

Wu Tsai Neurosciences Institute

2018/2019 ANNUAL REPORT



Our Mission

The Wu Tsai Neurosciences Institute is dedicated to understanding how the brain gives rise to mental life and behavior, both in health and in disease. Our research community draws from and informs multiple disciplines, including neuroscience, medicine, engineering, psychology, education and law. The discoveries that arise from these collaborations will transform our understanding of the human brain, provide novel treatments for brain disorders and promote brain health throughout the lifespan. Neuroscience is at an inflection point in its history. New technologies are transforming scientists' abilities to explore the brain — yielding more detailed images of its cells, more accurate measurements of its activity, and more precise ability to model its functions than ever before. With these new approaches have come astounding new insights about the exquisite complexity of the brain. The Wu Tsai Neurosciences Institute is at the forefront of this exploration.

Contents

04

*Message from
the director*

06

*Wu Tsai
Neurosciences
Institute*

08

*Engaging
extraordinary
people*

10

*Nurturing a
diverse and vibrant
community*

12

*Fostering
interdisciplinary
research:
NeuroDiscovery*

14

*Fostering
interdisciplinary
research:
NeuroEngineering*

15

*Fostering
interdisciplinary
research:
NeuroHealth*

18

*Creating vital
infrastructure*

20

*Development
activities at
Wu Tsai Neuro*

22

Meet our team



Message from the Director



“From the director’s chair, where I enjoy a bird’s eye view of all Institute activities, 2019 has been an exceptional year.”

2019, our first full year of operation as the Wu Tsai Neurosciences Institute, has been a whirlwind of activity on multiple fronts. Our most visible and intense challenge has been final preparation and opening of the new interdisciplinary research facility that will be a joint home-base for Wu Tsai Neuro and Stanford ChEM-H. Many hundreds of hours of diligent work by numerous Wu Tsai-ers have brought us to the threshold of creating a new research community around this building; hundreds more will be necessary to bring the elegant physical space to life with a vibrant scientific culture. Our effort will be successful to the extent that we amplify neuro-related research and educational activities of faculty, postdocs and students across our entire campus, and create new research possibilities that would not have been possible without the new facility.

The vanguard of occupants of the new Stanford Neurosciences Building, including the neurosciences graduate program, moved in within the past month. After 5 years of planning, it has been exhilarating to see the first live human beings go to work in the space and to experience our inaugural community events in the building. Yet there are only a handful of residents at the moment, and we rattle around in largely unoccupied space as I write these words on the first afternoon of 2020—a bit like the calm before the storm! This will change radically as the major tranche of labs moves in over the first few months of the new year, and as we continue to recruit new faculty, postdocs and students. It is exciting to imagine the new science that will be happening here by New Year’s day in 2021. It is up to all of us to make the science great and at the same time useful to our larger society.

Although the new facility has absorbed a great deal of effort by our staff and faculty over the past year, Wu Tsai has at the same time continued to support and expand our lively research and community building efforts. Seven active Big Ideas in Neuroscience teams are at work, three with sustained phase 2 support and four with exploratory phase 1 support. We granted new Interdisciplinary Scholar Awards to five Stanford postdocs, and Stanford Interdisciplinary Graduate Fellowships to three graduate students. Most notably, we successfully inaugurated our new Neuroscience:Translate program which seeks to accelerate interdisciplinary research that is on the cusp of useful social application. We gave five Neuroscience:Translate awards in 2019, and recently completed a competition for five new awards in 2020. Information about all of these Wu Tsai funded research projects can be found on our website.

On the educational front, a team of faculty led by Jay McClelland, EJ Chichilnisky, Surya Gangli and Jin Lee successfully acquired an NSF research training grant for a new neurotechnology graduate training effort. The first cohort of trainees has been selected and inaugural courses have been established and carried out in 2019. Equally exciting, we formalized our new Stanford Undergraduate Neuroscience Society with ~80 energetic undergrads in 2019, and are now developing a summer research participation program that will provide entry-level laboratory research training for a subset of SUNS students each year. Dedicated student leadership is central to all of our educational activities in including the neurosciences graduate program and our annual 7th grade Brain Day outreach program in addition to the two programs mentioned above.

From the director’s chair, where I enjoy a bird’s eye view of all Institute activities, 2019 has been an exceptional year. On February 11 we will celebrate the accomplishments of Wu Tsai Neuro and ChEM-H with a morning scientific symposium and afternoon dedication ceremony (plus building tours!) for the new research facility. We look forward to celebrating this intellectual and social milestone with all members of our community.

A handwritten signature in black ink that reads "W Newsome". The signature is fluid and cursive.

William Newsome
Vincent V.C. Woo Director and Harman Provostial Professor

Wu Tsai Neurosciences Institute



During our sixth year, the Wu Tsai Neurosciences Institute evolved from its initial “start up” mode to a well-established, vibrant and active community dedicated to exploring the mysteries of the brain. We began the year with the landmark announcement of our new institute name in October 2018, honoring the generous gift of Clara Wu Tsai and Joseph Tsai to support interdisciplinary neuroscience research and programs.

42

*grants awarded for
high-risk, high-reward
initiatives*

546

*faculty affiliates
representing nearly $\frac{3}{4}$
of Stanford's academic
departments*

110

*PhD students and
postdocs awarded
fellowships or training
support*

Wu Tsai Neuro launched several new programs this year. The road between fundamental neuroscience and real-world medical treatments, diagnostics and next-generation applications is often long and bumpy. The launch of our Neuroscience:Translate grants was a critical step in paving the way, awarding five teams of Stanford researchers funding to help their discoveries have real impact on the human condition. Other new programs are focused on training of graduate and undergraduate students. The leadership of the Center for Mind, Brain Computation and Technology launched the NeuroTech graduate training program with the support of an NIH training grant. In 2019, the first cohort of students was recruited, the first new course was held, and many preparations were made for 2020 - the first full year of the program. The Stanford Undergraduate Neuroscience Society blossomed into a vibrant and active community of students focused on building community across broad disciplines, matching students with mentorship opportunities and career development. In 2020, Wu Tsai Neuro will launch a new summer research program, the Neuroscience Undergraduate Research Opportunity fellowships.

The intensity of preparation for the opening of the new Stanford Neuroscience Building ramped up as finishing touches were put in place in advance of the moves of 18 neuroscience faculty labs, scheduled over the Winter of 2019 and 2020. The facility will become the hub of our institute on campus, serving the broad institute community (480 labs strong!). The new building includes key spaces for shared neuroscience community laboratories, and planning is underway for an animal MRI imaging facility, a human neuroscience lab, the neuroengineering Sandbox lab and the visualization lab — all brand new resources to support our neuroscience research mission.

Read on to learn about the community programs of Wu Tsai Neuro and the wide variety of research projects funded by grants and fellowships in our key target areas of NeuroDiscovery, NeuroEngineering and NeuroHealth: Big Ideas in Neuroscience, Seed Grants, Neuroscience:Translate grants, Research Accelerator projects, Interdisciplinary Postdoctoral Scholar Awards and Stanford Interdisciplinary Graduate Fellowships.

Engaging extraordinary people

In the 2018-2019 year, the Wu Tsai Neurosciences Institute community of faculty affiliates grew by 69 members to a total of 523, hailing from six of Stanford's seven schools. The institute engaged faculty, staff, students, postdocs and visiting scholars through its many seminars, symposia, workshops and community events. In January 2019, three faculty, Ada Poon (electrical engineering), Carolyn Rodriguez (psychiatry) and Leanne Williams (psychology), presented an Ideas Lab focused on precision psychiatry at the World Economic Forum conference in Davos, Switzerland. Wu Tsai Neuro held its first community picnic in September 2019 — a fun and informal opportunity for faculty, students, postdocs and laboratory staff to get to know each other, share research discoveries and expertise, and to form new collaborations.



Miriam Goodman in her lab at Stanford Medicine.

Faculty awards and honors

Several faculty affiliates of the Wu Tsai Neurosciences Institute were awarded major prizes or were appointed to preeminent academies in 2019.

Helen Blau, the Donald E. and Delia B. Baxter Foundation professor of microbiology and immunology and director of the Baxter Laboratory for Stem Cell Biology, was elected to *American Institute for Medical and Biological Engineering*.

Steven Chu, the William R. Kenan Jr. professor of physics of molecular and cellular physiology, was appointed by Pope Francis to the *Vatican's Pontifical Academy of Sciences*.

Karl Deisseroth, the D.H. Chen professor and a professor of bioengineering and of psychiatry and behavioral sciences, was elected to the *National Academy of Engineering*.

Jennifer Dionne, associate professor of materials science and engineering, received the *National Science Foundation Alan T. Waterman Award*.

Miriam Goodman, professor and chair of molecular & cellular physiology, was awarded the *National Institutes of Health 2019 Lanid Award for Outstanding Mentorship*.

Keren Haroush, assistant professor of neurobiology, was named a *2019 Sloan Research Fellow*.

Mark Krasnow, the Paul and Mildred Berg professor of biochemistry, was elected to the *National Academy of Sciences*.

Fei-Fei Li, the Sequoia Capital professor of computer science and co-director of the Stanford Institute for Human-Centered Artificial Intelligence, was awarded the *2019 National Geographic Further Award*.

Lauren O'Connell, assistant professor of biology, and **Vivianne Tawfik**, assistant professor of anesthesiology, perioperative and pain medicine, were named *2019 Rita Allen Foundation Scholars*.

Liqun Luo, the Ann and Bill Swindells professor in the School of Humanities and Sciences and professor of biology, has been honored with the *2019 Pradel Research Award from the National Academy of Sciences*.

Michelle Monje, associate professor of neurology, **Carolyn Rodriguez**, associate professor of psychiatry and behavioral sciences, **Gordon Wetzstein**, assistant professor of electrical engineering and **Jamil Zaki**, associate professor of psychology, were named recipients of the *Presidential Early Career Award for Scientists and Engineers*.

Roy Pea, the David Jacks professor of education, was elected to the *American Academy of Arts and Sciences*.

2019 Interdisciplinary Postdoctoral Scholars

We awarded five outstanding postdoctoral scholars with Interdisciplinary Scholar Awards, which include a two-year fellowship and support for their career development and network-building.

Daniel Bear (psychology)
Sponsor: Daniel Yamins

Dr. Bear seeks to develop algorithms that better-respond to the visual world, and illuminate how animals create internal maps of their environment.

Miguel Garcia (neurosurgery)
Sponsor: Bradley Zuchero
Co-sponsor: Alexander Dunn

Dr. Garcia studies how myelin wraps itself around neurons, insulating their electrical signals.

Tal Iram (neurology and neurological sciences)
Sponsor: Tony Wyss-Corey
Co-sponsor: Sergiu Pasca

Dr. Iram aims to accelerate maturation of human-derived brain organoids and produce the first-ever 3D aged human brain cultures

Dante Muratore (electrical engineering)
Sponsor: Boris Murmann
Co-sponsor: E.J. Chichinsky

Dr. Muratore will design a neural interface for an artificial retina, a device that can replace the function of retinal circuitry lost to disease.

Jessica Nowicki (biology)
Sponsor: Lauren O'Connell
Co-sponsor: Nirao Shah

Dr. Nowicki is shedding new light onto the evolutionary mechanisms that regulate and promote pair bonding in animal species.

2019 Stanford Interdisciplinary Graduate Fellows

Three SIGFs affiliated with Wu Tsai Neuro were awarded in 2019 to talented, young neuroscientists.

Isabel Low (neurosciences)
Advisor: Lisa Giocomo
Co-Advisor: Surya Ganguli

Isabel is studying how our internal state—like whether we are alert or tired—affects the way our brains work.

Khaled Kamal Saab (electrical engineering)

Advisor: Daniel Rubin
Co-Advisor: Christopher Re

Khaled is studying the use of multiple sensing modalities to improve detection and localization of seizures.

Jeffrey Wang (biophysics)

Advisor: Raag Airan
Co-Advisor: Brian Knutson
Faculty Collaborator: Kim Butts-Pauly

Jeffrey's research uses focused ultrasound to noninvasively deliver drugs to specific parts of the brain to maximize therapeutic efficacy.

Nurturing a diverse and vibrant community



Annual Symposia

In October, 2018, at our fifth annual symposium, Wu Tsai Neurosciences Institute announced its new name in honor of a transformational lead gift from Clara Wu Tsai and Joseph Tsai. In 2019, we interrupted our cadence of annual fall symposia, deciding to hold a joint symposium with ChEM-H on the occasion of the official dedication of the Stanford Neurosciences Building and the Stanford ChEM-H building on February 11, 2020. We look forward to both institute communities participating in this meeting, entitled CONNECT, and embodying the synergetic relationship between both institutes.

Seminar Series

Wu Tsai Neuro hosted 31 top scientists from across the country and around the world for our 2019-2020 Seminar Series. Three seminars were hosted in partnership with psychiatry and behavioral sciences. Speakers were nominated by members of our community, and represented a wide diversity of disciplines. This year's eminent speakers included: Daniel Choquet (University of Bordeaux), Hailan Hu (Zhejiang University), Yasmin Hurd (Mount Sinai), Diane Lipscombe (Brown University) and Konstantinos Meletis (Karolinska Institute).

Center for Mind, Brain, Computation and Technology

The Center for Mind, Brain, Computation and Technology (formerly the Center for Mind, Brain and Computation), founded in 2007 by Prof. Jay McClelland, has come under the umbrella of the Wu Tsai Neurosciences Institute and continues to engage the community in a multitude of ways.

The MBCT training program welcomed nine new graduate students, for a total of 50 in the program. The MBCT seminar series brought 13 scientists to speak at Stanford at the intersection of the neurosciences (including cognitive science and psychology) and applied sciences and engineering. The MBCT annual symposium brought four esteemed neuroscientists to Stanford around the theme "Navigating the neuronal code for time and space." Eminent scholar and Nobel Laureate Edvard Moser (Norwegian University of Science and Technology), was a keynote speaker.

This year also saw center faculty, led by Profs. E.J. Chichilnisky and McClelland, receive a \$3M research training grant from the National Science Foundation to launch the NeuroTech training program. The program aims to propel neuroscience research by helping Stanford graduate students from the technical disciplines of engineering, physics, statistics and computer science become leaders in the emerging field of neurotechnology. The NeuroTech program offered a popular new neuroscience immersion course and began recruitment efforts, resulting in the selection of its first cohort of six students.

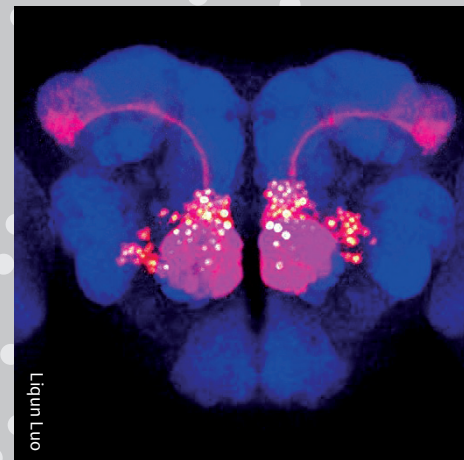
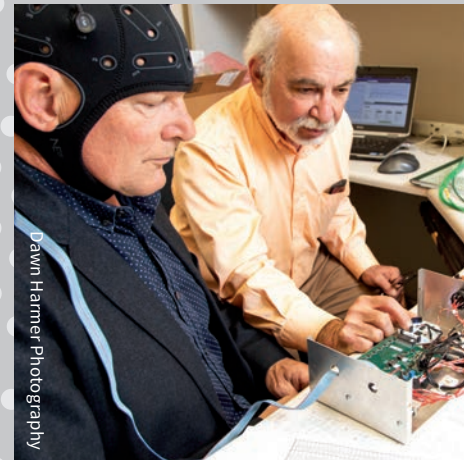
Stanford Undergraduate Neuroscience Society

In the spring of 2018, our institute helped a small handful of students launch the Stanford Undergraduate Neuroscience Society to bring together a community of undergraduates who shared a passion for understanding the mysteries of the brain and nervous system. In the year and a half since then, this group has expanded exponentially to become a university-recognized club with a mailing list of 539 students. Their professional development, social and research-related events, which they hold twice a quarter all year round, regularly draw an enthusiastic crowd of between 50 and 80 students each time.

Data Best Practices Workshop

Neuroscience advances increasingly rely on the collection and analysis of immense and complex datasets. This year, Prof. Paul Nuyujukian led a new workshop for more than 30 students, faculty and staff, teaching them how to take advantage of readily available cloud-based tools and resources provided by Stanford Research Computing so that they could securely and rapidly store and analyze data. Developing these computational skills allows researchers to streamline data analysis workflows, organize, annotate and preserve precious data, and more effectively share data and analytic tools with collaborators.

Fostering interdisciplinary research



3-D brain cultures are suspended in a lab dish at the lab of Sergiu Pasca.

NeuroDiscovery

Question-driven investigation of how the brain works

NeuroDiscovery research applies cutting-edge techniques to make fundamental discoveries in brain science — discoveries that could unlock new medical treatments, transform education, inform public policy and help us understand who we are. Over the past year, the institute supported NeuroDiscovery research at Stanford with two ongoing Phase 2 Big Ideas in Neuroscience projects, one exploratory Phase 1 Big Ideas project, and one ongoing Seed Grant.

Big Ideas in Neuroscience

NeuroPlant: Leveraging a botanical armamentarium to manipulate the brain

Team leaders: Thomas Clandinin (neurobiology), Miriam Goodman (molecular & cellular physiology), Seung Yon Rhee (Carnegie Institute of Biology)

ONGOING PHASE 1 PROJECT

Despite decades of research on mental disorders, understanding of how the central and peripheral nervous systems works remains limited, and tools suitable for manipulating and deciphering the underlying molecular pathways are lacking. To address this gap, this team aims to identify a novel archive of chemicals that act on neuronal receptors, focusing on compounds synthesized by medicinal plants. The team will first test chemical compounds on the roundworm *C. elegans*, and promising compounds identified in worms will then be tested in human cells. Successful outcomes will include: innovative, scalable platforms for mining a plethora of small molecules, targets of known psychoactive drugs and an initial framework for high-throughput chemical screening using direct behavioral assays in an animal.

Neurodevelopment: Elucidating the development of brain structure, function, and computations

Team leaders: Kalanit Grill-Spector (psychology), Jennifer McNab (radiology), Daniel Yamins (psychology)

ONGOING PHASE 1 PROJECT

Is it largely unknown how brain structure and function develop from infancy to adulthood to enable behavior. This project has the potential to provide a major breakthrough in understanding neurodevelopment by using collaborative research to generate two paradigm shifts. First, the

team aims to develop new in vivo imaging technologies that measure specific microstructural changes across development, with a comprehensive understanding of the relation between in vivo measurements and specific biological changes. Second, the team is striving toward a shift from examining isolated aspects of neurodevelopment to an integrated research program elucidating how the interplay among structural development, functional development, and experience together affect brain computations, and ultimately, behavior.

NeuroChoice—Understanding and treating addictive behavior, from circuits to policy

Team Leaders: Brian Knutson (psychology), Keith Humphreys (psychiatry), Robert Malenka (psychiatry)

ONGOING PHASE 2 PROJECT

Our decisions define the quality of our lives as well as those of future generations. Understanding the links from neural circuits to individual choice to group choices could spark major advances both in basic neuroscience research as well as the application of neuroscience findings to enduring societal problems. Addiction (e.g., to substances, gambling, overeating) can be framed as a pathological choice problem ripe for interdisciplinary multilevel solutions. This team continues to deepen interdisciplinary understanding of the neural mechanisms supporting healthy and addictive choices by combining conceptual, experimental, and clinical approaches that bridge historically disparate fields of inquiry. The team engages with policymakers whose work on addiction might be informed by neuroscience evidence, and who might reciprocally help identify promising new issues poised to benefit from transformative research advances.

Seed Grants

Genetic tools to determine circuit-specific roles of myelination

J. Bradley Zuchero (neurosurgery), Polly Fordyce (bioengineering, genetics), Ivan Soltesz (neurosurgery)

Neuroscientists have long focused on understanding how synapses and electrical excitability contribute to higher-order brain functions. Far less is known about whether the speed of electrical signals through axons is also dynamically tuned to regulate brain function. The team aims to determine how myelin—the electrical insulator around neuronal axons that speeds nerve signaling—contributes to the plasticity of neuronal circuits.

NeuroEngineering

New tools to probe and connect with our minds

The human brain has 100 billion nerve cells and trillions of connections between them. Understanding the workings of such a complex and dynamic organ requires new tools and technologies. NeuroEngineers are developing probes to stimulate and record signals from thousands of individual neurons at once, ways to manipulate neural circuits with electricity, light, ultrasound and magnetic fields, and others are listening to the brain, interpreting the language of neural signals and using that language to drive robotic arms or to type on a computer. New tools will enable as yet unimagined discoveries and will allow us to repair and even to augment the human brain. In 2019, Wu Tsai Neuro supported two Big Ideas in Neuroscience projects (one in Phase 2, and one in Phase 1), three Neuroscience:Translate grants and two Seed Grants.

Big Ideas in Neuroscience

Neuro-omics

Team leaders: Alice Ting (genetics), Liqun Luo (biology), Stephen Quake (bioengineering)

ONGOING PHASE 1 PROJECT

New technologies in the past two decades have enabled scientists to study many biological questions at the scale of all genes (genomics) and all their protein products (proteomics). This team aims to bring the omics revolution to the brain, the most complex organ with the largest number of cell types, by creating a suite of new tools and analysis methods that allow neuroscientists to interrogate what genes and proteins are produced in their favorite neuronal types, and what other neuronal types their favorite neurons connect with. These neuronal types include not only those traditionally defined by where they are and what type of neurotransmitters they produce, but also how they are activated by any stimulus or behavioral episode. The success of these efforts will help fill the chasm between our understanding of the brain at the level of genes and proteins on one hand, and circuits and systems on the other hand, with important clinical applications.

Stanford neurotechnology initiative

Team Leaders: Nicholas Melosh (materials science) and E.J. Chichilnisky (neurosurgery, ophthalmology)

ONGOING PHASE 2 PROJECT

Neural interfaces of the future will be used to treat a wide range of diseases for which there is yet no cure, ranging from sensory and motor degeneration to psychiatric disorders. However, present-day neural interfaces remain crude compared to the neural circuits in which they are embedded. This project's goal is to develop the next generation of neural interfaces that match the resolution and performance of the biological circuitry. This team is focused on two signature efforts to spearhead the necessary advances: high-density wire bundles for electrical recording and stimulation, and analog and digital bi-directional retinal prostheses for restoration of vision. In the process, the initiative will develop an interdisciplinary research and training environment to place Stanford as a global leader in neurotechnology.

Neuroscience:Translate Grants

Clinical translation of protein-engineered, matrix-mimetic nerve guidance conduits for peripheral nerve injury

Lead Researchers: Sarah Heilshorn (materials science), Paul George, (neurology)

Injury often results in chronic or permanent loss of motor function and sensation due to poor regeneration in the peripheral nervous system. Several nerve guidance conduits (NGCs) are available in the clinic to aid in peripheral nerve regeneration. However, despite the ~200,000 surgeries performed each year in an attempt to regain lost function, less than 25% of patients recover appropriate motor control and less than 3% regain full sensation. To address this clinical need, the team is developing a NGC composed of an engineered protein hydrogel (eNGC) which combines the reproducible and reliable fabrication of synthetic NGCs with the biochemical matrix cues of naturally-derived NGCs known to be critical in regeneration. These eNGCs are composed of a modular, engineered recombinant protein that has independently tunable biochemical and biomechanical cues, allowing the optimized presentation of multiple matrix cues to mimic the native extracellular matrix. This allows our eNGC to better emulate the complexity of the native nerve matrix within a synthetic, reproducible material.

NeuroRoots, brain/computer interface solution for paralysis

Lead Researchers: Nicholas Melosh (materials science), Jaimie Henderson (neurosurgery)

Brain-computer interfaces (BCIs) have the potential to restore independence for people with paralysis by translating neural activity into control signals for assistive devices such as computer cursors, robotic limbs and functional electrical stimulation systems. Despite rapid advances in understanding and decoding movement-related neural activity, BCIs remain limited by implant technology that is now more than 40 years old. A new interface is needed to provide stable long-term recordings of thousands of neurons over many years. NeuroRoots is a collaborative project that aims to provide the missing piece of this puzzle: a robust, implantable BCI platform resulting in minimal damage to neural tissue, long-term recording stability and an unobtrusive footprint. This project builds on a unique approach using ultra-flexible and low-profile implantable electronics that can reliably record the brain activity necessary to provide stable control signals for assistive technologies.

The rehab glove: Passive tactile stimulation for stroke rehabilitation

Lead Researchers: Allison Okamura (mechanical engineering), Maarten Lansberg (neurology)

Stroke is one of the leading causes of disability in the United States and globally. Many stroke survivors lose function in their upper extremities, which can make it difficult to do everyday tasks like dressing or eating. In addition to weakness and loss of sensation, spasticity and tone can cause hands to be involuntarily clenched in a rigid position — a problem for which there are few effective treatments. Getting rehabilitation therapy can be a challenge and up to 50% of stroke survivors do not qualify for traditional exercise-based therapies. This project investigates a novel stimulation method and a mobile, wearable device to provide therapy on-the-go and to those with very limited movement. The team's stimulation method may provide a powerful tool to reduce disability after a stroke, and the wearable form factor allows users to receive intensive therapy during their normal daily routine.

Seed Grants

Injectable photovoltaics for a wireless, gliosis-free neural stimulation interface

Guosong Hong (materials science), Marion Buckwalter (neurology), Alberto Salleo (materials science)

One major challenge in developing therapeutic neural implants is chronic gliosis, the brain's scarring response, that occurs at the implant/tissue interface. The team is developing ultra-flexible, injectable, wirelessly powered microdevices that can be delivered into the brain with less scarring.

Ultrasonic neural control and neuroimaging in the awake, mobile, and behaving small rodent

Raag Airan (radiology), Jeremy Dahl (radiology), Butrus Khuri-Yakub (electrical engineering)

This team is designing a lightweight, wearable system for integrated ultrasonic drug uncaging and focused ultrasound neuroimaging to noninvasively pharmacologically modulate a specific brain target area and then image the resultant changes in neural activity, while the small animal is awake and performing a behavioral task of interest, without significant motion limitations.

NeuroHealth

Translating neuroscience discoveries into treatments

Understanding the brain in health and disease will improve treatments for ourselves and our loved ones. Our clinical scientists not only treat patients, but are also working with basic scientists to pioneer novel treatments for psychiatric and neurological disease. Ongoing research aims to reverse brain aging, ease the devastating consequences of stroke, and develop non-invasive treatments to modulate brain activity associated with epilepsy and other neurological diseases. Breakthrough improvements in brain and mental health benefit not just individuals, but society as a whole. Wu Tsai Neuro supported two Big Ideas in Neuroscience projects (one in Phase 2, and one in Phase 1), two Neuroscience:Translate grants, three Seed Grants and two Research Accelerator projects.

Big Ideas in Neuroscience

Brain rejuvenation

Team Leaders: Tony Wyss-Coray (neurology) and Aaron Gitler (genetics)

ONGOING PHASE 2 PROJECT

Aging leads to a precipitous loss of cognitive faculties and is the key risk factor for dementia and neurodegenerative diseases. Many new genetic factors causing neurodegeneration have been identified, but how they cause disease and how aging modulates disease is unknown. The Stanford Brain Rejuvenation Project is focused on harnessing a powerful new approach to discover, characterize, and utilize brain rejuvenation factors harbored in the blood to improve human health and to combat neurodegenerative diseases. Together, the team aims to slow or reverse aging to maintain brain function and extend health span, to rejuvenate brains for the treatment of neurodegenerative and other neurological diseases, and to elucidate novel mechanisms of human neurodegenerative diseases to develop innovative therapeutic strategies.

Human Brain Organogenesis

Team leaders: Sergiu Pasca (psychiatry and behavioral science) and Karl Deisseroth (bioengineering)

ONGOING PHASE 1 PROJECT

A challenge in understanding the intricate programs underlying the development, assembly, function and dysfunction of the human brain is the lack of direct access to functioning human brain tissue. The Human Brain Organogenesis Project aims to recapitulate neural development in a dish by building next-generation technologies for deriving functioning human brain tissue non-invasively from stem cells. The research team will use these ‘brain-in-a-dish’ models to understand how human neurons talk to each other and identify what goes wrong when mental disorders develop. The team will maximize the impact of their research by broadly sharing their technology and developing ethical guidelines for this emerging field.

Neuroscience:Translate Grants

Multi-modal deep learning for automated seizure localization

Lead Researchers: Christopher Lee-Messer (neurology), Daniel Rubin (biomedical data science, radiology, medicine)

A major challenge in the practice of neurology is the functional localization of epileptic seizures. Current software for automated seizure detection is slow, inaccurate, and rarely precise enough for clinicians to rely upon, and there are no approaches for automated functional localization of seizures, which is a key component in differential diagnosis and treatment plan formation. This team is leveraging exciting recent advancements in artificial intelligence (AI) technologies to develop an automated seizure detection and localization system based on deep neural networks, electroencephalography (EEG) data and real-time video with the goal of dramatically increasing neurologist diagnostic capabilities while improving quality of care. By combining large, expertly curated datasets and deep learning applications, they aim to fill a market need by ensuring high-quality automated monitoring while providing additional clinical insight to neurologists.

A mobile game for domain adaptation and deep learning in autism healthcare

Lead Researchers: Dennis Wall (pediatrics, biomedical data science), James Landay (computer science)

The rapid increase in the prevalence of autism has created a pressing need for translational bioinformatics solutions that can scale. Standard methods of care require laborious sessions at clinical facilities with waitlists that are several months long. This team has invented a prototype mobile system (guesswhat.stanford.edu) that turns the focus of the camera on the child through a fluid social engagement with his/her social partner that reinforces prosocial learning while simultaneously measuring the child’s progress in socialization. GuessWhat challenges the child to imitate social and emotion-centric prompts shown on the screen of a smartphone held just above the eyes of the individual with whom the child is playing. The system uses computer vision algorithms and emotion classifiers integrated into gameplay to detect emotion in the child’s face via the phone’s front camera to determine agreement with the displayed prompt. The team seeks to make important therapeutic gains to target core deficits of autism, but also simultaneously generate data to support efficacy, progress tracking and iterative machine-learning model enhancement for precision healthcare that is individual to the child and his/her natural social partners.

Seed Grants

Investigating the role of a human-specific repeat element in neuropsychiatric disease risk and cerebellar function

David Kingsley (developmental biology), Jennifer Raymond (neurobiology)

The Kingsley lab recently discovered human gene variants of a calcium channel that correlate with Schizophrenia and bipolar disorder. The human genetic changes are linked to altered calcium channel gene expression in the cerebellum, a region of the brain extensively studied by the Raymond lab. The team will characterize molecular, cellular, neurophysiological, and behavioral defects in mice engineered to model the risk or protective variants in the human calcium channel gene with the ultimate goal of speeding the search for tailored treatments for common psychiatric diseases.

Quantifying auditory-vocal affect in human social communication

Karen Parker (psychiatry), Jonathan Berger (music), Michael Frank (psychology)

Human social communication is auditory-vocal in nature. This team seeks to understand the “speech-music continuum” and quantify the conveyance of affect through sound. This functionality is critical to human social behavior, and its impairment features prominently in multiple psychiatric disorders, including most significantly, autism. Once developed, validated, and normed, the team will deploy this test in the clinical context of autism to quantify impairments and direct neurobiological investigation. Findings from this research will advance auditory-vocal communication as a critical dimension of clinical research, and change the way we think about social function and dysfunction in autism and beyond.

Sensory processing in a pre-seizure state

John Huguenard (neurology, neurosurgery), Anthony Norcia (psychology), Brenda Porter (neurology, pediatrics)

Absence seizures are a common childhood epilepsy and impact learning and development. Our team has evidence that seizures are preceded by a period of altered sensation that can be observed in the brain’s electrical activity (EEG). This team combines expertise in child neurology/epileptology (Porter), human sensory perception (Norcia), and animal models of absence epilepsy (Huguenard) to identify and

capitalize on sensory-evoked pre-seizure signals that can be used to predict, and ultimately to prevent, seizures.

Research Accelerators

New tools, analytic methods and conceptual approaches for harnessing plasticity in the human brain

Amit Etkin (psychiatry), Gary Glover (radiology), James Gross (psychology), Manish Saggar (psychiatry), Surya Ganguli (applied physics), Brian Knutson (psychology)

Our ability to non-invasively manipulate human neural activity – both for gaining a more causal understanding of normal brain function and to therapeutically remediate dysfunctional circuits – remains very limited. Critical to advancing these capacities are a more robust understanding of which patient-relevant brain circuits are most important for which cognitive operations, how these circuits can be best modulated through repetitive transcranial magnetic stimulation, and how to advance societal understanding of mental illness so that new technologies best impact the lives of individuals in need. Projects range from tool development and experimental work in healthy individuals to complex data analysis and computational modeling, and ultimately to a larger-scale engagement with societal attitudes through educational interventions.

StrokeCog

Marion Buckwalter (neurology, neurosurgery) and Maarten Lansberg (neurology)

ONGOING PROJECT

StrokeCog, focused on cognitive problems after stroke, is an extension of the Stroke Collaborative Action Network (SCAN), a previously funded Big Idea project, and is a key component of the Stanford Stroke Recovery Program. While common, the exact mechanisms of post-stroke cognitive decline are not well understood. StrokeCog funds a large prospective cohort study aimed at identifying if neuroinflammation plays an important role in the development of post-stroke cognitive decline. In addition, this funding continues to support SCAN investigators with their clinical pilot studies via a clinical core. The core helps investigators with study design, stroke subject recruitments, and regulatory requirements for human research such as institutional review board applications and compliance.

Creating vital infrastructure

Stanford Neurosciences Building

After five years of planning and two years of construction, the Stanford Neurosciences Building and the Stanford ChEM-H Building are nearing completion. Laboratories from Wu Tsai Neuro will move into the new facility beginning in November 2019. When complete and fully occupied, the 235,000 square-foot facility will be home to 24 interdisciplinary neuroscience laboratories, critical neuroscience core facilities and vibrant meeting and interaction spaces. By bringing building residents together and drawing in researchers and students from many disciplines across campus, we will create a space where serendipitous encounters could lead to breakthrough neuroscience discoveries — a physical manifestation of Stanford's commitment to breaking down barriers between disciplines. Highlights of the structure include a light-filled courtyard embraced by the two buildings, state-of-the-art laboratories with bright, open shared spaces as well as customized zones for specialized equipment and techniques. A central architectural feature is the neuro-theory center. Surrounded with glass and embedded within the building's central common area, this three-story structure places theorists, who often work tucked away from view, front and center, encouraging collaborations with experimentalists from the surrounding labs. Reaching the important goal of understanding how the brain computes will require development of novel theoretical and analytical approaches, and the institute hopes to recruit the best and brightest quantitative minds to this center.

Neuroscience Community Labs

The Stanford Neurosciences Building will not only house faculty laboratories — we have also incorporated shared laboratory spaces that will provide scientific equipment and expertise, allowing researchers to expand their experimental repertoire and facilitate new collaborations. These labs will serve researchers from across the Stanford campus. In 2020, Wu Tsai Neuro will assume the management of three existing neuroscience community labs and work towards developing and implementing an additional five more.

Existing Community Labs

Gene Vector and Virus Core

Under the direction of Javier Alcudia, this group creates molecular tools for gene delivery based on viruses. Researchers use these gene vectors to express proteins that allow for neural stimulation or repression with optogenetics, calcium imaging of neural activity and other techniques.

Neuroscience Microscopy Service

Andrew Olson directs this facility, which provides a wide variety of microscopes and image analysis workstations to the neuroscience community. The facility boasts confocal, light sheet and 2-photon microscopes, and a new microscope that allows visualization of cleared tissues.

Behavioral and Functional Neuroscience Laboratory

Directed by Prof. Mehrdad Shamloo (neurosurgery) and managed by Nay Saw, this laboratory facilitates a wide variety of behavioral testing in animal models. Researchers use the facility to measure the efficacy of candidate drugs and treatments on animal models of neurological and psychiatric disease — part of the vital pipeline for translating scientific discoveries to real-world treatments. The facility was recently certified for studies exploring both the therapeutic and addictive effects of cannabis and narcotic drugs.

Community Labs Under Development

Human Brain Organogenesis Lab

Under the direction of Prof. Sergiu Pasca, the Bonnie Uytensu and Family Director of the Stem Cell Core and Human Organogenesis Program, the Human Brain Organogenesis lab will focus on disseminating stem cell techniques for

generating “mini brains” in cell culture and human-derived neural tissue for research studies. Brain organoids are promising because they are a mechanism for studying live human tissue in the lab — a significant step to utilizing molecular and cellular neuroscience techniques for human brain research .

Neuroscience Sandbox Lab

Wu Tsai Neuro is creating a unique laboratory space intended to reduce barriers to the sharing and learning of new techniques. The Sandbox is being developed by Profs. John Huguenard (neurology), Nick Melosh (materials science) and Ada Poon (electrical engineering), and will include an 18-bench lab, a makerspace, and spaces for tissue culture, microscopy, electrophysiology and surgery. The Sandbox leaders envision this space to be a lively and dynamic learning and collaboration zone, with workshops, design and fabrication, equipment demonstrations and other uses.

Neuroscience Imaging Lab

Under the direction of Prof. Jin Hyung Lee (neurology), Wu Tsai Neuro is establishing an animal imaging facility. The cornerstone of the facility is a 7T/40cm Magnetic Resonance Imaging System (MRI). The enlarged bore of the MRI enables neuroscience-specific techniques such as optogenetics to be used in tandem with imaging experiments. The magnet is scheduled for installation in the fall of 2020

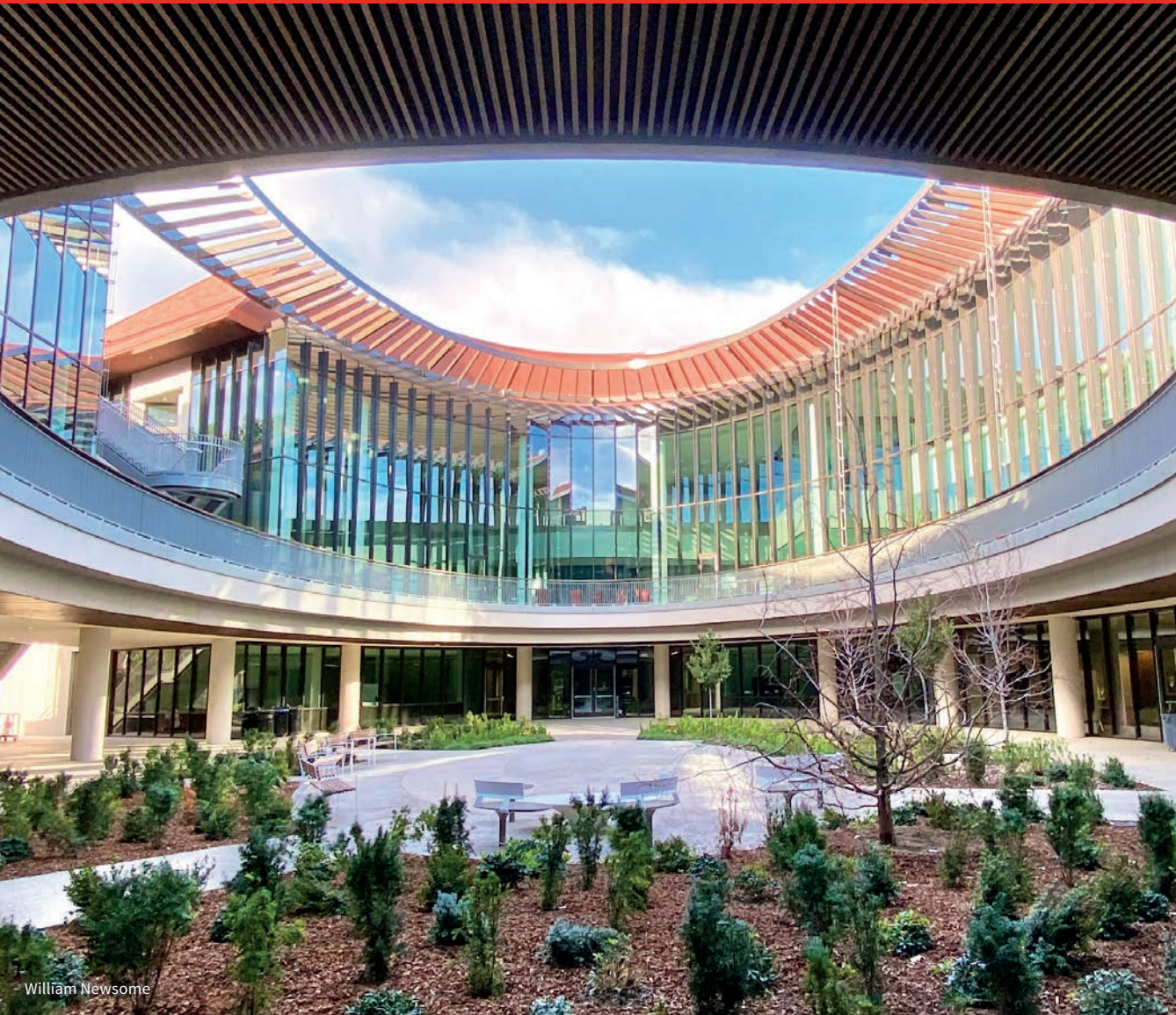
Human Neuroscience Community Lab

Profs. Anthony Norcia (psychology) and Nolan Williams (psychiatry) are developing the Human Neuro Lab to be a place where neuroscience research with human participants flourishes in Wu Tsai. This lab is conveniently located off of the Neurosciences Building lobby and features high-end equipment for electroencephalography (EEG), transcranial magnetic stimulation (TMS), eye tracking and more.

Visualization Lab

In conjunction with Alfredo Dubra (ophthalmology) and Christoph Leuze (radiology), Wu Tsai Neuro is planning a visualization lab that will feature both a high-performance adaptive optics system and an augmented/virtual reality space for application development and experiments.

Development activities at Wu Tsai Neuro



William Newsome

With appreciation for the ongoing generosity of donors and the thought leadership of Stanford Interdisciplinary Life Sciences Council members, the Wu Tsai Neurosciences Institute continues to engage Stanford alumni, parents, and friends in the philanthropic support of talented people and innovative brain science.

In fiscal year 2019, Wu Tsai Neuro was fortunate to have secured additional gifts toward the successful opening of a state-of-the-art, “team science” research complex comprised of the Stanford Neurosciences Building and the Stanford ChEM-H Building. Several donors provided gifts to name key spaces in this collaboration hub for faculty and students from all across campus. Wu Tsai Neuro also benefited from notable gifts in support of the Brain Rejuvenation Big Idea, the launch of Neuroscience:Translate – a pilot program focused on accelerating therapies and devices to help patients, and the establishment of an endowed directorship in support of Sergiu Pasca and his leadership of the Human Brain Organogenesis Program.

Wu Tsai Neuro leaders continue to be involved in important donor stewardship efforts including a special dinner for “brain trust” philanthropic partners to spend time with faculty and learn more about innovative brain research currently underway. Additionally, Wu Tsai Neuro faculty shared custom written updates with donors and participated in many meetings with donors and volunteer leaders. Stewardship efforts provide an opportunity to showcase the transformative research made possible by visionary philanthropic partners through Wu Tsai Neuro hallmark initiatives including Big Ideas in Neuroscience, Neuroscience:Translate, research accelerator and seed grants, and cross-disciplinary training programs.

Moving forward, Wu Tsai aims to secure major philanthropic gifts in support of the four new community labs/programs in the new Stanford Neurosciences Building, as well as efforts to recruit and retain talented people, including professorships as well as graduate and postdoctoral fellowships. Future donor gifts will enable Wu Tsai Neuro to continue to drive creative research, strengthen bridges for translational impact, and provide cross-disciplinary training for young neuroscientists.

Tony Wyss-Coray



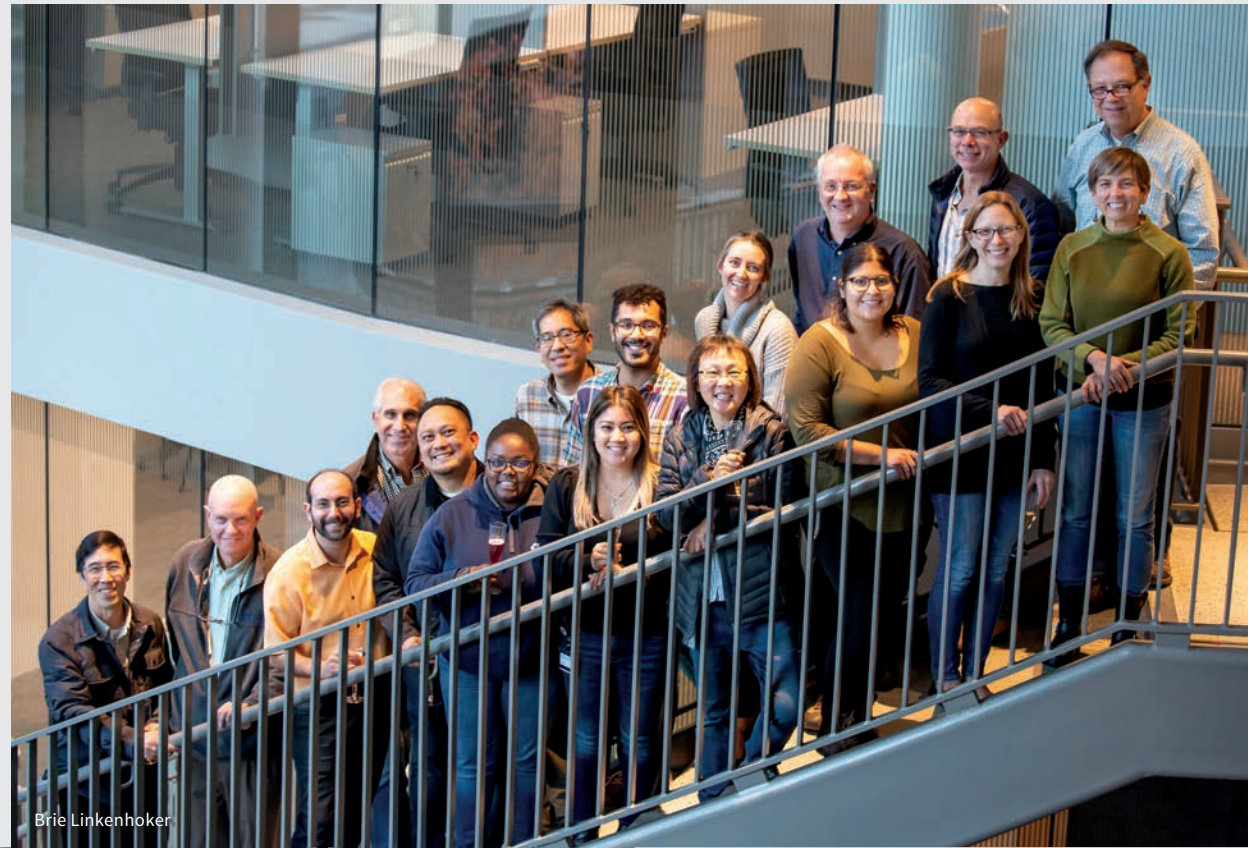
Norbert von der Groeben



Michelle James

Avery Krieger

Meet our Team



Brie Linkenhoker

The success of the Wu Tsai Neurosciences Institute is the result of combined efforts of the institute leadership, our dedicated staff, and the faculty and trainees who serve on our program committees.

Executive Committee

William Newsome (neurobiology)

Vincent V.C. Woo Director and Harman Family Provostial Professor

Marion Buckwalter (neurology, neurosurgery)

Deputy Director

Scott Delp (bioengineering, mechanical engineering)

Deputy Director and James H. Clark Professor

Robert Malenka (psychiatry and behavioral sciences)

Deputy Director and Nancy Friend Pritzker Professor

Brian Wandell (psychology)

Deputy Director and Isaac and Madeline Stein Family Professor

Tanya Raschke

Director for Planning and Operations

Staff

Ramy Abbady

Academic and Student Services Coordinator

Timothy Doyle

Assistant Director for Neuroscience Community Labs

Elise Kleeman

Scientific Program Manager

Cathy Lau

Financial Analyst

Maura McGinnity

Senior Director of Development

Daisy Ramirez

Program Coordinator

Tanya Raschke

Director for Planning and Operations

Emily Shimizu

Assistant Director of Development

Rose Vo

Administrative Associate

Midori Yoshimura

Digital Media Associate

Stanford Neurosciences Building
290 Jane Stanford Way, Room E152
Stanford, CA 94305

neuroscience@stanford.edu
650.723.3573
neuroscience.stanford.edu

