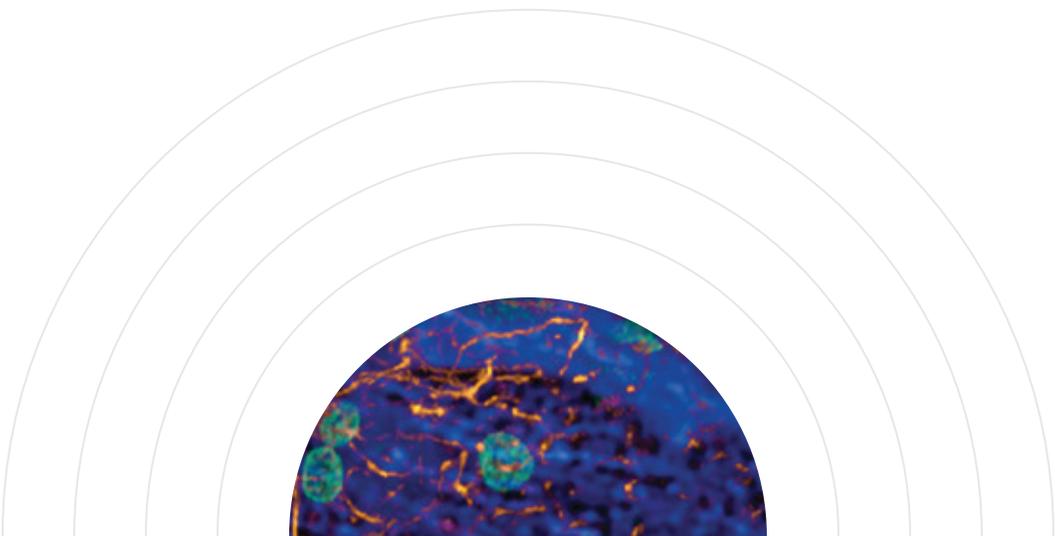


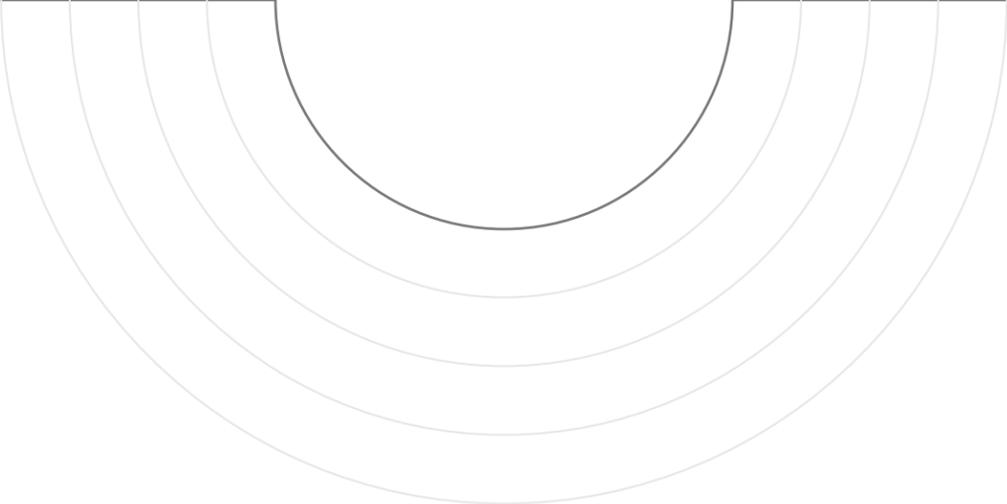
SOCIETY *for*  
NEUROSCIENCE

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ANNUAL REPORT FY 2018

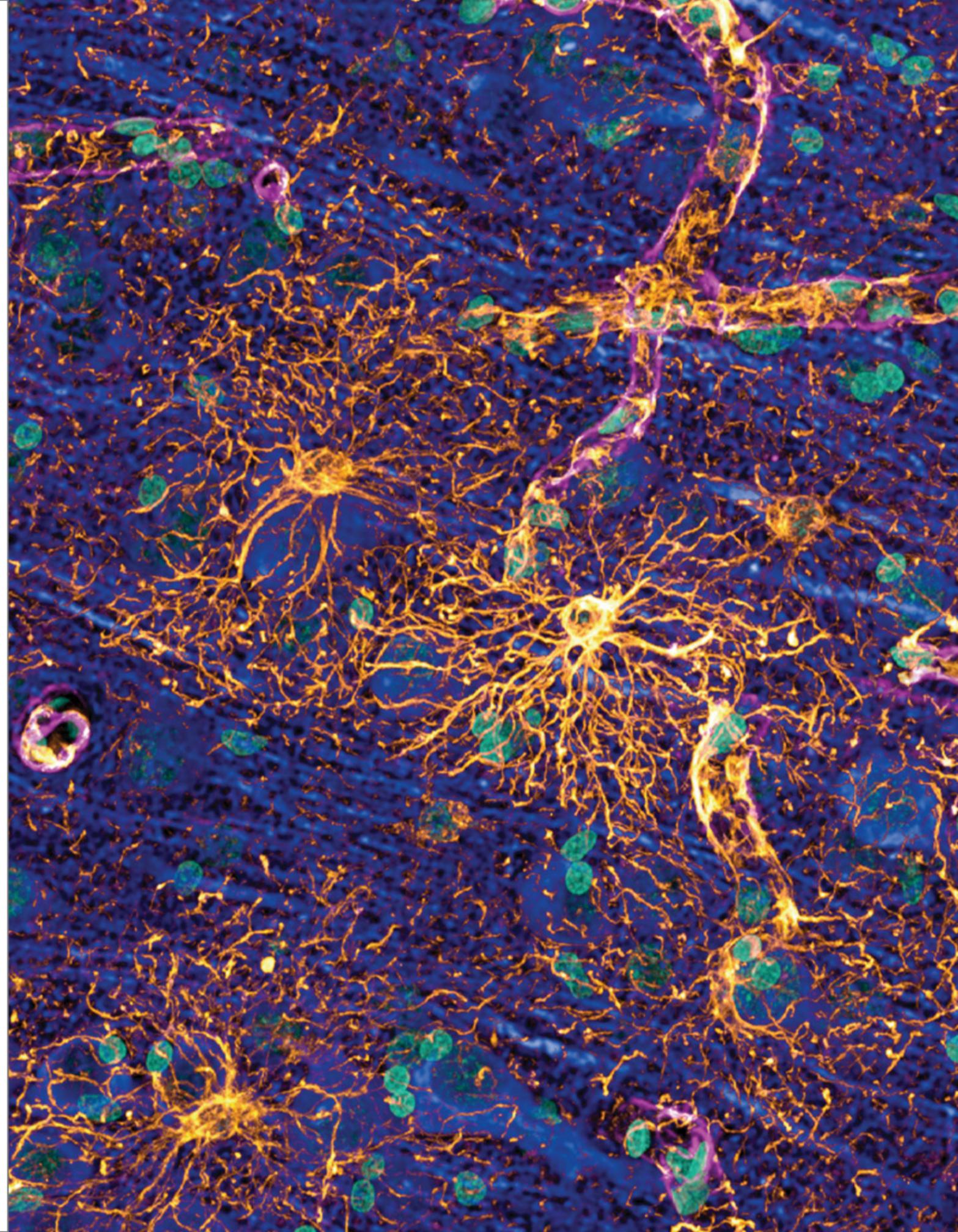
# Investing in Global Connections for Scientific Progress





“In order to unravel the mysteries of the human brain—*the most complex biological structure in the known universe*—we must initiate global connections and form powerful collaborations.”

—  
RICHARD HUGANIR, *SfN president and director of The Solomon H. Snyder Department of Neuroscience, Johns Hopkins University*



## 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.

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## Message From the President: Investing in Global Connections for Scientific Progress



— RICHARD HUGANIR, SfN PRESIDENT

The global neuroscience community is collaborating now more than ever in pursuit of answers to some of the most complex questions about the brain of our time, predicated on a history of scientific discovery.

Science continues to advance regardless of geographic boundaries or political climates. Governments across the globe are organizing in recognition of the promise of neuroscience and biomedical research, while scientists are collaborating across borders on an unprecedented scale.

The formation of multinational brain initiatives driven by team science and data sets is evidence of the changing nature of scientific research, and the Society for Neuroscience, as a leader in the global scientific community, is facilitating connections among scientists in the international space. This annual report illustrates some of the ways in which SfN is promoting scientific diversity and creating opportunities for its nearly 36,000 members to acquire and share scientific knowledge, and to contribute to collaborations that collectively drive scientific progress.

### CREATING OPPORTUNITIES TO SHARE SCIENCE

Neuroscience 2017 again provided a place for scientists of all backgrounds to present promising new research and to learn about the latest developments in the field on a global stage. More than 30,000 members of the global scientific community attended the annual meeting in Washington, D.C., which featured more than 900 sessions and 13,550 abstracts. Sessions focused on storytelling provided attendees with strategies for communicating about their science with the public, while attendees had the opportunity to share their science and to receive feedback on their work by presenting in poster sessions. In addition, digital interactives and encouraged use of social media helped attendees to connect with potential collaborators at the meeting.

This dedication to the future of the field extended to SfN's journals *JNeurosci*, which strives to publish impactful and enduring studies, and

*eNeuro*, which practices double blind review, consultation, and synthesis and has in the past year strengthened scientific rigor, added extended data, and improved the standard review process. Journal manuscripts are reviewed by working scientists across the globe. Those who publish with SfN's journals have repeatedly reported a positive author experience that is enhanced through promotion to the press of accepted papers, resulting in author recognition and broader sharing of science in leading media outlets. All manuscripts published in both SfN journals are promoted through the Society's Twitter account and other social media channels, resulting in greater exposure for the research, elevated awareness of the breadth of science that SfN journals publish, and expanded readerships that facilitate the sharing of science with a global audience.

### INNOVATING PLATFORMS FOR LIFELONG LEARNING

SfN prioritized the scientific training and professional development needs of its members this year through the development of year-round digital training resources and expanded content on Neuronline, SfN's home for learning and discussion. SfN's first virtual conference, on glial cells, attracted a high number of registrants, as did its first hybrid Neuroscience Scholars Program conference, which examined how diversity advances science. The opening session of this conference was recorded and made widely available online.

Building on the success of these programs, the Society hosted three virtual conferences this year that invited top speakers from around the world and focused on scientific rigor, single cell genomics, and optogenetics. The Society also is planning a fourth virtual conference for early 2019 on methods to mitigate implicit bias.

SfN's virtual conferences are hosted on Neuronline, which experienced growth in its number of weekly published articles, including resources that highlight international collaborations.

### SHARING THE STORIES OF NEUROSCIENCE

A redesigned *BrainFacts.org* made its debut in October 2017, taking an audience-centric approach to educating the public about topics in brain science. Narrative articles reveal how our nerve cells give rise to thoughts, perceptions, memories, emotions, and actions, while an innovative 3D brain model powered by the Wellcome Trust helps visitors to visualize brain structures and interactives illustrate Neuroscience Core Concepts. Additionally, the highly anticipated eighth edition of the *Brain Facts* book was completely refreshed and published in May 2018. Neuroscience Core Concepts also align with specific content throughout the book, adding to the complementary nature of these two public education resources. These resources, along with in-person outreach at conferences and events, help educators, policymakers, and the public to expand their knowledge of brain research and to make more informed decisions that affect the health and wellness of people around the world.

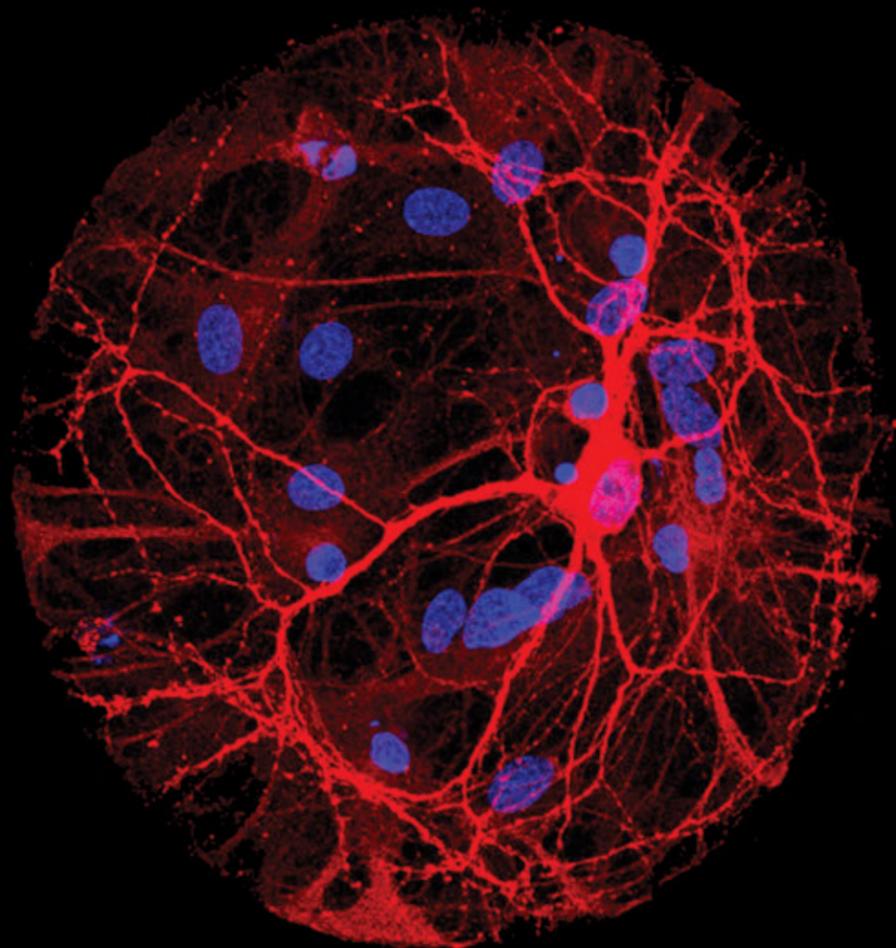
Not only have the new resources elevated the Society's opportunities to share promising neuroscience research, but SfN member advocacy efforts also contributed to a coalition effort that resulted in a \$3 billion increase in funding to NIH for FY 2018, a significant victory for all of biomedical research. SfN's expanded advocacy programs included developing member advocate capacity in key grassroots areas and expanding longstanding partnerships with international neuroscience organizations such as the Federation of European Neuroscience Societies, the Canadian Association for

Neuroscience, and the International Brain Research Organization. Op-eds contributed by SfN members were placed in newspapers around the U.S., increasing the visibility of neuroscience and biomedical research and underscoring the value of investment in basic research.

### THANK YOU TO THE GLOBAL NEUROSCIENCE COMMUNITY

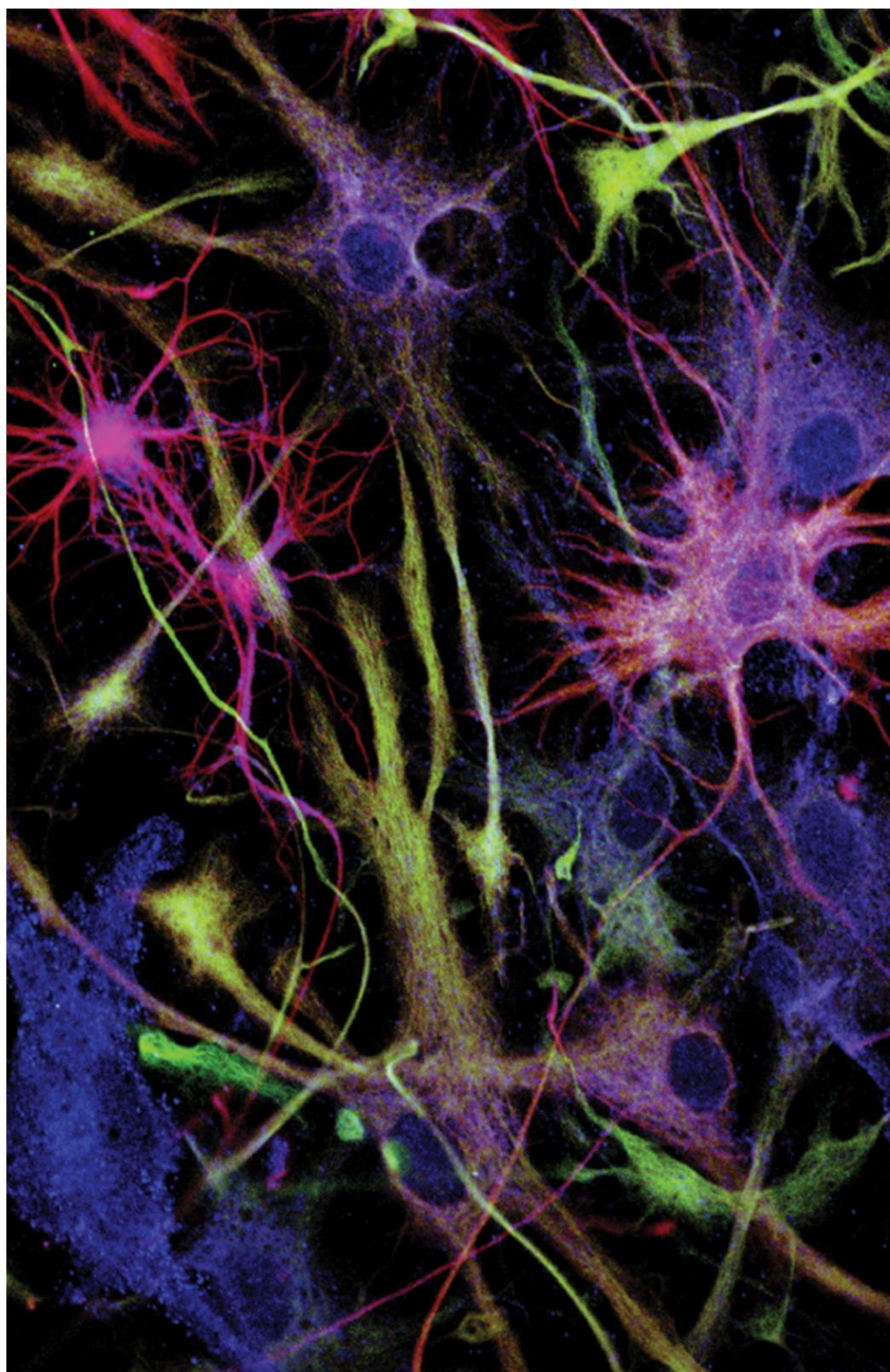
SfN members are lifelong learners, and this shared learning is what drives SfN members to work toward discoveries in their labs and to train the next generation of neuroscientists. I am grateful to all of our members for continuing to invest in our field and in the Society. We are indebted to this year's volunteer leaders of SfN, who helped to guide new and existing programming that responds to the evolving needs of the field and that continue to strengthen our Society. I am honored to have had the opportunity to lead this strong and global community of neuroscientists, whose passion and curiosity inspire novel directions of research. By continuing to connect with our desire to know more about the brain and to collaborate on finding the answers to our questions, we will continue to move the field forward and drive scientific progress that will benefit humankind.

RICHARD HUGANIR,  
PRESIDENT



“There is so much we don’t know about the brain —  
*it’s like an unknown universe inside our heads.*  
This makes every discovery all the more exciting.”

—  
DIANE LIPSCOMBE, *SfN president-elect*  
and director of the *Carney Institute for Brain Science,*  
*Brown University*



## Advancing Scientific Exchange: Neuroscience 2017: Expanding the Boundaries of Neuroscience Across the Globe

*Many of the more interesting scientific questions can't be answered by one country alone or one lab alone. Collaboration across borders is crucial to progress. I think this is a new trend over the last 20 or 30 years.*

CHARLES YOKOYAMA, *director of Research Administration, RIKEN Brain Science Institute, Japan*

From miniature human brains derived from stem cells to a new class of agonists to treat opioid use disorder, the science presented at Neuroscience 2017 demonstrated a breadth of research and innovation taking place around the world.

Neuroscience 2017 brought 30,021 attendees from 80 countries to Washington, D.C., last November, upholding the renown of SfN's annual meeting as the quintessential venue for international scientific exchange in neuroscience. Attendees presented in scientific sessions, learned from established neuroscientists and leaders in the field, acquired professional skills, and connected with peers both inside and outside of their areas of research.

The annual meeting creates opportunities for researchers to engage in global and interdisciplinary collaboration. As the nature of research evolves to draw on connectivity across disciplines and borders, scientific progress necessitates the sharing of science and collaboration of scientists to solve complex problems in neuroscience. Adapting to this changing landscape, the meeting continues to meet the needs of SfN members and the field more broadly, allowing it to follow novel directions

in translational research and clinical applications aimed at improving human health.

### CONNECTIONS AMONG SCIENTISTS AND THE PUBLIC

Facilitating scientific exchange among a diverse group of scientists remains a pillar of the Society's mission. Across the field, organizations are recognizing the importance of continued innovation in basic and translational research. By realizing opportunities for conversation and collaborative research among a diverse group of scientists, SfN helps researchers to establish connections and combine ideas in new ways.

To reinforce the Society's commitment to supporting the field, SfN Council invested \$100,000 for Trainee Professional Development Awards in FY 2018. Combined with other donations, this supported 203 trainees from around the world in attending Neuroscience 2017. The recipients,



*Methods, questions, and developments happen internationally, so it's not enough to talk to colleagues from your own country or your own university. You have to view science as an international endeavor. That's why coming to a meeting, being a member of an international society, is critically important.*

—  
STEFAN TREUE, head of the Cognitive Neuroscience Laboratory and director of the German Primate Center, University of Göttingen

—  
EXHIBITORS INCLUDING GOVERNMENT AND INDEPENDENT RESEARCH INSTITUTIONS, NONPROFIT ORGANIZATIONS, PUBLISHERS, AND BIOTECHNOLOGY AND PHARMACEUTICAL COMPANIES OFFER ATTENDEES THE CHANCE TO INTERACT WITH NEW TECHNOLOGIES AND TOOLS.

who represented 119 institutions in 11 countries, presented scientific research at a poster session, met peers and networked with senior scientists, and participated in learning opportunities.

SfN also encouraged early-career scientists in their pursuit of academic and independent research careers by adding two curated itineraries to the 11 topical itineraries, created by SfN's Program Committee, in the Neuroscience Meeting Planner. These itineraries helped attendees to plan their meeting experience by searching for sessions, workshops, social events, and more to add to their personal itineraries. Created by SfN's Trainee Advisory Committee, the new itineraries helped undergraduate

students as well as graduate students and postdoctoral fellows to find relevant professional development opportunities.

Increased communication during the meeting was achieved through display screens located throughout the Walter E. Washington Convention Center that featured attendees' posts to Twitter and Instagram, tagged with hashtags shared in *Neuroscience Extra!*, the annual meeting daily digital newsletter. Additionally, attendees could share why they believe global collaboration is important for scientific discovery by responding to a global advocacy poll, the results of which were displayed on a screen that highlighted individual responses and collected them into a world map. An advocacy wheel

prompted participants to complete challenges such as tweeting about their advocacy efforts or inviting legislators to their lab.

Acknowledging the personal and public impact of neuroscience, several Neuroscience 2017 sessions demonstrated how storytelling can transform science communication. Two professional development workshops taught attendees valuable storytelling skills for sharing their research with other scientists and the public in a way that elucidates the value of science to society, while a minisymposium featured a panel of speakers who explained the science behind storytelling and shared powerful personal anecdotes. All three

sessions were well-attended—reflecting a growing interest in communicating about science through storytelling. A second storytelling minisymposium will take place at Neuroscience 2018.

#### SCIENTIFICALLY RIGOROUS INNOVATION

The emergent reproducibility crisis demands redoubled attention to maintaining the trust of both scientists and the public. SfN has taken steps to improve transparency and encourage rigorous experimental design, statistical analysis, and reporting.

As evidence of its enduring commitment to enhancing scientific rigor while promoting innovation in research, SfN required presenters to summarize efforts to ensure scientific rigor, including sample sizes and replication, blinding, and controls. SfN also asked presenters to transparently report experimental design and analytical methods in their presentation. To assist speakers in demonstrating and understanding the expectations of scientific rigor, SfN provided presenter resources, including templates for poster and dynamic poster presentations, on SfN.org. This year, the Abstracts Rigor Working Group of SfN's Program Committee developed a template specifically for nanosymposia presentations.

SfN increased the number of dynamic poster presentations from 10 to 15 per session, for a total of 135 at Neuroscience 2017. Dynamic, or digital, posters allow presenters to visualize their data and to connect with the audience by incorporating additional storytelling components into their presentations, such as video, 3D graphics, animations, and other multimedia.

#### MEDIA

Attracting 304 registered journalists and public information officers and producing 252 original stories and 1,772 news hits and mentions from North America and internationally, Neuroscience 2017 further served to connect scientists and nonscientists across the globe. Articles appeared in news outlets including NPR, *The Washington Post*, *The Hill*, *Axios*, *Forbes*, and *New Scientist*, as well as respected scientific publications including *Nature*, *Science* magazine, *Scientific American*, *Spectrum*, *STAT*, and *Popular Science*. Ten press conferences and a Hot Topics book of 100 newsworthy abstracts inspired many of these stories, which covered topics related to health, technology, and medicine, and helped the public to better understand neuroscience discoveries and the value of investment in research.



—  
COLLABORATION IN NEUROSCIENCE ADVANCES THE FIELD BY BRINGING TOGETHER PEOPLE WHOSE IDEAS CAN BE COMBINED IN CREATIVE WAYS TO SOLVE COMPLEX PROBLEMS.



—  
DYNAMIC POSTERS AT NEUROSCIENCE 2017 OFFERED PRESENTERS THE ABILITY TO INCORPORATE MULTIMEDIA ELEMENTS INTO THEIR POSTER.



NEUROSCIENCE 2017 BROUGHT MORE THAN 30,000 SCIENTISTS FROM ALL OVER THE WORLD TO WASHINGTON, D.C., TO SHARE THEIR SCIENCE AND LEARN ABOUT THE LATEST DISCOVERIES IN THE FIELD.

WASHINGTON, D.C.

## Neuroscience 2017 By the Numbers

NOVEMBER 11-15

**30,021**

ATTENDEES  
FROM  
80 COUNTRIES

**13,527**

ABSTRACT  
PRESENTATIONS

**15**

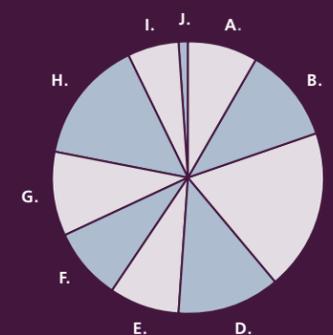
PROFESSIONAL DEVELOPMENT  
WORKSHOPS

**814**

SCIENTIFIC SESSIONS

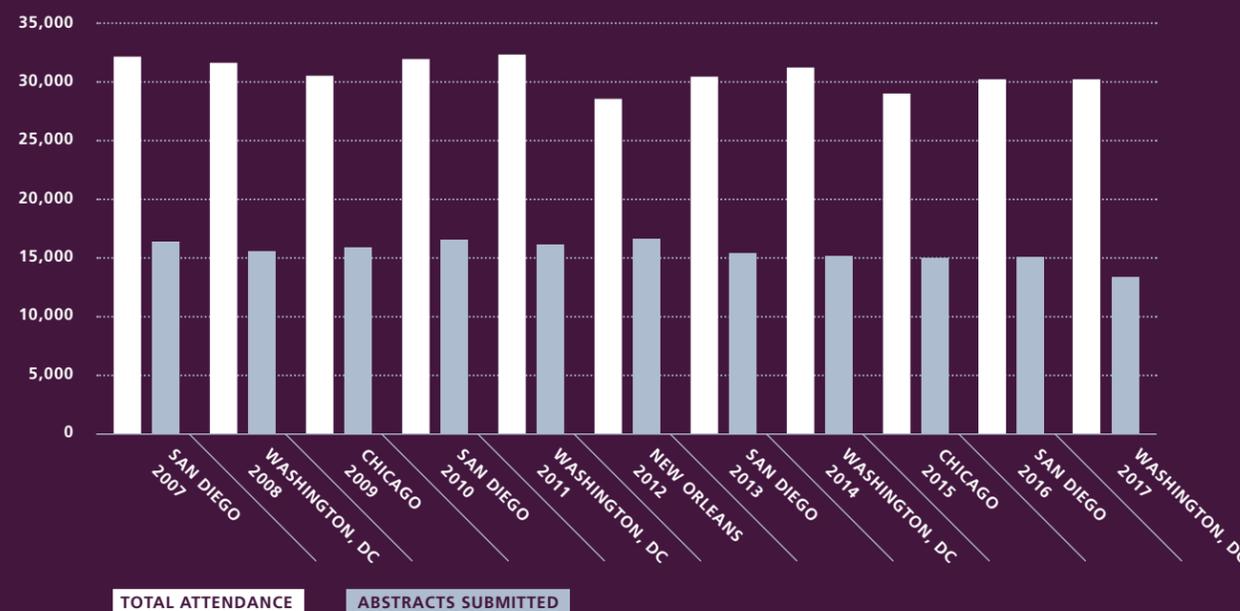
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EXHIBITORS



### PERCENT OF ABSTRACT SUBMISSIONS IN EACH THEME

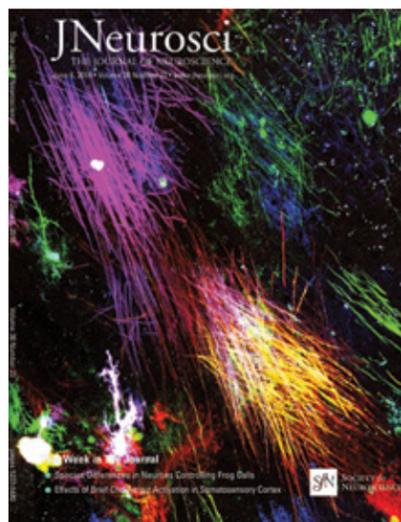
- THEME A: Development 8.61%
- THEME B: Neural Excitability, Synapses, and Glia 11.38%
- THEME C: Neurodegenerative Disorders and Injury 19.03%
- THEME D: Sensory Systems 12.16%
- THEME E: Motor Systems 8.43%
- THEME F: Integrative Physiology and Behavior 8.69%
- THEME G: Motivation and Emotion 10.02%
- THEME H: Cognition 14.53%
- THEME I: Techniques 6.08%
- THEME J: History and Education 1.07%



TOTAL ATTENDANCE

ABSTRACTS SUBMITTED

## SfN Journals: Working Together to Advance Neuroscience



—  
THE COVER IMAGE OF THE JUNE 6, 2018 ISSUE OF *JNEUROSCI* SHOWS OLIGODENDROCYTES IN THE MOUSE NEOCORTEX.

SfN's two peer-reviewed journals, *JNeurosci* and *eNeuro*, publish neuroscience research that has an immediate and lasting impact on the field. By providing scientists with the flexibility to report their findings in the way that best suits their work, SfN journals advance the understanding of the brain and the nervous system by adapting scientific journals to science—not the other way around.

### **JNEUROSCI: UPHOLDING HIGH STANDARDS OF RIGOR**

Published since 1981, *JNeurosci* continues to receive more citations than any other neuroscience journal. In FY 2018 *JNeurosci* published more than 900 articles, nearly twice as many as its next largest competitor. The journal has also maintained an acceptance rate of 25 to 35 percent over the past four years. This combination of volume and selectivity distinguishes *JNeurosci* as a premier venue for research that is shaping the field.

#### *Providing Opportunities for Junior Scientists*

*JNeurosci* recognizes and values the contribution of early-career researchers to the future of neuroscience. Students and postdoctoral fellows are invited to submit a scholarly review of a recently published *JNeurosci* paper in the form of a Journal Club. In addition to

providing readers with commentary and context about contemporary neuroscience research, Journal Clubs offer neuroscientists-in-training an opportunity to assess a current topic in the field and publish in its leading journal.

“Educating the next generation of neuroscientists is absolutely critical to me as a value of *JNeurosci*,” said Editor-in-Chief Marina Picciotto.

*JNeurosci* also engages early-career scientists in peer review. In January Picciotto announced *JNeurosci* would begin offering one-on-one peer review training to teach early-career scientists how to fairly and constructively evaluate a manuscript. Interest in the new Reviewer Mentoring Program has exceeded expectations: 27 associate editor mentors and 49 trainees have signed up to participate in the

*The peer review process at eNeuro is fast, which is very important nowadays. ... The process at eNeuro is also transparent, and communication with the office is easy and fast. We are very happy with how eNeuro handles the overall review process.*

CSABA CSERÉP, senior research fellow, Institute of Experimental Medicine, Hungarian Academy of Sciences

training. Six trainees have completed the program so far, including one who has shared his review of a preprint on bioRxiv. *JNeurosci*'s Reviewer Mentoring Program pairs associate editors with those who do not have experience as reviewers, reinforcing the value of peer review across the field by introducing early-career scientists to the process by which manuscripts are reviewed. Over time, this program has the potential to share best practices in peer review with multiple generations of neuroscientists.

### **eNEURO: DRIVING THE FUTURE OF PUBLISHING**

SfN Council's strategic investment in 2014 in the future of scientific publishing enabled the creation of a fully open-access neuroscience journal owned and operated by a nonprofit scientific society. Since launching four years ago, *eNeuro* has published more than 700 research manuscripts. Traffic to *eneuro.org* has increased dramatically over the past few years as awareness of the journal continues to grow. Website traffic increased by 93 percent in calendar year 2017 to more than 250,000 visits from 195 countries and territories.

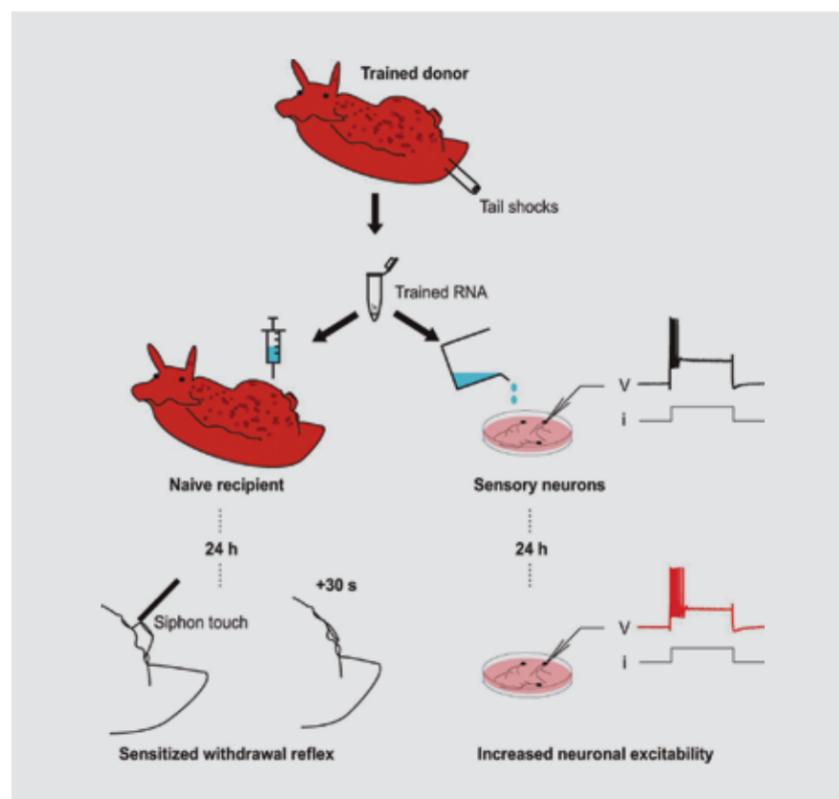
Editor-in-Chief Christophe Bernard is leading the journal on an ambitious journey to “improv[e] the way science is done, evaluated, and published.” To that end, *eNeuro* provides neuroscientists with a place to report data that often goes unpublished. “This is a major issue when people have negative results. They don't get published, and as a result other groups may redo the experiments again and again,” Bernard said. “We also know that there is a problem with some studies that cannot be reproduced by others, and it's very important to report them. *eNeuro* was created to fill this void in the field.”

*eNeuro* publishes several article types designed to address the reproducibility crisis in science. The journal continues to encourage submissions formerly characterized as “Failure to Replicate” in which an independent group is unable to replicate findings of a previously published, and, in some cases, influential paper. On the other hand, “Confirmation” papers are those in which the authors are able to replicate and extend another group's work. Together these article types serve the scientific community by providing an additional check on published, peer-

reviewed research and informing the funding of future work.

To promote scientific rigor, the journal in March opened submissions for a new article type called “Registered Reports.” This new article type allows authors to preregister their research with the journal before conducting any experiments. If the proposed research question and methodology are accepted by *eNeuro*'s editorial board, the journal agrees to publish the results upon submission of the full manuscript, provided the authors have adhered to the proposal.

*eNeuro* is rapidly increasing its content offerings to provide readers with new and innovative ways to keep up and engage with the latest neuroscience. The journal hired its first features editor, Rosalind Carney, who has started writing Research Highlights—articles that place findings of recent *eNeuro* papers in the context of current scientific knowledge and real-world implications.



*As an author it is extremely helpful to receive a Consensus Synthesis Statement. Also, the reviews were fast, polite, and professional.*

GUILLAUME SESCOUSSE, senior postdoctoral researcher, Donders Institute for Brain, Cognition and Behaviour, Radboud University, Netherlands

#### EXPANDING REACH AND DISCOVERABILITY

##### Media Relations

With Council's investment in strategic opportunities, SfN has expanded its capacity to promote research published in the journals beyond academia. Each week the Society prepares and distributes concise summaries of select *JNeurosci* and *eNeuro* articles to the press in advance of online publication. These Weekly Journal Highlights communicate the main findings and implications of papers identified by SfN's Public Education and Communication Committee as suitable for promotion to science reporters. Since launching this initiative in May 2017, SfN journal articles promoted by the Society have earned considerable media coverage.

THIS VISUAL ABSTRACT ACCOMPANIED *eNEURO*'S MOST WIDELY READ PAPER THIS YEAR, ON EPIGENETIC ENGRAMS IN THE SEA SNAIL *APLYSIA*. THE PAPER RECEIVED UNPRECEDENTED MEDIA COVERAGE AND WAS FEATURED IN 81 NEWS OUTLETS. *eNEURO* ARTICLES GENERATED 410 NEWS AND BLOG ARTICLES AS WELL AS 5,147 SHARES OF NEWS STORIES ON SOCIAL MEDIA IN FY 2018.

For example, SfN coordinated with Penn Medicine in July 2017 to publicize a randomized controlled trial published in *JNeurosci* of the commercial brain training program Lumosity that found no effect on decision-making or standard cognitive assessments. These efforts generated media coverage in high-profile publications such as *The Washington Post*, *New Scientist*, NPR, and Reuters.

Additionally, in May 2018 SfN worked with the University of California, Los Angeles to promote a provocative study, published in *eNeuro*, challenging the widely accepted view that long-term memory is housed within modified connections among brain cells. Using trained and untrained *Aplysia*, the researchers reported evidence that memory storage may involve changes in gene expression induced by noncoding

RNAs. *The New York Times*, CNN, *Smithsonian*, *Newsweek*, and *Scientific American* were among the mainstream media outlets to report on the research.

##### Growing Awareness

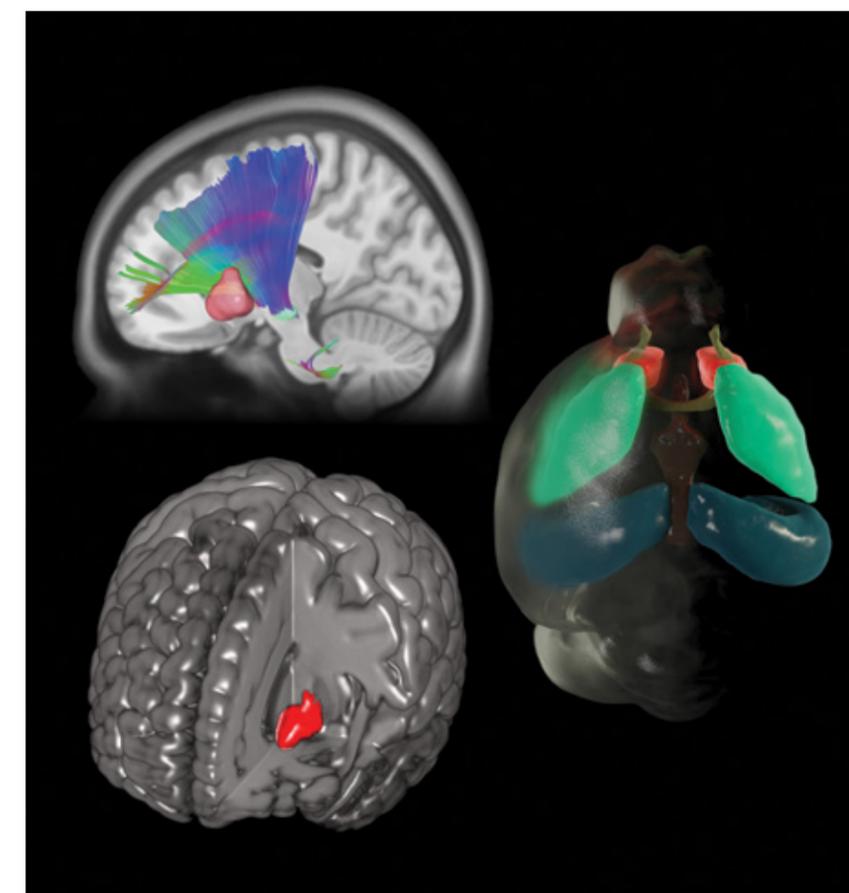
In addition to generating public awareness of research published in *JNeurosci* and *eNeuro*, SfN is expanding its scientific audience through a number of tactics. The journals' official Twitter account, @SfNJournals, gained more than 1,000 new followers in FY 2018—many of whom are early- and mid-career scientists. Impressions and engagement on this channel have grown substantially, demonstrating the value of disseminating scientific content on Twitter.

To expand the reach of *eNeuro*, SfN sends electronic tables of contents (eTOCs) highlighting recently published articles to SfN members and authors who have published in its journals twice monthly. In FY 2018, the *eNeuro* eTOCs drove traffic directly to the featured articles, resulting in more than 37,000 sessions and accounting for 11 percent of total traffic to the site. Both journals also offer e-Alerts that allow readers to sign up for email notifications when articles are published, either as "Early Release" articles or in an issue.

A recently introduced content recommendation service for scholarly publishing called TrendMD further expands the reach of the science published in *JNeurosci* and *eNeuro*. In the lower right hand corner of each article page, readers now see a "We Recommend" widget powered by TrendMD. This tool increases exposure of SfN journal articles by recommending them to readers of more than 2,500 scholarly publications that are a part of the TrendMD network. *JNeurosci* and *eNeuro* have a strong presence in *Neuroscience Nexus*, SfN's biweekly newsletter sent to its more

than 30,000 members around the world. Each issue of *Nexus* highlights recently published research in both journals as well as papers picked up in the news. Further, selected authors in the journals can prepare a summary of their work to be published on Neuronline, SfN's professional development and training website. Research summaries are some of the most popular Neuronline content.

*JNeurosci* and *eNeuro* strive to recognize that scientists have an ever-expanding universe of journals in which to share their work. As complementary venues for publishing influential research, SfN's journals are uniquely positioned to move neuroscience forward by reaching the largest community of neuroscientists in the world and helping them to advance in their careers.



A STUDY PUBLISHED IN *JNEUROSCI* FOUND THAT A MUTATION IN A HUMAN AXON GUIDANCE GENE REDUCES CONNECTIVITY BETWEEN REGIONS OF THE BRAIN'S REWARD SYSTEM. *JNEUROSCI* ARTICLES GENERATED 1,479 NEWS AND BLOG ARTICLES AS WELL AS 19,324 SHARES OF NEWS STORIES ON SOCIAL MEDIA IN FY 2018.

SCIENCE *in* PROGRESS

## COMMUNICATING THE VALUE OF SCIENTIFIC RESEARCH TO THE PUBLIC

**NEUROSCIENCE ARGUABLY** is unrivaled in its ability to fascinate and inspire, but too often, the importance of discoveries and their potential to relieve human suffering don't reach the public. Communicating the promise of scientific inquiry to the public is particularly pressing in light of funding challenges and latent distrust of science. "If scientists don't take hold of the conversation around science and public policy, then who [will]?" asked Siddhartha Mukherjee, oncologist and assistant professor of medicine at Columbia University Irving Medical Center, and Pulitzer Prize-winning author of *The Emperor of All Maladies: A Biography of Cancer*.

In the Neuroscience 2017 Dialogues Between Neuroscience and Society Lecture, a conversation with SfN Past President Eric Nestler, Mukherjee pointed to two public mandates—understanding nature and curing disease—as guidelines for communicating with patients, policymakers, and other lay audiences. Most labs run on public funding, and so it benefits scientists to ensure that the public understands how research

*If scientists don't take hold of the conversation around science and public policy, then who [will]?*

SIDDHARTHA MUKHERJEE, *oncologist and Pulitzer Prize-winning author*

works toward those mandates, Mukherjee said. Communication between scientists and the public is also necessary as researchers consider adapting technologies for revising the human genome to treat disease, a subject of Mukherjee's latest book, *The Gene: An Intimate History*. The public must be involved so that decisions about how to implement these technologies are thoughtful and informed.

### EFFECTIVE SCIENCE COMMUNICATION

In describing their research to the public, scientists may encounter challenges including communicating the role of basic science as the foundation of discoveries that may lead to promising treatments, as well as anti-science sentiment and distrust of scientific findings. These barriers have intensified in recent years, with negative implications for public policy.

To communicate with policymakers, the general public, and other scientists, Mukherjee advised following two principles: first, avoiding jargon, and second, telling the truth. When communicating with lay audiences, scientists must tell the story of their research simply. "Distill it into what is still true but is simple enough for people to understand," he said. Distillation of findings may not please every researcher looking for acknowledgement of his or her individual work, but it will help the audience—the public—to understand how science relates to their everyday lives.

Another communication challenge scientists face is qualifying the promise of research discoveries with the need for patience while awaiting new treatments. "It's foolhardy to promise too much," Mukherjee cautioned. Instead, he said, scientists can remind

people of the history of the field so they can better understand its current state. Scientists can also describe what they are finding now and where the field is going. "And don't forget to talk about failure," he said, advising researchers to acknowledge that some experiments will fail and not everything is understood—but therein lies the value of discovery.

### BALANCING CREATIVITY AND SAFETY

Within the current regulatory environment, and especially in light of recent changes to NIH clinical trials guidelines intended to increase the transparency and accountability of biomedical research, some scientists may struggle to implement creativity in clinical trials. "It is not unusual to go into the clinic and find clinicians and patients frustrated because they feel as if they can't push the boundaries," Mukherjee said. As a historian of science, however, Mukherjee stressed that medical history is rife with failed experiments and unexpected results, and that in neuroscience as in clinical oncology, creativity must be balanced with patient safety.

SCIENCE *in* PROGRESS

SIDDHARTHA MUKHERJEE AT THE NEUROSCIENCE 2017 DIALOGUES BETWEEN NEUROSCIENCE AND SOCIETY LECTURE.

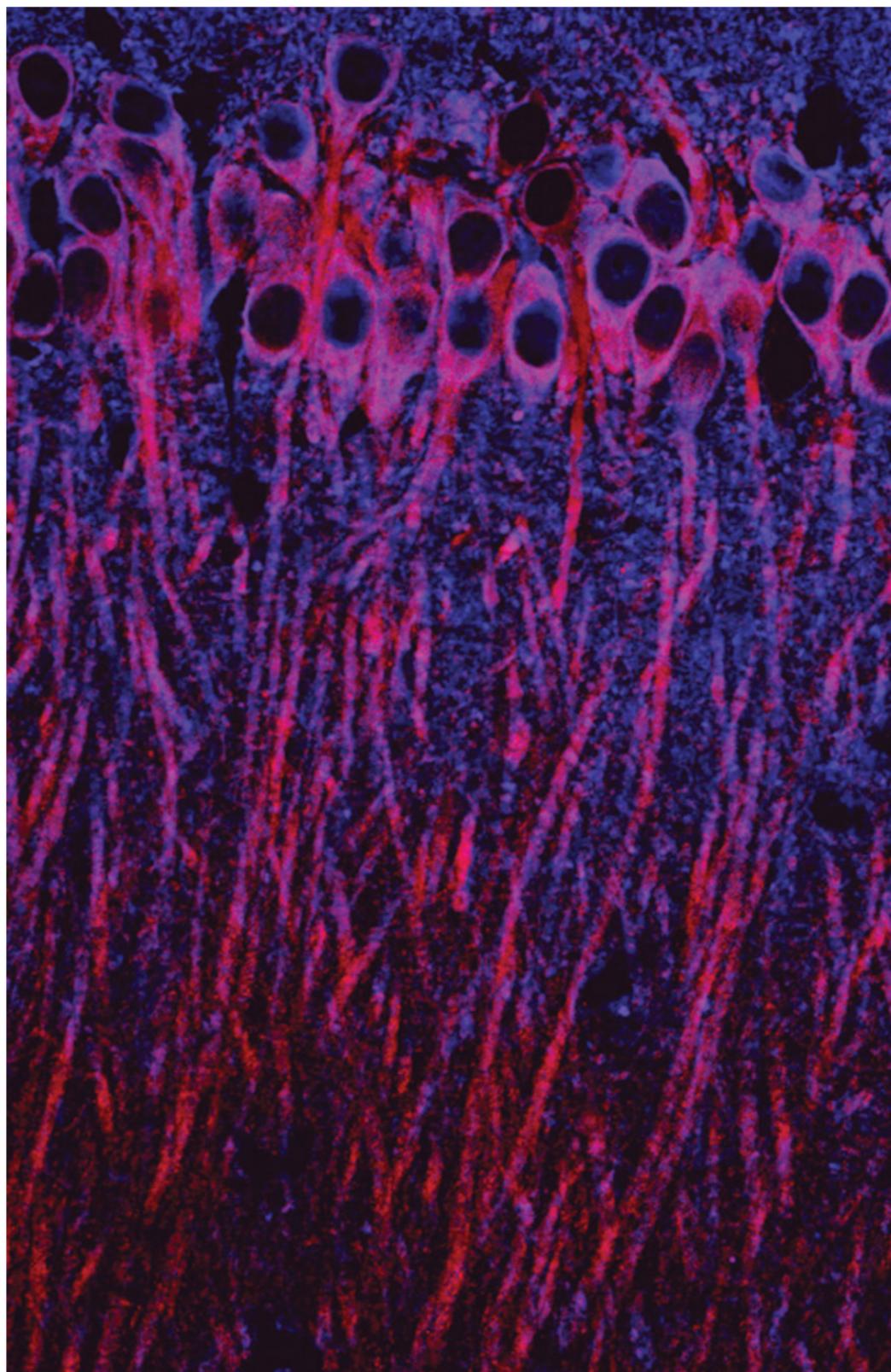
"Finding the balance between allowing creative impulses to flourish is extraordinarily tough, and I think it would be fair to say that in clinical oncology, particularly people who are leading investigative trials are feeling a kind of frustration in being able to deliver the most creative kinds of trials," he said. "Finding that balance is going to be crucial, and it's a moving line."

This balance is currently being weighed in the emerging conversation around gene therapy. While gene-editing technologies are powerful tools that may one day offer cures for genetic diseases, their safety for patients—and more broadly, their effect on humanity as a whole—is not fully understood.

Mukherjee presented a three-sided framework, or "triangle," for considering whether genetic research should be undertaken, in which each side represents a different consideration. One consideration is extraordinary suffering: Does the genetic change proposed address a condition of utmost severity? Another is penetrance, or the strength of

the relationship between the gene and the disorder: How strong is the evidence that altering the genetic code will ameliorate the disease? The last is justifiable choice: Is gene editing justified or can the condition be treated without altering the human genome?

While the answers to these questions will be subjective, the framework can help to guide discussions between scientists and the public. Critically, such discussions will shape the relationship between scientists and the public as well as future regulations influencing how quickly and safely scientific progress is realized.



## Supporting the Neuroscience Community: Career Development in an Interconnected World

*How science is done in different countries is slightly different, and it's really interesting to work with people who have different constraints in their funding, or different ways for how they undertake research.*

CLARE HOWARTH, *vice chancellor's advanced fellow, University of Sheffield, U.K.*

SfN members belong to a global community of neuroscientists who embrace a philosophy of lifelong learning. To support continuous scientific training and professional development, SfN offers members and the field a variety of resources and high-quality programming on emerging topics and techniques to enrich their research and careers, regardless of career stage.

### **ACCESSIBLE, YEAR-ROUND TRAINING**

This year SfN reaffirmed its commitment to supporting the scientific training needs of its community, developing a variety of resources on topics including new approaches to scientific rigor, as well as emerging tools and technologies.

SfN continued its commitment to promoting rigor and transparency in neuroscience research and communication. In alignment with this initiative, SfN hosted a virtual conference in April 2018 titled “Enhancing Rigor and Transparency in Neuroscience.” This virtual conference was funded by the National Institute on Drug Abuse and shared information on evolving best practices for rigorous data collection, management, and analysis; changes in publishing to enhance transparency; and recognizing and addressing perverse incentives

in science. This virtual conference, available open access and on demand, adds to SfN’s growing collection of training resources to promote rigor in research practices that the Society has developed over the past three years in collaboration with neuroscientists from around the world and with funding support from NIH.

This virtual conference was the first of two the Society hosted in FY 2018 focused on scientific training. The second, titled “Advances in Single Cell Genomics to Study Brain Cell Types” and hosted in June 2018, covered technical and conceptual advances in single cell analyses in the brain that are providing scientists with new approaches to better understand brain development, evolution, and disorders.

On August 1, SfN also piloted an optogenetics training series, comprising eight complementary digital modules



available on Neuronline as well as a virtual conference. The eight modules, available to members at their convenience, include on demand webinars, videos, and other written content. The virtual conference, which took place September 20 and is now available on demand, focused on the future tools and applications of optogenetics. This pilot is being evaluated alongside SfN's comprehensive training strategy.

Future virtual conferences will cover topics including implicit bias, neuroethology, and machine learning applications. Moving forward, SfN anticipates hosting a regular schedule of virtual conferences at the rate of four per year.

Another SfN initiative that showcases SfN's commitment to developing year-round programming for members is the Best Practices in Neuroscience Training series. Building on a framework established in 2015, the Best Practices Working Group of SfN's Neuroscience Training

Committee continues to develop three webinars and related digital resources annually for neuroscience departments and programs on topics such as career planning, unique needs of international trainees, program development and curriculum, and recruitment and retention of graduate students and early-career faculty. In February, "Demystifying the Academic Chalk Talk," which modeled this unique component of the academic job interview, attracted nearly 270 early-career researchers, and in May, "Undergraduate Neuroscience Pedagogy: Perspectives from Different Institutions," offered in partnership with the Faculty for Undergraduate Neuroscience, engaged more than 120 viewers.

Designed to supplement institutional training efforts, these resources support the field by ensuring that the institutions at which neuroscientists train are able to continually improve the quality of education that they provide. To leverage the impact of these resources for neuroscience training,

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SfN DEVOTED SUBSTANTIAL RESOURCES IN FY 2018 TO DEVELOPING YEAR-ROUND SCIENTIFIC TRAINING OPPORTUNITIES FOR ITS MEMBERS, AN INITIATIVE IT WILL CONTINUE TO PRIORITIZE INTO THE FUTURE.

beginning in 2019 Institutional Program membership will expand beyond degree-granting neuroscience departments and programs to include programs that provide training but do not grant a degree in neuroscience or a closely related discipline.

#### PROFESSIONAL DEVELOPMENT FOR THE GLOBAL COMMUNITY

Neuronline, SfN's website for learning and discussion, provides a venue through which neuroscientists can advance in their training and career and connect with the global scientific community. With more than 920 articles published since its launch in 2015 and 21 countries represented through interviews with experts published on the site in the past year, Neuronline delivers resources including SfN annual meeting event recordings, scientific research summaries, interviews with experts, personal stories about career paths and research interests, toolkits, and more. Continuing the strategy to supply local SfN Chapters and Institutional Program members with content in the

form of presentation-ready toolkits, SfN developed a series of Career Skills Toolkits that provides trainees with nonscientific skills essential to succeed in the field. Two of three planned toolkits, "Designing Effective Science Presentations" and "Leadership, Management, and Team Building," have been released and are available on Neuronline, with the third, on career transitions, to be released next year.

To provide additional support for early-career scientists, SfN created a Notable Careers series that allows them to learn from the experiences of emeritus SfN members, including their challenges, collaborations, and hopes for the field. Comprising five interviews with neuroscientists from the United States, France, and Argentina, the series features advice on topics such as resilience, community building, and career transitions.

As a platform for year-round training and professional development, Neuronline demonstrates the value of global collaboration. SfN interviewed scientists from England and Canada as well as China and the United States who shared insights about the benefits of collaboration, managing difficulties in communicating across oceans, and engaging in successful PI-postdoc research collaborations. These videos offer additional membership benefits by supplementing existing articles on productive collaborations, global networking, and experiences abroad.

In May 2018, Neuronline moved to a staged access model that encourages scientists worldwide to grow in their careers and share applicable resources. This model provides open access to five Neuronline resources of a visitor's choosing every 30 days, exposing prospective members to the breadth and quality of content available to SfN members year-round. After

exploring five resources, SfN members can log in to continue to explore all available resources. This Neuronline open-access model has led to a 6 percent increase in page views and an 11 percent increase in time spent on each article—evidence that the model encourages more visitors to engage with Neuronline content.

#### STRENGTHENING SfN'S GLOBAL NETWORK

In recognition of continued financial pressures facing many scientists and to build greater awareness of the value of SfN membership, SfN offered two-year membership, covering 2018 and 2019, at a 20 percent discount for both years. This membership incentive was intended to encourage the continued participation of scientists at all career stages and disciplines, reflecting the value the Society places on scientific diversity.

Identifying support for trainees as a priority area for FY 2018, SfN Council continued its contribution to the Trainee Professional Development Award (TPDA) Program. These awards provide young scientists with the chance to attend Neuroscience 2018 to present their science in a TPDA poster session, to attend any of 14 professional development workshops, and to network with peers and leaders in the field. Council committed \$100,000 plus an additional \$100,000 in matching of direct contributions to the Friends of SfN Fund, with plans to share year-round training opportunities in FY 2019 such as a leadership development program.

With a focus on highlighting the value of the global scientific community, SfN recognizes effective local neuroscience communities among its nearly 160 global chapters through its Chapter of the Year Award and additionally is leveraging creativity and collaboration

among SfN chapters through SfN Chapter Grants. In 2018, SfN granted nearly \$100,000 to SfN chapters around the world to support local professional development activities, networking, and engagement in advocacy and with the public.



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SfN'S PROFESSIONAL DEVELOPMENT RESOURCES EMPOWER FEMALE SCIENTISTS AS WELL AS SCIENTISTS AT ANY STAGE OF THEIR CAREER TO CONDUCT RIGOROUS AND INNOVATIVE RESEARCH THAT ADVANCES THE FIELD.

SCIENCE *in* PROGRESS

## GLOBAL BRAIN INITIATIVES ARE TRANSFORMING THE WAY SCIENCE IS CONDUCTED AND SHARED

**A**S RESEARCHERS DISCOVER more about the brain, their findings uncover even more questions. Some researchers are striving to learn what prompts two neurons to form a synapse. Others are focused on how neural networks are built or what gives rise to consciousness, to personality, and to memories.

In the search for answers that define who we are, scientists are joining forces in large-scale collaborations that span scientific disciplines and, increasingly, international borders. This shift toward larger, open science is raising new questions about data accessibility and standardization and transforming how brain research is done.

Researchers in the Seung Lab, overseen by Sebastian Seung, of the Princeton Neuroscience Institute, are at the forefront of a new wave of collaborative projects aimed at deciphering the immense complexity of the brain, with its 150 trillion synapses connecting 86 billion neurons. One of the lab's projects, called Neo, crowdsources the arduous task of charting neural circuits to a

vast community of online gamers, with the goal of reconstructing a cubic millimeter of mouse primary visual cortex—about 100,000 neurons and 1 billion synapses—to begin to reveal how those connections encode the beginnings of perception.

Neo improves on the artificial intelligence algorithms developed for a similar project called Eyewire, which enlists gamers in building an interactive 3D map of the neurons in a sliver of mouse retina. Both are part of the Machine Intelligence from Cortical Networks (MICrONS) program funded by the Intelligence Advanced Research Projects Activity (IARPA). To date, Eyewire's mapping efforts have revealed six previously undiscovered cell types in the retina.

"As we're beginning to identify and classify the different cell types and find all these anomalies, I think it's going to be a pivotal resource for sharing neuroscience with non-neuroscientists," said Amy Sterling, executive director of Eyewire. "The entire data set will be publicly available as well as the reconstructions and the code. We're anticipating that

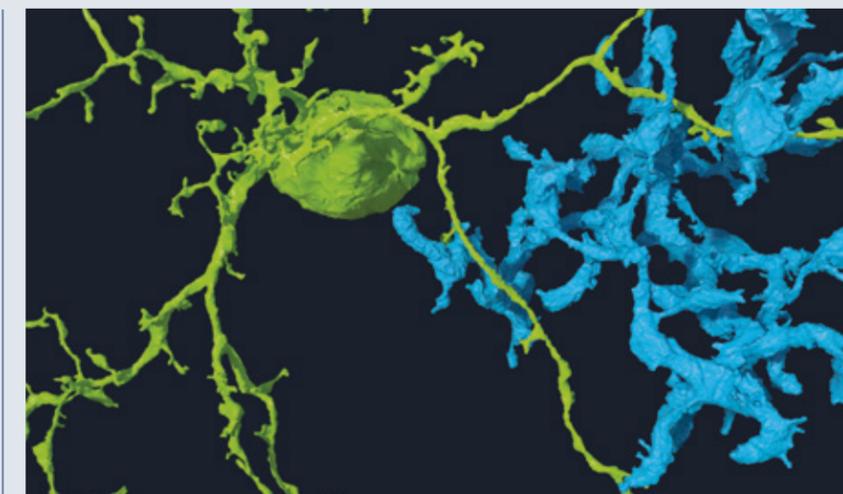
people will be making discoveries from it for quite some time after the MICrONS program finishes."

### THE BRAIN INITIATIVE

Neo is one of more than 500 projects encompassed in the U.S. Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, a multidisciplinary collaboration that this year celebrated its five-year anniversary. It received \$550 million from NIH as of FY 2017 and an additional \$400 million for FY 2018. It is also supported by NSF, the Defense Advanced Research Projects Agency (DARPA), IARPA, and other federal agencies as well as private foundations, institutions, and corporations, all of which are working together to deepen the understanding of the inner workings of the human mind and to improve treatment and prevention of disorders of the brain.

The BRAIN Initiative shows how cross-disciplinary investment and partnerships can drive innovative, high-impact research. Achievements in its first five years include identification of new cell types and detailed characterization of gene

SCIENCE *in* PROGRESS



NEURONS DISCOVERED BY GAMERS PLAYING EYEWIRE. A STARBURST INTERNEURON (GREEN) AND BIPOLAR CELL (BLUE, NO RELATION TO BIPOLAR DISORDER).

expression patterns in the brain; engineering of fluorescent proteins and advanced microscopy methods that allow researchers to witness neural activity and the release of the neurotransmitters dopamine and serotonin in the brains of living animals; improvement of whole brain imaging and optical techniques such as three-photon microscopy that enable researchers to look deeper inside the brain; and technological advances to help people with depression, paralysis, and other neurological disorders.

According to Richard Huganir, SfN president and director of The Solomon H. Snyder Department of Neuroscience at Johns Hopkins University, the BRAIN Initiative's emphasis on multidisciplinary collaborations is boosting the impact of the NIH investment.

"It's providing the tools that will accelerate discovery," he said. "The success of the BRAIN Initiative has been an exemplar for the world. A lot of people are starting their own initiatives, and there are now people trying to coordinate the different initiatives across different nations."

### GLOBAL BRAIN INITIATIVES

As the field faces increasingly complex questions and rising technological demands needed to investigate them, groups around the world are harnessing the power of collaborations with large, coordinated efforts that transcend borders, with the goal of inspiring creative approaches to research.

One of the first international initiatives to emerge was the Human Brain Project (HBP), a 10-year commitment launched by the European Union in late 2013. Using advanced information and communication technologies, the HBP aims to establish a robust integrated research infrastructure to advance brain science, medicine, and computing. Its six research platforms drive neuroscience projects that include detailing the structure and organization of human and rodent brains and both theoretical and experimental studies of cognition and neural systems.

In 2014, the Japanese government established the Brain Mapping by Integrated Neurotechnologies

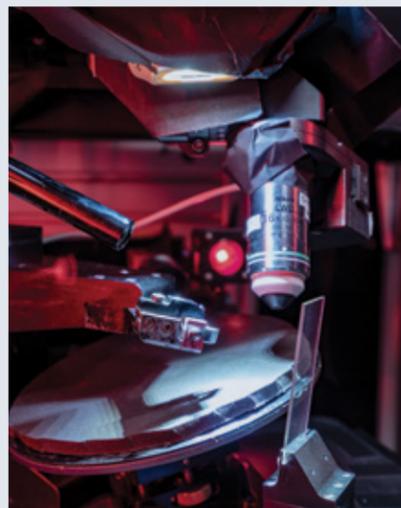
for Disease Studies (Brain/MINDS) project. This initiative focuses on developing the marmoset as a new animal model for studying the neural networks controlling higher-order functions, which are often implicated in disorders of the human brain. The major goals are the completion of a genome-wide atlas of gene expression changes in the marmoset brain throughout neural development and the creation of an integrated data platform to facilitate data access and sharing. The project is also developing novel imaging tools to aid research into brain disorders.

Brain/MINDS plans to collaborate with other initiatives including the China Brain Project, named "Brain Science and Brain-Inspired Intelligence," which uses another nonhuman primate, the macaque monkey, to study mechanisms underlying cognition and neuropathology. Planned to run from 2016 through 2030, the project seeks to improve early diagnosis and develop new therapeutic approaches for the neuropsychiatric and neurodegenerative diseases that affect an estimated one-fifth of China's population.

**SCIENCE in PROGRESS**

*The idea is to standardize, standardize, standardize, to the extent possible. Across labs, publish all your data and your metadata and all the details, the exact protocols, because, really, the small details matter, it turns out. They really matter.*

**CHRISTOF KOCH**, chief bioscientist and president of the Allen Institute for Brain Science



THIS PHOTO SHOWS THE SPECIALIZED MICROSCOPE THAT ALLOWS ALLEN INSTITUTE RESEARCHERS TO RECORD THE ACTIVITY OF NEURONS IN A MOUSE'S BRAIN WHILE IT LOOKS AT MOVIES, PICTURES, AND ARTIFICIAL STIMULI.

Similar efforts announced in 2016 include the Korea Brain Initiative, a 10-year plan to map the brain and strengthen partnerships with industry, and the Australian Brain Initiative, which will build on the country's expertise in neuroprosthetics to make advances in understanding healthy brain function and create industries based in neurotechnology. Meanwhile, Brain Canada has for 20 years been supporting collaborative research predicated on a "One Brain, One Community" approach that views the brain as a single, interconnected system with commonalities across multiple diseases.

In recognition of the increasingly global nature of research, representatives from many of the world's largest brain projects established the International Brain Initiative late last year. Comprising Europe, Japan, Korea, Australia, and the United States, the coalition in December 2017 issued a Declaration of Intent committing the global brain initiatives to align efforts with one another and with government, academic, industry, and public stakeholders; to devote resources to

data sharing and standardization; and to recognize ethical considerations that may arise from advances in neuroscience, neurotechnology, and artificial intelligence.

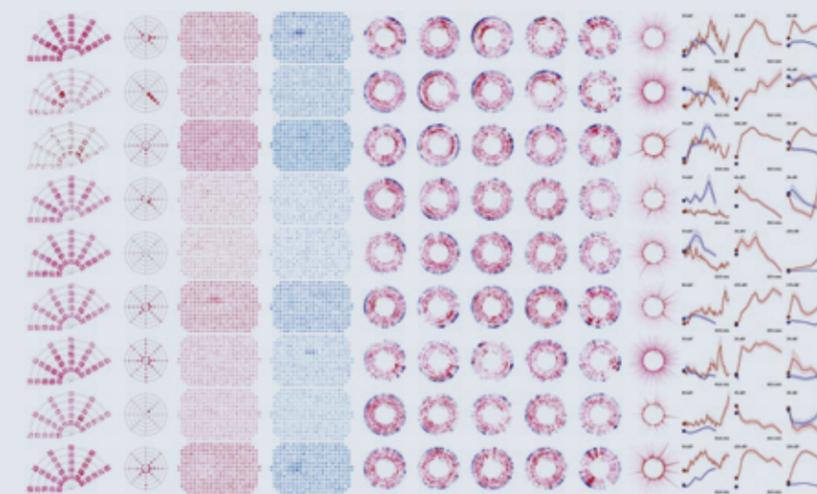
**OPEN SCIENCE**

The trend toward collaborative science is producing unprecedented amounts of data, necessitating additional collaborations to build tools for analyzing and sharing data accurately and reproducibly. With petabytes—millions of bytes—of information being collected and stored in data repositories and in the cloud, computational neuroscience on the exascale—capable of making a billion billion calculations per second—will play an increasingly important role in analyzing this data.

At the same time, the international community will need to coordinate to standardize data so scientists around the world can contribute and expand on findings. According to Christof Koch, chief bioscientist and president of the Allen Institute for Brain Science, making data and metadata openly available can result in more statistically valid results and

THESE BIG DATA VISUALIZATIONS SHOW THE RESPONSE OF INDIVIDUAL NEURONS IN THE MOUSE VISUAL CORTEX AS THEY FIRE IN RESPONSE TO VARIOUS TYPES OF PICTURES, MOVIES, AND ARTIFICIAL STIMULI AS A MOUSE WATCHES THEM ON A COMPUTER SCREEN. ALL OF THESE DATA ARE AVAILABLE IN THE ALLEN BRAIN OBSERVATORY.

**SCIENCE in PROGRESS**



mitigate the reproducibility crisis. Increased standardization of data collection and reporting can also help scientists to control as many aspects of the experimental process as possible.

"Even a single cell has thousands or tens of thousands of degrees of freedom: all the different proteins, all the different concentrations, what it was exposed to, etc.," Koch said. "The idea is to standardize, standardize, standardize, to the extent possible. Across labs, publish all your data and your metadata and all the details, the exact protocols, because, really, the small details matter, it turns out. They really matter."

Known for its publicly available data resources such as atlases of gene expression in adult and developing human and mouse brains, the Allen Institute for Brain Science is making strides to standardize neuroscience data on an international scale. For example, the Allen Cell Types Database features neurophysiology data in a format designed by the Neurodata Without Borders: Neurophysiology (NWB:N) project to reduce barriers to access. According to

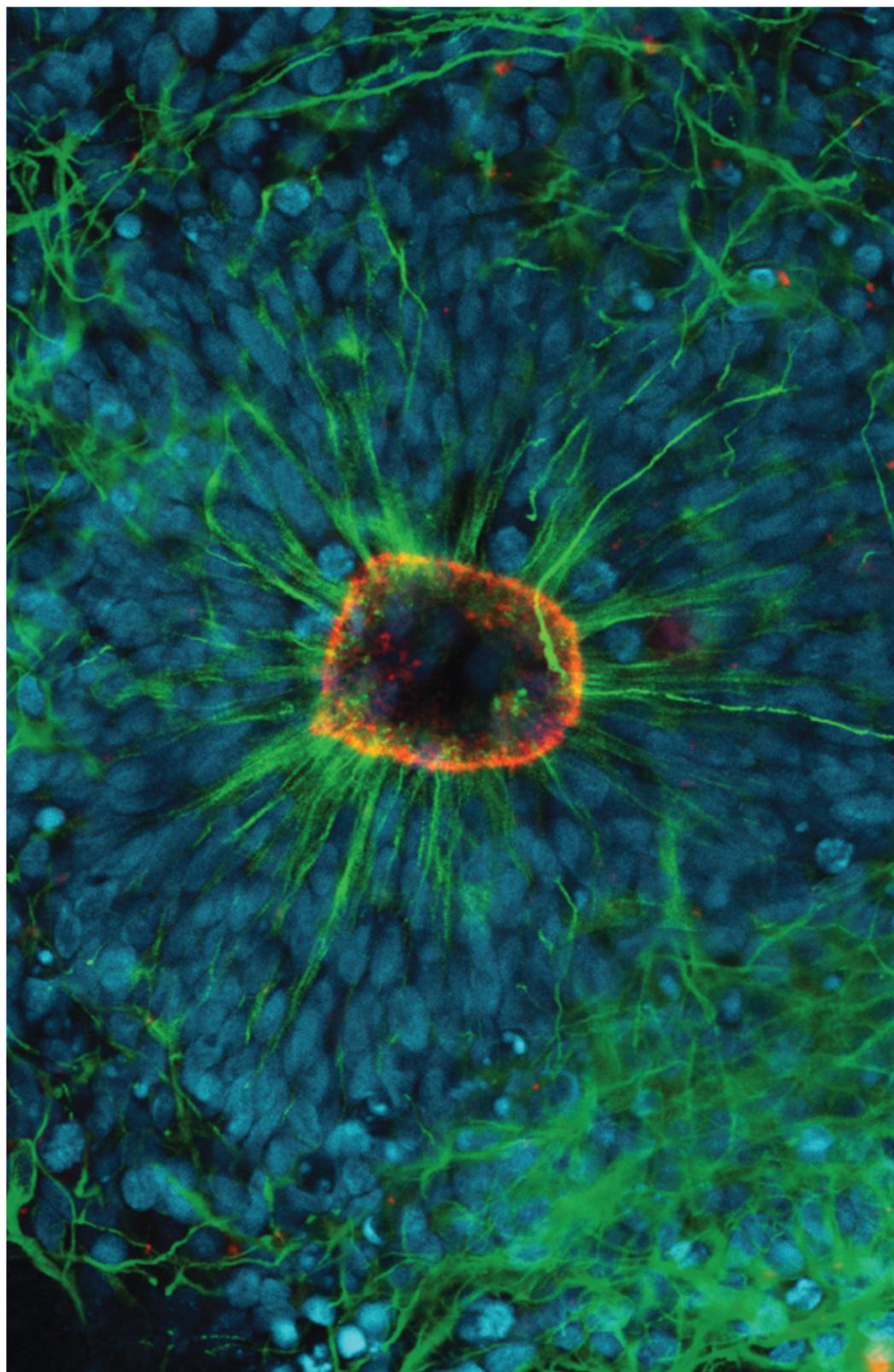
Koch, the Institute recently received funding from NIH to develop a way for scientists to translate data from other formats into NWB:N.

In addition, the Institute is leading three collaborative consortia established by grants from the BRAIN Initiative Cell Census Network (BICCN), which aims to create a comprehensive reference of cell types in the brain. "We're investing enormous amounts of resources into that, both for the mouse as well as for the human brain," Koch said. Two of the consortia will create whole-brain atlases of cell types in mouse and human brains. The third will develop a BRAIN Cell Data Center (BCDC) as a portal for compiling and sharing the data, tools, and knowledge generated by the BICCN.

With the continued involvement of the scientific community in defining research questions, coordinating large-scale projects, and sharing data, collaborations have the potential to accelerate scientific progress far beyond what any one lab or institution could accomplish. As the BRAIN Initiative Working Group 2.0 considers directions for the next

phase of the BRAIN Initiative, greater emphasis will be placed on translating basic science into clinical applications with a direct effect on human health and well-being.

"The long-term impact is that we're getting tools to be able to understand brain circuits and functions, what is controlling motivational states, emotion, fear. If we understand the circuits and the pathways and cell types involved, we can apply that to helping people with depression and other neurological and psychiatric diseases," Hugarir said. "The long-term benefit is going to be huge."



## Educating and Engaging the Public: Driving Narrative Around the Wonders of the Brain

*Any time you can have an interactive 3D atlas of a structure like the brain, which nobody really ever gets to interact with in real life in such a unique way, it is a great opportunity and a great tool.*

RAMONA VON LEDEN, *postdoctoral researcher, Dell Medical School, University of Texas at Austin*

By telling the stories of neuroscience underlying human behavior, *BrainFacts.org*, together with a new *Brain Facts* book and in-person outreach, is increasing global understanding of the brain.

Since the debut last October of a reimagined *BrainFacts.org*, which highlights an expansion of multimedia and interactive elements, the site has been visited by more users each month, more than 50 percent of whom reside outside of the U.S. This growing international audience for *BrainFacts.org* speaks to the worldwide interest in the brain.

### SHARING NEUROSCIENCE KNOWLEDGE

Founded in 2012 and relaunched after a complete redesign in 2017, *BrainFacts.org*, a public information initiative of The Kavli Foundation, the Gatsby Charitable Foundation, and SfN, is a trusted source of information about the brain and the nervous system, from functional neuroanatomy to diseases and disorders. A fundamental knowledge of how the brain works sets the foundation for knowing oneself and others, which can lead to increased self-awareness and understanding in both social and global interactions. *BrainFacts.org* explores the wonders

of the brain, telling the stories of how the connections and processes in our brains make us who we are. Some of these stories show why animal models are necessary to the breakthroughs that lead to clinical advances. By building shared knowledge, it also increases support for neuroscience research, which allows us collectively to understand the brain more deeply and solve human problems.

Keeping the focus on user experience, *BrainFacts.org* strives to develop compelling narrative inclusive of all content forms: articles, images, videos, interactives, and more. By increasing user engagement with *BrainFacts.org*, SfN can further reach its public audience.

With nearly 230,000 page views from the time of the site's relaunch to the end of FY 2018, the most visited piece of content was a scientifically accurate, interactive 3D brain model, supported by funding from the Wellcome Trust. The model allows users to visualize and

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ENGAGING WITH THE PUBLIC AROUND THE WONDERS OF THE BRAIN RAISES AWARENESS OF THE IMPORTANCE OF BRAIN RESEARCH AND HELPS TO INFORM THE PUBLIC ABOUT HOW THEY CAN PARTICIPATE IN DISCUSSIONS ABOUT ITS FUTURE.



isolate parts of the brain and to read short descriptions of their functions. Its development was overseen by expert neuroanatomists and neuroscientists, and it was modeled on data sets from the Allen Human Brain Atlas, which integrates multimodal anatomic and genomic data to map gene expression across the brain.

The *BrainFacts.org* site redesign brought to life the Neuroscience Core Concepts, eight key principles of neuroscience as determined by SfN's Public Education and Communication Committee. Each concept is now accompanied by animations and interactives, illustrating and reinforcing the concept and supporting all types of learning. SfN mapped the Neuroscience Core Concepts to the U.S. National Science Education Standards in 2009. Mirroring this effort, and supported by funding from the Wellcome Trust, SfN partnered with the British Neuroscience Association (BNA) this year to align the Neuroscience Core Concepts to the U.K. National Curriculum for biology at all levels. The resulting series of 21 curriculum maps were well received at the annual meeting of The Association for Science

Education in January 2018 and are accessible on both *BrainFacts.org* and the BNA website.

*BrainFacts.org* is designed to support users' curiosity through tangential learning, resulting in more time spent on the site. Revised navigation more quickly connects site visitors with the information they are looking for while encouraging exploration. On the home page, icons indicate content type, and at the bottom of every piece of content, readers can find suggested related topics, articles within the same topic, and trending articles. Anatomical descriptions in the 3D brain model help users to recognize how structures work individually and together to guide thoughts, perceptions, memories, emotions, and actions.

With new core support from the Lundbeck Foundation as a five-year grant starting in FY 2019, SfN plans to increase the functionality of the 3D brain model and is considering ways to expand the multimedia content of *BrainFacts.org*. SfN continues to receive funding from the Stanley Center for Psychiatric Research at the Broad Institute for mental health-related

content and also received support from the BRAIN Initiative Alliance and NIH for content on the discoveries funded by the BRAIN Initiative.

#### THE STORY OF BRAIN FACTS

In May, SfN published the eighth edition of *Brain Facts*, a book used by secondary school teachers to supplement science curricula and by the science-interested public to learn more about the brain. The first edition, published in 1990, was 32 pages; the eighth edition spans 140 pages and includes new chapters as well as an extensive glossary. Additionally, the Neuroscience Core Concepts are now designated as such throughout the book to more closely align with *BrainFacts.org*. Teachers may request one free copy of the book, and others can download it on *BrainFacts.org*.

The *Brain Facts* book serves as a source of questions in the Brain Bee, a neuroscience competition for secondary school students that begins at the local level and culminates in an international competition, which this year took place July 5 in Berlin at the 11th Federation of European Neuroscience Societies (FENS) Forum of Neuroscience. SfN

hosts the D.C. Chapter Brain Bee, one of approximately 175 local Brain Bee competitions that are held in more than 50 countries, engaging over 25,000 students across six continents every year.

SfN joined this year with the American Psychological Association (APA), the Dana Foundation, FENS, and the International Brain Research Organization (IBRO), in partnership with International Brain Bee (IBB) Founder Norbert Myslinski, from the University of Maryland, Baltimore, to provide funding to support the formal establishment of the IBB as a nonprofit educational organization. The primary goal of the IBB is to motivate students to learn about the brain and to inspire them to pursue careers in neuroscience so they may treat and find cures for brain disorders.

#### GLOBAL CONNECTIONS

SfN continually looks for ways to provide opportunities for members to engage nonscientists in their local communities with their science. This year, SfN focused on growing these outreach opportunities to reach key audiences in new ways, strengthening connections between scientists and nonscientists and expanding public understanding of the importance of neuroscience research.

Brain Awareness Week (BAW), a global coming together for one week every March in celebration of the brain, was started by The Dana Foundation in 1995 to increase public awareness

of the progress and benefits of brain research. On March 12, SfN hosted a webinar on *BrainFacts.org* on the topic of memory that provided an online, interactive experience for anyone who did not have a local event to attend and that was accessible anywhere in the world. SfN also hosts an annual Brain Awareness Video Contest, in which participants make a video that presents a neuroscience topic creatively. The 2018 contest received 26 submissions, and the first-place winner received a trip to the SfN annual meeting. All of the winning videos are posted on *BrainFacts.org*.

In addition, SfN members and staff traveled to conferences around the U.S., including American Association for the Advancement of Science (AAAS) Family Science Days, the D.C. STEM Festival, the USA Science and Engineering Festival, and Science Unrestricted. These in-person outreach events offered attendees the opportunity to participate in workshops and to ask questions of SfN member volunteers. SfN staff led hands-on activities and distributed educational resources on a breadth of neuroscience topics. At the National Science Teachers Association National Meeting, which was attended by more than 8,000 teachers, and conferences sponsored by The Association for Science Education in the United Kingdom, science teachers interacted with the 3D brain model and discovered ways to use it to inform their lessons.

*We always hope that teaching science and neuroscience to kids at schools will bring them to university to learn neuroscience, to study neuroscience as a student and as researchers, but it's also very important to me to reach the families, and to reach the general public.*

JACQUES NOËL, professor, Université Côte d'Azur and researcher, Institute of Molecular and Cellular Pharmacology (CNRS), France



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BRAIN FACTS AND RELATED EDUCATIONAL RESOURCES HELP TO PROVIDE CHILDREN AROUND THE WORLD WITH FOUNDATIONAL KNOWLEDGE ABOUT THE BRAIN.

SCIENCE in PROGRESS

SCIENCE in PROGRESS

# UNLOCKING THE MOLECULAR MYSTERIES OF ADDICTION AND DEPRESSION

**A**DDICTION AND DEPRESSION are mental health disorders with biological origins in the brain. They are also public health challenges with serious consequences. Globally, depression is the leading cause of disability, affecting up to 15 percent of the population, while addiction's devastating effects have made headlines across the globe and especially in the United States in relation to the opioid crisis. Unfortunately, today's treatments for addiction and depression are inadequate for many patients. Continued basic research is needed in order to better understand these disorders and formulate more effective therapeutics.

SfN Past President Eric Nestler has spent the last 30 years studying how the brain changes at the molecular level in response to addiction and depression. Nestler, Nash Family Professor of Neuroscience and director of the Friedman Brain Institute at the Icahn School of Medicine at Mount Sinai, uses animal models of these disorders to determine how drugs of abuse or stress change the brain, leading to addiction- or depression-like behaviors.

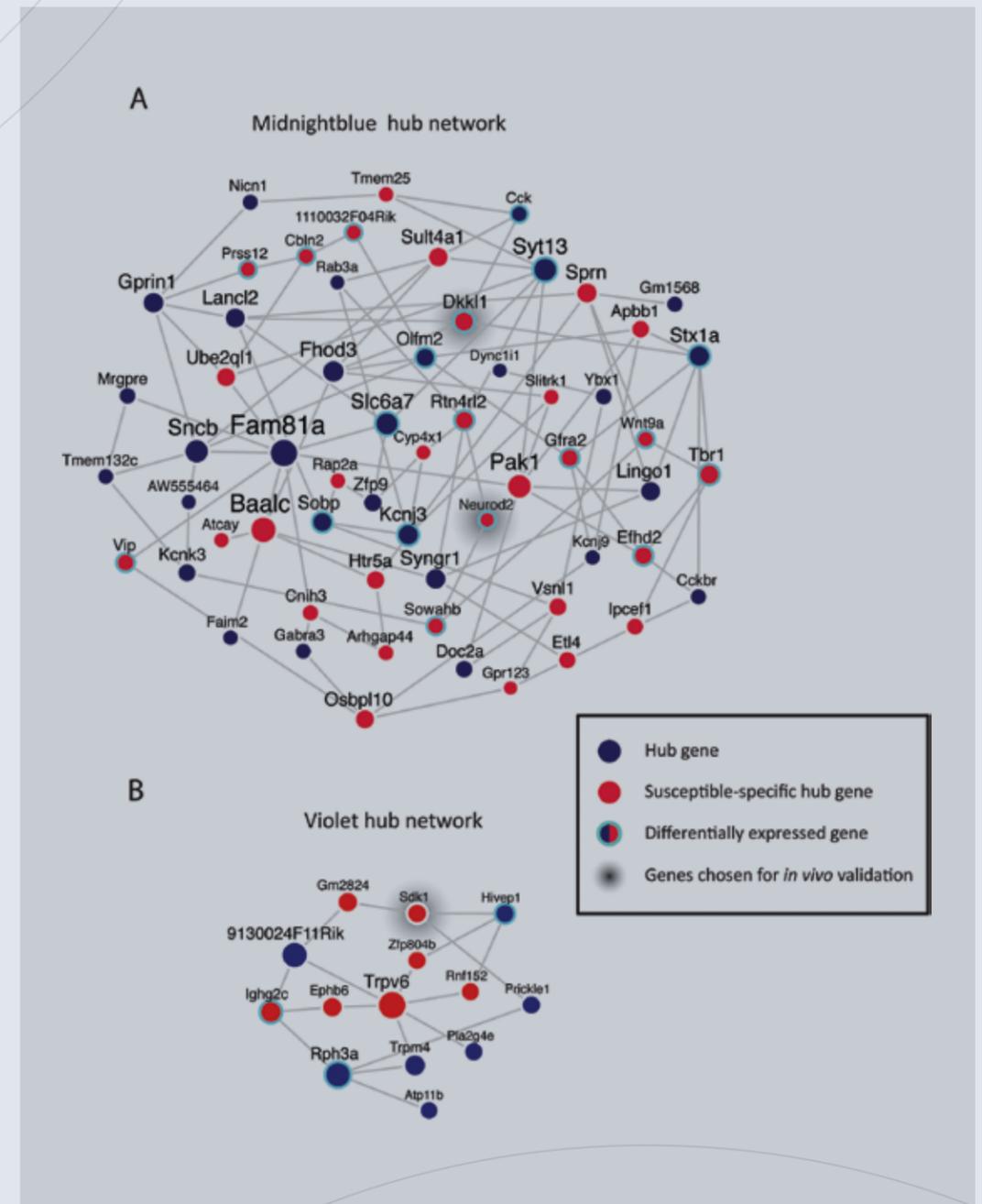
*We have learned an enormous amount about how the brain functions under normal conditions at the molecular, cellular, and circuit levels and what goes wrong in individual syndromes, addiction and depression among them.*

ERIC NESTLER, *Nash Family Professor of Neuroscience and director of the Friedman Brain Institute at the Icahn School of Medicine at Mount Sinai*

Nestler studies addiction and depression together because they both involve key emotional centers in the brain called reward pathways. These brain regions, including the nucleus accumbens and ventral tegmental area, control mood, motivation, and sense of well-being. Nestler's research shows that these reward pathways change over time in response to drug abuse and stress, resulting in the dramatic alterations in motivation and reward processing that characterize both addiction and depression.

Like most psychiatric disorders, addiction and depression are defined behaviorally: There is no objective laboratory measure, such as a blood

test or brain scan, with which to diagnose patients or determine a course of treatment for these disorders. The animal models in the Nestler Laboratory, however, accurately replicate much of the human addiction syndrome. If given the opportunity, animals will self-administer drugs and a subset will become addicted, choosing to take drugs at the cost of eating and socializing. More challenging is determining whether a mouse is depressed. Nestler uses stress-induced models of depression, in which mice or rats are exposed to periods of social or other types of stress; some of the stressed animals will develop behaviors that resemble human depression, such as not eating,



FROM THE PAPER "CIRCUIT-WIDE TRANSCRIPTIONAL PROFILING REVEALS BRAIN REGION-SPECIFIC GENE NETWORKS REGULATING DEPRESSION SUSCEPTIBILITY," ON WHICH ERIC NESTLER WAS SENIOR AUTHOR. THE PAPER INVESTIGATED MOLECULAR MECHANISMS OF DYSREGULATED CIRCUIT FUNCTION IN DEPRESSION TO IDENTIFY DISTINCT INTERREGIONAL TRANSCRIPTIONAL NETWORKS REGULATING DEPRESSION SUSCEPTIBILITY AND RESILIENCE. THE IMAGES SHOW HUB GENE COEXPRESSION NETWORKS OF TWO MODULES (MIDNIGHT BLUE AND VIOLET) IN SUSCEPTIBLE MICE.

**SCIENCE in PROGRESS**



ERIC NESTLER, NASH FAMILY PROFESSOR OF NEUROSCIENCE AND DIRECTOR OF THE FRIEDMAN BRAIN INSTITUTE AT THE ICAHN SCHOOL OF MEDICINE AT MOUNT SINAI, WITH MARIE DOYLE, ASSOCIATE RESEARCHER (LEFT), AND DOMINIKA BUREK, ASSOCIATE RESEARCHER (RIGHT).

sleeping, and interacting with other animals normally.

Using these powerful models, Nestler has been able to home in on the molecular changes that drugs and stress induce in the brain's reward pathways and how these changes contribute to the behavioral symptoms of addiction and depression.

An important component of Nestler's work has been examining not only the mice that succumb to stress but also those that are resistant to it. This recapitulates the human condition, as most individuals function normally despite exposure to severe stress. He has identified molecular, cellular, and circuit-level changes that underlie resilience to stress. These findings could lead to novel approaches to developing antidepressant medications, such as through promoting resilience rather than simply opposing the harmful effects of stress.

Another contribution of Nestler's work has been his pioneering use of a technique known as viral-mediated gene transfer to turn genes on and off in specific cells of an adult animal's brain. This method involves the use of recombinant viruses to express a protein in certain cell types in a localized brain area. "Using this technique, we were able to provide causal evidence that individual genes and proteins acting in a specific cell type are crucial in addiction-and depression-related phenomena," Nestler said.

Additionally, Nestler has helped to demonstrate the important role of epigenetics in mediating addiction and depression. Epigenetic changes occur when an environmental stimulus, such as drug abuse or stress, produces long-lasting changes in the way an organism's genetic code is expressed. Behavioral experience could create such permanent changes in the brain and be a contributing factor to the lifelong consequences of many psychiatric disorders.

**SCIENCE in PROGRESS**

*The advances being made at both the molecular and the circuit level are making it possible to bridge the gap between these two dimensions of brain function. We will establish a more complete understanding of the brain and its diseases so that we can do a far better job of mining that information for more effective treatments for our patients.*

ERIC NESTLER

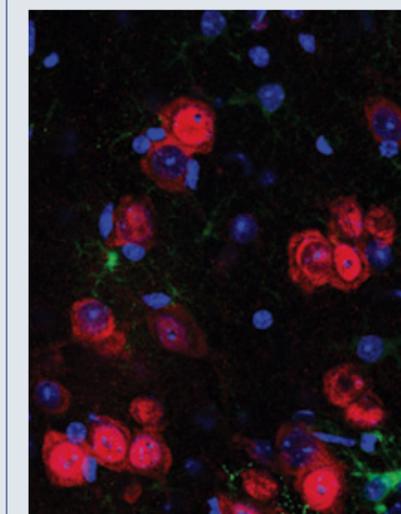
"We have provided evidence that some of the same types of epigenetic modifications that control cell differentiation during development or cell transformation in cancer are involved in analogous ways in mediating the long-lasting effects of drugs of abuse and stress on the brain and behavior," Nestler said.

Nestler believes that an improved understanding of the molecular changes that occur in addiction and depression will ultimately lead to innovative therapies that address the changes in the brain that drive addictive and depressive behaviors. "We have learned an enormous amount about how the brain functions under normal conditions at the molecular, cellular, and circuit levels and what goes wrong in individual syndromes, addiction and depression among them," he said.

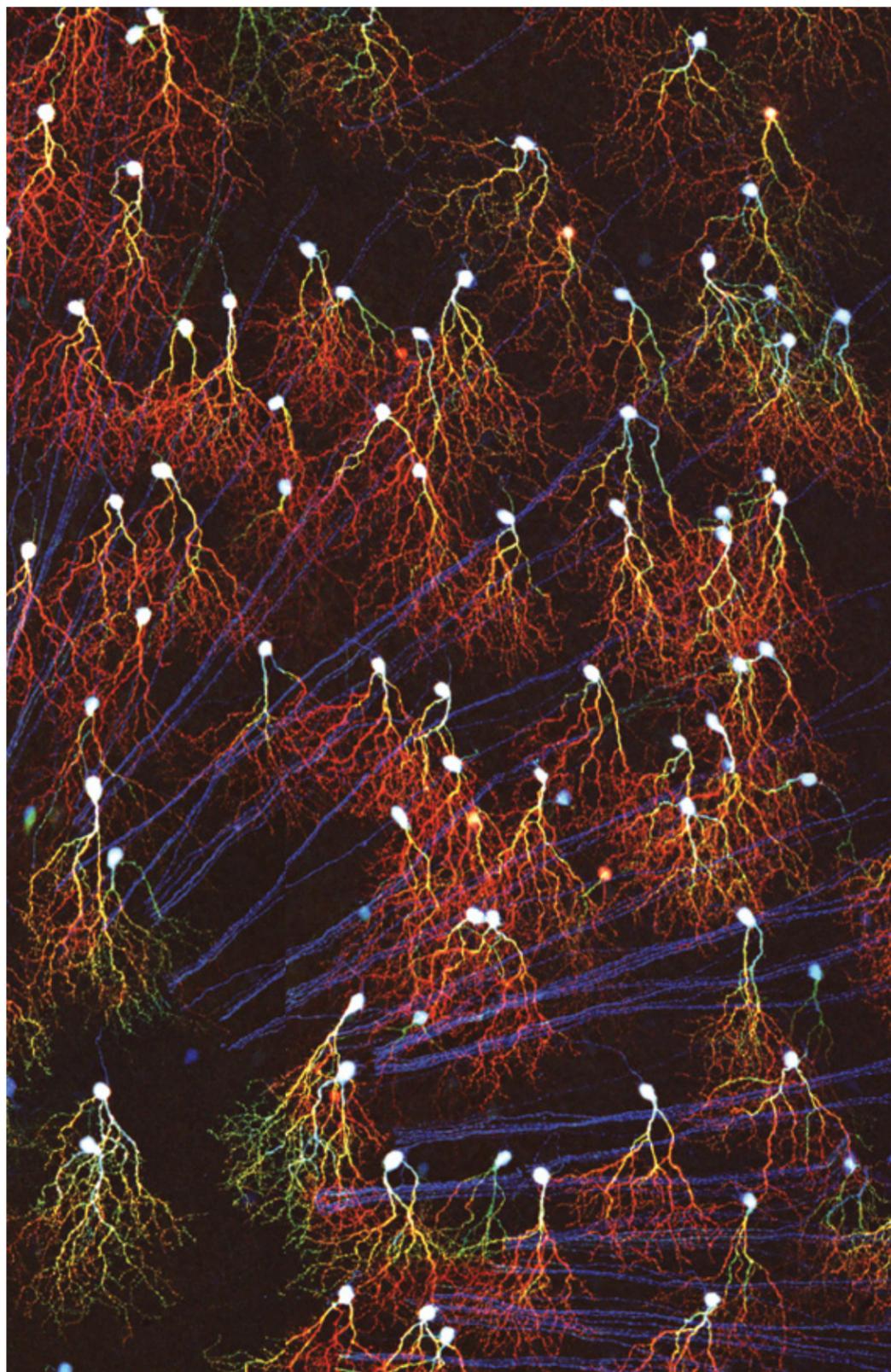
The challenge will be to translate that knowledge into the clinic—in addition to the molecular changes that take place in individual brain cells, one must also consider the billions of connections among them.

"Attacking the molecular abnormalities in one or a few types of brain cells will not be enough. To understand these syndromes, one also has to tackle the associated circuitry," Nestler said. Still, he remains optimistic.

"The advances being made at both the molecular and the circuit level are making it possible to bridge the gap between these two dimensions of brain function. We will establish a more complete understanding of the brain and its diseases so that we can do a far better job of mining that information for more effective treatments for our patients."



THIS IMAGE SHOWS VIRALLY TARGETED ASTROCYTES WITHIN THE MOUSE NUCLEUS ACCUMBENS.



## Advocating for the Field: Empowered Advocates Advance Neuroscience Funding

*Communicating your science is just as important as doing the science. It's up to me and to you, the scientists, to convey that to the public and to our members of Congress.*

NAOMI CHARALAMBAKIS,  
director, Science Policy and Outreach  
Group, University of Louisville School  
of Medicine, Kentucky

SfN members across the globe are taking a more active role than ever in advocating for science, yielding significant achievements for the field.

Acknowledging SfN members' expressed desire for more opportunities to advocate for neuroscience research, in FY 2018 the Society expanded its commitment to advocacy, with a focus on member engagement, cultivation of congressional champions, and increased advocacy-related communications via traditional and social media platforms. By engaging scientists as the best messengers for promoting investment in biomedical research and the responsible use of animals in the research process, SfN amplified its voice for neuroscience within the U.S. Congress and continues to advance neuroscience priorities across the globe.

The intersection of these efforts, combined with collaboration among SfN's science advocacy partners, contributed to key legislative accomplishments in FY 2018, including an additional \$3 billion in funding for NIH; a \$295 million increase for NSF; and the preservation of the tax-exempt status of graduate tuition waivers. These accomplishments contribute to the Society's goal of

promoting robust and predictable investment in basic and translational neuroscience research.

SfN continues to work with international organizations to advance neuroscience priorities in a locally and culturally relevant manner, including through continued partnerships with the International Brain Research Organization (IBRO), the Federation of European Neuroscience Societies (FENS), the Canadian Association for Neuroscience (CAN), and SfN's Mexico City Chapter.

### **INCREASING FEDERAL INVESTMENT THROUGH MEMBER ADVOCACY**

Working directly with advocacy leaders across the U.S., SfN entered the second phase of a long-term plan to provide opportunities for SfN members to establish relationships with their representatives and advocate the importance of funding for their research.

Expanding on the first phase of the plan, which mobilized member advocates in six key geographic areas, SfN identified an additional five priority areas for year-round focus, extending its advocacy presence into Miami, Florida; Montgomery and Birmingham, Alabama; Charleston, South Carolina; and the state of Missouri. Continued development of member advocates in these and other areas, combined with the continuation of the successful Early Career Policy Ambassadors Program, will contribute to the continued growth of a nationwide network of coordinated neuroscience advocates.

This grassroots strategy provides local advocacy leaders with the tools and skills necessary to form local cohorts of dedicated advocates who host lab tours, schedule in-district meetings, and organize local events to build relationships with members of Congress and demonstrate the need for neuroscience funding. To further amplify this message, SfN also worked with members to write and publish op-eds in newspapers across the country to reach both policymakers and the public.

Further growing the network of neuroscience advocates, the Early Career Policy Ambassadors (ECPA) Program entered its fifth year in FY 2018, representing 12 institutions across 11 states. Throughout the year, ECPAs planned and carried out a substantive list of advocacy activities, from producing a policy-themed newsletter to coordinating regional Hill Days to crafting policy-focused seminars for colleagues in their local areas. In an era in which diverse issues compete for limited federal funds, the advocacy efforts of ECPAs and members across the U.S. boost recognition of the impact of neuroscience research and ensure that neuroscience priorities are recognized in Congress.



AT CAPITOL HILL DAY, SfN MEMBERS LED CONVERSATIONS WITH POLICYMAKERS ABOUT HOW INVESTMENT IN BASIC AND BIOMEDICAL RESEARCH LEADS TO DISCOVERIES THAT IMPROVE HUMAN HEALTH.

**FOSTERING ADVOCACY COMMUNICATION SKILLS**

Understanding that the crux of effective advocacy is tailored communication with policymakers, SfN held a Public Advocacy Forum at Neuroscience 2017, “Advocating for Basic Science in a Disease-Focused World,” to endow scientists with skills for communicating the value of basic neuroscience research for developing treatments for a wide range of diseases and disorders. In collaboration with Research!America, SfN also deployed a four-part webinar training series titled “Taking Your Advocacy to the Next Level.” Available on demand, the series offers members key takeaways to apply to their

advocacy activities, from inspiring others to become advocates to measuring advocacy outcomes.

The Society also developed an advocacy training program that will pilot in late 2018. This interactive training will educate neuroscientists at any stage of their career about the importance of building relationships with policymakers.

**ADVOCATING ON CAPITOL HILL**

Capitol Hill Day in March 2018 was another major highlight for advocacy this fiscal year. More than 50 SfN members, including the newly selected class of ECPAs, met with 93 congressional offices, garnering

hundreds of social media posts including messages from Sens. Roy Blunt (R-MO) and Jack Reed (D-RI). At the start of the event, SfN honored Sen. Roy Blunt (R-MO) and Rep. Tom Cole (R-OK) with its 2017 Public Advocacy Award, recognizing their strong leadership of the successful congressional effort to increase federal funding for biomedical research.

SfN’s annual meeting in Washington, D.C., provided a unique opportunity to showcase neuroscience to congressional offices. Nine congressional offices met with constituents at Neuroscience 2017 to take in the breadth of research presented on the poster floor. These interactions between scientists and lawmakers help policymakers to understand how the decisions they make about federal investment in biomedical research translate into scientific progress and economic growth.

Earlier this year, SfN President Richard Haganir submitted congressional testimony on behalf of NIH and NSF, underscoring the value of strong investment in basic scientific research. Moving forward, members can expect SfN to build on these successes to increase its advocacy efforts, build more relationships with policymakers, encourage further engagement with neuroscience advocates, and broaden its efforts to support basic and neuroscience research across an increasing span of topics and disciplines.

**SUPPORTING RESPONSIBLE USE OF ANIMALS IN RESEARCH**

SfN remains committed to making the case for the necessity of animal models for making discoveries that increase our understanding of the brain and the nervous system. The Neuroscience 2017 Animals in Research Panel brought a diverse group of scientists together to review and practice communication

techniques and the importance of highlighting the discoveries made possible through animal research.

SfN collaborated with a wide range of partners to issue recommendations to reduce the administrative burden related to animal research. This issue was raised directly with NIH in an effort to alleviate the pressures felt uniquely by research facilities. Further, Mar Sanchez, chair of SfN’s Committee on Animals in Research, penned an essay published in *Inside Higher Ed*, which reaches 1.5 million faculty and administrators in academia each month, regarding the need for institutions to proactively communicate the need for animal research and to protect researchers who conduct responsible animal research for scientific progress.

SfN also works with counterparts in Europe to support animal researchers and their institutions. By working with FENS and the European Animal Research Association (EARA), SfN provides neuroscientists with support and resources to help to convey the importance of their work with animal models to the public and policymakers across Europe. SfN maintains a formal relationship with FENS, which in turn supports the work conducted by EARA. By sharing information and resources, SfN, FENS, and EARA maintain critical lines of communication to address current issues related to animal research including opportunities to strengthen institutional support, provide engagement tactics, and maintain awareness related to efforts to discredit animal model-based research.



SfN PRESIDENT RICHARD HUGANIR AND REP. CATHY MCMORRIS RODGERS (R-WA-5), CO-CHAIR OF THE CONGRESSIONAL NEUROSCIENCE CAUCUS, CONNECTED AT CAPITOL HILL DAY ON NEUROSCIENCE PRIORITIES.

*[Biomedical research] is a point that has actually, in a divided and polarized time, brought Republicans and Democrats, conservatives and liberals, together. ... It’s a very compelling case to be made as to why these investments will pay off for the American people.*

TOM COLE, U.S. House Representative (R-OK)

SCIENCE *in* PROGRESS

## MITIGATING THE OPIOID CRISIS

**F**OR MILLENNIA, humans have employed opium and its derivatives to quell pain. Ancient societies around the globe cultivated opium poppies. To this day, opioids excel at tamping down the acute pain associated with surgery or severe injury.

For people suffering daily chronic pain, as an estimated 25 million Americans and 20 percent of people worldwide do, opioids may be ineffective while at the same time causing serious—even deadly—side effects. Unfortunately, the open-ended use of opioids to treat chronic pain—particularly in the U.S.—has fueled an opioid addiction epidemic.

In response to this rising epidemic, neuroscience researchers from around the world are working to develop new treatments for chronic pain.

“Tens of thousands of people who take opioids die every year, and so we need safer and more effective drugs for treating pain and related conditions,” said Bryan Roth, Michael Hooker Distinguished Professor at the University of North Carolina School of Medicine.

*Tens of thousands of people who take opioids die every year, and so we need safer and more effective drugs for treating pain and related conditions.*

**BRYAN ROTH**, *Michael Hooker Distinguished Professor at the University of North Carolina School of Medicine*

Opioids lessen pain by mimicking endorphins—neurotransmitters that bind opioid receptors in the brain and relieve pain. But side effects like respiratory depression, what kills people who overdose, and dependence, tolerance, and addiction—three separate but intertwined physiological effects—limit the use of opioids.

After one week of regular opioid use, all patients become dependent—they experience physical withdrawal including nausea and increased pain sensitivity if they stop taking the drug. Tolerance develops with longer-term use—the opioid dose that once relieved pain becomes inadequate, and the patient requires a higher dose. Addiction, or substance use disorder, is more complicated. People addicted to drugs seek the euphoric

“high” that opioids produce and take them inappropriately, often at great risk including death by overdose. Interfering with the development of any of these side effects could save lives.

Roth’s group aimed to design pain-relieving drugs without side effects. Opioids relieve pain by acting at four different receptors, including the mu and kappa receptors, which were discovered in the 1970s. Activating mu-opioid receptors relieves pain but risks addiction and respiratory depression. Drugs aimed at the kappa-opioid receptor also relieve pain, but cause hallucinations.

Roth’s team reasoned that knowing the structure of an activated receptor could guide their efforts. His team

—  
ALICE JIANG LOOKS OVER “THE ROBOT” (A ROBOTIC SMALL MOLECULE SCREENING DEVICE), WHICH SCREENS NOVEL PSYCHOACTIVE COMPOUNDS FOR PHARMACOLOGICAL AND FUNCTIONAL ACTIVITY AT CLONED HUMAN OR RODENT CNS RECEPTORS, CHANNELS, AND TRANSPORTERS FOR THE NATIONAL INSTITUTE OF MENTAL HEALTH’S PSYCHOACTIVE DRUG SCREENING PROGRAM (PDSP).



*The current opioid crisis impacts all of us, not just people addicted to opioids.*

*A concerted effort on the part of scientists and health care providers is needed to overcome this crisis.*

**TUAN TRANG**, *researcher at the University of Calgary, Canada*

focused on solving the structure of the kappa-opioid receptor (KOR). Using nanoantibodies to stabilize the receptors, the researchers mapped the structure of the activated KOR and synthesized a compound to fit snugly into it. The compound activated the pathway, lessening pain without triggering the pathway leading to respiratory depression and dependence. Roth’s team and others are using these structures to discover new medicines in a systematic way.

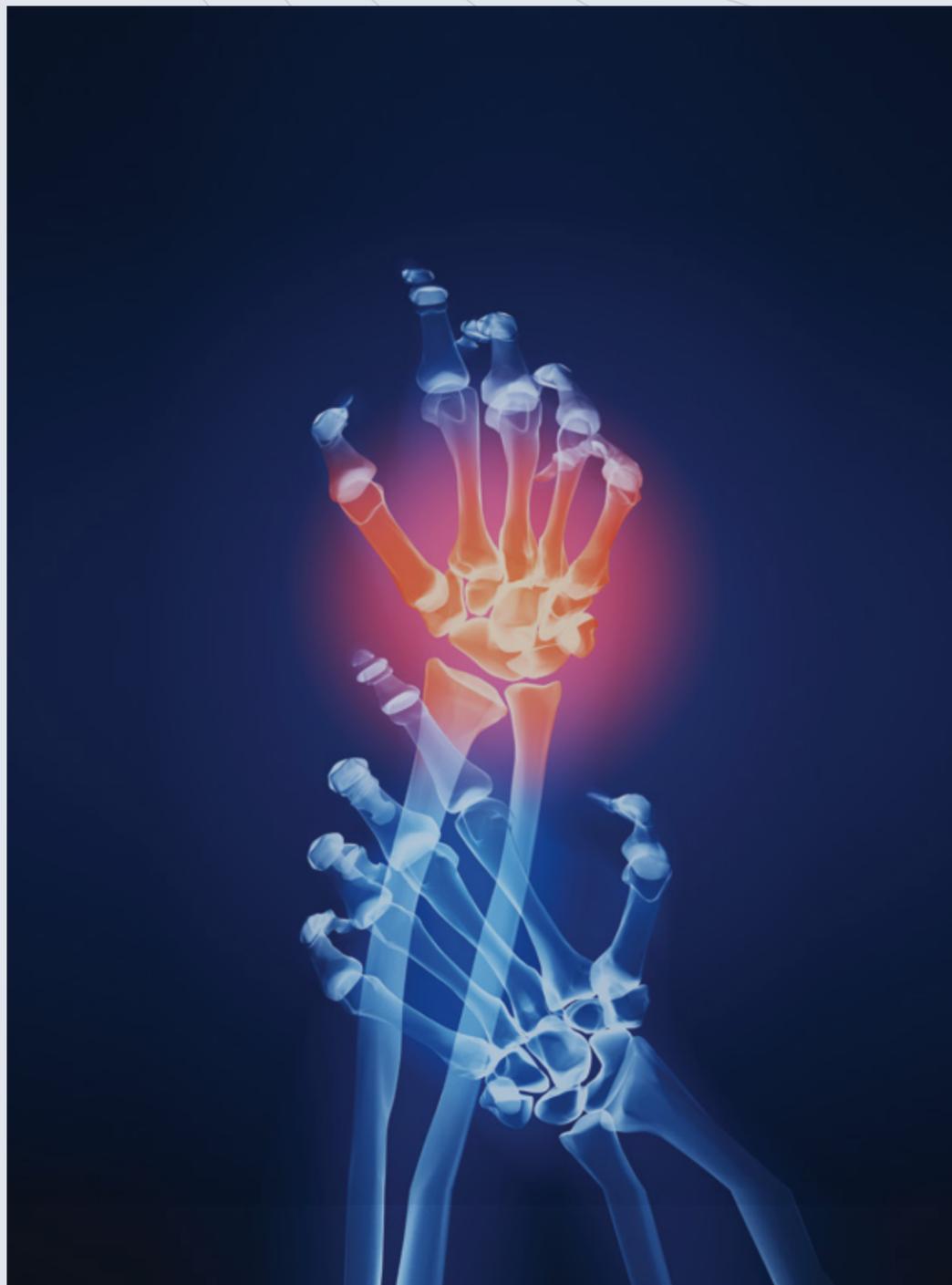
Taking a different tack, Japanese research has focused on tolerance. A team led by Taka-aki Koshimizu of Jichi Medical University and Yukio Takano of Fukuoka University identified a molecular complex—comprising vasopressin 1b receptors, mu-opioid receptors, and beta-arrestin-2—that not only heightens pain but accelerates morphine tolerance. Working with mice, the researchers disrupted the complex, slowing the development of tolerance without increasing pain. Drugs that break up this complex may reduce the amount of an opioid needed to treat pain by preventing tolerance.

For people dependent on opioids, stopping the drug outright means undergoing the muscle aches, nausea and vomiting, and diarrhea associated with opioid withdrawal. Tuan Trang, a researcher at the University of Calgary, in Canada, and his team explored the underlying causes of opioid withdrawal.

His team focused on microglia, specialized immune cells in the brain and spinal cord thought to be associated with opioid withdrawal. Working with rodents, the researchers blocked the pannexin-1 channel on microglia, alleviating the animals’ withdrawal symptoms. They also discovered that an anti-gout medicine called probenecid could block these channels, without affecting pain relief. Trang and his team are working to develop a clinical trial to test probenecid in humans.

The opioid crisis “must be addressed in a comprehensive, integrated, and strategic fashion,” Nora Volkow, director of the National Institute on Drug Abuse (NIDA), said, because it arises from interrelated factors including mismanagement of chronic

SCIENCE *in* PROGRESS



RESEARCHERS ARE INVESTIGATING WAYS TO MANAGE PAIN THAT DO NOT LEAD TO DEPENDENCE ON OPIOIDS, WHICH CAN BE DEADLY.

SCIENCE *in* PROGRESS



TEAGUE COLE AND ALICE JIANG AT THE BENCH, IN THE ROTH LAB AT THE UNIVERSITY OF NORTH CAROLINA.

pain, the availability of opioids, and economic distress.

NIH in collaboration with the U.S. Food and Drug Administration (FDA) and the private sector is working to accelerate biomedical research focused on stemming the opioid crisis by improving treatments for opioid misuse disorder and addiction, and by finding new treatments for chronic pain. In April 2018, it launched a program called the Helping to End Addiction Long-term (HEAL) Initiative.

Funding for this program will boost efforts to find new nonaddictive pain medications, such as those targeting voltage-gated sodium channels. Sodium channels provide the spark that helps neurons to “fire,” and blocking them would short-circuit pain signals from reaching the spinal cord.

“When you sit in the dentist’s chair, you don’t feel pain, because they have blocked your sodium channels with anesthetic,” Sulayman Dib-Hajj, STET of the Yale School of Medicine and the Veterans’ Affairs Medical Center,

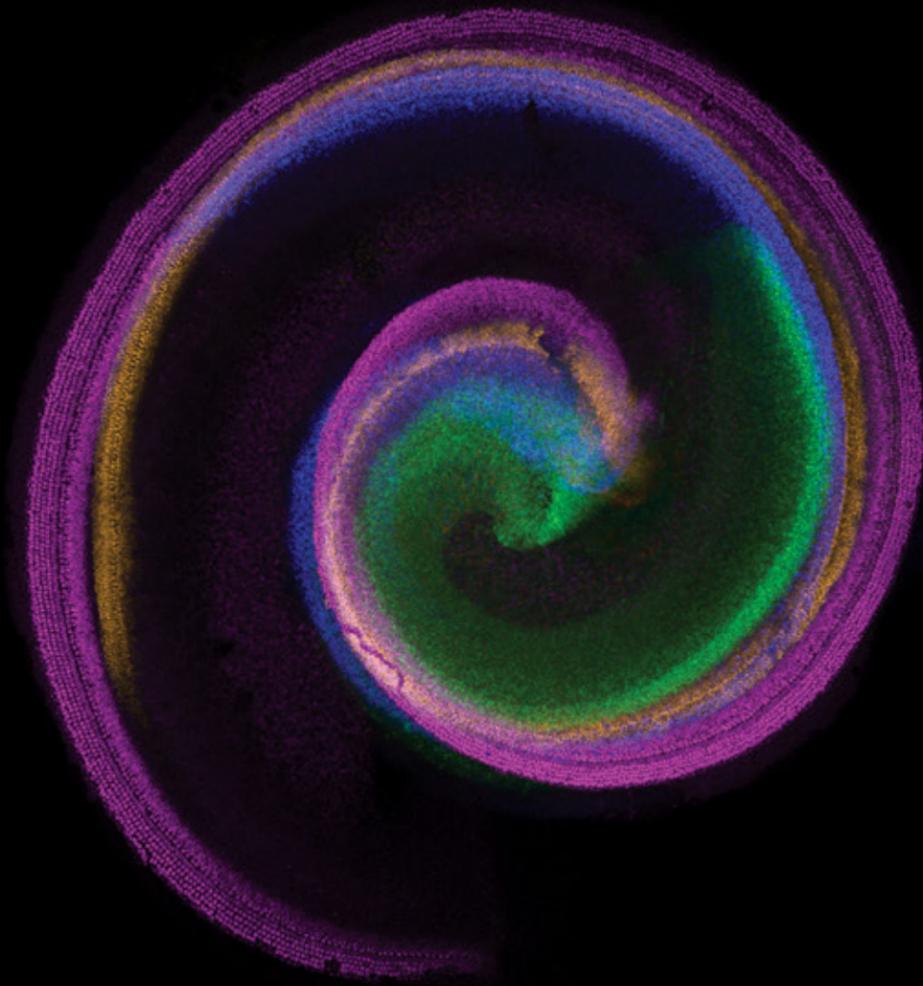
said. “The problem is the drugs are not selective.” Sodium channels are key to running the heart and brain as well as peripheral nerves, so blocking them all would be deadly.

One attractive drug target came from the realization in the 1990s that a particular channel called Nav1.7 is found only in peripheral nerves. Theoretically, a drug could block Nav1.7 and pain without stopping the heart and brain. The discovery that inherited pain syndromes result solely from genetic mutations in the gene for Nav1.7 solidified its potential as a target, and about a half dozen companies are currently developing drugs aimed at Nav1.7.

Another strategy employs the use of antibodies, tiny peptides aimed at proteins that contribute to pain sensations. Recently, the FDA approved an antibody aimed at the calcitonin gene-related peptide, a protein that causes migraine headaches. Nerve growth factor (NGF) is another pain-associated protein. It stimulates the growth and differentiation of neurons and also

serves as a pro-inflammatory mediator at pain-sensing neurons. Antibodies blocking NGF should dull pain. Early clinical studies of anti-NGF antibodies caused joint damage in some osteoarthritis patients, but researchers improved the safety of the treatment and more trials are now underway.

A concerted effort on the part of scientists and health care providers is important to overcome this crisis because it “impacts all of us, not just [people addicted to opioids],” Trang said.



*“It’s such an exciting time to be a neuroscientist. My colleagues in labs all around the world are deeply engaged in collaborating in scientific inquiries that are leading to breakthroughs that will help us to understand more about how the brain works, and about what makes us human.”*

—  
BARRY EVERITT, *incoming SfN president-elect and director of research at the University of Cambridge, United Kingdom*

# Financial and Organizational Highlights: Investing in Our Mission

Progress in neuroscience depends on responsible investment in opportunities to support the global neuroscience community. By drawing on its financial strength to facilitate connections among scientists of all backgrounds and disciplines, the Society for Neuroscience is ensuring its ability to catalyze scientific progress long into the future.

The Society’s finances remained strong in FY 2018, and the Society continues to deploy its financial strength to strategically invest in programs that support its members as they innovate, collaborate, and advance the field. With a net operating surplus inclusive of investment returns of about \$3.5 million at the end of FY 2018, SfN focused new and increased efforts on advocating for the field; creating opportunities for its global membership to advance their careers through accessible, year-round training; and disseminating information and discoveries to scientists and nonscientists through a number of public-facing venues.

SfN’s annual meeting and scientific journals remain the greatest sources of revenue, this year totaling over \$22 million, with continuing contributions from membership and from SfN’s investment in its headquarters building in Washington, D.C. SfN continues to deploy revenues and reserves in support of mission-focused activities, while maintaining an investment strategy that allowed the Society to end the fiscal year with reserves of approximately \$77 million.

As described in its Strategic Plan, and in alignment with its Organizational Values, SfN undertakes many activities

in collaboration with external strategic partners, both in the U.S. and across the globe. Key partners include other scientific societies and associations, health advocacy groups, foundations, public agencies, government entities, educational institutions, corporate entities, and information technology service providers. These collaborations take various forms, including direct fundraising by SfN, joint funding of shared priorities, robust information-sharing, and co-creation or coordinated execution of selected activities and strategies.

### INVESTMENT IN STRATEGIC OPPORTUNITIES

Recognizing the impact of projects undertaken in FY 2017, SfN Council allocated an additional \$2.25 million for FY 2018 to the Strategic Opportunities Fund, initiated in 2016 as a part of a plan by SfN Council to direct financial resources to high-impact organizational priorities as they arise. Council identified two new strategic priorities, expanding areas for investment from five to seven areas and actively enhancing the value of SfN membership.

A redesigned SfN.org launched in August 2018, featuring simplified navigation and reimagined content that clearly communicates the Society’s

mission and contributions to the field. With greater emphasis on user experience, SfN.org launched with and continues to grow its multimedia content such as video, graphics, and photography, allowing site visitors to learn about SfN and its mission in a variety of ways.

Following the *BrainFacts.org* relaunch in October 2017, the new 3D brain feature captured the most visitor time. The interactive 3D brain model allows visitors the opportunity to peer deep inside the brain, rotating and isolating parts of the model to get a full picture of different parts of the brain. Continued interaction of this popular feature with site content will enhance visitors’ ability to “explore the universe between our ears.”

SfN is investing in tools that will help the Society to better understand and meet the evolving needs of its membership by leveraging data to recognize trends, enhance business operations, and best serve member needs. This support will help to drive decision-making and program improvements by analyzing member engagement, scientific publications, professional development, marketing and communications, fundraising, and advocacy initiatives.

Increased opportunities for member engagement in grassroots advocacy complement efforts to communicate the importance of robust and predictable funding for neuroscience and biomedical research to lawmakers on Capitol Hill. SfN promotes opportunities for scientists to lead

advocacy activities within the research community through advocacy communications including op-eds and statements related to federal funding and support of scientific research on Capitol Hill.

As a part of expanding SfN’s year-round membership value, SfN continues to grow its offerings of accessible and engaging content and networking opportunities for members around the world through digital content and programs. SfN has invested in a regular series of four annual virtual conferences focused on scientific training and professional development topics, and the Neuroscience Training and Professional Development Committees have identified virtual conference topics through FY 2019 and into FY 2020.

### THE SUSTAINED VALUE OF GLOBAL COLLABORATION

SfN is thoughtfully investing in relationships with international partners to support strong connections among neuroscientists globally. For example, SfN provided funding to the Canadian Association for Neuroscience (CAN) to grow neuroscience advocacy programs in Canada; came together with other leading international neuroscience organizations to formalize and incorporate the International Brain Bee (IBB) organization; and contributed \$100,000 toward the recovery of the neuroscience community in Puerto Rico following Hurricane Maria.

As SfN looks forward to FY 2019 and the third year of its Strategic Opportunities Plan, it will continue to evaluate opportunities to drive scientifically rigorous and innovative programs that support its members and the global neuroscience community.

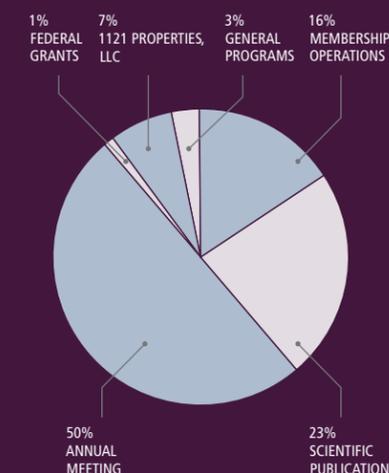
### LOOKING AHEAD

In FY 2018, several decisions were made to continue to support priorities of the Society, including adding \$100,000 of SfN funding to Trainee Professional Development Awards, along with a commitment to match donor contributions up to an additional \$100,000; and enhancing training opportunities through the development of a specialized series of online training modules and a series of virtual conferences. With the successful relaunch of *BrainFacts.org* in the fall of 2017, investment in new interactive content including educational games has remained a priority as the website evolves its content in a sophisticated and competitive online landscape. Further, Council extended the freeze of membership dues and journal publication fees through 2019 and designated a direct member benefit fund to direct resources as the need arises to support or subsidize activities that will decrease the financial impact on members, with a focus on benefiting trainees and members in under-resourced countries.

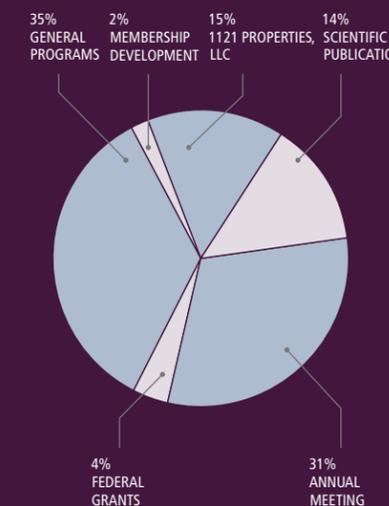
To celebrate SfN’s 50th anniversary in 2019 and 50th annual meeting in 2020, the Society is planning a series of celebrations, reflections, and activities spanning the 2019 and 2020 annual meetings in Chicago and Washington, D.C., with support from SfN Council. Additionally, special 50th anniversary content will be developed and shared across digital platforms including SfN.org.

FY 2018

**30,510,313\***  
REVENUE



**32,286,416\***  
EXPENSES



\* UNAUDITED

## PHOTOGRAPHY CREDITS

**COVER:** The image shows immunofluorescent labeling of cortical astrocytes stained with GFAP (yellow) and aquaporin 4 (pink). Neurons were stained with MAP2 (blue), and cell nuclei were stained with DAPI (green). The magnification was 60x. Note that GFAP is localized in the cell body and major astrocytic processes, whereas aquaporin 4 is primarily found in the vascular endfeet. Image by NancyAnn Oberheim and Takahiro Takano. Courtesy, with permission: Lovatt et al., 2007, *JNeurosci*, 27(45): 12255–12266.

**PAGE 6:** Confocal image of a hippocampal neuron grown on a glial cell microisland. The neuron was labeled with anti-MAP2 antibody (red). Blue staining (DAPI) identifies cell nuclei. Autaptic cultures of single hippocampal neurons were used to investigate the effects of intracellular accumulation of amyloid-β protein on glutamatergic synaptic transmission. Courtesy, with permission: Ripoli et al., 2014, *JNeurosci*, 34(38): 12893–12903.

**PAGE 8:** Immunofluorescence image reflecting the expression of the CB1 cannabinoid receptor (blue) in nestin-positive mouse hippocampal progenitors (green) that coexpress GFAP (red). In addition, CB1 is also present in differentiated astrocytes nestin-GFAP+ and other double-negative cells. Courtesy, with permission: Aguado et al., 2006, *JNeurosci*, 26(7): 1551–1561.

**PAGE 14:** This image shows oligodendrocytes in the mouse neocortex, derived from neural progenitors in the embryonic dorsal forebrain. Neural progenitor cells were electroporated in utero at embryonic day 15.5 with plasmids encoding various fluorescent proteins. These progenitors give rise to a diverse array of morphologically and functionally distinct cell types, including neurons, astrocytes and oligodendrocytes. During embryonic development, Sonic hedgehog from multiple sources acts as a timing mechanism that promotes the transition from neurogenesis to oligodendrogenesis in the neocortical progenitor pool. Courtesy, with permission: Winkler et al., 2018, *JNeurosci*, 38(23): 5237–5250.

**PAGE 20:** Expression of phosphorylated glycogen synthetase kinase 3 (GSK3; red) and β-tubulin (blue) in the CA1 region of a rat hippocampal slice in which late-LTP was induced. Synaptic stimulation that induces late-LTP also leads to the inhibitory phosphorylation of GSK3 in the apical dendrites of these neurons, an event that regulates the activity of mammalian target of rapamycin. Courtesy, with permission: Ma et al., 2011, *JNeurosci*, 31(48): 17537–17546.

**PAGE 25:** Neurons discovered by gamers playing EyeWire. A starburst interneuron (green) and bipolar cell (blue, no relation to bipolar disorder). These cells form part of a circuit that results in a mechanism of direction selectivity,

a mammal's ability to see which direction something is moving. Image by Alex Norton for EyeWire.

**PAGE 26:** This photo shows the specialized microscope that allows Allen Institute researchers to record the activity of neurons in a mouse's brain while it looks at movies, pictures, and artificial stimuli. Courtesy of the Allen Institute for Brain Science.

**PAGE 27:** These big data visualizations show the response of individual neurons in the mouse brain visual cortex as they fire in response to various types of pictures, movies, and artificial stimuli as a mouse watches them on a computer screen. All of these data are available in the Allen Brain Observatory. Courtesy of the Allen Institute for Brain Science.

**PAGE 28:** This image shows a neural rosette derived from a pluripotent stem cell. Apical localization of N-cadherin (red) is seen, with beta III tubulin (green) showing both polarized rosette cells, and non-polarized neuronal cells outside of the rosette. Nuclei are visualized with DAPI (blue). Courtesy, with permission: Coulthard, Hawksworth et al., 2017, *JNeurosci*, 37(22): 5395–5407.

**PAGE 33:** Figure 4. Hub Gene Coexpression Networks of MB and V Modules in Susceptible Mice (A) Network plot of hub genes within MB module. (B) Network plot of hub genes identified within V module. Node size is proportional to node's network centrality. Blue nodes indicate hub genes, red nodes indicate susceptible-specific hub genes, and cyan halos indicate differential expression of a gene early post-defeat in at least one brain region. Edges reflect significant interactions between genes based on mutual information. Early post-defeat, Dkk1 was differentially expressed inPFC (increased inRversus C) and AMY (decreased in both S versus C and R versus C), and Neurod2 was differentially expressed inNAC (increased inRversusC), whereas Sdk1 was not differentially expressed in any region. Courtesy, with permission: Bagot, Rosemary C. et al., 2016, *Neuron*, 90(5): P969–983.

**PAGE 34:** Eric Nestler with Marie Doyle, associate researcher (left), and Dominika Burek, associate researcher (right). Courtesy of the Nestler Lab.

**PAGE 35:** Confocal image of astrocytes selectively infected with a cre-dependent AAV virus expressing green fluorescent protein (GFP) in the nucleus accumbens of Aldh11-cre male mice. Astrocytes are in green; neurons, stained with NueN, are in red; and nuclei, stained with DAPI, are in blue. Courtesy of the Nestler Lab.

**PAGE 36:** This image is an *en face* view of developing type J retinal ganglion cells in the postnatal mouse retina.

Colors represent depth through the retina, with axons at the surface in blue and the deepest dendrites in red. Image by Jinyue Liu. Courtesy, with permission: 2017, *JNeurosci*, 37(50).

**PAGE 41:** Alice Jiang looks over “the robot” (a robotic small molecule screening device), which screens novel psychoactive compounds for pharmacological and functional activity at cloned human or rodent CNS receptors, channels, and transporters for the National Institute of Mental Health's Psychoactive Drug Screening Program (PDSP). Photo by Brian Strickland.

**PAGE 43:** Teague Cole and Alice Jiang at the bench, in the Roth Lab. Photo by Brian Strickland.

**PAGE 44:** Development of the sensory epithelium in the mouse cochlea. The developing sensory epithelium was labeled with an antibody against the prosensory marker Sox2 at embryonic day (E) 13.5 (green), E14.5 (blue), E16.5 (yellow), and E18.5 (magenta). Courtesy, with permission: Okano et al., 2011, *JNeurosci*, 31(49): 18104–18118.

**PAGE 50:** This hippocampal neuron, 14 d *in vitro*, lacks NMDA receptor subunit GluN2B. It was immunostained for the AMPA receptor subunit GluA1 (green), the vesicular glutamate transporter VGLUT1 (red), and the microtubule-associated protein MAP2 (blue). An edge-detect filter was used to enhance color and cluster contour. In the absence of the GluN2B subunit, synaptic clustering of AMPA receptors is increased as a result of impaired anchoring of the synaptic proteasome. Courtesy, with permission: Ferreira et al., 2015, *JNeurosci*, 35(22): 8462–8479.

**AUDITED FINANCIAL STATEMENTS COVER:** Serotonergic fibers (labeled for serotonin transporter; red) and cell nuclei (labeled with diamidino-2-phenylindole; blue) in the hippocampus of mice lacking cytoplasmic regions of protocadherin-α. The serotonergic fibers abnormally innervate the hippocampus. Courtesy, with permission: Katori et al., 2009, *JNeurosci*, 29(29): 9137–9147.

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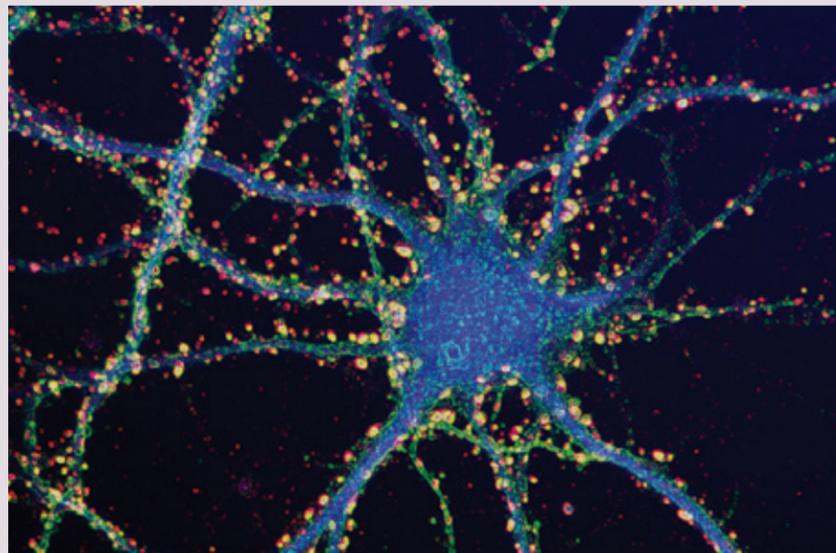
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THIS HIPPOCAMPAL NEURON, 14 D *IN VITRO*, LACKS NMDA RECEPTOR SUBUNIT GLUN2B. IT WAS IMMUNOSTAINED FOR THE AMPA RECEPTOR SUBUNIT GLUA1 (GREEN), THE VESICULAR GLUTAMATE TRANSPORTER VGLUT1 (RED), AND THE MICROTUBULE-ASSOCIATED PROTEIN MAP2 (BLUE).

“Science is a community endeavor. It’s not what it used to be before, where individual people might have done great things. I think now it’s really about working together globally.”

—  
 MARK MIKKELSEN, *Denmark, postdoctoral fellow at Johns Hopkins University*



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