Society for Neuroscience
House Appropriations Subcommittee on Commerce, Justice, Science, and Related Agencies
Request at least $7.4 Billion for FY2011 National Science Foundation Appropriations

Introduction

Mr. Chairman and members of the subcommittee, I am Dr. Michael E. Goldberg, President of the Society for Neuroscience and the David Mahoney Professor of Brain and Behavior in the Departments of Neuroscience and Neurology at Columbia University College of Physicians and Surgeons. It is my honor to submit this testimony on behalf of the Society for Neuroscience (SfN) in support of the National Science Foundation (NSF).

My research focuses on information processing in the monkey and human brains. In particular, I am interested in the cerebral cortical mechanisms underlying visual attention and spatial perception. I use the Rhesus monkey as a model because much of its brain resembles that of the human, and the psychological processes underlying visual attention and spatial perception are strikingly similar to those in the human. My research lab approaches these questions by recording the activity of individual brain cells in monkeys who are performing psychological tasks. This enables us to study the brain with a precision impossible to do in the human, yet our results have shed light on deficits which I, as an active clinical neurologist, see in human patients with brain disease. I am the recipient of federal support from the National Eye Institute of the National Institutes of Health (NIH) and the NSF for research and for training of the next generation of American scientists.

FY2010 Budget Request

SfN, as a member of the Coalition for the National Science Foundation, **supports a budget of at least $7.4 billion for NSF in FY2011, an 8 percent increase above FY2010,** as outlined in the Obama Administration's budget request released this month. SfN and the scientific community applaud this strong support for the agency – it is a crucial step to advance science, build a science-driven new economy, and keep the U.S. competitive in science and technology.

Continued investment in basic research at NSF is essential to laying the groundwork for discoveries that will inspire scientific pursuit and technological innovation for future generations. As reflected in the America COMPETES Act, aggressive investment in technology and scientific research is crucial to ensure America sustains its global leadership and competitiveness. Science is now a truly global enterprise that has the potential to revolutionize the human experience, health, and wellness – the question is whether America will maintain its role leading the next generation of scientific advances.

Congress and the Administration made a bold investment in NSF by providing $3 billion in last year's economic recovery package. The funds in the recovery package have already begun to set the path for a stronger and more competitive economy, and will continue to contribute to creation of high-wage jobs, and form the foundation for enhanced health and life expectancy of many Americans. The $3 billion provided to NSF is going directly into the hands of the nation's best and brightest researchers at the forefront of promising discoveries, to deserving graduate students at the start of their careers, and to developing advanced scientific tools and infrastructure that

will be broadly available to the research community. With both long-term and short-term investments in basic science, the United States is poised to continue its leadership in science-based innovation.

With FY2011, Congress has an opportunity to ensure the nation seizes the scientific momentum created by the historic recovery investment. SfN urges Congress to support President Obama's call to "return science to its rightful place" and fund future innovation at NSF with at least $7.4 billion in FY2011.

NSF and Neuroscience

SfN supports this increase because NSF research is indispensible to studying how the brain functions, how it controls behavior and health, and how to develop new tools to treat many debilitating diseases and disorders.

The field of neuroscience is deeply interdisciplinary and relies on crucial advances in physics, computer science, mathematics, chemistry, engineering, and basic biology to develop new tools and techniques for studying brain cell activity. For instance, the field of neuroinformatics is driven in part by emerging computational innovation generated by NSF. The physics necessary to create wonders like 11 Tesla functional Magnetic Resonance Imaging or advanced microscopy also emerge from NSF – with these tools, scientists can peer deeper into the brain.

In return, many of these fields are applying neuroscience discoveries to their own fields to create new potential treatments and health interventions. For instance, with the aid of a tiny brain implant known as a brain-computer interface (BCI), scientists have developed technology that enables communication between brain activity and an external device. People almost completely paralyzed by an earlier spinal cord injury have been able to turn on a television, access e-mail on a computer, play simple video games, and even grasp a piece of candy and hand it to someone using a robotic hand—all by thinking about such movements and having a computer translate those thoughts into action. Recent studies involving monkeys have shown that the brain can even accept a mechanical arm as its own, manipulating it like a normal limb to perform a complex motor task, such as grabbing and eating food. These and other remarkable advances in neural (brain-controlled) prosthetics are the result of decades of basic research into how the brain turns thought into physical action. Such findings demonstrate that movement areas of the brain continue to work years after the onset of paralysis.

Interdisciplinary collaboration is the hallmark of NSF research. For example, NSF-funded biologists and neuroscientists are discovering fundamental mechanisms important to understanding how humans and other animals behave, develop, communicate, learn, and process information. Understanding the neuroscience of animal diversity is necessary as we confront environmental and agricultural changes in the future. Also, NSF-funded physicists, mathematicians, computer scientists, and engineers have done ground-breaking work that enables the analysis of EEG data, the development of advanced brain prosthetic devices, and other technologies that will assist in the rapid diagnosis and treatment of epilepsy and stroke. NSF-funded statisticians are developing new methods for analysis of the large amounts of genome data, on humans and other organisms, and developing better statistical tools for looking at the effects of the environment on human and animal populations. NSF-funded chemists have

developed new methods that allows for the extremely accurate measurement of very small amounts of brain hormones.

Basic research funded by NSF is forming foundations for revolutionary science, such as the discovery and use of Green Florescent Protein (GFP) which received the Nobel Prize in 2008. We were deeply honored that two of the three winners are neuroscientists and members of SfN, Martin Chalfie and Roger Tsien. NSF support for this basic marine biology research to study nervous systems in crustaceans and other animal models was instrumental in the discovery of this protein in jellyfish. It has since become one of the most important tools used in contemporary bioscience, since it allows us to directly visualize specific types of nerve cells in the brain. In particular, GFP has become a crucial tool for studying many kinds of cell proteins, helping to elucidate pathological processes contributing to brain diseases including nerve cell damage in Alzheimer's disease.

Researchers studying the natural world have made startling discoveries that impact both science and medicine. Simple curiosity about the sting of a scorpion or the toxicity of food poisoning has yielded unexpected results — novel research tools and drug targets. These surprising sources are resulting in new treatment opportunities for brain cancer and neurological disorders. For example, intrigued by reports that some native people poisoned arrow heads with chemicals produced by frogs, a pharmacologist traveled to South America to collect samples. Back in his lab, he found that mice injected with a frog extract reacted as if they had been treated with powerful pain reliever their tails over their backs. Years later, the researcher isolated the pain-relieving compound in the frog skin, discovering that the chemical acts on molecules that communicate messages from the central nervous system to muscles. This research suggested new treatment targets for pain research, and drug companies are taking notice.

Indeed, many of the new findings in neuroscience can be traced back to fundamental work in diverse research fields that has contributed to new technologies of all kinds. This allows us to carry out new kinds of experiments not imaginable even 5-10 years ago. These discoveries have great potential to improve the lives of Americans and almost certainly would not have been made without the strong commitment to interdisciplinary research at NSF.

Commitment to Furthering Science Education and Training

Another key aspect of NSF is its support for science education and training. SfN recognizes the leadership role that NSF plays in driving innovation in science education and that NSF is committed to furthering the study of learning, memory, and perception by uniting education and neuroscience. Additionally, I must emphasize that NSF is a leading force in the development of the next generation of scientists through its support of training. Through NSF grants and cooperative agreements with colleges, universities, K-12 school systems, and other research organizations throughout the United States, neuroscientists can continue to conduct the basic research that advances scientific knowledge and leads to tomorrow's treatments and cures, while mentoring and training students of all levels.

Finally, NSF often provides the initial grant mechanism supporting early career scientists before they transition to their first NIH grant. Future scientific progress relies upon the kinds of

quantitative and interdisciplinary training that NSF fosters. NSF programs such as the Integrative Graduate Education and Research Traineeship Program **(**IGERT) are producing a cohort of scientists who have learned to work cooperatively, and have learned to apply their research across disciplinary boundaries, ensuring that the workforce is provided highly trained scientists who are unafraid of the challenges of the future.

About the Society for Neuroscience

The Society for Neuroscience is a nonprofit membership organization of basic scientists and physicians who study the brain and nervous system. Recognizing the field's tremendous potential, the Society was formed in 1969 with less than 500 members. Today, as we celebrate over 40 years of advancing science and improving health, SfN's membership numbers more than 40,000, and it is the world's largest organization of scientists devoted to the study of the brain. Neuroscience advances the understanding of human thought, emotion, and behavior. Our member neuroscientists work to understand animal and human nervous systems, how they develop and learn, and how they interact with their environment. Our membership includes investigators from backgrounds as diverse as physics, chemistry, engineering, mathematics, biology, biochemistry, and psychology, brought together to understand all aspects of brain function, from molecules and genes to cognition.

SfN is devoted to education about the latest advances in brain research and to raising awareness of the need to make neuroscience research a funding priority. Many SfN members are committed to developing educational innovations that take advantage of new neuroscience research. This has given rise to an exciting new breed of neuroscientists who wish to combine their research careers in neuroscience with a commitment to enhancing K-12 education in the nation.

Conclusion

With passage of the American Recovery and Reinvestment Act, Congress and the Administration have entrusted the U.S. scientific enterprise, led by NSF and other agencies, to play one important role in a larger effort to help reinvigorate the American economy. With sustained, robust increases, NSF will be able seize the momentum created by the additional funds and build a science-driven economy. Providing at least $7.4 billion for NSF in FY2011 helps ensure the agency is able to continue to fund high-quality, interdisciplinary and basic research, even after the recovery funds are expended. The nation cannot afford to lose the collaborations among scientists, engineers, physicists, and biologists that have resulted in such tremendous advances, contributing to improved health. Further, NSF's support for education and training cannot continue without stable funding, as a severe decrease would leave the next generation of researchers with few options, perhaps forcing them to leave science altogether.

The scope of the challenge of understanding the human mind requires a bold approach and the ability to undertake high-risk, high-reward, interdisciplinary projects. NSF is a strong supporter of the kind of research that allows neuroscientists and our colleagues to push the boundaries to ensure groundbreaking, life-enhancing discoveries. By laying the groundwork for revolutionary advances in neuroscience with interdisciplinary research, NSF is poised to keep the U.S. internationally competitive in the 21st century and beyond.

We urge the subcommittee to support and approve at least $7.4 billion for NSF in FY2011. Thank you for the opportunity to submit this testimony.

Sincerely,

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