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Larry Abbott, Emery Neal Brown, Terrence Sejnowski, and Haim Sompolinsky Share $500,000 Gruber Neuroscience Prize for Their Pioneering Contributions to Computational and Theoretical Neuroscience

Larry Abbott   Emery Neal Brown   Terrence Sejnowski   Haim Sompolinsky

May 17, 2022, New Haven, CT – The 2022 Gruber Neuroscience Prize is being awarded to Larry Abbott, PhD, of Columbia University, Emery Neal Brown, MD, PhD, of the Massachusetts Institute of Technology and Massachusetts General Hospital, Terrence Sejnowski, PhD, of the Salk Institute for Biological Studies and UC San Diego, and Haim Sompolinsky, PhD, of the Hebrew University of Jerusalem and Harvard University, for their seminal contributions to the fields of computational and theoretical neuroscience. As datasets have grown ever larger and more complex, these fields have played an increasingly important role in helping scientists unravel the mysteries of the how the brain functions in both health and disease.

The Gruber Neuroscience Prize, which includes a $500,000 award, will be presented to Abbott, Brown, Sejnowski, and Sompolinsky, in San Diego, California, on Nov. 13 at the annual meeting of the Society for Neuroscience.

"These four remarkable scientists have applied their expertise in mathematical and statistical analysis, physics, and machine learning to create theories, mathematical models, and tools that have greatly advanced how we study and understand the brain," says Joshua Sanes, Professor of Molecular and Cellular Biology and Founding Director of the Center for Brain Science, Harvard University, and member of the Selection Advisory Board to the Prize. "Their insights and research have not only transformed how

experimental neuroscientists do their research, but also are leading to promising new ways of providing clinical care."

In landmark studies, Abbott suggested how spike-timing dependent plasticity (STDP), a process by which neurons adjust their synaptic connections with each other, supports memory and learning. In collaboration with experimental groups, he has uncovered functional principles underlying neural circuits involved in sensory processing, including olfaction and electrosensation, and motor behaviors ranging from rhythmic pattern generation to navigation.

Brown's groundbreaking findings include a novel algorithm that decodes the position of an animal by observing the activity of a small group of place cells in the animal's brain. This finding established a new framework for specifying the relationship between the spike trains (the timing sequence of firing neurons) and factors from the outside world. Brown went on to develop more accurate and informative ways to monitor the brain state of patients receiving anesthesia for surgery.

Among Sejnowski's transformative contributions to computational neuroscience is the introduction of the first unsupervised learning algorithm for independent component analysis (ICA), which is now a mainstay in brain imaging. He has also shown that sleep spindles (brain wave patterns during non-rapid eye movement, or NREM, sleep) are not synchronous across the cortex, as was previously believed, but instead create circular traveling waves—a finding that has shed significant new light on how the brain learns and how memory is affected in disorders such as Alzheimer's disease.

Sompolinsky's pioneering research provided a deep understanding of attractor-network models that describe the collective behavior and informational processing of large, complex neural circuits in the brain. He has also described how the combination of neuronal excitation and inhibition lead to chaotic yet controllable patterns of activity in the brain—findings that have profoundly influenced our understanding of brain systems.

"By demonstrating that physics and mathematics can make an enormous contribution to neuroscience, Drs. Abbott, Brown, Sejnowski, and Sompolinsky have inspired an entire new generation of physicists and other quantitative scientists to follow in their footsteps," says Frances Jensen, Professor and Chair Department of Neurology, Co-Director Penn Medicine Translational Neuroscience Center, Perelman School of Medicine, University of Pennsylvania, and chair of the Selection Advisory Board to the Prize. "The ramifications for neuroscience have been broad and profound. It is a great pleasure to be honoring each of them with this prestigious award."

Additional Information

In addition to the cash award, each recipient will receive a gold laureate pin and a citation that reads:

The Gruber Foundation proudly presents the 2022 Neuroscience Prize to Larry Abbott, Emery Neal Brown, Terrence Sejnowski and Haim Sompolinsky for seminal contributions to computational and theoretical neuroscience. These fields are playing increasingly important roles in helping us understand the brain as datasets get so large and complex that they can no longer be grasped intuitively.

Bringing their expertise in physics, machine learning and statistics to neuroscience, each has generated theories, models and tools that are now widely used. Among them are: Abbott's models of homeostatic plasticity, olfactory processing and learning in networks; Brown's methods for decoding spike trains in behaving animals and analyzing synchronized oscillations during anesthesia; Sejnowski's independent component analysis method for distributing complex data into separate channels; and Sompolinsky's attractor and balanced state network models of complex circuit function.

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The Neuroscience Prize honors scientists for major discoveries that have advanced the understanding of the nervous system.

Laureates of the Gruber Neuroscience Prize:

- **2021: Christine Petit and Christopher A. Walsh,** for elucidating the genetic and molecular mechanisms that underlie human neurodevelopmental hereditary disorders
- **2020: Friedrich Bonhoeffer, Corey Goodman and Marc Tessier-Lavigne,** for elucidating developmental mechanisms that guide axons to their targets
- **2019: Joseph S. Takahashi,** for pioneering work on the molecular and genetic basis of circadian rhythms in mammals
- **2018: Ann M. Graybiel, Okihide Hikosaka and Wolfram Schultz,** for pioneering work in the study of the structure, organization and functions of the basal ganglia
- **2017: Joshua Sanes,** for groundbreaking discoveries about synapses, transforming our understanding of how the human brain functions
- **2016: Mu-Ming Poo,** for pioneering and inspiring work on synaptic plasticity
- **2015: Carla Shatz and Michael Greenberg,** for their elucidation of the molecular mechanisms through which neural activity controls wiring and plasticity of the brain
- **2014: Thomas Jessell,** for pioneering work on the differentiation of spinal cord neurons and their wiring into networks
- **2013: Eve Marder,** for contributions to understanding how circuit dynamics and behavior arise from the properties of component neurons and their synaptic connections
- **2012: Lily and Yuh Nung Jan,** for fundamental contributions to molecular neurobiology
- **2011: Huda Y. Zoghbi,** for work on revealing the genetic underpinnings of neurological disorders
- **2010: Robert H. Wurtz,** for pioneering work on neural bases of visual processing in primates
- **2009: Jeffrey C. Hall, Michael Rosbash,** and **Michael Young,** for revealing the gene-driven mechanism that controls rhythm in the nervous system
- **2008: John O'Keefe,** for discovering place cells, leading to important findings in cognitive neuroscience
- **2007: Shigetada Nakanishi,** for research into communication between nerve cells in the brain
- **2006: Masao Ito** and **Roger Nicoll,** for work on molecular and cellular bases of memory and learning
- **2005: Masakazu Konishi** and **Eric Knudsen,** for work on the neural basis of sound localization
- **2004: Seymour Benzer,** for applying the tools of molecular biology and genetics to the fruit fly, Drosophila, and linking individual genes to their behavioral phenotypes

The Society for Neuroscience partners with the Foundation on the Prize and nominates the members of the Selection Advisory Board that chooses the Prize recipients. Its members are:

Frances Jensen, University of Pennsylvania (Chair); **Pierre Magistretti**, King Abdullah University of Science and Technology; **Eric Nestler**, Icahn School of Medicine at Mount Sinai; **Anthony Phillips,** University of British Columbia; **Angela Roberts,** University of Cambridge; **Joshua Sanes,** Harvard University; and **Carla Shatz**, Stanford University.

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The Gruber International Prize Program honors individuals in the fields of Cosmology, Genetics and Neuroscience, whose groundbreaking work provides new models that inspire and enable fundamental shifts in knowledge and culture. The Selection Advisory Boards choose individuals whose contributions in their respective fields advance our knowledge and potentially have a profound impact on our lives.

The Gruber Foundation was established in 1993 by the late Peter Gruber and his wife Patricia Gruber. The Foundation began its International Prize Program in 2000, with the inaugural Cosmology Prize.

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For more information on the Gruber Prizes, visit www.gruber.yale.edu, e-mail info@gruber.yale.edu or contact A. Sarah Hreha at +1 (203) 432-6231. By mail: The Gruber Foundation, Yale University, Office of Development, PO Box 2038, New Haven, CT 06521.

Media materials and additional background information on the Gruber Prizes are in our online newsroom: www.gruber.yale.edu/news-media

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