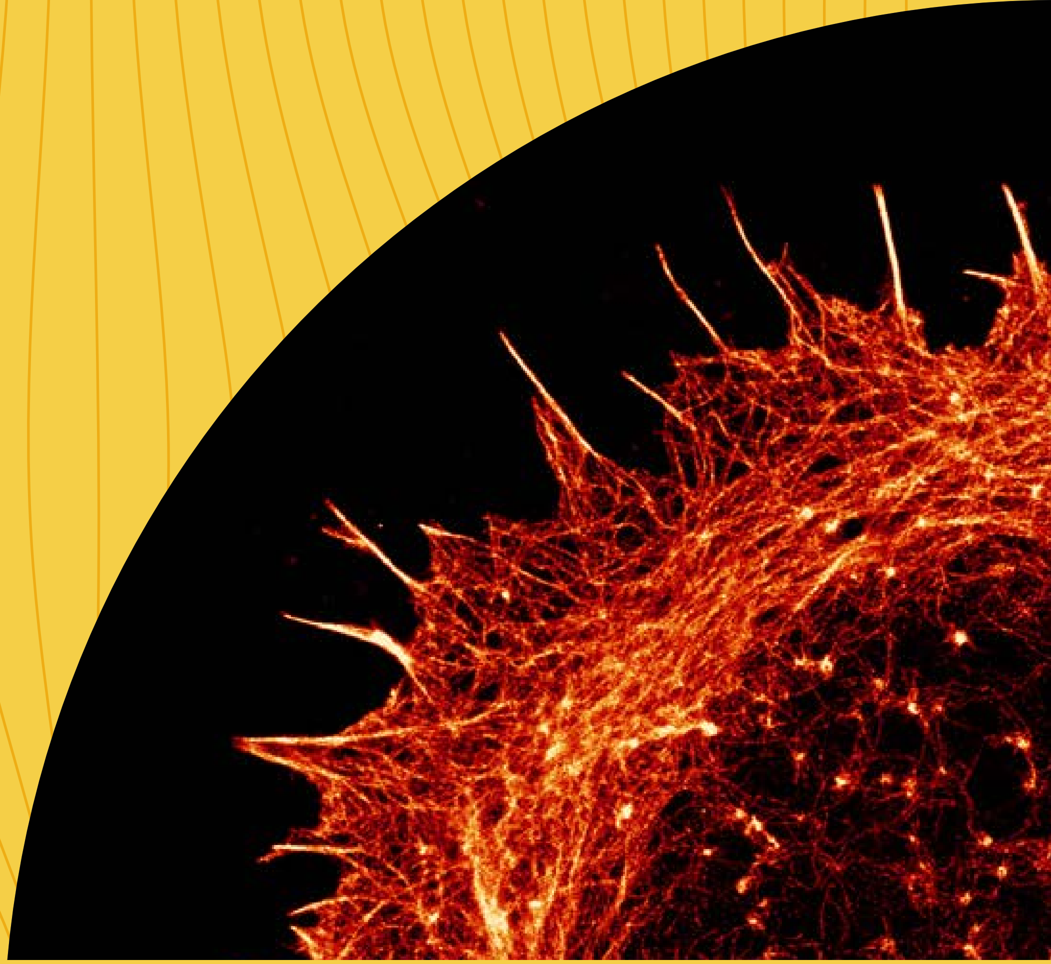
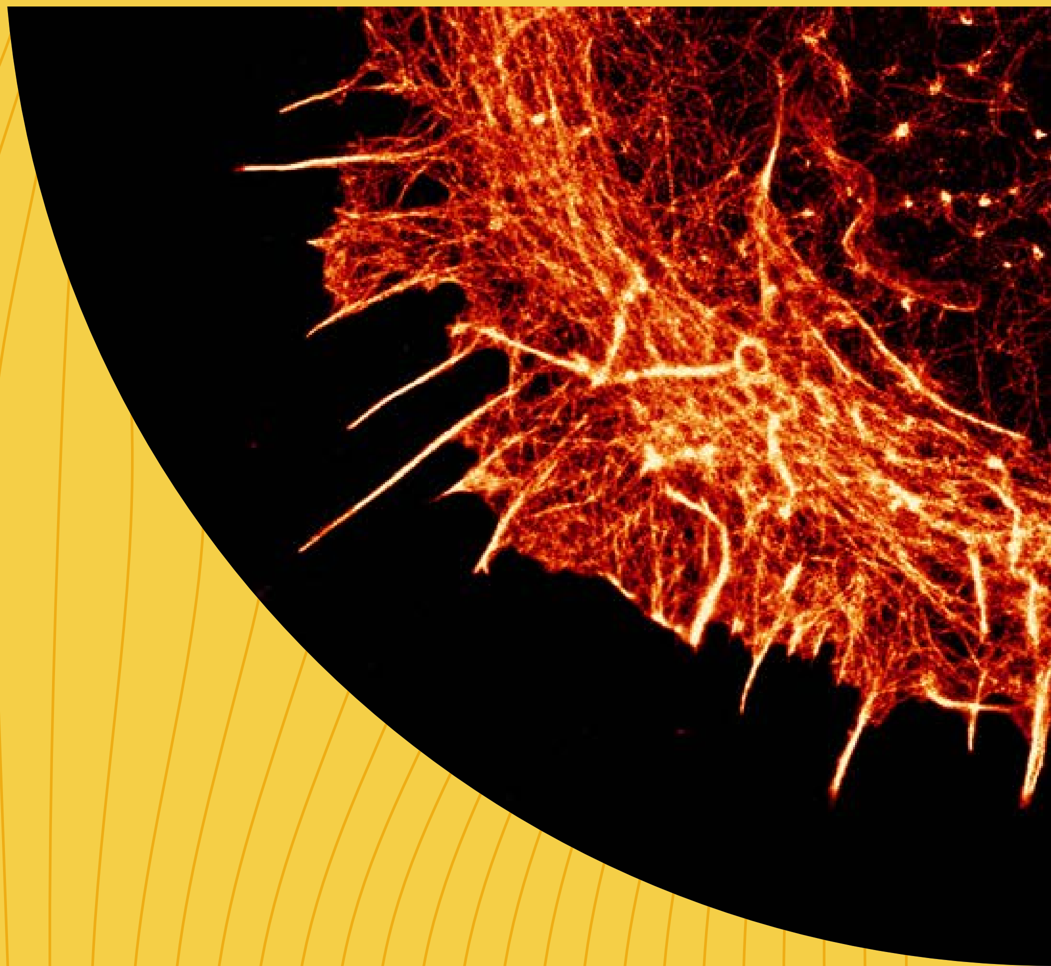


RESILIENCE

In a *Turbulent* Year



Society *for* Neuroscience

ANNUAL REPORT FY 2021

Donor Spotlight

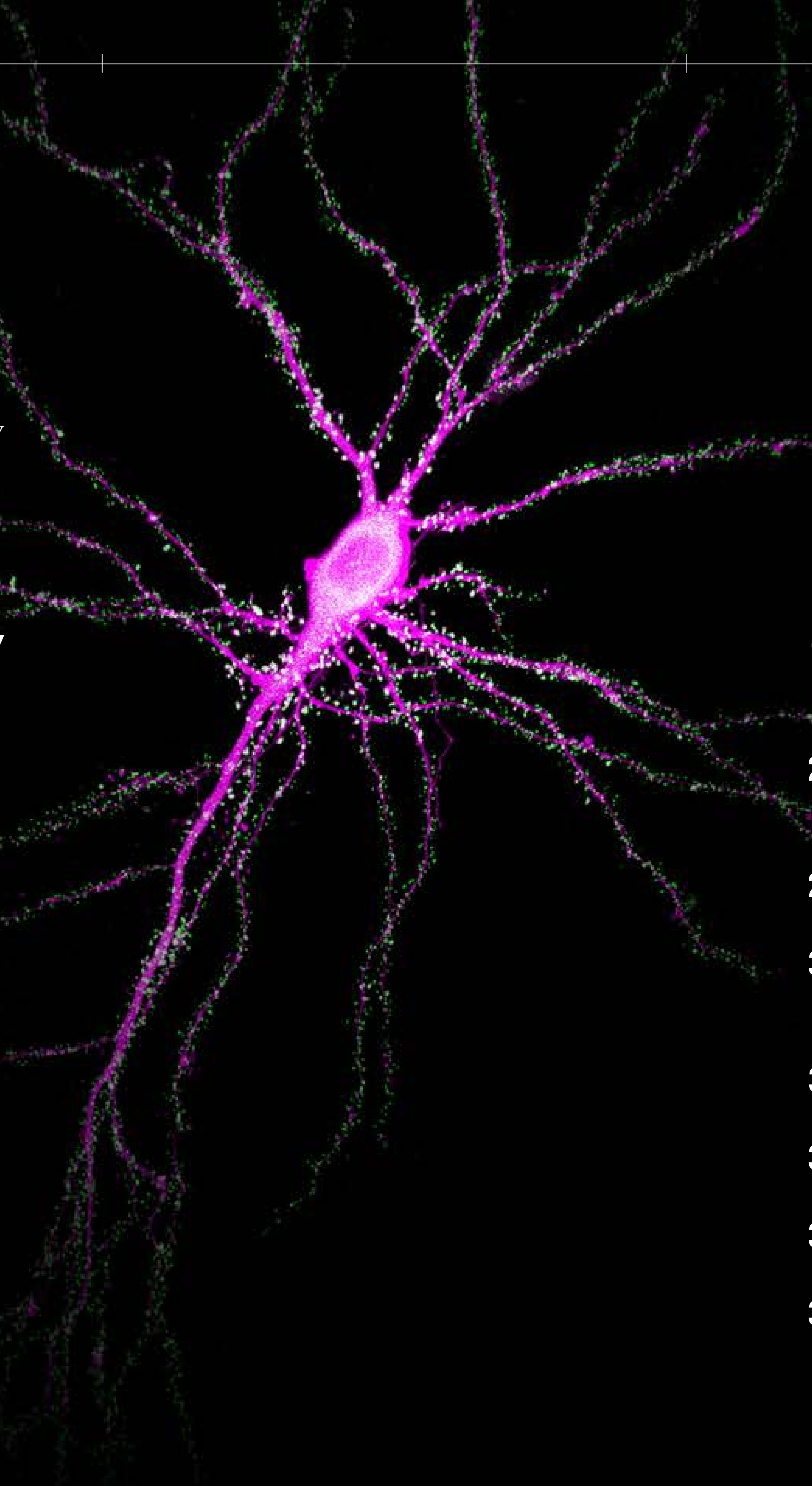
BERNICE GRAFSTEIN, Vincent and Brooke Astor Distinguished Professor in Neuroscience, Weill Cornell Medical College, SfN president 1985–1986 and sponsor of the Bernice Grafstein Award for Outstanding Accomplishments in Mentoring

"Since joining the Society for Neuroscience at its inception I have had the opportunity to serve in a number of elected positions — as a member of various committees, as treasurer, and as the first woman to become president. These have brought me a great deal of satisfaction in supporting the important role of SfN in shepherding the field of neuroscience. My sponsorship of an award for mentorship of women in neuroscience has been of special significance to me because it represents both my continuing commitment to the growth of SfN and my determination to support young women entering our field."

2020 Bernice Grafstein Award for Outstanding Accomplishment in Mentoring

CARMEN S. MALDONADO-VLAAR, University of Puerto Rico

BARBARA SHINN-CUNNINGHAM, Carnegie Mellon University



SfN MISSION

ADVANCING SCIENTIFIC EXCHANGE

Advance the understanding of the brain and the nervous system by bringing together scientists of diverse backgrounds, by facilitating the integration of research directed at all levels of biological organization, and by encouraging translational research and the application of new scientific knowledge to develop improved disease treatments and cures.

SUPPORTING THE NEUROSCIENCE COMMUNITY

Provide professional development activities, information, and educational resources for neuroscientists at all stages of their careers, including undergraduates, graduates, and postdoctoral fellows, and increase participation of scientists from a diversity of cultural and ethnic backgrounds.

EDUCATING AND ENGAGING THE PUBLIC

Promote public information and general education about the nature of scientific discovery and the results and implications of the latest neuroscience research. Support active and continuing discussions on ethical issues relating to the conduct and outcomes of neuroscience research.

ADVOCATING FOR THE FIELD

Inform legislators and other policymakers about new scientific knowledge and recent developments in neuroscience research and their implications for public policy, societal benefit, and continued scientific progress.

TABLE OF CONTENTS

Science in Progress

These articles explore the potential of neuroscience research and its impact on the world around us.

Message From the President

We have weathered a turbulent year. The COVID-19 pandemic, the renewed spotlight on racial injustice – these world-shaking events have revealed many of our longstanding assumptions as fragile and the status quo as unacceptable. Alongside each of us as individuals, the Society for Neuroscience (SfN) has taken time to reflect on these revelations and decide how to do things differently.

BARRY EVERITT, SfN president

This Annual Report serves to summarize how our Society acted to support the neuroscience community in this challenging time.

The cancellation of Neuroscience 2020, what was to be SfN's 50th annual meeting, was a significant loss to all of us who so enjoy gathering to exchange science and stories with one another. Yet, SfN adapted to the limitations on gatherings imposed by the pandemic to create its first neuroscience-spanning virtual meeting. SfN Global Connectome: A Virtual Event brought together our worldwide community in January 2021 and acted as a testing ground to inform what future virtual events may look like. The Connectome experience made it feasible to offer the recently announced entirely virtual Neuroscience 2021 to share neuroscience with our peers.

As the world reacted to the murder of George Floyd, SfN shared its reaction via a powerful statement reaffirming its commitment to diversity, equity, and inclusion (DEI). The Society then organized a webinar titled "Black Lives Matter: Why This Moment Matters," which became the most widely viewed SfN webinar ever. SfN's commitment to DEI is longstanding, as demonstrated by its 40-year support of the Neuroscience Scholars Program.

With most of us facing significant limitations on lab access during the pandemic, the need for scientific content accessible online soared. In response, SfN offered numerous webinars and a limited-series podcast addressing scientific rigor. SfN's two journals, *JNeurosci* and *eNeuro*, lowered barriers facing authors and reviewers by extending deadlines and eliminating submission fees, while celebrating *JNeurosci's* 40th anniversary and *eNeuro's* first impact factor. *BrainFacts.org* covered the rapidly evolving science surrounding COVID-19's impact on the brain and nervous system for a public anxious to learn more about the dangerous disease.

Advocacy efforts were particularly important this year as policymakers needed to be informed of the challenges facing neuroscientists with limited access to their labs. SfN organized its first virtual Hill Day, where participants shared the hurdles they faced and the funding needs of the community.

As we begin to emerge from the pandemic, the world around us has changed. So has SfN. I suspect the changes wrought this year will do much to make SfN accessible to a larger share of the neuroscience community than ever before. And I look forward to taking further steps toward a strong, diverse, and resilient Society.

"SfN Global Connectome: A Virtual Event brought together our worldwide community in January 2021 and acted as a testing ground to inform what future virtual events may look like."

SfN Journals Thrive Amidst Unprecedented Challenges

The COVID-19 pandemic interrupted the normal pace of science. Researchers lost access to their labs, abruptly halted data collection, and adjusted their personal and professional priorities. *JNeurosci* and *eNeuro* addressed these changing needs with flexibility and new initiatives, resulting in increased author engagement.

Celebrating 40 Years of *JNeurosci*

In 2021, *JNeurosci* celebrates its 40th anniversary with a special collection. Throughout the year, authors from the journal's first issues are publishing reflections on their 1981 papers and how neuroscience has evolved in the years since. A photo essay chronicles the evolution of neuron cytoskeleton research through microscopy images and *JNeurosci* covers.

Beyond the Table of Contents

This year, the journals piloted new methods for sharing research with the public and encouraging scientific discussion. These efforts include:

- A press conference at the Global Connectome, featuring newsworthy papers and moderated by *JNeurosci* Editor-in-Chief Marina Picciotto
- Commentaries on philosophical issues in science — such as experimental bias, neuroscience vocabularies, and giant collaborative projects — led by *eNeuro* Editor-in-Chief Christophe Bernard
- A webinar on estimation statistics, moderated by Bernard

Continuing a longstanding tradition, SfN published the 11th volume of *The History of Neuroscience in Autobiography*. Edited by Tom Albright and Larry R. Squire, the new volume offers 12 autobiographical chapters from eminent senior neuroscientists.

Meeting the Needs of Authors

To address pandemic-based research challenges, the editorial boards extended deadlines for both authors and reviewers. In 2020, *JNeurosci* eliminated its submission fee; there is now no cost for submitting to either SfN journal.

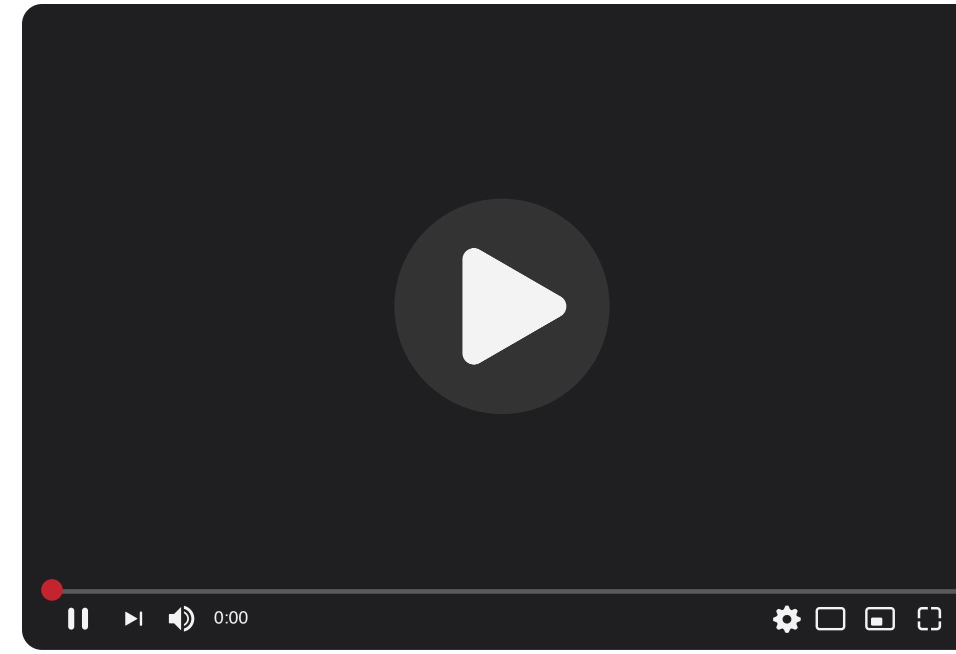
These efforts redoubled authors' engagement with the journals: readership and submissions increased in both journals in 2020. *JNeurosci* maintained its rank as the most cited journal in the neuroscience category while improving its impact factor from 5.674 to 6.167. The eNeuro website reached a record 500,000 website visits; the journal also improved upon its first impact factor – 3.544 in 2019 – to 4.081 in 2020. Both journals have strong citation half-life scores, the median age of cited articles, with *JNeurosci* at 11 and *eNeuro* at three.

Promotion efforts continue to grow in success. The SfN Journals Twitter account reached a record 11,000 followers. Papers shared with the press earn high Altmetric scores, an indicator of how much attention a paper is receiving, and frequently appear in news outlets like *The New York Times*, Science News, NPR, and *The Guardian*.

4.081
***eNeuro* IMPACT FACTOR**

11,000
FOLLOWERS

$0
SUBMISSION FEE



"The Journal of Neuroscience, launched by the Society for Neuroscience 40 years ago, has been a major influence in the field since its inception… [it] has been, and remains, a powerful engine driving innovation and advancement in our field."

THOMAS J. CAREW, professor, New York University

SCIENCE *In Progress*

Primate Research Labs: The Other Frontline of the Pandemic

Grocery stores and hospitals transformed when the pandemic hit — as did the labs researching COVID-19.

Lab technician Alexandria Scott cuts brain slices so they can be examined under the microscope. These sections will be stained with antibodies to reveal the effects of COVID-19 on the brain.

When the COVID-19 pandemic hit the United States, organizations and businesses on the front lines transformed almost overnight. Government officials set up testing sites in parking lots. Grocery store employees erected plastic barriers and plastered the floor with tape to mark out six feet of social distance in aisles. Hospitals shuffled beds and supplies to create COVID-19 wards.

Another group of workers weathered the front line of the pandemic out of public sight: scientists at primate research centers. The United States houses 22,000 monkeys across a network of seven National Primate Research Centers. As the pandemic swept across the country, the primate research centers dropped everything to begin researching the coronavirus.

John Morrison, professor of neurology at the University of California Davis School of Medicine and director of the California National Primate Research Center, runs a lab studying monkey models of Alzheimer's disease and HIV-associated neurocognitive disorder. In the first week of March 2020, Morrison's lab had just begun new projects when he received some startling news about the coronavirus. "I was listening to our infectious disease specialists, and they were saying, 'This is not going away. This is going to be a full-blown pandemic,'" Morrison says.

Bring in the Monkeys

He had four priorities to address immediately: protect his staff, protect the monkey colony, slow down ongoing research, and begin COVID-19 research. "NIH came to us very early and said they were going to make [grant] supplements available, and they wanted us to develop a rhesus monkey model."

A robust monkey model is a critical first step for understanding what the coronavirus does to its host and how. "Monkeys tend to react to these viruses in a manner very similar to humans," Morrison says. "That's not true of other animal models." Studying the monkey model of COVID-19 would allow scientists to understand how the virus works, which body systems it affects, and how it impacts different age groups. Plus, monkey models receive the first round of tests for treatments and vaccines, which makes it safe for human clinical trials to begin.

A rhesus monkey

But setting up this type of research is difficult. Working with airborne microbes like the coronavirus requires Biosafety Level 3 (BSL-3) conditions in the lab, a high level of containment and safety. "Everything's harder, and everything takes longer in a BSL-3 facility," Morrison says. The research staff completed extensive training and wore cumbersome protective equipment. The monkeys involved in experiments had to be housed in their own secure enclosure to protect the rest of the colony from infection. Staff also tested the colony for COVID-19 each week — not an easy task when you have a colony of 4,200 monkeys.

Each study entailed tracking the monkeys' symptoms for 7 to 14 days as the virus ran its course — which is not as simple as it sounds. "You have to monitor the monkeys essentially 24 hours a day," Morrison says, and the center was operating with only 50% of its staff. "So, a given study goes fairly quickly, but there's so much involved in each study in terms of all the endpoints that you want to measure." This includes things like the viral load — a measurement of the intensity of infection — and biomarkers in plasma and cerebral spinal fluid.

The Trade-Off

This level of intensity and speed does not come without a cost. To accommodate the COVID-19 studies, the center slowed down and postponed other studies — sometimes for an entire year. The Alzheimer's disease research pushed to the back burner still mattered, but Morrison's lab made some tough decisions. "Of course, we had to put COVID at a high priority, but is COVID ever really a higher priority than Alzheimer's disease?" Morrison says. "That's a tough question to answer."

Deliberations over which studies to delay or minimize took place in tandem with the start of the COVID-19 studies. "The labor force is being drawn in many different directions, and some of them are getting sick [with COVID-19]," Morrison says. "Almost on a daily level, we had to review everything that was going on and determine what could continue, what couldn't, what could be started, and what shouldn't be started."

The round-the-clock work and immense pressure weighed on Morrison's staff. "They had these demands at work and these demands at home, and it was often very difficult to satisfy both sets of demands," Morrison says. For postdoctoral researcher Danielle Beckman, the COVID-19 research posed a heightened risk. "I have an autoimmune disease and take medication that suppresses my immune system," Beckman says. Every time she went into the lab, she worried about catching the virus.

The research also took an emotional toll. Outside of work, Beckman kept tabs on the pandemic in the U.S. and in Brazil, where her family lives. "I couldn't see my family, but [when you come into lab] you have to concentrate and have the mindset to do your research," she says. This became increasingly difficult when her research echoed her life. "In the beginning, I was feeling a little uncomfortable because, unfortunately, my grandma in Brazil passed away from a stroke [related to COVID-19 infection]," Beckman says. "I was looking and seeing the same [effects] in my monkeys' brains … It was very intense, a lot of emotions."

But the center carried on. Lab members continued their original research, developed the COVID-19 monkey model, tested therapeutics, and ensured the virus did not spread among the colony. They even managed to publish a paper on an Alzheimer's disease monkey model — one of the studies they were forced to slow down. "There was an incredibly strong sense of teamwork and incredibly strong sense that we're doing something — it's hard, what we're trying to do, but we're in there," Morrison says. "We're in the fight; we're helping."

Waiting in the Wings

And the fight continues: after six months of studies, Morrison and his team have an abundance of data to analyze, including 50 monkey brains. The data should reveal more about how COVID-19 impacts the brain. "[Now] there's a new line of research in my lab, which is the interface between infectious disease and neuroscience, centered right now on COVID," Morrison says. "We'll continue that area of research because I think it's going to become one of the most important areas of neuroscience."

After examining brains infected with COVID-19, Beckman decided to pivot her career in this new direction. "I'm so shocked with how viruses are getting into the brain and doing so much damage," she says. "I learned during my PhD that the brain is immunoprivileged; viruses don't reach the brain that much. And when they do reach it, there's a lot of support from the immune cells. But this is not what we are seeing."

Even once the COVID-19 pandemic ends, the work is far from over. The difficulties of the past year illuminated what science needs to do to remain agile and flexible, ready to address public health needs as they arise. "There's a lot of interest, both from the primate centers and from NIH, in making sure we're ready for the next pandemic so we can initiate the nonhuman primate work immediately," Morrison says. "Because there will be another one, there's no question about that. It's just a matter of when and how severe." And when the next pandemic does happen, Morrison remains confident the nation's primate research centers will be ready to do their part to help defeat it.

Postdoctoral scholar Giovanne Diniz cuts brain sections and prepares tissue for examination.

A Source of Stability

With the simultaneous impacts of the pandemic and renewed awareness of racial injustice, neuroscientists faced unprecedented disruption to their personal and professional lives. Serving its mission to strengthen the community, SfN adapted its programming to help its members weather — and even thrive — in these turbulent times.

A Longstanding Voice for Diversity

When George Floyd, a Black American man, died under the knee of police, the world responded to the recorded event with calls to dismantle systemic racism. SfN responded quickly, organizing a webinar titled "Black Lives Matter: Why This Moment Matters." Featuring Black neuroscientists across the career spectrum, the panelists spoke about challenges they and other underrepresented researchers have faced within the field and how viewers could leverage the moment for change. The webinar drew more than 3,800 viewers, setting the attendance record for an SfN webinar and clearly illustrating the desire for such conversations. A follow-up live chat titled "Black Lives Matter and Neuroscience: Continuing the Conversation" enabled the audience to ask their questions to the same panelists.

While acknowledging a need to do more, SfN has long been committed to increasing the participation of scientists from diverse backgrounds in neuroscience. The Neuroscience Scholars Program (NSP) is a signature example of this commitment. Celebrating its 40th anniversary in 2021, NSP is now a two-year online training program, funded by NIH, open to underrepresented graduate students and postdoctoral researchers. The program provides NSP Fellows resources to attend the SfN annual meetings, a mentor, and numerous opportunities to connect with other underrepresented neuroscientists.

As part of its anniversary celebrations, NSP hosted an "Enhancing Neuroscientific Discovery Through Diverse Communities" virtual conference to bring together NSP Scholars and alumni. Virtual social hours and more frequent meetings between NSP Fellows and their mentors helped to keep the community connected during the pandemic-induced lockdown.

Connecting the Community Virtually

In the absence of Neuroscience 2020, SfN Global Connectome: A Virtual Event allowed the neuroscience community to gather safely for scientific exchange during the pandemic. As a brand new, digital-only event, Connectome provided an opportunity to rethink the structure and format of an SfN meeting. Highlights included:

- New session types, including "Neuroscience in Society," with a focus on engagement between speakers and the virtual audience
- Plenary sessions featuring an established neuroscientist followed by a conversation between the presenter and two up-and-coming neuroscientists
- A new sponsorship model for organizations
- The most diverse speaker list of any SfN meeting to date
- More than 300 Trainee Professional Development Awards (TPDAs), which covered the Connectome registration fee for awardees and offered access to professional development opportunities year round

Judging by the strong attendance (see graphic) and positive feedback from participants, Connectome helped meet the need of the community to share their science while teaching SfN volunteers and staff valuable lessons on hosting a large virtual event.

A new virtual Awards Announcement Week (AAW) allowed SfN to recognize its award and prize winners in the absence of an annual meeting. During a four-day span, SfN honored 16 awards with videos narrated by SfN President Barry Everitt and significant promotion across SfN's communication channels.

Expanding Online Resources

SfN offered a wide range of online resources to support the community while many had limited access to their labs. One of the first steps taken after the pandemic began was to provide trainees at Institutional Program departments unlimited access to

HIGHLIGHTS FROM SfN GLOBAL CONNECTOME: A VIRTUAL EVENT

5,293
Attendees from 50 countries

27
Sessions featuring 91 speakers

2,405
digital poster presentations

130
Exhibitors

128
Graduate School and Career Fair exhibitors

67
Attendee-organized socials

content on Neuronline, SfN's home for learning and discussion. SfN organized webinars on important topics, including "Navigating the Neuroscience Job Market during COVID-19 and Beyond" and "Breaking the Stigma – Neuroscientists Prioritizing Our Own Mental Health as a Community."

In early 2021, SfN launched a limited-series podcast as part of its Foundations of Rigorous Neuroscience Research (FRN) program. Supported by a grant from the National Institute for Neurological Disorders and Stroke (NINDS), "Pathways to Enhance Rigor: A Collection of Conversations" features neuroscientists discussing ways to better embed rigor into every part of the scientific process.

Online resources grew to include a variety of collections and speaker lists. For example, the Learning Initiative in Neuroscience collection gathers all Neuronline content on specific scientific research topics like microscopy and optogenetics. And to help identify researchers from diverse backgrounds for programming purposes, SfN curated a diverse speakers list linking to numerous external organizations.

2020 Peter and Patricia Gruber International Research Award

VIDYA RANGARAJU,
Max Planck Florida Institute for Neuroscience

HIDEHIKO INAGAKI,
Max Planck Florida Institute for Neuroscience

> "Everyone in neuroscience knows about the TPDAs through SfN and that they're difficult to get. They're very competitive. If you receive one, there's some understanding that you've worked hard to get to that point."

JENN HONEYCUTT, assistant professor, Bowdoin College

PANELISTS DURING SfN'S "BLACK LIVES MATTER: WHY THIS MOMENT MATTERS" WEBINAR

3,832

Unique attendees to the "Black Lives Matter: Why This Moment Matters" webinar, the highest attendance of any SfN webinar ever

NII ADDY,
associate professor of Psychiatry & of Cellular & Molecular Physiology, Yale School of Medicine

JOANNE BERGER-SWEENEY,
president, Trinity Collegee

MARGUERITE MATTHEWS,
scientific program manager, National Institute of Neurological Disorders and Stroke (NINDS)

FITZROY WICKHAM,
Wesleyan University

SCIENCE *In Progress*

Children May Experience 'Social Cravings' From Prolonged Isolation

The phrase 'starved for attention' takes on real meaning for children experiencing the loneliness social distancing presents.

At the end of March 2020, the U.K's COVID-19 lockdown had just begun. Max, age nine, and his father sat in the dining room of their home in a small town in southern England. Movement outside the window caught their attention. Someone was walking past the house, down the street. Immediately they rushed out the door to talk to the passerby — from a distance.

"Whether they knew the person or not, they were leaping out of the front door to have contact with a human being," says Judy Claughton, Max's mother, a communications consultant and meditation teacher. "You could see hunger in their eyes to speak to someone — they need human contact."

Loneliness drives that hunger. Like Max, other children have grown especially lonely during quarantine. There's much scientists still need to learn about loneliness, the brain, and mental health, but they know that youth need socialization for healthy development. Loneliness is also associated with clinical depression and anxiety, even months later. Although the long-term effects of the COVID-19 pandemic are unknown, experts have urged clinicians should prepare to confront the mental health consequences of children who are separated from friends and family they had bonds with outside of their household.

> "'Whether they knew the person or not, they were leaping out of the front door to have contact with a human being,' says Judy Claughton, Max's mother, a communications consultant and meditation teacher."

Distinct from solitude, loneliness describes a distressful emotion and desire for human connection. COVID-19 lockdowns have, for some, become an incubator for this feeling. "We know that children, young people particularly, are vulnerable to developing mental health problems," says Maria Loades, a senior lecturer of psychology at the University of Bath. Given that lockdowns have prevented youth from seeing their friends, "We know that they're likely to get lonelier. That's bad for mental health." But it's not clear if loneliness can cause mental health problems, or vice versa.

Studies of social isolation in animals and loneliness in humans offer clues to how this social distress affects the brain and behavior. Midbrain structures, evolutionarily old areas situated above the brainstem — in both animals and people — seem important in this domain. When it comes to behavior, according to Mental Health America, lonely children might create imaginary friends, misbehave or act silly for attention, cling to their caregivers, or start acting unsure of themselves. Teenagers might start talking to caregivers more than usual, appear sad, retreat to their rooms, or criticize themselves.

"Dopamine-containing midbrain regions are heavily implicated in motivation, in social behavior, in feeding behavior — doing the things we need to do to survive," says Gillian Matthews, a research scientist at the Salk Institute.

Young and adolescent rodents, social creatures who, like human youth, seek the company of their peers', can experience stress after just one day of social isolation. Rodents come out of these brief isolation periods hyperactive and anxious.

In experiments separating rodents from peers during adolescence, brain development takes a different route. Prolonged social deprivation triggers release of more dopamine in reward-related midbrain structures, but less dopamine in the prefrontal cortex. Scientists think that increased release may, in the short term, motivate animals to seek out companions. It also makes them more sensitive to rewards, even after they're reintroduced to peers. The overall dysregulation of dopamine might change how rodents process important stimuli. These rodents also become anxious, hyperactive, and more aggressive, with impairments to learning and attention skills.

"Schlosser and Tomova also suggest video chatting and using social media to stay in touch with friends might help mitigate the effects of loneliness for some children and teens."

In children, surveys suggest loneliness often co-occurs with depression and anxiety. And, as with rodents, socializing is key to development. "For children, playing with other people is a way they learn about the world. For teenagers, it's the way they transition to being independent," says Loades.

So far, few human studies investigate the mechanisms behind this need. Recently, Livia Tomova, postdoctoral researcher at the Massachusetts Institute of Technology, and her team conducted an experiment doing just that. In their study, 40 people each spent 10 hours confined to a room with no social contact. Another day, they fasted for 10 hours. After each 10-hour period, participants had their brains scanned while viewing images meant to cue cravings for social contact or food.

Functional MRI scans revealed that for both conditions, the substantia nigra, a midbrain structure, became active. The published results suggest that loneliness and hunger share brain space. "Almost all of the neurons within that brain region are dopaminergic and fire strongly whenever we want something," says Tomova.

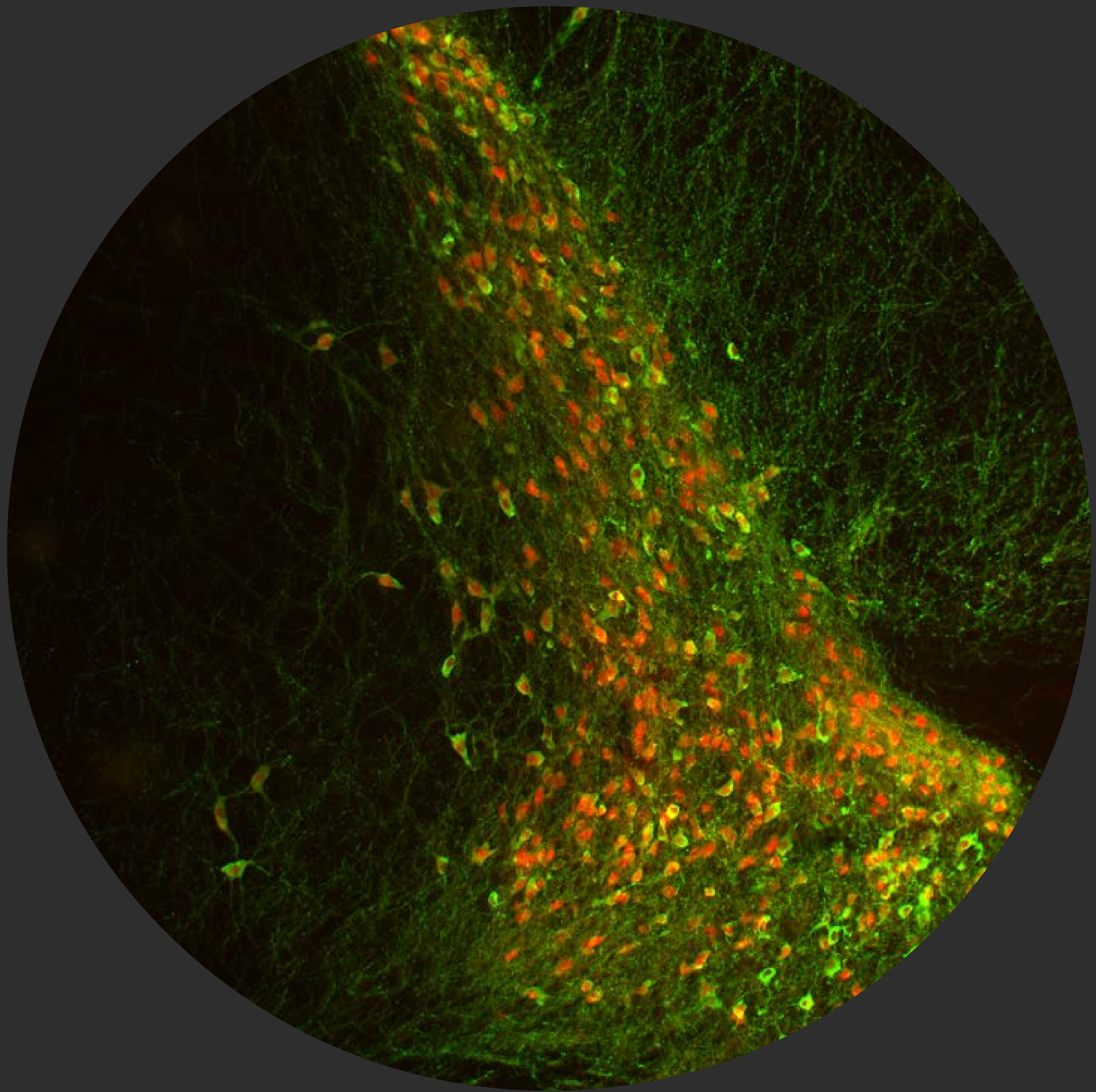
These results support similar findings from observational studies. A 2013 study from Rutgers University found hunger-related midbrain structures overlap with structures activated when one reports loneliness and views cues meant to elicit a "social craving."

For some children, lockdowns make it harder to satiate that craving. Loades and a fellow psychologist realized that the lockdown conditions are, in her words, "a perfect melting pot for creating mental health problems."

Child and family therapist Dahyana Schlosser noticed an uptick in clients reporting loneliness. "It's something coming up in almost every session," she says. While the children who typically have trouble with peers have been doing well with this break from school, Schlosser has seen that children who are more socially connected felt much lonelier than usual.

Though it is imperative for children to maintain safe social-distancing and mask-wearing protocols, there are ways to help them cope. Schlosser says caregivers should listen to children's feelings and talk them through coping strategies. "Now is prime time to be teaching these skills, how to overcome loneliness," says Schlosser. Schlosser and Tomova also suggest video chatting and using social media to stay in touch with friends might help mitigate the effects of loneliness for some children and teens. It's still unclear which types of social media usage might best support the social lives of young people, but Tomova is looking into that question.

Claughton is trying some coping strategies with her own son, encouraging him to come on socially-distanced walks with friends and engage in virtual activities. "I catch glimpses of the old Max," she says. During a recent virtual Cub Scouts session, a magician performed for the children. Claughton saw the old Max make a reappearance, saying she'd never seen him so engaged with anything online. "It was amazing [to see]."



This image shows tyrosine hydroxylase-immunoreactive neurons (green) in substantia nigra pars compacta. These neurons coexpress the dopamine transporter (red). In contrast, less than half of tyrosine-hydroxylase-expressing neurons in the hypothalamus expressed dopamine transporter, and those that don't are required for the autoregulation of growth hormone secretion.

Reaching a Distanced Public With Online Experiences

Social distancing resulted in the suspension or scale down of many in-person engagement opportunities with the public. At the same time, demand for virtual learning resources soared. SfN ensured free online access to educational neuroscience content via *BrainFacts.org*.

Individual and Organizational Partnerships

Guided by a volunteer editorial board of prominent neuroscientists from around the world, *BrainFacts.org* helps the science-interested public engage with neuroscience. Leading the board is Editor-in-Chief Richard Wingate and Associate Editor Charles Yokoyama, both of whom agreed to extend their service through the end of 2023. In 2020, BJ Casey and Robert Knight joined the board as new members, offering their considerable experience in education and outreach in support of *BrainFacts.org's* mission.

As a public information initiative, *BrainFacts.org* would not be possible if not for the generous support of its funders. The Kavli Foundation, the Gatsby Charitable Foundation, and SfN comprise the founding partners of the initiative, having started their support in 2012. This year, the Dana Foundation became a new supporting partner, joining The Lundbeck Foundation – The Brain Prize.

Supporting Online Learning

BrainFacts.org's audience grew as individuals and classrooms spent more time online during the COVID-induced global lockdown. Significant site traffic originated from platforms like Google Classroom and Project Lead the Way, suggesting teachers were finding value in the website's content. *BrainFacts.org* offers a special "For Educators" section dedicated to offering interactive neuroscience tools and resources appropriate for teachers and families.

The top 10 most popular stories on *BrainFacts.org* reflected a wide range of interests, including stories on aging, touch, taste, and smell. COVID-related stories were also popular, and *BrainFacts.org* kept up with the rapidly evolving science. In a regularly-updated article, neurological consequences of COVID-19 such as stroke and loss of smell were laid out in an approachable manner.

Reimagining Outreach Online

With large, in-person outreach events curtailed, SfN members and staff stepped up to produce additional online opportunities to engage. A collaboration with NWNoggin produced a webinar showing how to create neuroscience art with materials found around the home. A second webinar cosponsored with the American Brain Coalition shared ideas for neuroscientists to connect with the public about brain science. SfN also hosted a virtual booth at the 2020 USA Science and Engineering Festival.

The annual Brain Awareness Video Contest, which encourages the public to submit videos exploring the wonders of the brain and nervous system, enjoyed another year of excellent submissions. The 2020 winner as selected by SfN judges, and the People's Choice as selected by the video submission with the most likes on YouTube, was titled "How Do We Move Around the World?"

"To see children's faces light up while a grad student describes their research… a grad student who often looks like them, is inspiring."

BILL GRIESAR, senior instructor, Portland State University

BrainFacts.org

A PUBLIC INFORMATION INITIATIVE OF: The Kavli Foundation, Gatsby, SfN Society for Neuroscience, The Dana Foundation

Google classroom referral traffic increased

113%

from 2019 to 2020

Nearpod referral traffic increased

787%

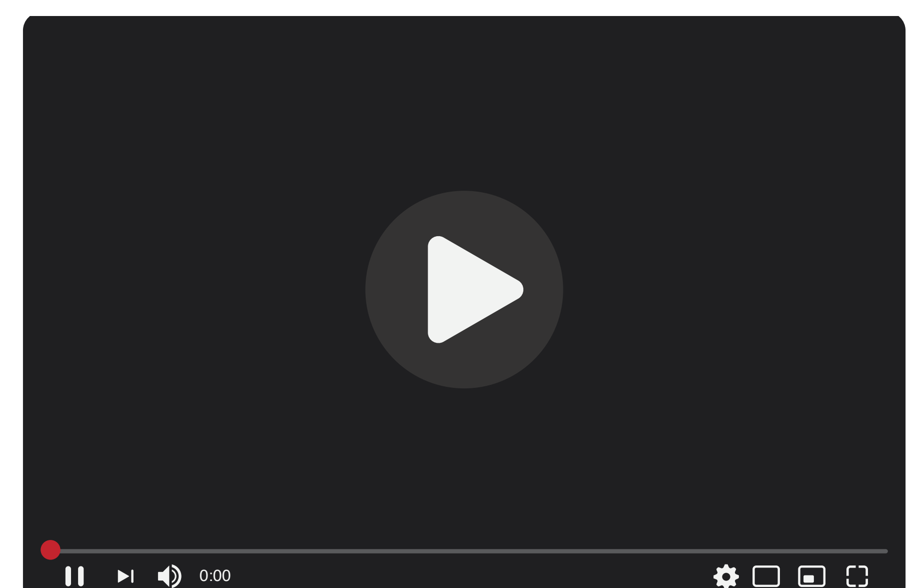
from 2019 to 2020

Facebook: **44,058** Followers

Twitter: **41,865** Followers

Instagram: **6,808** Followers

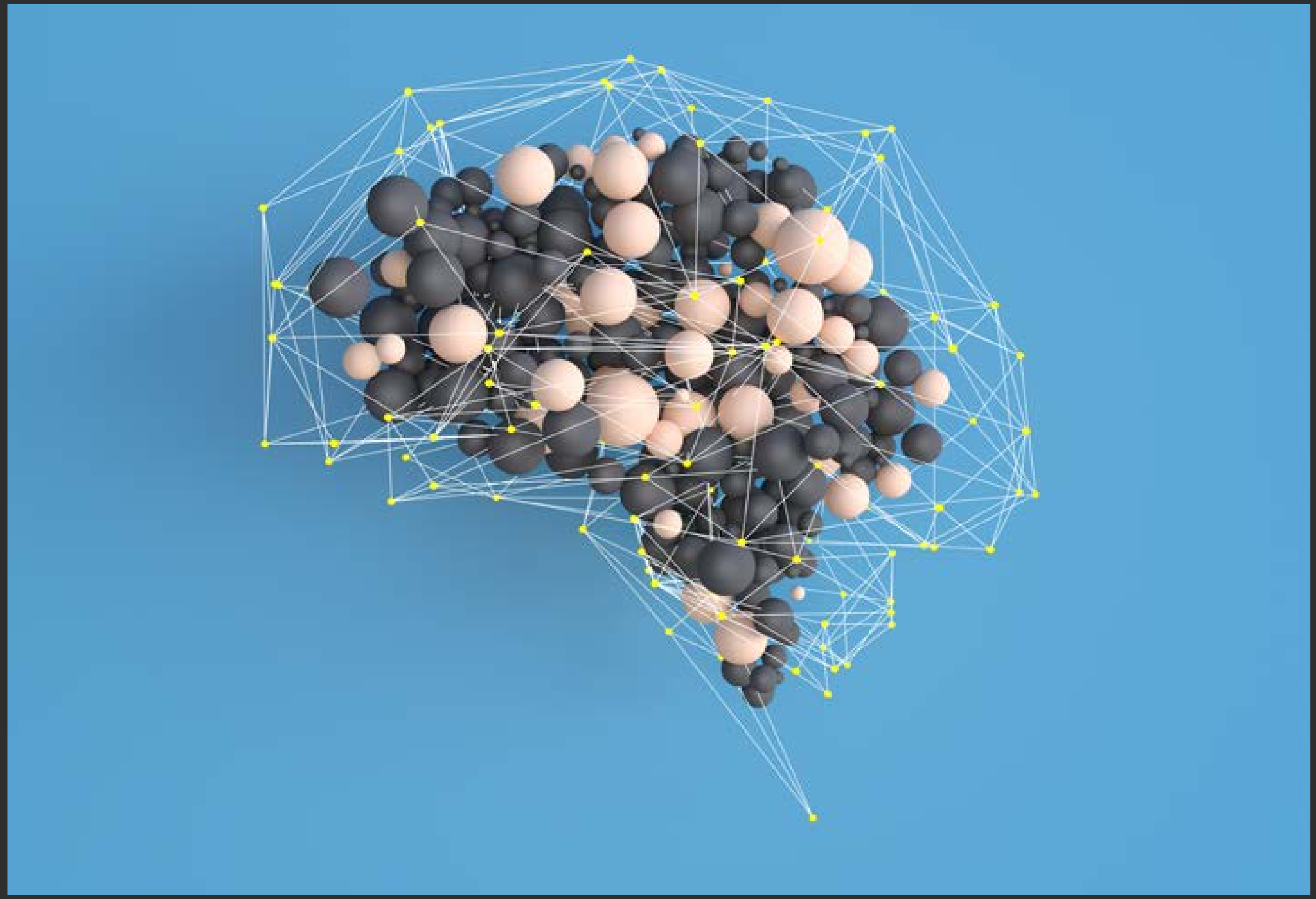
YouTube: **41,865** Followers



SCIENCE *In Progress*

Creating Personalized Prescriptions for Transcranial Brain Stimulation

Researchers are working against the one-size-fits-all model for brain stimulation dosing with the help of AI.



Two millennia ago, the Roman physician Scribonius Largus placed bioelectric torpedo fish on the scalps of headache sufferers until the fish's static made them pain-free. Today, researchers are exploring transcranial direct current stimulation (tDCS), a noninvasive technique deploying battery-powered devices to transmit a painless, mild electrical current to treat a variety of conditions such as depression and schizophrenia.

The treatment is promising — one study showed tDCS increased recall of newly-learned words by 15%. But, it has one catch. Everyone has an anatomically unique head, and so a one-size-fits-all treatment protocol doesn't benefit everyone the same way. But artificial intelligence may solve that problem.

Adam Woods, associate director of the Center for Cognitive Aging and Memory at the University of Florida, runs the largest NIH-funded study on tDCS in the United States. His laboratory uses tDCS to slow the cognitive decline that comes naturally with age. When stimulating participants' brains, the researchers place electrodes on peoples' foreheads to target their frontal lobes, the brain region first to degenerate with age. Stimulation usually lasts around 20 minutes; for the sham (control) condition, participants receive 30 seconds of stimulation to mimic the sensation that something is happening — although it's not long enough to have a significant effect on the nervous system. The participants test their skills through brain games while they receive stimulation. Many do show fewer signs of cognitive decline — especially in episodic memory and attention — than those who receive sham stimulation. Others don't respond to the stimulation at all.

"In the realm of non-invasive brain stimulation, individual variability is a monstrous reality," Woods says. That's true for all treatments using electricity to penetrate the skull and rewire the brain without surgery. "You can do the exact same stimulation and this person responds, and this one doesn't."

That uniform methodology may underlie the problem. Woods and other scientists, including Hannah Filmer, a tDCS expert at the University of Queensland in Australia, suspect our unique brain anatomies dictate what is an effective dose of electricity and where on our scalps it is best placed. "We accept the fact there'll be a little bit of variation as to exactly where the area we're targeting is in that person," Filmer says. Using the same stimulation patterns for everyone could doom the procedure to failure in some — possibly many — individuals.

"When you're putting electrical current into the brain, there's a whole bunch of features that relate to your head and brain that are unique to you," Woods says. "The thickness of your skull, the amount of fatty tissue underneath the skin, the amount of cerebrospinal fluid in the brain from, let's say an aging atrophy process versus a young healthy brain, the unique folds of gyri and sulci of the brain. All these things are unique. They're like a fingerprint. They're unique person-to-person."

Filmer, Woods, and others monitor what's happening to the electrical current aimed at the brain with magnetic resonance imaging (MRI). "We scan them, and then run them through a tDCS study," Filmer says. "And what we do is we say 'Well, how much was that individual affected by stimulation? Are there any markers, any indicators as to who is going to respond particularly well, and who isn't going to respond particularly well?'"

By collecting a database of these markers and feeding them into artificial intelligence systems, Woods's team successfully predicted who would respond to tDCS 86% of the time in a small study of older adults. By defining individual parameters that result in an effective response, researchers seek to personalize tDCS administration to increase the benefit to each and every individual.

When targeting a brain region for stimulation, researchers and doctors typically match a predetermined template of the human head to the head of the participant. That map includes spots to place two or more electrodes. Matthew Krause, a research fellow at McGill University/Montréal Neurological Institute notes in the case of tDCS, current flows between the electrodes. The electrical current is carried through the scalp and skull and predominantly permeates the first few centimeters of the brain.

Exposing large areas of the brain to a single source of electricity makes them more likely to talk with each other.

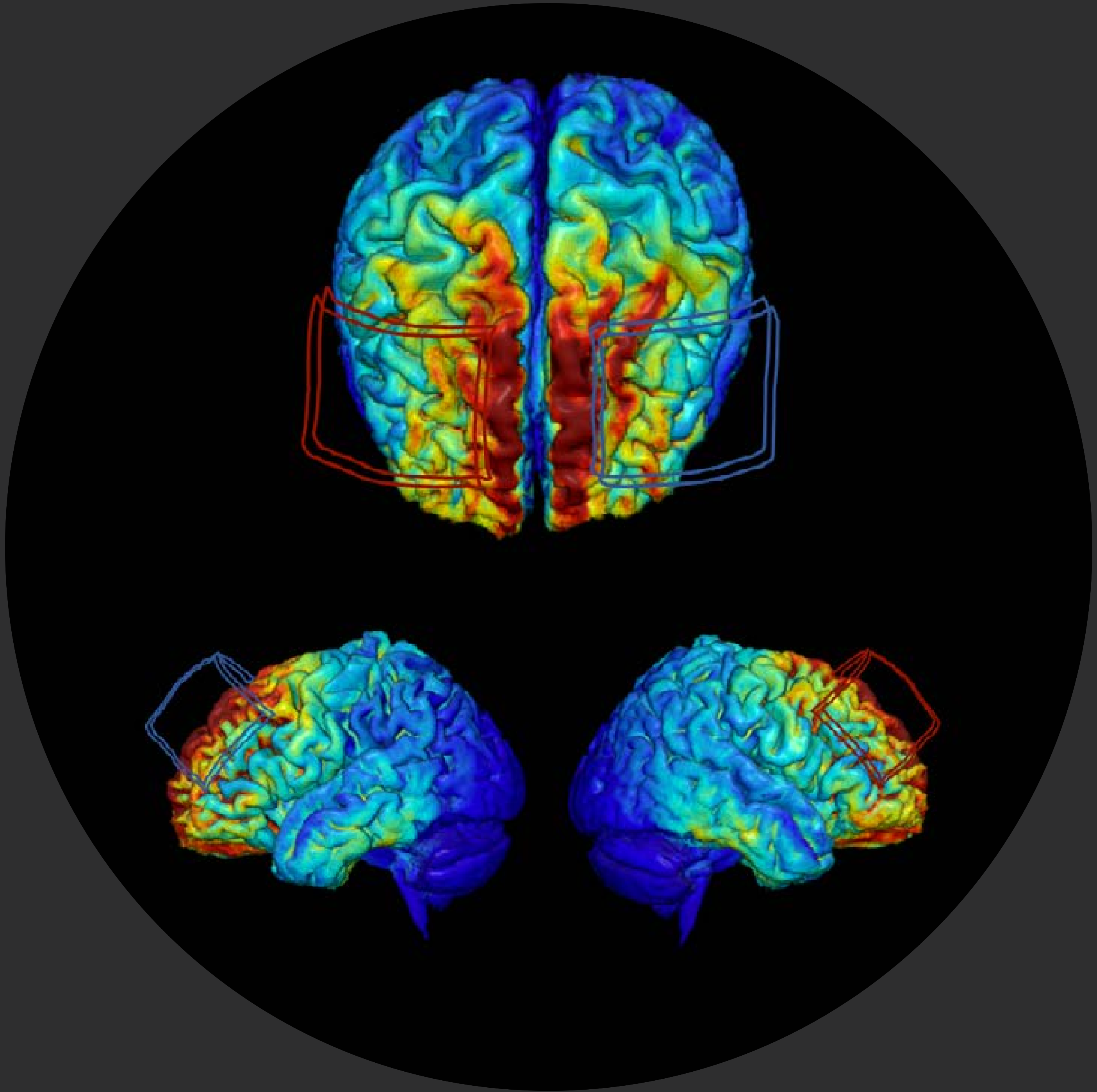
The nerve cells become receptive to signals from other nerve cells after the stimulation. The increased connectivity can induce a neuroplastic response, causing brain networks that have deteriorated with age, for example, to relearn how to work in synchronicity with healthy networks. With MRI scans of people's brains before and after tDCS trials, researchers are using machine learning techniques to discern each person's anatomical fingerprints and understand how a specific dose of electricity changes an individual's brain.

With data from every research participant, Woods and his team are training algorithms to analyze the data and identify specific features which predict whether any given person will respond to stimulation. By identifying common characteristics across the responders and non-responders, and by further identifying patterns in responders and non-responders, Woods can make more detailed, refined templates to develop a profile of an individual and know where to put the electrodes and how much current to use.

Woods and his collaborators are aiming for a "push-button" scenario where a patient walks in to get treated for a condition such as depression or age-related cognitive decline, receives a brain scan, and the clinician presses a button that outputs a stimulation prescription. The computer algorithm-derived prescription would dictate the exact dosage, duration, and location of stimulation specific for that person's unique skull, brain, and symptoms. Normally, it would take Woods' team months to give an individual such personalized attention, but if their approach is realized, with the support of neuroimaging and AI, these empowered prescriptions could be churned out the same day someone receives the MRI scan.

With an individualized approach, researchers and physicians could better understand how noninvasive brain stimulation might be used to prevent or slow cognitive decline, or positively change the course of Alzheimer's disease and other dementias. Woods notes, "As we start to dig into this technique and really start to understand mechanistically what's driving these differences, the better we can titrate this technique to impact more people in a positive direction."

"With an individualized approach, researchers and physicians could better understand how noninvasive brain stimulation might be used to prevent or slow cognitive decline, or positively change the course of Alzheimer's disease and other dementias."



An MRI-derived model of electric current flow in an individual's brain. Red and blue outlines represent the size and position of electrodes placed on the scalp to deliver transcranial direct current stimulation to the brain. Electrical current is injected at the location of the red outline and returned at the location of the blue outline during stimulation.

Taking Advocacy Online in Support of Neuroscience

With the massive disruption brought on by the COVID-19 pandemic, governments around the world responded to the crisis. Alongside its many NeuroAdvocates, SfN leveraged longstanding relationships with policymakers to ensure the needs of the neuroscience community were met.

NeuroAdvocates Engage Policymakers Digitally

NeuroAdvocates are the backbone supporting all SfN advocacy initiatives. This year, they engaged with policymakers in new online gatherings:

- Virtual Hill Day, where attendees educated policymakers about the neuroscience community and made requests via Zoom related to biomedical research funding and the use of animal research over three days
- Public Advocacy Forum, an SfN-organized Hill briefing discussing recent discoveries in neuroscience research related to addiction, post-traumatic stress disorder, and dementia

Despite the pandemic, SfN's NeuroAdvocates continued to grow in number and skill. SfN accepted twenty Early Career Policy Ambassadors (ECPAs) this year – twice the normal class size. SfN also concluded the NeuroAdvocate Challenge, a year-long engagement opportunity which tracked and scored advocacy challenges, and congratulated two winners.

Legislative Successes and Unmet Needs

Advocacy efforts by SfN and its many partners (see graphic) helped influence the size and scope of Congress' response to the pandemic. For fiscal year 2021, NIH received $42.9 billion. Within that top line number, $560 million is set aside for the BRAIN Initiative – the first time the initiative received more than $500 million in a year. NSF appropriations came in at $8.5 billion, and $815 million went to the Veterans Affairs Medical and Prosthetic Research program.

Of the several coronavirus relief bills that became law, two in March 2020 offered NIH a total of $1.6 billion to "prevent, prepare for, and respond to" the coronavirus. These funds could not be extended to grant holders. As such, SfN and the larger biomedical community spent much of pandemic working to build support for the Research Investment to Spark the Economy — RISE Act, a bill that would provide $25 billion to the nation's science-related agencies to mitigate the financial consequences of research interrupted by the pandemic.

Rapid Vaccines Through Animal Models

Highly effective COVID-19 vaccines were developed in less than a year – an impossible feat if not for the use of animal models in testing the vaccines' safety and efficacy. SfN continued to work with its partners to educate policymakers on the necessity of ethical and well-regulated use of animals in research. Opportunities to engage on the topic included Hill Day, in report language to Congress, and in the creation of an animals in research factsheet.

> "As a result of the training I received through ECPA, I've also done my own outreach. I've made my own meetings with members of Congress outside of the parameters of SFN Hill Day and made the push for certain types of science to be funded."

MICHAEL WELLS, postdoctoral fellow, Stanley Center for Psychiatric Research of the Broad Institute

VIRTUAL HILL DAY STATISTICS

3	11	80	115	31
Virtual Days	Meetings with Elected Officials	Attendees from Three Countries	Office Visits	States Represented

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FENS · Research!America · NABR National Association for Biomedical Research · CLS Coalition for the Life Sciences · CNSF Coalition for National Science Funding · Discovering Knowledge Conquering Disease · IBRO International Brain Research Organization · CAN-ACN · American Brain Coalition · Coalition for Health Funding · AAMC · SfN CDMX

Financial and Organizational Highlights: Evolving in the Wake of a Canceled Annual Meeting

Facing an unprecedented and unpredictable financial future from the cancellation of Neuroscience 2020, SfN entered FY 2021 in a position to make a number of difficult decisions to ensure the short- and long-term viability of the Society.

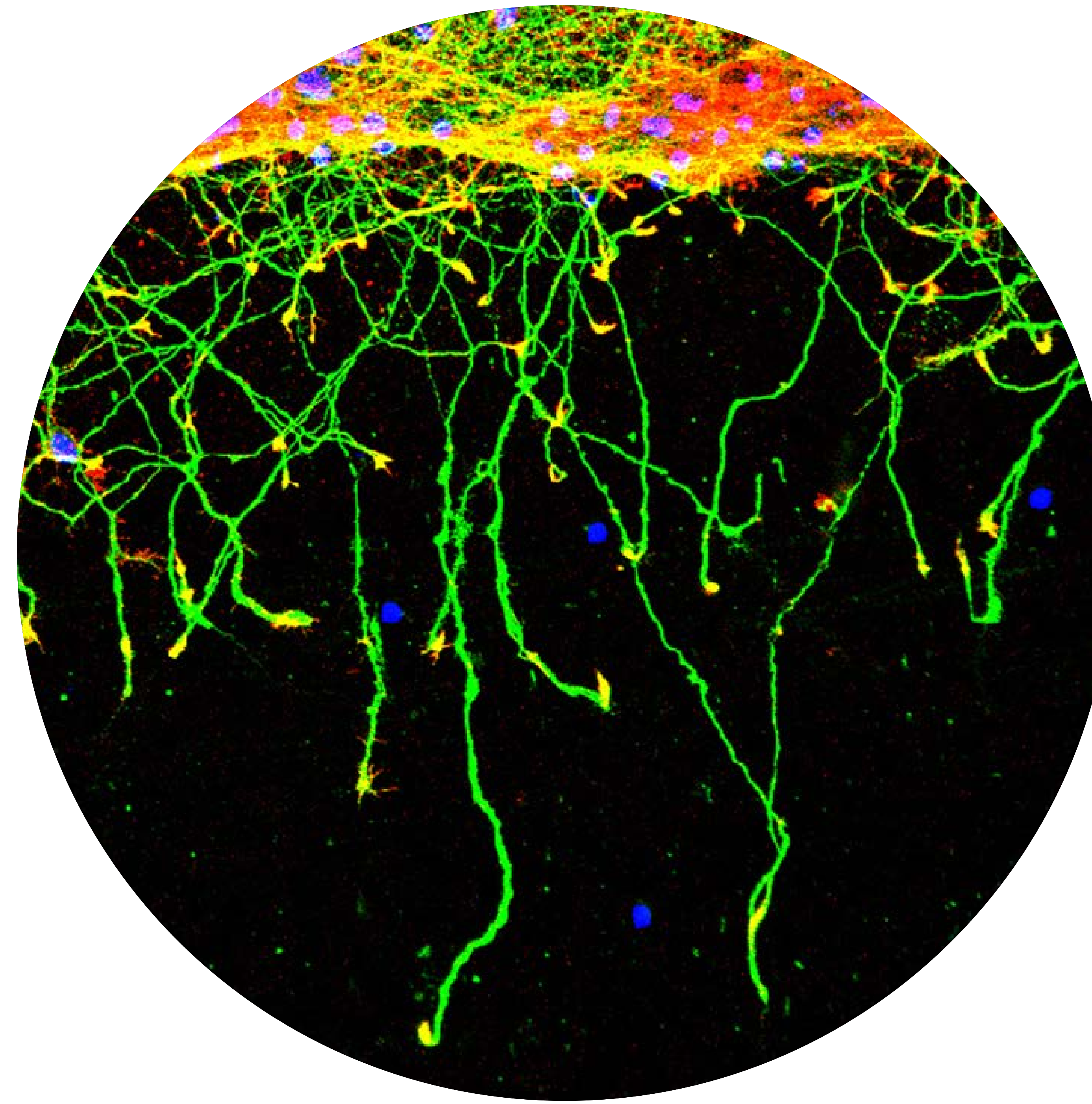
The loss of Neuroscience 2020 contributed to a $15 million revenue decrease in FY 2021. Even though canceling the meeting due to a pandemic was a covered event under SfN's insurance policy, SfN does not know when or under what terms and exceptions it would receive payment from an insurance claim.

To cover the gap in revenue, SfN took numerous steps to cut expenses. In September, SfN deferred staff pay increases and reduced discretionary contributions until the start of the next fiscal year; staffing was also reduced by ~10%. A $1 million cut in the FY 2021 programming budget was enacted as well. At the same time, SfN tapped its two lines of credit, backed by the Society's Strategic Reserve Fund, to support operations. Using these lines of credit was deemed preferable to withdrawals from the reserves because the interest rate on borrowed funds was much lower than the rate of return on the reserves. Later in the year, when a second round of the Paycheck Protection Program (PPP) loans were made available, SfN applied for and received a $2 million PPP loan.

New and existing revenue sources were developed as SfN looked beyond the annual meeting to diversify its balance sheet. In January 2021, SfN Connectome: A Virtual Event became the first digital-only, neuroscience-spanning meeting organized by SfN. The event earned a modest profit and educated volunteers and staff on how to plan and execute large-scale virtual events. The Society also made a $1.5 million investment in RhythmQ, a growing online platform that streamlines submission programs like awards, scholarships, and more. The investment equates to a minority ownership stake of the company and will provide an annual dividend. Finally, the SfN journals *JNeurosci* and *eNeuro* saw submissions increase 7% during the 2020 calendar year. While that increase held steady for the first half of 2021, it may be a temporary increase attributable to the pandemic halting experiments and leaving more time to write and submit research.

Behind these organizational activities, efforts to improve SfN's infrastructure and efficiency continued. February saw the launch of a new association management software platform with better capabilities to store, retrieve, organize, and protect SfN's membership data and streamline processes. SfN staff successfully worked from home the entire fiscal year, reflecting well on past and ongoing investments in the Society's digital infrastructure.

Toward the end of the year, SfN Council approved two new prizes. The Peter Seeburg Integrative Neuroscience Prize will be funded through the establishment of a $3 million endowment from the Schaller-Nikolich Foundation and be presented by FENS and SfN every other year at their annual meetings. The Jennifer N. Bourne Prize in Brain Ultrastructure, funded by former Councilor Kristen M. Harris, will be a $5,000 prize that seeks to recognize an early-career neuroscientist for outstanding work that advances our understanding of brain structure and structure-function relationships at the nanometer scale. Peter Seeburg was a pioneer in molecular neurobiology who passed away in 2016, and Jennifer Bourne was Kristen Harris' postdoc mentee and colleague who died tragically in an automobile accident in 2021.



This image shows neurite outgrowth by cultured mouse neurons 16 hours after a scrape wound was made with a pipette tip. Neurite outgrowth is enhanced by soluble SORLA.

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The Society for Neuroscience (SfN) gratefully acknowledges the generous contributions to SfN from the following organizations and individuals in FY 2021 (July 1, 2020 – June 30, 2021).

Donations to the Friends of SfN Fund support the Society's mission of advancing the understanding of the brain and nervous system. Visit https://www.sfn.org/Support-SfN or contact development@sfn.org to learn more about the Fund and becoming a donor.

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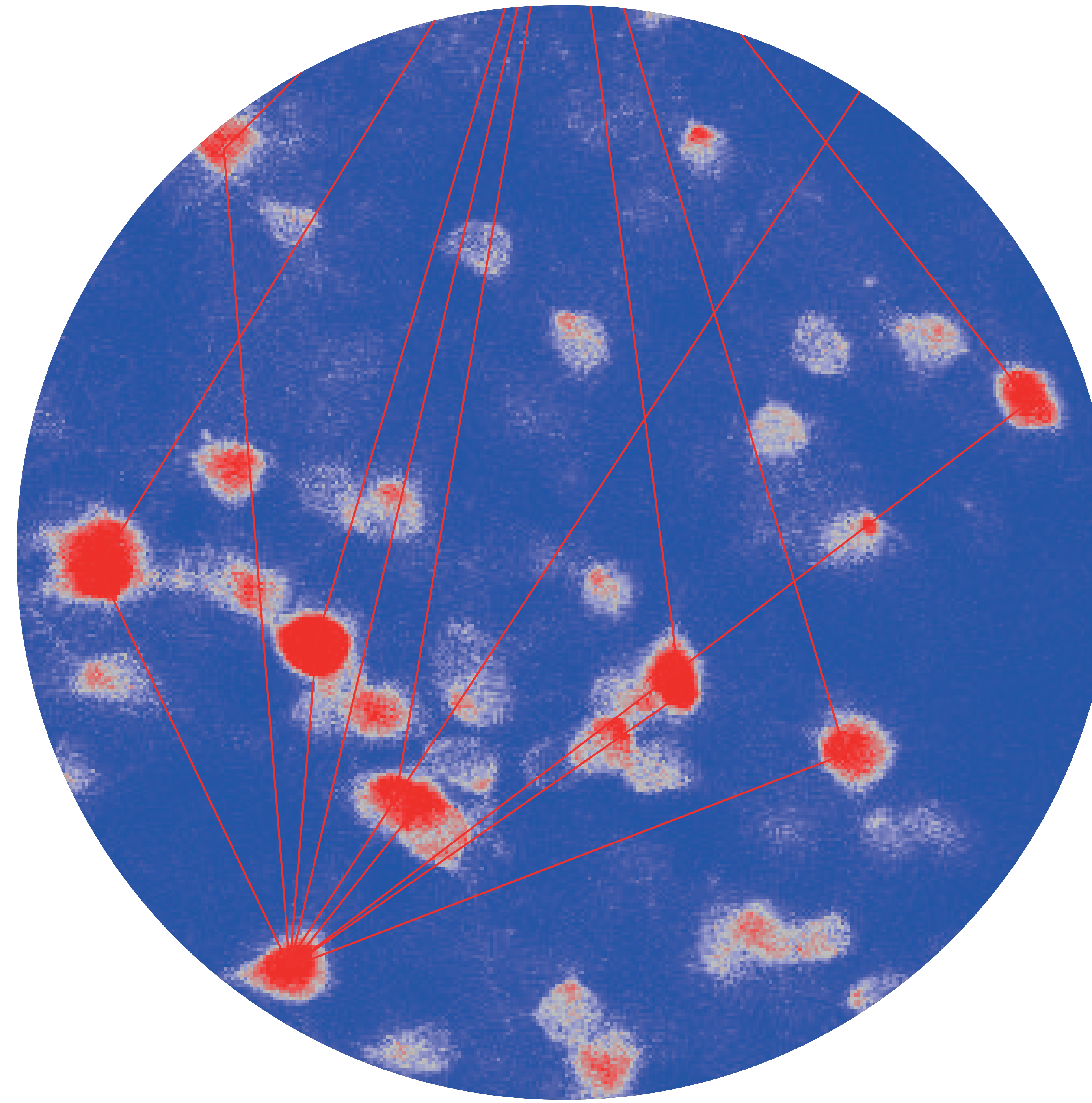
Pasko Rakic, MD, PhD, 1995–96
Carla J. Shatz, PhD, 1994–95
Larry R. Squire, PhD, 1993–94
Ira B. Black, MD, 1992–93
Joseph T. Coyle, MD, 1991–92
Robert H. Wurtz, PhD, 1990–91
Patricia S. Goldman-Rakic, PhD, 1989–90
David H. Hubel, MD, 1988–89
Albert J. Aguayo, MD, 1987–88
Mortimer Mishkin, PhD, 1986–87
Bernice Grafstein, PhD, 1985–86
William D. Willis, Jr., MD, PhD, 1984–85
Gerald D. Fischbach, MD, 1983–84
Dominick P. Purpura, MD, 1982–83
David H. Cohen, PhD, 1981–82
Eric R. Kandel, MD, 1980–81
Solomon H. Snyder, MD, DPhil, DSc, 1979–80
Torsten N. Wiesel, MD, 1978–79
W. Maxell Cowan, MD, PhD, 1977–78
Floyd E. Bloom, MD, 1976–77
Robert W. Doty, PhD, 1975–76
Edward V. Evarts, MD, 1974–75
Theodore H. Bullock, PhD, 1973–74
Walle J. H. Nauta, MD, PhD, 1972–73
Neal E. Miller, PhD, 1971–72
Vernon B. Mountcastle, MD, 1970–71
Edward R. Perl, MD, 1969–70



This image shows active neurons (red) in layer 2/3 of mouse primary visual cortex, along with functional connections (red lines) between the neurons. The top and bottom neurons were identified as pattern completion neurons using a graphical model called conditional random fields (CRFs). Pattern completion neurons are able to recall a neuronal ensemble; note that the two identified here are functionally connected with all the other neurons in the image.

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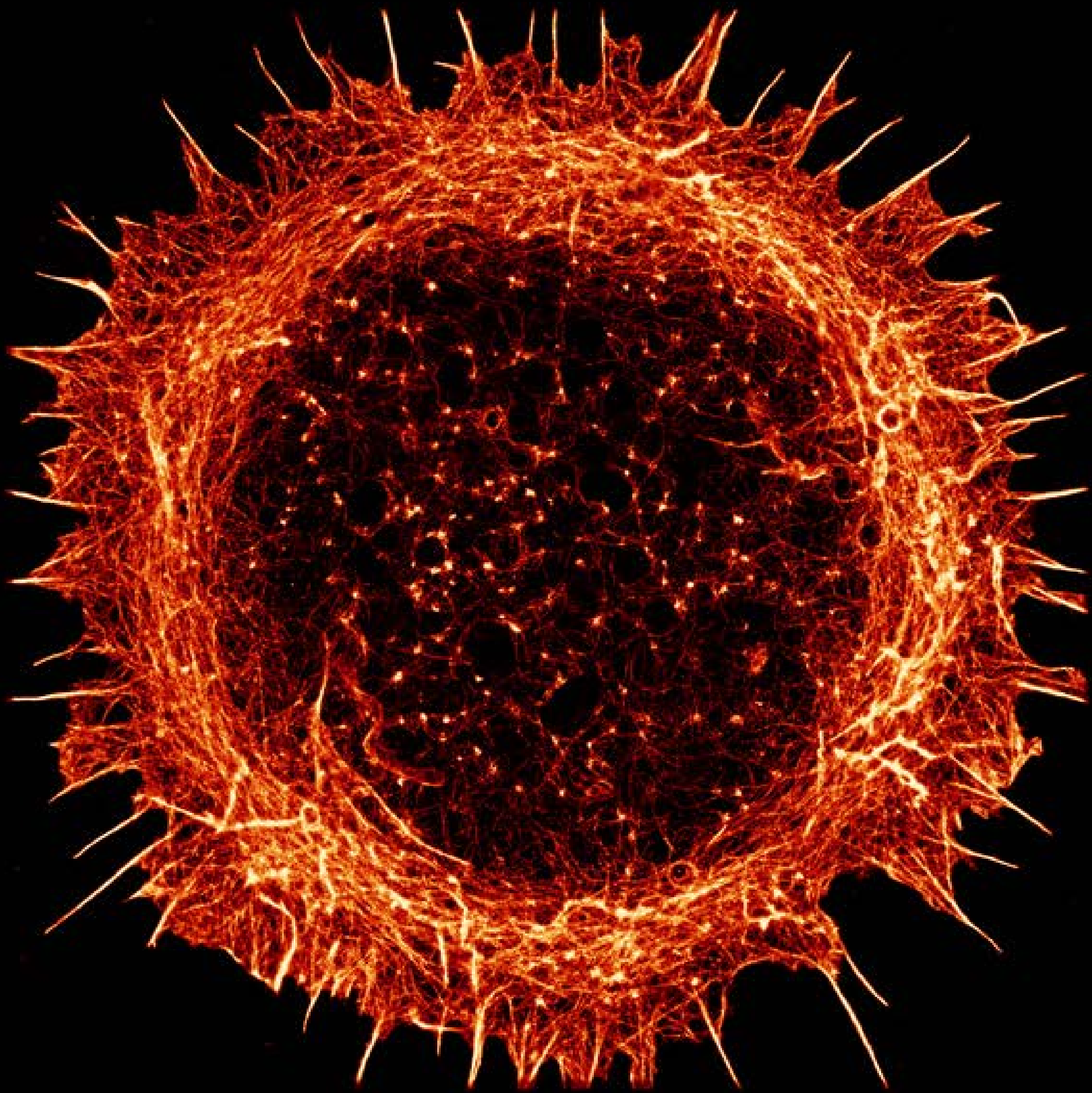

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