognitive recruitment when automatic motor control is impaired and has been shown to be greater in PwPD during overground walking than in healthy older adults. However, additional consideration is warranted for the nature of the walking context, as it may effectively influence cognitive demands. Treadmill walking, for example, may alleviate some of the attentional and executive burden of step initiation and timing by providing externally paced, rhythmic cues. By contrast, overground walking requires continuous self-initiation and adaptive planning along with integration of information. Therefore, treadmill walking may minimize the cognitive load for basic gait, whereas overground walking may more completely demonstrate cognitive-motor integration limitations, particularly under dual-task conditions. In fact, previous work has compared prefrontal activation across gait conditions in PwPD and demonstrated less activation during treadmill than overground walking.

Although previous work has shown reliable associations between attention and gait, it remains to be seen how individual differences in executive and attentional control predict both prefrontal activation and gait speed during walking under differing walking contexts. Preliminary results from our group (10 PwPD and 10 healthy older adults) demonstrate differences between PwPD and healthy older adults in prefrontal activation during dual-task walking relative to single-task walking under overground conditions using fNIRS. We are currently working to examine whether attentional capacity explains the role that an external pacer (i.e., treadmill) has on prefrontal cortex recruitment. Further elucidating these associations may clarify how attentional capacity influences effective compensatory recruitment and functional mobility in aging and PwPD and provide insights into targets for rehabilitation.

Neurophotonics Supported Research

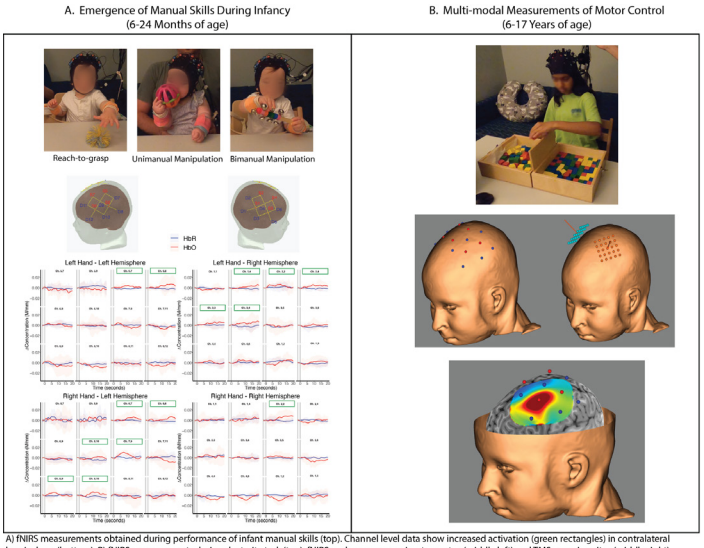
TRACKING BLOOD FLOW AND PRESSURE WITH LIGHT

Claudio Ferre

The timing, location, and extent of developmental brain injuries vary widely, resulting in extensive and highly individualized neural reorganization. Cerebral palsy (CP), the most common pediatric motor disability, typically arises from perinatal brain injury and is marked by movement impairments, particularly affecting the upper limbs. Despite the availability of well-established therapies, motor deficits in children with CP often persist, and treatment outcomes remain inconsistent. This is due in part to an incomplete understanding of how the brain adapts to early injury and how to optimally target neuroanatomical reorganization through therapy.

A critical step toward developing targeted interventions is to systematically characterize how motor pathways reorganize following perinatal brain injury, and how this reorganization relates to upper-limb function in children with CP. Our long-term goal is to develop objective, evidence-based rehabilitation strategies that leverage a mechanistic understanding of neuroplasticity to improve motor outcomes. To achieve this, we use multimodal techniques to examine the relationship between brain function and motor control in both typically developing children and those with CP. One line of our research longitudinally tracks the emergence of manual skills in infants, from 6 to 24 months, to understand how these skills shape the development of lateralized brain activity. By linking real-time cortical function with motor behavior during a critical period of neurodevelopment, we aim to identify behavioral markers that could guide the design of early movement interventions (A in figure). (Study supported by an NINDS K01 award, PI: Ferre)

In parallel, we investigate patterns of brain organization in school-aged children with CP. Transcranial magnetic stimulation (TMS), a non-invasive neurophysiological technique, allows us to probe motor pathway connectivity by stimulating cortical regions and measuring resulting muscle responses via surface electrodes (B in figure).



A) fNIRS measurements obtained during performance of infant manual skills (top). Channel level data show increased activation (green rectangles) in contralateral hemisphere (bottom). B) fNIRS measurements during dexterity task (top). fNIRS probe over sensorimotor cortex (middle left) and TMS mapping sites (middle right). Heatmap of motor-evoked potential amplitudes obtained during TMS overlaid on fNIRS probe layout (bottom).

These responses can be spatially mapped onto individual MRI scans to create brain maps of hand and arm representation. Although TMS is considered a gold standard for assessing cortical reorganization in CP, it captures brain activity only under static, resting conditions and may not reflect neural dynamics during actual movement. In contrast, using fNIRS, we can study real-time motor control in dynamic environments. By combining these two approaches, TMS and fNIRS, our goal is stratify children with CP based on patterns of cerebral reorganization that occur in response to early brain insult. These patterns might provide a potential neural substrate for therapeutic brain stimulation that can be paired with movement therapy to boost motor function. (Study supported by an NICHD R03 award, PI: Ferre)

THREE-PHOTON POPULATION IMAGING OF SUBCORTICAL BRAIN REGIONS

Ben Scott, Jerome Mertz

Comprehending how large networks of neurons interact in the brain is key to understanding both normal brain function and the origins of neurological disorders. The challenge is that many important circuits lie deep below the surface, in areas such as the hippocampus. Tools like fMRI and ultrasound can image at these depths, but they only show coarse activity patterns, not the behavior of individual neurons. Three-photon imaging is a new microscopy approach that can penetrate deeper into the brain than other optical techniques, making it a promising tool for studying the activity of ensambles of neurons in subcortical regions. Its application, however, has been limited because of the high laser pulse energies required for imaging, which restrict the size of the imaging area and the number of neurons whose activity that can be monitored.

Recently, the groups of Jerome Mertz and Benjamin Scott were able to overcome this limitation by combining smarter sampling strategies with deep learning-based noise reduction of the acquired data. The team developed a large field of view three-photon microscope capable of recording the activity of more than 1500 neurons simultaneously in the mouse hippocampus and surrounding deep brain regions in awake, behaving mice. The new instrument opens the door to exploring how networks of neurons drive the function of the hippocampus and other deep brain regions, and how this function is disrupted in disease.

NPC Faculty Collaborative Publications

Cheng, S., Chang, S., Li, Y., Novoseltseva, A., Lin, S., Wu, Y., Zhu, J., McKee, A. C., Rosene, D. L., Wang, H., **Bigio, I. J., Boas, D. A., & Tian, L.** (2025, January 20). *Enhanced multiscale human brain imaging by semi-supervised digital staining and serial sectioning optical coherence tomography*. ***Light: Science & Applications, 14***(1), Article 57. https://doi.org/10.1038/s41377-024-01658-0

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NPC Faculty Collaborative Grants

Neurophotonics Center faculty were awarded over **$17M** this year in collaborative grants. The table below summarizes the NPC Center, New Collaborative, and Ongoing Collaborative grant funding for FY25. Grants shaded in yellow were catalyzed by the Neurophotonics Center, while grants shaded in blue were led by the Center.

NPC Faculty labelled with "*" are listed as Co-PIs.

	Award Title	PI	Sponsor	Project Dates	Total Obligated Funds
	Optimization And Validation Of Quantitative Birefringence Microscopy For Assessment Of Myelin Pathologies Associated With Cognitive Impairments And Motor Deficits In Young And Old Aging Monkey Brain	Bigio J Irving	Nih/National Institute On Aging	01/01/2022 - 11/30/2026	$ 503,149
	Neurophotonic Advances For Mechanistic Investigation Of The Role Of Capillary Dysfunction In Stroke Recovery	Boas David	Nih/National Institute Of Neurological Disorders & Stroke	09/27/2022 - 08/31/2027	$ 638,725
	Brain Connects: Mapping Connectivity Of The Human Brainstem In A Nuclear Coordinate System	Boas David	The General Hospital Corporation D/B/A Massachusetts General	09/01/2023 - 08/31/2026	$ 102,155
	Low-Cost High-Performance Nirs-Scos Device For Non-Invasive Monitoring Of Cerebral Blood Flow And Intracranial Pressure In Traumatic Brain Injury	Boas David	The General Hospital Corporation D/B/A M	06/01/2024 - 05/31/2029	$ 114,927
	Graduate Training At The Interface Of Neuroscience, Optical Engineering And Data Science	Boas David	Nih/National Institute Of Neurological Disorders & Stroke	07/08/2024 - 06/30/2029	$ -
	Graduate Training At The Interface Of Neuroscience, Optical Engineering And Data Science	Boas David	Nih/National Institute Of Neurological Disorders & Stroke	07/08/2024 - 06/30/2029	$ 37,202
	Graduate Training At The Interface Of Neuroscience, Optical Engineering And Data Science	Boas David	Nih/National Institute Of Neurological Disorders & Stroke	07/08/2024 - 06/30/2029	$ -
	Graduate Training At The Interface Of Neuroscience, Optical Engineering And Data Science	Boas David	Nih/National Institute Of Neurological Disorders & Stroke	07/08/2024 - 06/30/2029	$ 130,176

NPC Faculty Collaborative Grants

	Award Title	PI	Sponsor	Project Dates	Total Obligated Funds
	Expanding Inclusion Of All Subjects For Ultra-High Density Wearable Fnirs In The Everyday World	Boas David	Nih/National Institute Of Biomedical Imaging & Bio-engineerin	09/01/2024 - 07/31/2026	$ 422,619
	Novel Volumetric Optical Microscopy To Unravel Cerebral Microvascular Architecture And The Role In Functional Neuroimaging In Human	Boas David	The General Hospital Corporation D/B/A Massachusetts General	08/01/2024 - 07/31/2025	$ 50,789
	Edlow Scholar Award In Clinical Research (Cambareri)	Boas David	The General Hospital Corporation D/B/A M	06/01/2023 - 07/31/2024	$ 55,041
	Emerging Consciousness Program (Cambareri)	Boas David	The General Hospital Corporation D/B/A M	09/26/2022 - 05/31/2023	$ 24,137
	Bridging Function, Connectivity, And Transcriptomics Of Mouse Cortical Neurons	Chen Jerry	Allen Institute, D/B/A Allen Institute For Cell Science	09/01/2022 - 06/30/2027	$ 213,657
	Local And Long-Range Cortical Circuits Underlying Tactile Perception	Chen Jerry	Nih/National Institute Of Neurological Disorders & Stroke	12/01/2024 - 11/30/2029	$ 548,088
	Vibrational Spectroscopic Imaging To Unveil Hidden Signatures In Living Systems	Cheng Ji-Xin	Nih/National Institute Of General Medical Sciences	07/01/2020 - 06/30/2025	$ 577,500
	High-Content High-Speed Chemical Imaging Of Metabolic Reprogramming By Integration Of Advanced Instrumentation And Data Science	Cheng Ji-Xin	Nih/National Institute Of Biomedical Imaging & Bio-engineerin	04/01/2022 - 12/31/2025	$ 454,378
	High-Content High-Speed Chemical Imaging Of Metabolic Reprogramming By Integration Of Advanced Instrumentation And Data Science	Cheng Ji-Xin	Nih/National Institute Of Biomedical Ima	04/01/2022 - 12/31/2025	$ 50,488
	Ipa For Cheng Ji-Xin	Cheng Ji-Xin	Jesse Brown Va Medical Center	01/01/2023 - 12/31/2025	$ 24,858
	Personnel Agreement For Research Services Of Hongjian He	Cheng Ji-Xin	Jesse Brown Va Medical Center	01/01/2023 - 12/31/2025	$ 103,520
	Incorporation Of Quantitative Srs Imaging In Seisa For Developing Anticancer Nanomedicines	Cheng Ji-Xin	Brandeis University	03/01/2022 - 02/28/2028	$ 123,750

NPC Faculty Collaborative Grants

Award Title	PI	Sponsor	Project Dates	Total Obligated Funds
Super-Sensitive Vibrational Imaging By Synergic Development Of Instruments And Probes	Cheng Ji-Xin	Nih/National Institute Of Biomedical Imaging & Bioengineerin	01/01/2024 - 12/21/2027	$ 543,462
Super-Sensitive Vibrational Imaging By Synergic Development Of Instruments And Probes	Cheng Ji-Xin	Nih/National Institute Of Biomedical Ima	01/01/2024 - 12/21/2027	$ 60,384
Bio-Orthogonal Mid-Infrared Photothermal Imaging Of Cancer Metabolism	Cheng Ji-Xin	Nih/National Cancer Institute	09/01/2024 - 08/31/2027	$ 407,113
A Transformative Method For Functional Brain Imaging With Speckle Contrast Optical Spectroscopy	Cheng Xiaojun	Nih/National Institute Of Biomedical Imaging & Bioengineerin	08/15/2023 - 07/31/2026	$ 364,842
Local Neuronal Drive And Neuromodulatory Control Of Activity In The Pial Neurovascular Circuit	Devor Anna	Nih/National Institute Of Neurological D	08/16/2021 - 05/31/2026	$ 2,564,400
Metabolic And Neural Activity Normalization By Cerebral Blood Flow Increase In Ad/Adrd Models	Devor Anna	Cornell University	04/15/2023 - 01/31/2028	$ 472,243
Cell Type And Circuit Mechanisms Of Non-Invasive Brain Stimulation By Sensory Entrainment	Devor Anna	Allen Institute, D/B/A Allen Institute For Cell Science	09/01/2024 - 08/31/2025	$ 27,845
Three-Photon Microscope For Fluorescence And Phosphorescence Lifetime Imaging	Devor Anna	Nih/Office Of The Director	05/15/2025 - 05/14/2026	$ 749,227
Illuminating Cholinergic Modulation Of Cortical Dynamics Through Its Effect On Dendritic Excitability	Devor Anna	United States - Israel Binational Science Foundation (Israel	10/01/2024 - 09/30/2028	$ 11,316
Preventing Freezing Of Gait In Parkinson Disease Using Soft Robotic Apparel	Ellis D Theresa	Michael J. Fox Foundation For Parkinson's Research	09/01/2024 - 08/31/2027	$ 901,247
Multimodal Characterization Of Cerebral Reorganization In Children With Unilateral Cerebral Palsy	Ferre Claudio	Nih/National Institute Of Child Health & Human Development	07/15/2024 - 06/30/2026	$ 330,000
Cellular And Network Mechanisms Of Epilepsy And Neuromodulation	Han Xue	Nih/National Institute Of Neurological D	06/01/2025 - 05/31/2030	$ 657,958

NPC Faculty Collaborative Grants

	Award Title	PI	Sponsor	Project Dates	Total Obligated Funds
	Targeting Pathologic Spike-Ripples To Isolate And Disrupt Epileptic Dynamics	Han Xue	The General Hospital Corporation D/B/A M	01/01/2021 - 11/30/2025	$ 319,171
	Striatum Wide Dynamics And Neuromodulation Of Cell-Type Specific Striatum Populations During Learning	Howe Mark	Nih/National Institute Of Mental Health	04/27/2021 - 02/28/2026	$ 517,455
	Development Of Crystal Ribcage For Imaging Of Functioning Lung At High Spatiotemporal Resolution	Nia Hadi	The Arnold And Mabel Beckman Foundation	09/01/2022 - 08/31/2026	$ 150,000
	Nanotherapeutics For Targeted Glial Cell Drug Delivery	O'shea Mark Timothy	Nih/National Institute Of Neurological D	04/01/2024 - 03/31/2026	$ 206,250
	Regulating Parenchymal Repair In Wound Healing	O'shea Mark Timothy	Nih/National Institute Of General Medica	07/01/2024 - 04/30/2029	$ 412,500
	Studying Astrocyte Borders Using Injectable Biomaterials	O'shea Mark Timothy	Nih/National Institute Of Neurological Disorders & Stroke	09/20/2024 - 09/19/2026	$ 446,126
	The Role Of The Locus Coeruleus-Norepinephrine System In Flexible Decision-Making	Scott Benjamin	Nih/National Institute Of Mental Health	04/13/2023 - 03/31/2025	$ 41,250
	The Role Of The Lc-Ne System In Perceptual Deficits In A Shank3 Mouse Model	Scott Benjamin	Simons Foundation	02/01/2025 - 01/31/2027	$ 300,000
	Flexible Processing Of Complex Auditory Scenes Using Attention	Sen Kamal	Department Of Defense/Onr	09/01/2024 - 08/31/2027	$ 101,997
	A Novel Method For Volumetric Oxygen Mapping In Living Retina	Tian Lei	The Johns Hopkins University	03/01/2021 - 02/28/2025	$ 81,550
	Computational Miniature Mesoscope For Cortex-Wide, Cellular Resolution Ca2+ Imaging In Freely Behaving Mice	Tian Lei	Nih/National Institute Of Neurological D	04/01/2022 - 03/31/2027	$ 371,250
	Mesoscopic Microscopy For Ultra-High Speed And Large-Scale Volumetric Brain Imaging	Tian Lei	The Johns Hopkins University	04/01/2023 - 03/31/2027	$ 86,798
	Mesoscopic Microscopy For Ultra-High Speed And Large-Scale Volumetric Brain Imaging	Tian Lei	The Johns Hopkins University	04/01/2023 - 03/31/2027	$ 88,569
	Developing Next Generation Photoacoustic Implant For Retinal Stimulation	Yang Chen	Axorus	09/01/2023 - 09/30/2025	$ 27,060
	That New Baby Smell: Mosquito Attraction To Human Odor Across Life Stages	Younger Meg	The Pew Charitable Trusts	07/15/2024 - 07/31/2029	$ 300,000

NPC Faculty Collaborative Grants

	Award Title	PI	Sponsor	Project Dates	Total Obligated Funds
	Dr. Hill Is A Shurl And Kay Curci Foundation Fellow Of The Life Sciences Research Foundation	Younger Meg	Life Sciences Research Foundation	08/01/2025 - 07/31/2028	$ 231,000
	Understanding Neuronal Dysfunction In Down Syndrome Using Assembloids And Xenotransplanted Cortical Organoids	Zeldich Ella	Nih/National Institute On Aging	09/30/2024 - 08/31/2027	$ 2,357,335

TOTAL: $17,303,508

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