Reuniting with Resilience

Wu Tsai
Neurosciences Institute
Annual Report

September 2020
to August 2021

Wu Tsai Neurosciences Institute
Stanford University

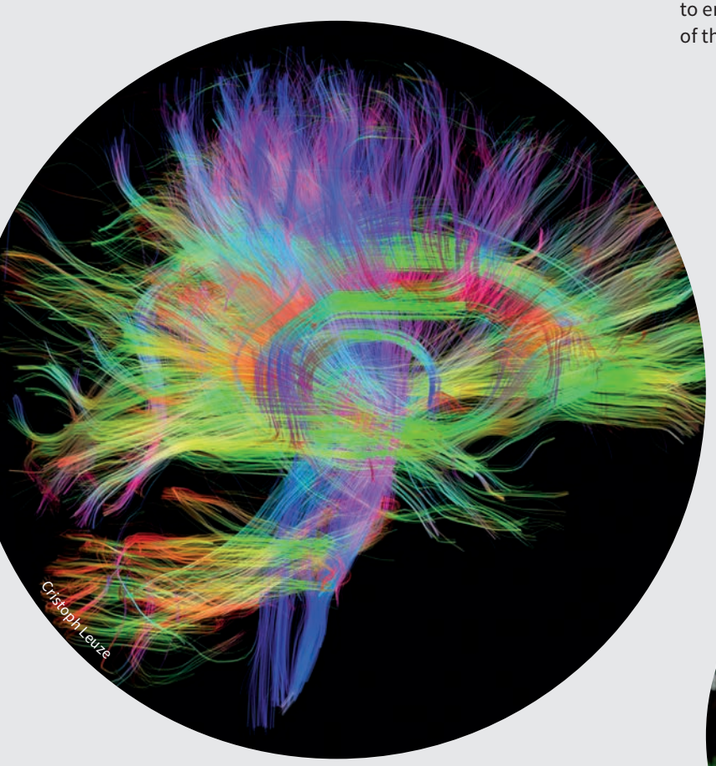
Contents

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 mimic 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.



Diversity Statement

The Wu Tsai Neurosciences Institute believes diversity, inclusion, equity and belonging are essential to the advancement of science and to the development of a vibrant intellectual community. Research conducted in the absence of diversity and inclusion of all people and their ideas slows the pace of science and our ability to treat diseases and improve lives.

The disparities produced by the history of exclusion of certain groups from science, on the basis of race, gender, sexuality or socioeconomic background, persist today, and it is our duty to commit to ending these injustices. We, the Wu Tsai Neurosciences Institute, strive to correct these inequities, and our work is far from done. We commit to implementing changes within our organization to produce and sustain equity for historically underrepresented groups.

We call upon ourselves and our community to reevaluate all components of the institute, including our research, programs, staff, leadership structures and hiring practices, to identify ways that we can ensure that all voices are heard and all have equitable access to resources. We welcome and look forward to engagement with all of the Wu Tsai Neuro community as part of this processes.

Message from the Director

NOVEMBER 10, 2021 As we approach the end of another year, our community has much to be thankful for. Last fall we were hunkered down in a largely empty campus, doing research through a conservative combination of remote and in-lab work, and anxiously awaiting the rollout of SARS-Cov-2 vaccines. A year later, more than 95% of our community is vaccinated, our COVID-19 positivity rate is approximately 0.1%, and our research buildings are re-opened to the Stanford community (with appropriate masking and social distancing precautions). Although we must continue to be cautious, these are reasons to celebrate!

Despite our obstacles, the institute has pursued a vigorous slate of programs and activities, which you can read about in detail throughout this report. We have continued to promote great science with new discovery and translational research grants, and to support the next generation of neuroscientists with training awards to new classes of interdisciplinary postdoctoral scholars, graduate fellows, and undergraduate researchers. Together, this represents a commitment of $7.8 million to Stanford neuroscience in 2020-21, most of it due to the incredible generosity of our philanthropic partners.

This year we opened four new community laboratories focused on human neuroscience, preclinical brain imaging, virtual reality and collaborative science, and welcomed new staff directors Jieun Kim, Gordon Wang and Christoph Leuze. We also welcomed our first-ever dedicated communications manager, Nicholas Weiler, who happens to be a Stanford Neurosciences PhD alum.

Our 2021 symposium, "The Addiction Epidemic: from Neuroscience to Policy," was excellent. It was a particular thrill to have an in-person poster session once again to cap off the inspiring and thought-provoking day of talks. After interacting mostly through 2x2" Zoom boxes for the previous 18 months, folks stayed and stayed to talk science and enjoy being together face to face. Many thanks to the NeuroChoice Big Ideas team who organized the symposium (Rob Malenka, Keith Humphreys and Brian Knutson), and to the team spearheaded by Jill Wentzell who executed the hybrid model so beautifully.

Indeed, that we could carry out any of these programs effectively during a pandemic year is due to our dedicated staff who plan, lead and support our grant programs, student-facing activities, community labs, seminars and symposia, and fund-raising efforts. We owe so much to this wonderful team, and especially to Tanya, who continues to keep the whole ship afloat and on-course. And none of these programs would be possible without the dedicated faculty and trainee leaders who have participated in grant reviews, diversity initiatives, seminar planning and more. Thanks to you all. You ARE Wu Tsai Neuro!

Perhaps the most important lesson that I have learned from the pandemic experience is the social nature of our scientific enterprise. We have sorely missed the serendipitous moments of creativity and inspiration that come from very human encounters over coffee or lunch, in courtyards and gathering spaces, and in spontaneously solving problems together at the bench or whiteboard. As it turns out, much of the enjoyment in science lies in shared experience that is very tough to simulate on-line. Our major task for the coming year must be to create more opportunities for collaboration and camaraderie as we rebuild our campus-wide neuroscience community. We have made a down-payment with our Fall picnic at the new pub, and our in-person/hybrid symposium. There will be more to come. Stay tuned!

William T. Newsome, PhD
Vincent V.C. Woo Director, Harman Family Provostial Professor, Professor of Neurobiology

Institute update

Andrew Brodhead

In many ways, the 2021 academic year brought out the resilience and perseverance of the Wu Tsai Neuro community. Research advanced, but sometimes in different locations and in new and interesting ways. Scientific paper, thesis and grant writing was remarkably prolific. Members of our community found ways to connect despite masks, social distancing and video conferencing. We came together in cyberspace to share and learn about new neuroscience discoveries at our seminars. Students and trainees connected purposefully and enthusiastically through interest groups and training activities. On-site research activities in the Stanford Neurosciences Building also grew steadily throughout the year as researchers and staff made their way back into our labs and shared facilities to stoke the embers of dormant experiments. The engines of our collaborative research enterprise are now accelerating steadily down the tracks!

It was a challenge, but we are emerging from 2021 with renewed hope and determination to rebuild our community to be even stronger, more collaborative and more inclusive than before. This changed perspective and re-centering on key community and scientific values will only enhance our ongoing and future endeavors to unlock the mysteries of the brain and behavior for the good of society.

Executive Committee update

They say the only constant is change, and at the end of the 2021 academic year, Wu Tsai Neuro is announcing key leadership changes to our Executive Committee, which is composed of five faculty representing broad disciplinary areas of neuroscience across Stanford.

We are pleased to welcome Prof. **Allison Okamura** (mechanical engineering) and Prof. **Anthony Wagner** (psychology) to the Executive Committee as our newest deputy directors. Allison leads the CHARM lab, which develops principles and tools for robotic and human-machine systems capable of haptic (touch) interaction, with a particular focus on biomedical applications. Wagner leads the Stanford Memory Lab, which aims to understand how memories are built and expressed, as well as how these mechanisms change with age and disease. We look forward to their leadership as Wu Tsai Neuro explores new and exciting directions.

We also share our deepest gratitude with outgoing deputy directors, Prof. **Scott Delp** (bioengineering and mechanical engineering) and Prof. **Brian Wandell** (psychology). During their eight years on the Wu Tsai Neuro Executive Committee, Scott and Brian have shared their deep insights, key disciplinary perspectives and driving energy to fuel our many successful programs. Thank you for your service! Scott has taken on directorship of the new Wu Tsai Human Performance Alliance, while Brian is returning to his research, teaching and mentoring, and assisting with an upcoming Wu Tsai Neuro faculty search.

Supporting transformational research

We continue to support new neuroscience research in three areas of emphasis: NeuroDiscovery, NeuroEngineering and NeuroHealth. A major accomplishment for Wu Tsai Neuro in 2021 was the awarding of new grant funding for impactful collaborative neuroscience research through all three of our main funding mechanisms: Big Ideas in Neuroscience, Neuroscience:Translate and our Seed Grant program.

Big Ideas

While all four of our second round of Big Ideas projects have made significant progress, rigorous review by a committee of senior faculty identified two projects to progress to phase 2 beginning in the 2022 academic year. The Neuro-Omics Initiative and the Stanford Brain Organogenesis Program will receive extended Big Ideas

Nicholas Weiler

funding over the next three years to continue their work, while the Neurodevelopment Initiative and the NeuroPlant Initiative will receive continued support through the Research Accelerator mechanism. Read more about our flagship projects in the Research section below.

Neuroscience:Translate: The third round of Neuroscience:Translate Awards funded six projects, including a device to diagnose Parkinson's disease tremors, another to diagnose dizziness and vestibular disorders, and a third that improves hearing loss through extracochlear stimulation. Other awards supported a screening platform for neurodegenerative disease drugs in killifish, a sensor to monitor intracranial pressure in ambulatory patients, and an automated web-based assessment of reading for use in education.

Seed Grants: Wu Tsai Neuro Seed Grants are awarded every other year, and in 2021 we awarded five grants in our fourth round of awards. Research projects include the molecular underpinnings of synapse formation, investigating how maternal infections may lead to neurodevelopmental disorders, and the development of new tools to stimulate and record signals from the brain using optogenetics and magnetic sensors.

Neuroscience Community Labs

In addition to funding team research projects, Wu Tsai Neuro supports many labs and projects through our shared research facilities. Custom-designed spaces within the new Stanford Neurosciences Building allowed us to incubate three new labs in 2021.

Neuroscience Preclinical Imaging Lab Led by Dr. **Jieun Kim**, this new lab received its $4.25M 7 Tesla / 40 cm bore MRI system in April, installation and testing occurred throughout the spring and summer, and the lab was ready to launch as an active service center in fall of 2021.

Koret Human Neuroscience Lab Our new human neuroscience space was equipped with a 128-channel EEG system, and a TMS system with a robotic arm. Several research projects are underway in the lab, as we continue to search for a lab director.

Visualization Lab This new facility was built out from a shell space, and now includes an arena for augmented and virtual reality, led by Dr. **Christoph Leuze** and Prof. **Jennifer McNab**. Prof. **Alfredo Dubra**'s custom adaptive optics instrument is expected to come online in 2022.

We also welcomed Dr. **Gordon Wang** as the new director of the **Neuroscience Microscopy Service**, following the retirement of founding director, Dr. **Andrew Olson**. We look forward to the lab's next phase under Dr. Wang's leadership.

Directors Prof. **Mehrdad Shamloo** and Dr. **Javier Alcudia** continued to deliver excellent service at the **Behavioral and Functional Neuroscience Lab** and the **Gene Vector and Virus Core**, while deftly regrowing their operations after COVID-19 slowed research in 2020.

Cultivating a dynamic and inclusive neuroscience community

Community is a cornerstone of Wu Tsai Neuro, and the Institute's commitment to **diversity, inclusion, belonging, equity and justice** (DIBEJ) was channeled into action through the work of our DIBEJ committee.

To drive engagement with these key principles within our community, we worked with community members and institute stakeholders to develop a diversity statement that is now included in all our grant, fellowship and faculty search applications, along with a rubric to aid review committees in its evaluation.

To cultivate a more inclusive and welcoming environment for community members who identify as Black, Indigenous, Latinx, and/or People of Color (BIPOC), we sponsored the community-driven **BIPOC Emerging Leaders of the Next Generation** (BELONG) program. The program helps build community, enables sharing of the unwritten rules of science, and has launched a new postdoctoral speaker series for 2022 to highlight young BIPOC neuroscientists.

To support community members who are facing challenges to their work or wellbeing or that make them feel unsafe or unwelcome (including discrimination, micro/macro-aggressions or harassment), Student Services Coordinator **Melissa Landeros** stepped into the newly-created role of Community Advocate, serving as an ally and resource to help community members get the support they need..

To promote the success of neuroscience trainees from under-represented groups, Profs. **Marion Buckwalter**, **Miriam Goodman** and **Erin Gibson** developed the **Pathways to Neuroscience Training Program**, focusing on the key career transition points where historically under-represented scientists often decide to shift to other careers. Pathways recently received funding from the NIH and launches in the 2022 academic year.

Our trainees are another key Wu Tsai Neuro community, and each of our training programs succeeded despite remote learning and COVID restrictions continuing to affect laboratory work.

Looking forward

Academic year 2021 was Wu Tsai Neurosciences Institute's eighth year of operation. To ensure we are achieving our mission effectively and efficiently, we took the opportunity to engage with Stanford Improvement, Analytics, and Innovation Services to begin an internal review of our programs, organization and operations. The assessment included one-on-one interviews with faculty, focus groups of trainees and research staff, and a broad community survey conducted in 2021, and we eagerly anticipate receiving and analyzing the results in 2022. We plan to use the assessment results to provide input for strategic planning by institute leadership, to target areas of operational improvement and to ultimately feed into an external scientific review of our achievements and areas for growth.

In the 2020-21 academic year we welcomed:

6 innovative young scientists into our seventh cohort of Interdisciplinary Postdoctoral Scholars. As Stanford increases its fellowship and programmatic support for postdocs, we are proud to see key elements of our groundbreaking fellowship, training and mentorship program being designed into new postdoc initiatives campus-wide.

4 talented graduate students, including our first ever Wu Tsai Neurosciences Institute Graduate Fellow, and three other Stanford Interdisciplinary Graduate Fellows (SIGFs) affiliated with the institute.

7 students each into our *Mind, Brain, Computation and Technology* and *NeuroTech* graduate training programs.

18 Stanford undergraduates into our *Neuroscience Undergraduate Research Opportunity* (NeURO) summer program, supporting students engaging in neuroscience research and laboratory work for the first time. With an investment from the DIBEJ committee, two undergraduate students from Foothill College joined the summer program as part of a pilot program designed to increase outreach to future neuroscientists from historically under-represented backgrounds.


Andrew Brodhead

Building Community and Engaging Extraordinary People

Institute Scholars

The Wu Tsai Neurosciences Institute has recruited talented interdisciplinary faculty to Stanford to further broaden our research efforts and build new bridges between the subfields within our neurosciences community.

Todd Coleman (bioengineering)
Associate professor Todd Coleman, our newest institute scholar, studies the largely unexplored world of interactions between the nervous system and the gut. His lab, which moved into the Stanford Neurosciences Building in July, 2021, has developed the high-resolution electrogastrogram (HR-EGG)—a novel, non-invasive tool to measure electrical signals and mechanical contractions of the stomach and small intestine—and is working with clinicians to explore ways to better understand and diagnose gastrointestinal (GI) malfunction and disease.

Guosong Hong (materials science)
Assistant Professor Guosong Hong's lab leverages the latest materials advances to develop new tools to interface with the brain. The lab uses bio-compatible materials with unique electrical and optical properties to peek into the inner workings of the brain at the single-neuron level with minimal perturbation of the brain's intrinsic function.

Julia Kaltschmidt (neurosurgery)
Associate Professor Julia Kaltschmidt and her lab aim to understand the molecular basis of neuronal circuit formation, particularly those underlying locomotion, sexual function and gut motility. They are shedding new light on the fundamental role that local inhibitory microcircuits have in shaping animal behavior, revealing the circuitry of the enteric nervous system in the gut, and are exploring the functional consequences of enteric nervous system abnormalities.

Scott Linderman (statistics)
Assistant Professor Scott Linderman's lab works at the intersection of machine learning and computational neuroscience, developing models and algorithms to better understand complex biological data generated by modern neuroscience tools. Recent work in the Linderman lab includes: state space models for simultaneous recordings of multiple neural populations, point process models for discovering sequences in neural spike trains, and probabilistic models of larval zebrafish behavior.

Paul Nuyujukian (bioengineering, neurosurgery)
Assistant Professor Paul Nuyujukian leads the Brain Interfacing Laboratory, and is working to establish brain-machine interfaces as a platform technology for understanding and treatment of neurological disorders. The lab seeks to understand the causal relationships between multi-dimensional cortical dynamics and behavior. Collaborating with clinicians, Paul is improving the diagnosis and treatment of brain-related disorders such as stroke and epilepsy.

Daniel Yamins (psychology, computer science)
Assistant Professor Dan Yamins' research lies at the intersection of neuroscience, artificial intelligence, psychology and large-scale data analysis. The lab's approaches are unique in that they seek to use biology as inspiration to develop better artificial intelligence algorithms and, in turn, to use improved artificial intelligence algorithms to discover better models of how the brain works.

Faculty Awards and Honors

Wu Tsai Neurosciences Institute faculty are among the brightest leaders in neuroscience. In the 2020-2021 academic year, our faculty received many awards and honors in recognition of their scientific achievements.

Prestigious Elections

Marc Tessier-Lavigne, Stanford University President, was named an Officer of the Order of Canada in November, 2020, by the office of the Governor General of Canada, "for his groundbreaking contributions to developmental neuroscience, and for his renowned academic leadership and strong advocacy of science."

Three Wu Tsai Neuro faculty affiliates were elected in April, 2021, to the National Academy of Sciences, recognizing their distinguished and continuing achievements in original research. **Judith Frydman**, the Donald Kennedy Chair and professor of biology and genetics, was recognized for her multidisciplinary study of protein folding and degradation mechanisms, including in the context of neurodegenerative disease and potential therapies. **Kathryn A. "Kam" Moler** is Stanford vice provost and dean of research and the Marvin Chodorow Professor in the departments of Physics and Applied Physics, where she has developed new tools to measure magnetic properties of quantum materials and devices

that could advance quantum computing. **Tirin Moore**, a professor of neurobiology, has developed innovative approaches to studying the brain circuits and systems underlying visual attention and movement.

Wu Tsai Neuro affiliate **Kunle Olukotun** was elected in February, 2021, to the National Academy of Engineering, one the highest professional distinctions accorded any engineer. Olukotun, the Cadence Design Systems Professor in the departments of Electrical Engineering and Computer Science, was recognized for pioneering research in multicore processor design while leading the Stanford Hydra chip multiprocessor project.

Two Wu Tsai Neuro affiliates were elected in October, 2020, to the National Academy of Medicine, which provides independent, scientifically informed analysis on health and biomedical issues of national interest. **Jeffrey Goldberg**, Blumenkranz Smead Professor and chair of the Department of Ophthalmology, was recognized for his work studying regeneration of retinal ganglion cells and axonal growth and driving clinical trials for vision restoration for glaucoma patients. **Fei-Fei Li**, the Sequoia Capital Professor in the Department of Computer Science and co-director of the Stanford Institute For Human-Centered Artificial Intelligence (HAI), was recognized for helping establish the field of vision-based artificial intelligence and its diverse medical applications.

Four Wu Tsai Neuro affiliates were elected in April, 2021, to the American Academy of Arts and Sciences, which honors exceptional scholars, leaders, artists and innovators engaged in advancing the public good. **Zhenan Bao**, the K.K. Lee Professor and chair of the Department of Chemical Engineering, specializes in synthesis of functional organic and polymer materials and the design and application of organic electronic devices. **Axel Brunger**, a professor of molecular and cellular physiology and of neurology, studies molecular mechanisms of neurotransmitter release and their physiological function. **Fei-Fei Li** and **Tirin Moore**, whose work is described above, were also elected to the academy.

Two Wu Tsai Neuro affiliates were elected in March, 2021, to the American Institute of Medical and Biological Engineering. **Michael Moseley**, professor of radiology, was elected for his pioneering contributions to diffusion MRI for assessing brain injury, and cognitive performance. **Fan Yang**, associate professor of orthopaedic surgery and of bioengineering, was elected for her outstanding contributions to biomaterials science and engineering for tissue regeneration and cancer biology applications.

In addition to her election to the National Academy of Medicine and American Academy of Arts and Sciences, **Fei-Fei Li** was named to the new National Artificial Intelligence Research Resource Task Force in June, 2021. The task force was created by the White House Office of Science and Technology Policy (OSTP) and the National Science Foundation (NSF) to write a road map for expanding access to critical resources and educational tools that will spur AI innovation and economic prosperity nationwide.

Prominent Awards

Annelise Barron, the W.M. Keck Associate Professor of bioengineering, was awarded a National Institutes of Health (NIH) Pioneer Award in October, 2020. She intends to use the funding to explore a novel mechanism of sporadic Alzheimer's disease and a safe, cost-effective path to treatment.

Shaul Druckmann, an assistant professor of neurobiology and of psychiatry and behavioral sciences, was one of seven early-career neuroscientists to receive a 2021 McKnight Foundation Scholar award in June, 2021 for his research into how the brain computes using activity distributed across neuronal populations and brain areas.

Justin Du Bois and **Guosong Hong** were among three faculty members awarded Stanford's Walter J. Gores Award for Excellence in Teaching in June, 2021. Du Bois, the Henry Dreyfus Professor of Chemistry, was honored for "showcasing the importance of chemical concepts to human life and disease," with passion and enthusiasm. Hong, an assistant professor of materials science and engineering, was honored for his ability to share "his broad knowledge, extensive experience and sharp insights in the field of neurotechnology" with his students.

Keren Haroush, assistant professor of neurobiology, received a NIH New Innovator Award in October, 2020, and will use her award to elucidate the neuronal building blocks that allow us to interact with one another.

Liqun Luo, Ann and Bill Swindells Professor of Biology, received an Award for Education in Neuroscience from the Society for Neuroscience in November, 2020, in recognition of his "outstanding contributions" to education and training in the field.

In addition to his election to the National Academy of Science and the American Academy of Arts and Sciences, **Tirin Moore** was awarded the National Academy of Science Pradel Research Award in January, 2021, for his contributions to the study of visual attention.

Trainees and Training Programs

Center for Mind, Brain, Computation and Technology

The Center for Mind, Brain, Computation and Technology, founded in 2007 by Prof. **Jay McClelland**, continues to promote interdisciplinary computational neuroscience and neurotechnology research and community in many ways.

The MBCT training program welcomed seven new graduate students, for a total of 37 in the program. For the center's annual seminar series, we invited eight guest faculty, one Stanford faculty member and six trainees from the MBCT community to speak about their research at the intersection of neuroscience (including cognitive science and psychology), applied sciences and engineering. The series also featured its first panel discussion, bringing together leaders in academia and industry to discuss the feasibility and ethics of brain-computer interfaces in humans. The MBCT annual symposium included three esteemed neuroscientists from institutions around North America to present their work on the theme "Where the rubber meets the road: Computational models and empirical evidence."

This year also saw the selection of the third cohort of seven graduate students for the NeuroTech training program, led by Profs. **E.J. Chichilnisky**, **Ivan Soltesz** and **McClelland**. This five-year, $3M research training grant from the National Science Foundation 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 encompasses a popular new neuroscience immersion course and graduate training seminar, and collaborates with its partner departments to recruit and support promising students from underrepresented groups in STEM. It now includes 21 graduate students, more than half of whom are women — particularly notable given the longstanding underrepresentation of women in neurotechnology.

"I cannot recommend this training program more highly. It has served an integral role in the development and refinement of my own research interests; has provided me with valuable background knowledge, technical and professional development skills to continue pursuing this line of research; and has given me a network of friends and mentors that I will carry forward."

NeuroTech trainee, spring 2021

Stanford Undergraduate Neuroscience Society

Since its launch in the spring of 2018 by a small handful of enthusiastic undergraduates, our institute has supported the growth of the Stanford Undergraduate Neuroscience Society, which aims to bring together a community of students with a shared passion for understanding the mysteries of the brain and nervous system. In the three and a half years since it was founded, this group has expanded to become a university-recognized club of more than 750 students. Despite the social distancing imposed by the pandemic, SUNS continued to hold virtual professional development, social and research-related events for the undergraduate neuroscience community. Among their most popular events for the year were those highlighting the accomplishments and challenges faced by scholars of color, including a talk by Stanford social psychologist and noted author **Jennifer Eberhardt**, and the panel discussion "Diverse perspectives on navigating graduate school," hosted in partnership with the BELONG student organization.

Neuroscience Undergraduate Research Opportunity

This year brought the expansion of the institute's new program to support undergraduate research — the Neuroscience Undergraduate Research Opportunity (NeURO) fellowship. Designed

> **"[I] finally feel like I belong; Extremely proud and hope to stay a part of the Stanford neuro community throughout my time here."**
>
> **NeURO fellow, summer 2021**

particularly to meet the needs of students without previous access to research opportunities and those from underrepresented groups in STEM, the program includes a research fundamentals course, a neuroscience foundations course, and 10 weeks of full-time lab immersion. This year, in addition to a new cohort of 18 Stanford undergraduates, the institute piloted an extension of the NeURO program to include two promising young scholars from nearby Foothill Community College. Nominated for the program by the counselors of the Umoja and Puente learning communities at Foothill, which serve Foothill's Black and Latinx student communities, respectively, these students participated in every aspect of the NeURO program alongside their Stanford peers. This pilot was supported by the institute's Diversity, Inclusion, Equity, Belonging and Justice (DIBEJ) committee, which is now working to identify funding sources to expand the pilot into a larger, self-sustaining program in future years.

2021 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.

Ernie Hwaun (neurosurgery)
Sponsor: Ivan Soltesz, Co-Sponsor: Zhenan Bao

Dr. Hwaun aims to employ new soft-material probes to collect neural signals from behaving octopuses, gaining insights into fundamental neuronal mechanisms underlying spatial navigation.

Isaac Kauvar (education)
Sponsor: Nick Haber, Co-Sponsor: Karl Deisseroth

Dr. Kauvar is interested in advancing curiosity-driven algorithms to investigate how animals and robots explore.

Mabel Lam (neurosurgery)
Sponsor: Brad Zuchero, Co-Sponsor: Michael Bassik

Dr. Lam is using genetic approaches to identify molecular pathways essential for generating myelin, which will inform the development of therapeutics for demyelinating diseases.

Matt McCoy (pathology)
Sponsor: Andrew Fire

Dr. McCoy is applying experimental and computational methods to understand the causes and consequences of gene size expansion of neuronal genes.

Caitlyn Seim (mechanical engineering)
Sponsor: Allison Okamura,
Co-Sponsor: Maarten Lansberg

Dr. Seim works at the intersection of computing devices and the body to design new technology-based interventions to improve sensorimotor function.

2021 Interdisciplinary Graduate Fellows

This year marked the inaugural Wu Tsai Neurosciences Interdisciplinary Graduate Fellow Award, funded by an anonymous donor.

Erin Kunz (electrical engineering)
Advisors: Krishna Shenoy and Jamie Henderson,
Co-Advisor: Scott Linderman

Kunz seeks to use novel machine learning and statistical modeling techniques to improve decoding algorithms for brain computer interfaces in assistive neural prosthetic devices.

In addition, three Stanford Interdisciplinary Graduate Fellowships affiliated with Wu Tsai Neuro were awarded to talented young neuroscientists selected by anonymous donors.

Tamara Chan (neuroscience)
Advisor: Marius Wernig

Chan creates human stem cell-derived models of the brain to learn more about how cells interact on a cellular and molecular level, and how this contributes to homeostasis.

Kyrstyn Ong (materials science)
Advisor: Stephen Baccus,
Co-Advisors: Evan Reed and Merritt Maduke

Ong seeks to determine the molecular effect of ultrasound neuromodulation through simulations and in vitro animal experiments.

Yixiu Zhao (applied physics)
Advisor: Scott Linderman

Zhao is interested in making neuroscientific inquiries using machine learning. His current project involves combining Bayesian inference and deep neural networks for behavioral studies of mice.

Community Programs

Annual Symposium: *The Addiction Epidemic, from Neuroscience to Policy*

Our Eighth Annual Symposium on October 21, 2021 marked a new milestone for the institute as we embarked on our first hybrid symposium, featuring world leaders in addiction research, policy and journalism. The symposium was organized by the Wu Tsai Neuro-funded Neurochoice Initiative, led by Profs. **Brian Knutson** (psychology), **Keith Humphreys** (Esther Ting Memorial Professor, psychiatry) and **Robert Malenka** (Nancy Friend Pritzker Professor, psychiatry). We welcomed top neuroscientists to share their work: **Yasmin Hurd** (Icahn School of Medicine at Mount Sinai), **Brain Kobilka** (Stanford University), **George Koob** (National Institute on Alcohol Abuse and Alcoholism), **Marina Picciotto** (Yale University) and **Valerie Voon,** (University of Cambridge). In addition to scientific presentations, we heard from **Mariano-Florentino Cuéllar**, president of the Carnegie Endowment for International Peace and former Justice of the Supreme Court of California about the state of public policy related to addiction and prescription drug abuse and from Washington Post reporter **Lenny Bernstein**, reflecting on his years of covering the opioid epidemic and how scientists can work most effectively with the media.

At the symposium, we also celebrated outstanding research by our postdoctoral scholars and graduate students with the annual the Sammy Kuo Awards in Neuroscience, honoring the memory of Sammy Kuo, who died of a rare, progressive encephalitis in 2006. Prof. **Corinna Darian-Smith** (comparative medicine) announced this year's first-place awards to postdoctoral scholar **Frank Willett** for his paper, "High-performance brain-to-text communication via handwriting" (*Nature*, 2021) and to graduate student **Eddy Albarran** for his paper, "Enhancing motor learning by increasing the stability of newly formed dendritic spines in the motor cortex" (*Neuron*, 2021).

Seminar Series

Our weekly seminar series resumed in full force this year with 25 eminent scientists visiting for virtual seminars. This year's speakers included: **Leslie Vosshall** (The Rockefeller University), **Mark Churchland** (Columbia University), **Stephen Lisberger** (Duke University), **Sally Temple** (Neural Stem Cell Institute), **Liam Paninski** (Columbia University) and **Loren Looger** (Howard Hughes Medical Institute, Janelia Research Campus). Wu Tsai Neuro thanks former seminar committee chair Prof. **John Huguenard** (neurology and neurological sciences), and our new chair **Andrew Huberman** (neurobiology) for their leadership of the seminar committee.

Institute Picnic

To kick off the 2021-22 academic year, we invited the Stanford neuroscience community to a fall picnic, hosted for the first time in our neurosciences building courtyard. More than 200 community members attended; getting reacquainted over BBQ from Get Tha Fork Outta Here, the institute's new on-site pub and eatery. We hope this is the first of many events leveraging the power of our shared space to spark new collaborations, enhance our science and enrich our community.

Neuroscience Research

The research emphases of Wu Tsai Neurosciences Institute fall into three areas, encompassing our objective of fostering interdisciplinary research in the neurosciences broadly defined.

NeuroDiscovery

Our scientists pursue fundamental discoveries in brain science — powered by cutting-edge technologies and collaborative research — that will unlock new medical treatments, transform education, inform public policy and help us understand who we are.

NeuroEngineering

Our engineers are developing new tools and technologies to enable as-yet-unimagined discoveries about the workings of the 100 billion nerve cells and trillions of connections that comprise the human brain, and eventually to repair and even to augment it.

NeuroHealth

Our physician researchers not only treat patients, but are also working with basic scientists to pioneer novel treatments for psychiatric and neurological disease, benefiting not just individuals, but society as a whole.

Sergiu Pasca

Big Ideas in Neuroscience

Our flagship research projects, each Big Ideas initiative represents an innovative idea by a cross-disciplinary team of researchers that could fundamentally change how we understand the brain. Our first round of Big Ideas projects will complete their second phase of funding in early 2022. Based on their tremendous progress, the second round of Big Ideas projects all received additional funding through phase 2 big ideas awards and research accelerator grants to continue their work in 2022 and beyond.

Round 2 Big Ideas

Neurodevelopment Initiative: Elucidating the development of brain structure, function and computations
Team Leaders: **Kalanit Grill-Spector** (psychology), **Jennifer McNab** (radiology) and **Daniel Yamins** (psychology)
NeuroDiscovery

The first year of life is a time of incredible learning and cognitive growth, but the neurological changes that underlie this transformative period are not well understood. This team of cellular and computational neuroscientists, bioengineers and MRI experts aims to address that gap in knowledge by focusing on the development of the visual system from birth to one year of age. By combining newly developed and traditional brain imaging technologies, the team can link infants' brain anatomy to their visual function. The team has already made the unexpected discovery that the level of myelination (thought to be an indicator of neuronal maturity) does not predict how fast a cluster of neurons will develop. The team has also shown that cutting-edge deep neural networks can accurately model brain development and predict neural responses seen in infants.

Awarded a research accelerator grant in 2021.

Neuro-omics Initiative
Team leaders: **Alice Ting** (genetics), **Liqun Luo** (Ann and Bill Swindells Professor, biology) and **Stephen Quake** (Lee Otterson Professor, bioengineering)
NeuroEngineering

This team of bioengineers, neurobiologists and molecular tool builders realized that the big data technologies driving the past decade's "omics revolution" — paired with modern machine learning — could allow scientists to comprehensively and reliably classify the cells of the brain based on their genetic programming. The suite of new tools and analysis methods that this team is developing allow neuroscientists for the first time to confidently examine the same brain cells from many different perspectives: from their local anatomy and physiology to their participation in the large-scale circuit activity that is responsible for the ability to perceive, think, remember, and act. 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.

Awarded phase 2 big ideas funding in 2021.

NeuroPlant Initiative: Leveraging a botanical armamentarium to manipulate the brain
Team Leaders: **Thomas Clandinin** (Shooter Family Professor, neurobiology), **Miriam Goodman** (Mrs. George A. Winzer Professor in Cell Biology, molecular & cellular physiology) and **Seung Yon Rhee** (Carnegie Institute of Biology)
NeuroDiscovery

This team of neuroscientists, plant biologists, computational scientists and chemical engineers aims to identify plant-derived chemicals that can be used to study the nervous system and develop novel therapies to augment the array of 50-year-old drugs currently used for psychiatric conditions. The team leveraged decades of knowledge about the genetics and neurobiology of the roundworm, C. elegans, to develop a high-throughput screening method and identify promising plant compounds. The team is now working to understand how identified compounds affect roundworm and human cells, by looking for the receptors that these plant-derived compounds act on. Understanding the lock and key style interaction of chemicals and receptors is a crucial step in harnessing these novel compounds for treating psychiatric disease.

Awarded a research accelerator grant in 2021.

Stanford Brain Organogenesis Program
Team Leaders: **Sergiu Pasca** (Bonnie Uytengsu & Family Director, psychiatry) and **Karl Deisseroth** (D.H. Chen Professor, bioengineering)
NeuroHealth

Our bony skulls protect our fragile brains, but also prevent neuroscientists from directly studying functioning human brain tissue. Bridging campus-wide expertise in neurosciences, stem cell biology, engineering, chemistry, medicine and law, and leveraging unique Stanford technologies, this team aims to overcome this challenge by using stem cells to recapitulate the development of human brain tissue in the lab. These 3-D 'brain-in-a-dish' models, called neural organoids and assembloids, will help reveal how human neurons communicate and identify early causes of neuropsychiatric disorders. In the belief that science is a community effort, the team is dedicated to training a diverse group of students, to broadly and openly sharing its technologies with laboratories around the world, and to developing ethical guidelines for this emerging field.

Awarded phase 2 big ideas funding in 2021.

Round 1 Big Ideas

Neurochoice Initiative: Optimizing choice, from neuroscience to policy
Team Leaders: **Brian Knutson** (psychology), **Keith Humphreys** (Esther Ting Memorial Professor, psychiatry) and **Robert Malenka** (Nancy Friend Pritzker Professor, psychiatry)
NeuroDiscovery

Our decisions define not only our lives but those of future generations. Understanding the links from neural circuits to individual and group choices could spark major advances in basic neuroscience research and its application to enduring societal problems. This team of neuroscientists, clinicians, engineers and public policy experts is examining addiction to deepen our understanding of the neural mechanisms of healthy and addictive choices. The team engages with policymakers whose work on addiction might be informed by neuroscience evidence, and who might help researchers identify other societal issues poised to benefit from transformative research advances.

Stanford Brain Rejuvenation Initiative
Team Leaders: **Tony Wyss-Coray** (D.H. Chen Professor II, neurology) and **Aaron Gitler** (genetics)
NeuroHealth

Aging 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. This team of engineers, neurologists, neuroscientists, chemists, geneticists and stem-cell biologists will tackle this problem by creating a campus-wide infrastructure for the study of brain aging: seeking ways to slow aging and extend health-span, to maintain or rejuvenate brain function, and to identify the fundamental mechanisms of brain degeneration.

Stanford Neurotechnology Initiative
Team Leaders: **Nicholas Melosh** (materials science) and **E.J. Chichilnisky** (John R. Adler Professor, neurosurgery, ophthalmology)
NeuroEngineering

Neural interfaces of the future will treat a wide range of diseases for which there is yet no cure, from sensory and motor degeneration to psychiatric disorders. Currently, such interfaces remain crude compared to the neural circuits in which they are embedded. This team is leveraging expertise in neuroscience, biomaterials engineering, nanofabrication and integrated circuit design to develop the next generation of neural interfaces with a focus on two signature efforts: high-density wire bundles for electrical recording and stimulation, and bi-directional retinal prostheses for restoration of vision. The team recently completed fabrication of the neural interface, which is now being tested, as well as the first large-scale recording from human retina.

Neuroscience:Translate Awards

In 2021, we awarded our 3rd round of Neuroscience:Translate grants. This grant program encourages teams of researchers—typically clinicians paired with engineers—to rapidly translate promising basic or clinical science discoveries in any area of neuroscience into treatments, devices or software that improve people's lives.

The wearable ENG: A dizzy attack event monitor (Dizzy Dx)
Kristen Steenerson (otology & neurotology), **Peter Santa Maria** (otology & neurotology) and **Ada Poon** (electrical engineering)
NeuroEngineering

This team has developed a device to diagnose recurrent dizziness attacks, a condition that was previously hard to diagnose, often requiring multiple hospital admissions and large batteries of tests. Timely diagnosis is essential because it reduces the chance that patients will habituate to frequent dizziness, and increases the chance that existing therapies will be effective. This 2020 project was renewed for a second year of funding through the Neuroscience:Translate Award to support commercialization of the device.

Optimization of the African killifish platform for rapid drug screening for aggregate based neurodegenerative diseases
Anne Brunet (Michele and Timothy Barakett Endowed Professor, genetics), **Karl Deisseroth** (D.H. Chen Professor, bioengineering) and **Daniel Jarosz** (chemical and systems biology, developmental biology)
NeuroHealth

To advance the development of drugs to treat neurodegenerative diseases, this team developed a new vertebrate model system with high throughput capacity. The African killifish is the shortest-lived vertebrate; within its 4-6 month lifespan the killifish exhibits multiple age-dependent phenotypes and pathologies that arise over decades in humans, including cognitive decline and neurodegeneration. The team is optimizing the killifish platform for phenotypic screening of drug libraries, notably those targeted at protein aggregation, which is central to neurodegenerative diseases.

Remote reliable measurements of movement using a bluetooth-enabled engineered keyboard solve an unmet need in neurological diseases
Helen Bronte-Stewart (John E. Cahill Family Professor, neurology) and **Allison Okamura** (mechanical engineering)
NeuroEngineering

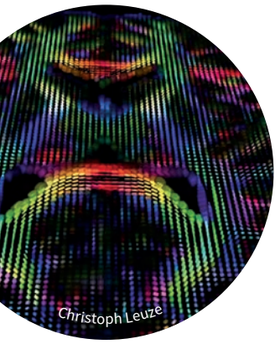
Parkinson's disease is a progressive neurological disorder that has a complex diagnosis criteria requiring a specialized neurologist. Telemedicine has increased access of patients to specialized care, but assessment of rigidity, one of the three hallmarks of Parkinson's, is currently impossible via telemedicine. This team developed a technology for Quantitative DigitoGraphy using a repetitive alternating finger tapping task on a musical instrument digital interface (MIDI) keyboard that will allow diagnosis of rigidity by telemedicine.

Rapid and automated educational assessment through the web browser
Jason Yeatman (pediatrics, education, psychology) and **Heidi Feldman** (Ballinger-Swindells Endowed Professor, developmental and behavioral pediatrics)
NeuroDiscovery

This team aims to develop an automated reading ability assessment tool, providing normative measures of reading ability collected through a game that runs in the participant's web-browser on their personal computer. The resulting scores are more accurate and reliable than current "gold standard" assessments that require long, in person testing sessions and trained test administrators. This technology offers a low-cost alternative to testing that was previously available only in expensive specialist or clinical settings, with the goal of providing support for struggling readers, regardless of their families' means.

Extracochlear neurostimulation (Auricle)
Peter Santa Maria (otology & neurology) and **Ada Poon** (electrical engineering)
NeuroEngineering

Sensorineural hearing loss is an increasingly prevalent condition that progressively affects high-frequency hearing that is critical for speech comprehension. For the 1.2M US adults with bilateral severe-to-profound high-frequency hearing loss, the only available treatment is a cochlear implant, however the risk of residual



hearing loss associated with this irreversible procedure leads most patients to forgo treatment. This team is developing a breakthrough device to restore high-frequency hearing that preserves residual hearing through a reversible and minimally invasive approach.

A minimally-invasive intracranial pressure microsensor (mICP) for long-term, continuous ambulatory monitoring
Chirag Patel (neurology) and **Melanie Hayden-Gephart** (neurosurgery)
NeuroEngineering

Glioblastoma is the most common and lethal form of primary brain cancer in adults. The limited available treatments can lead to unpredictable swelling in the brain and elevated intracranial pressure which results in headaches, vomiting, or seizures. This team hopes to develop a pressure-sensing microfluidic intracranial pressure microsensor that could be implanted in glioblastoma patients to detect elevated pressure early on. The microsensor is small in size, low cost, free of all electrical components and with no mechanical parts; it will provide a long-term, continuous, in-hospital and at-home approach to on-demand monitoring in patients.

Seed Grants

In 2021, we selected our fourth round of Wu Tsai Neuro Seed Grants, which are designed to foster collaborations between small teams of researchers from different backgrounds and disciplines, allowing them to pilot novel research ideas that may be risky but have the potential to dramatically impact the field.

Rapid brain-wide optogenetic screening with a noninvasive, dynamically programmable in-vivo light source
Guosong Hong (materials science & engineering) and **Xiaoke Chen** (biology)
NeuroEngineering

This team aims to develop a noninvasive technology for on-demand control of targeted cell populations throughout the brains of live mice. Optogenetics is a powerful technique for controlling the activity of genetically-defined brain cells using light, but it is challenging to deliver the light deep into the brain or to dynamically shift stimulation between different brain regions. The proposed research will employ mechanoluminescent nanoparticles that can be made to produce light anywhere in the brain using focused ultrasound. The researchers will test the system's ability to screen multiple brain regions for their contributions to addictive drug seeking behavior.

Elucidating the biophysical mechanisms of latrophilin activation in excitatory synapse formation
Alexander Dunn (chemical engineering) and **Thomas Südhof** (Avram Goldstein Professor in the School of Medicine, molecular and cellular physiology, neurosurgery)
NeuroDiscovery

This team aims to understand the role of mechanical force on synapse formation in the wiring of brain circuits during development. A family of synaptic molecules called latrophilins are known to play an important role in synapse formation, but the mechanism of their contribution is unknown. The proposed research will test the innovative hypothesis that latrophilins mediate molecular-scale mechanical signals to sculpt synapse formation and will shed light on how latrophilin signaling regulates synapse formation during brain development and how it may go awry in neuropsychiatric disease.

Mapping the mitophagy network in parkinson's disease
Xinnan Wang (neurosurgery) and **Michael Bassik** (genetics)
NeuroHealth

This team aims to reveal how the failure of mitochondrial quality control during aging contributes to nerve cell death in Parkinson's disease — and how this process could be reversed to treat the disease. Little is known about the molecular drivers of age-related mitochondrial dysfunction and the toxic factors the cell's power plants produce when they fail. The researchers plan to comprehensively map this gene network in PD-afflicted cells for the first time using cutting-edge CRISPR DNA-targeting technology. If successful, the project could identify novel targets for the first disease-modifying therapies for PD.

Magnetic recording and stimulation of neural tissue
Ada Poon (electrical engineering), **Shan Wang** (Leland T. Edwards Professor, electrical engineering) and **Paul George** (neurology and neurological sciences)
NeuroEngineering

This team aims to engineer a magnetic sensor and stimulator of neuronal activity that could complement or replace standard microelectrodes in experimental and clinical neuroscience. By recording magnetic fields, such a device could directly record the electrical currents within neurons through a protective coating designed to minimize the inflammatory scarring that limits the useful lifetime of conventional micro-electrodes. The proposed device would take advantage of the team's expertise in cutting-edge circuit design and fabrication techniques, and the development of novel laboratory testing platforms to systematically validate the sensor.

Inflammation, major histocompatibility complex class I and human brain development
Carla Shatz (Sapp Family Provostial Professor, biology, neurobiology) and **Anca Pasca** (pediatrics)
NeuroDiscovery

This team aims to examine what happens when the developing brain experiences a viral infection, which has been linked to neurodevelopmental disorders such as schizophrenia and autism. The research centers on a family of molecules called MHCI, which plays important roles in both immune responses to infection and in synapse formation during brain development. These researchers will study what happens when the brain and immune system collide, using innovative human brain organoid models and fetal brain samples to examine how virus-associated interferons affect MHCI levels as well as synapse density and function.

Research Accelerators

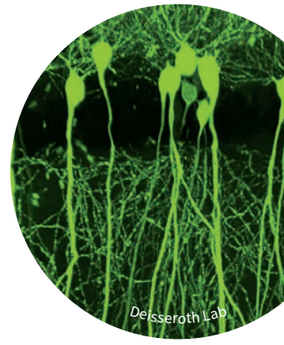
Our research accelerator program supports interdisciplinary projects with the potential for high impact in understanding the brain and improving mental health, and which are funded through philanthropic gifts to the institute.

Brain rejuvenation sequencing cluster
Tony Wyss-Coray (D.H. Chen Professor II, neurology)
NeuroHealth

Sequencing the human genome revolutionized biology by giving scientists access to the entire code for the human body, but the value of the human genome lies in understanding where and when genes do their work. The shared resource established by this team allows the Stanford community to perform high-throughput RNA sequencing to detail these patterns of gene expression across the vast numbers of cells that work together to form the nervous system. In 2021 the core contributed to discoveries about brain inflammation of COVID-infected brains, the beneficial effects of exercise on the brain, and the cellular components of human brain vasculature.

Developing an early enteric marker of Parkinson's disease
Julia Kaltschmidt (neurosurgery)
NeuroHealth

A major challenge for the treatment of neurodegenerative diseases like Parkinson's Disease (PD), is the lack of early-detection methods. By the time symptoms become severe enough that a person seeks medical advice, the nervous system has typically suffered irrecoverable damage. Up to 80% of PD patients report constipation before the motor symptoms that define the disease, which led Julia Kaltschmidt to consider if there might be a link between what's happening in the brain and what's happening in the gut. This team has developed novel mouse models to study mechanisms of constipation in PD, which could result in early detection methods that would further our understanding of this devastating disease and to develop effective treatments.



The neural prosthetics translational laboratory
Krishna Shenoy (Hong Seh and Vivian W. M. Lim Professor, electrical engineering) and **Jaimie Henderson** (John and Jene Blume - Robert and Ruth Halperin Professor, neurosurgery)
NeuroEngineering

This team is translating fundamental principles of human neuroscience to develop high-performance brain–computer interfaces to help restore lost motor function to people with paralysis. Using small, surgically implantable sensors, this group decodes nerve cell activity from the areas of the brain that control movement, allowing research participants with paralysis to move computer cursors, robotic limbs, and other assistive devices. The team has made surprising discoveries about what brain regions are active in speech production and have been able to accurately decode imagined handwriting from patients with paralysis.

Neuroscience Community Labs

The Stanford Neurosciences Building is a huge step forward in the realization of our vital shared research platforms—the Neuroscience Community Laboratories. With specialized spaces in the building for five new laboratories as well as new homes for two of our three existing labs, our facilities and staff were ready and waiting to support our returning research community as COVID-19 restrictions lifted in 2021.

Andrew Brodhead

Wu Tsai Neuro Community Laboratories director **Timothy Doyle** served on the Community of Shared Advanced Research Platforms (c-ShARP), a committee of Deans, faculty, service center staff and institute directors that will promote, advocate and fund shared facilities across the campus. In addition to providing funding for new instrumentation, cShARP has prioritized the greatest asset of the service centers: the scientists and staff that support, manage and direct these shared facilities.

The Wu Tsai Neurosciences Institute recruited two new community lab directors in the past year, as well as several new dedicated staff scientists to facilitate community lab operations. Dr. **Jieun Kim** will lead the new Neurosciences Preclinical Imaging Lab and Dr. **Gordon Wang** will lead the Neurosciences Microscopy Service, which has moved into the Neurosciences building. The institute is actively seeking a director for the Koret Human Neurosciences Community Lab, and plans to hire a new director for the Vincent V.C. Woo Sandbox lab in the near future. These directors and staff are the biggest asset of the Wu Tsai Neuro community labs, providing training, advice and dedicated service to the neuroscience community at Stanford.

New Community Labs

Koret Human Neuroscience Community Laboratory
This new lab facilitates cutting-edge human neuroscience and clinical research under the faculty direction of Profs. **Anthony Norcia** (psychology) and **Nolan Williams** (psychiatry). The lab provides state-of-the-art transcranial magnetic stimulation (TMS) and electroencephalogram (EEG) equipment and facilities. TMS is a non-invasive brain stimulation technique that shows promise in treatment of psychiatric disorders. The Koret lab houses a computer-controlled robot arm that accurately and reproducibly positions the device to deliver magnetic stimulation to the desired target region. The EEG equipment has generated great interest across campus for experiments on human perception and behavior because our setup allows subject isolation for precise visual or auditory stimulation to monitor brain activity. The center is now interviewing candidates for the laboratory director position, who will oversee daily operations, as well as assisting in designing new studies, conducting studies and assisting in data analysis.

Neuroscience Preclinical Imaging Laboratory
Wu Tsai Neuro custom-designed this new facility to house a new 7T magnetic resonance imaging (MRI) instrument for small animal imaging, that was purchased, in part, with funds provided by the NIH from a grant written by Prof. **Jin Hyung Lee** (neurology). Further funds for the purchase of the instrument and lab construction were provided by Wu Tsai Neuro and several other Stanford departmental partners. With lab construction completed at the start of 2021, the magnet was delivered in April, and following installation was put online as a shared facility in September 2021. Dr. **Jieun Kim** was recruited as a staff scientist director for the facility in January, and has overseen the delivery, installation and operational process. The new MRI is optimally configured for neuroscience-focused experiments using a broad range of animal species, such as non-human primates and large rodents.

Vincent V.C. Woo Sandbox Laboratory
In software development, a “sandbox” refers to a separate environment where research and code development can be done without affecting production systems. Part biological wet lab, part engineering workshop and part maker space, the Sandbox Lab will be a hub of novel collaborative research and cross-training between neuroscientists and engineers with a deep interest in neuroscience applications. The lab programs are directed by Profs. **John Huguenard** (neurology), **Nicholas Melosh** (materials science), **Sergiu Pasca** (psychiatry), **Ada Poon** (electrical engineering) and **Todd Coleman** (bioengineering). Several Wu Tsai Neurosciences Institute faculty teams have already taken advantage of the Sandbox space to work on novel projects, and the Stanford Intensive Neuroscience bootcamp for incoming neuroscience graduate students was successfully run in the Sandbox in September 2021.

Visualization Laboratory
The Visualization Lab is a collaborative space focused on human perception, and is spearheaded by two research projects that informed the design of the lab: a virtual reality/augmented reality (VR/AR) facility led by Prof. **Jennifer McNab** (radiology) and Dr. **Christoph Leuze** (radiology), and an

adaptive optics facility led by Prof. **Alfredo Dubra** (ophthalmology). The VR/AR facility invites users from across the university to experiment and develop new applications for mixed reality technology, such as visualizing scientific data, guiding clinical procedures and studying the psychology of decision-making. Professor Dubra's adaptive optics rig will allow non-invasive visualization and stimulation of single retinal cells of human subjects using techniques developed by astronomers to resolve distant stars from ground based telescopes. The VR/AR team has set up an active lab and already run their first symposium in the space. Prof. Dubra's adaptive optics facility is expected to be completed in Winter Quarter 2022.

Established Community Labs

Gene Vector and Virus Core

Molecular tools are a cornerstone of current cellular and circuit-based neuroscience experiments. Optogenetics, calcium imaging and CRISPR-Cas9 all rely on novel genetic constructs. These tools can change the biochemistry of cells which may mimic a disease, permit specific imaging of cells or allow researchers to control cellular events. The Gene Vector and Virus Core (GVVC), led by Dr. **Javier Alcudia**, provides scale-up production of genetic constructs (either in the form of "plasmids" or "viral vectors") to neuroscientists at Stanford and around the globe. Packaging genetic constructs within specially designed viruses allows the tools to be deployed with cell-specific accuracy. GVVC provides an important service by centralizing the production of genetic constructs, delivering high-quality products widely, and improving experimental reproducibility. GVVC operations were able to continue throughout the COVID shelter-in-place due to the new laboratory design enabling staff to work in separate rooms, thus meeting the room occupancy limits imposed by the county. While demand for services was reduced over the last 18 months, the team took advantage of the available time to test new technologies that will facilitate operations in the future, and with the help of the Wu Tsai Neurosciences Institute purchased a state-of-the-art digital PCR machine, and optimized its use into their production operations. It is hoped that other labs in the building will also be able to take advantage of this new equipment.

Neuroscience Microscopy Service

The Neuroscience Microscopy Service (NMS) offers access to cutting-edge microscope technologies to the Stanford neurosciences community, with a collection of high-end microscopes not typically available in individual laboratories. Following the retirement of Dr. **Andrew Olson**, the founding director of the NMS, an international search for a new director was conducted with the assistance of the Stanford Cell Sciences Imaging Facility. Dr. **Gordon Wang** was chosen as the new director, and took over the role in February 2021. Dr. Wang has submitted instrumentation grants to internal and national funding sources and trained many new users of the state-of-the-art microscopes in the Stanford Neurosciences Building. Under his direction, use of the NMS has increased sufficiently that the service center met their budget, despite COVID-19 restrictions. Dr Wang has also worked with vendors to bring new microscopes onto campus to demonstrate their capabilities to the Stanford research community and to identify future research needs.

Behavioral and Functional Neuroscience Laboratory

The Behavioral and Functional Neuroscience Laboratory (BFNL), directed by Prof. **Mehrdad Shamloo** (neurosurgery), provides rodent models of neurological and psychiatric disease and offers a range of research services to study brain function, behavior and drug response in these models— important experimental steps in the translational pipeline of basic scientific discovery to clinical treatment. BFNL is the only community lab located outside the Stanford Neurosciences Building, and recent renovations of its Arastradero facility have enabled the creation of separate rat and mouse housing and testing spaces. A successful NIH S10 shared instrumentation grant allowed the lab to purchase new automated equipment that will allow real-time remote access of data by research staff, minimizing rodent-researcher interactions and improving research reproducibility. Increased demands for use of the BFNL by both Stanford and external researchers have enabled the group to hire several new scientists, and this shared community lab is ready to meet the growing needs of the neurosciences research community.

Development

The Stanford Neurosciences Building is a huge step forward in the realization of our vital shared research platforms—the Neuroscience Community Laboratories. With specialized spaces in the building for five new laboratories as well as new homes for two of our three existing labs, our facilities and staff were ready and waiting to support our returning research community as COVID-19 restrictions lifted earlier this year.

The 2021 fiscal year was fueled by the energy and momentum generated by the dedication of the state-of-the-art Stanford Neurosciences Building and Stanford ChEM-H Building. With the easing of safety restrictions and return of students to campus, this unique research facility is once again a bustling hub of innovation. Stanford is grateful for the pivotal donor support that made this possible. Fundraising efforts continue to advance Wu Tsai Neuro through support of faculty, students, and creative research as well as shared research platforms such as Wu Tsai Neuro Community Labs.

Wu Tsai Neuro leveraged virtual engagement and stewardship opportunities to strengthen relationships with existing donors and build bridges to new audiences. In addition to providing high-touch written stewardship updates and facilitating intimate faculty discussions, these efforts converged around a continued Science in Motion Zoom program. This successful series facilitated meaningful conversations about the work of the life science institutes with esteemed faculty, university leaders, and key supporters of the Stanford life sciences. Highlights included lively discussions about the neuroscience of early childhood learning and the intersections of AI and neuroscience. Important supporters were also engaged in strategic workshops to help strengthen messaging and better convey the tremendous impact of shared research platforms like the Wu Tsai Neuro Community Labs.

Looking forward, the institute continues to seek much-needed support for key Wu Tsai Neuro priorities. This includes building a collective endowment to support shared research platforms and fuel innovative team science across campus.

Other priorities include shoring up support for flagship research programs like Big Ideas in Neuroscience and Neuroscience:Translate, and securing gifts to endow professorships for faculty retention and recruitment, and fellowships for interdisciplinary PhD and postdoctoral scientists.

Leadership and Staff (September 1, 2020 – August 31, 2021)

Executive Committee

Marion Buckwalter, MD, PhD
Professor of Neurology and of Neurosurgery

Scott Delp, PhD
James H. Clark Professor of Bioengineering and of Mechanical Engineering

Rob Malenka, MD, PhD
Nancy Friend Pritzker Professor of Psychiatry and Behavioral Sciences

William Newsome, PhD
Vincent V.C. Woo Director, Harman Family Provostial Professor, Professor of Neurobiology

Allison Okamura, PhD
Professor of Mechanical Engineering

Tanya Raschke, PhD
Director for Planning and Operations

Anthony Wagner, PhD
Lucie Stern Professor in the Social Sciences, Professor of Psychology

Brian Wandell, PhD
Isaac and Madeline Stein Family Professor, Professor of Psychology

Administrative Team

Tim Doyle, DPhil
Associate Director, Neurosciences Community Labs

Tammie Forbes
Administrative Associate, Neurosciences Community Labs

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Associate Director for Fellowships and Training

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Staff Technician
GVVC

Jieun Kim, PhD
Director
NPIL

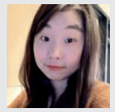
Mehrdad Shamloo, PhD
Professor of Neurosurgery, Director
BFNL

Nay Lui Saw
Lab Manager
BFNL

Andrew Evans, PhD
Staff Scientist
BFNL

Jennifer Lin, PhD
Staff Engineer
BFNL

Rachel Lam
Staff Scientist
BFNL



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