Written Statement
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Subcommittee on Commerce, Justice, Science and Related Agencies
Appropriations Committee
In Support of FY22 Appropriations for the National Science Foundation

Chair Cartwright, Ranking Member Aderholt, and members of the Subcommittee, on behalf of the Society for Neuroscience (SfN), we are honoured to present this testimony in support of robust appropriations for biomedical research at the National Science Foundation (NSF). SfN urges you to provide at least $10.2 billion, an increase of approximately $1.7 billion, in funding for NSF in FY22. Dr. Moses Chao and I, as Chair of the Government and Public Affairs Committee and President of SfN respectively, understand the critical importance of federal funding for neuroscience research in the United States. I currently serve as a researcher and as a Professor in the Department of Psychology at Cambridge University and Dr. Chao is a professor of Cell Biology, Physiology and Neuroscience, and Psychiatry at the New York University School of Medicine. Our research serves as two examples of the wide variety of neuroscience research advancing our collective understanding of the brain.

My own research focuses on the neural and psychological basis of drug addiction and is dedicated to understanding the maladaptive engagement of the learning, memory, and motivational mechanisms underlying compulsive drug use. Drug abuse and addiction have devastating consequences at the individual, family, and society levels, as clearly evidenced by the opioid crisis and also increased alcohol drinking during pandemic lockdowns. My research group made significant advances in showing structural and neurochemical changes in the brain associated with behavioral impulsivity confer a major risk on vulnerability to develop cocaine addiction. We also demonstrated the neural circuit basis of the transition from recreational to the compulsive use of opioids, stimulants, and alcohol, revealing commonalities as well as differences in the neural basis of addiction to these drugs. This understanding opened the door to the development of novel pharmacological and psychological treatments for addiction which may promote and maintain abstinence from drug use.

Dr. Chao's research efforts focus on growth factors (also called neurotrophins) in the brain. These proteins are crucial for everything from neuron differentiation, growth, and survival during development to learning and memory in children and adults. Deficits in neurotrophins are involved in neurodegenerative disorders such as Alzheimer's, Parkinson's and Huntington's diseases, and Amyotrophic Lateral Sclerosis (ALS), as well as limiting recovery after stroke or brain injury.

Dr. Chao and I cover different areas of neuroscience research, though we have come together to convey the need for further and ongoing investment in neuroscience research. SfN believes strongly in the research continuum: basic science leads to clinical innovations, which lead to translational uses positively impacting the public's health. Basic science is the foundation upon which all health advances are built. To cure diseases, we need to understand them through fundamental discovery-based research. However, basic research depends on reliable, sustained funding from the federal government. SfN is grateful to Congress for its support of the important mission of the NSF, which includes a focus on promoting the progress of science and advancing the national health, prosperity, and welfare, through increased appropriations in recent years.

## The Importance of the Research Continuum

NSF funding for basic research is critical for facilitating groundbreaking discoveries and for training researchers at the bench. For the United States to remain a leader in biomedical research, Congress must continue to support basic research fueling discoveries as well as the economy. The deeper our grasp of basic science, the more successful those focused on clinical and translational

research will be. We use a wide range of experimental and animal models not used elsewhere in the research pipeline. These opportunities create discoveries – sometimes unexpected discoveries – expanding knowledge of biological processes, often at the molecular level. This level of discovery reveals new targets for research to treat all kinds of brain disorders that affect millions of people in the United States and beyond.

NSF basic research funding is also a key economic driver of science in the United States through funding universities and research organizations across the country. Federal investments in scientific research fuel the nation's pharmaceutical, biotechnology and medical device industries. The private sector utilizes basic scientific discoveries funded through NSF to improve health and foster a sustainable trajectory for American's Research and Development (R&D) enterprise. Basic science generates the knowledge needed to uncover the mysteries behind human diseases, which leads to private sector development of new treatments and therapeutics. This important first step is not ordinarily funded by industry given the long-term path of basic science and the pressures for shorter-term return on investments by industry. Congressional investment in basic science is irreplaceable in the pipeline for development of drugs, devices, and other treatments for brain-related diseases and disorders.

Another example of NSF's success in funding neuroscience is the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative. A part of the research landscape in neuroscience, the BRAIN Initiative has been critical in promoting future discoveries across neuroscience and related scientific disciplines. By including funding in 21st Century Cures, Congress helped maintain the momentum of this endeavor. Note, however, using those funds to supplant regular appropriations would be counterproductive. There is no substitute for robust, sustained, and predictable funding for NSF. SfN appreciates Congress' ongoing investment in the BRAIN Initiative and urges its full funding in FY22. Some recent exciting advancements in NSF funded neuroscience research include the following:

*Increasing happiness through new experiences*

As COVID-19 has affected Americans' daily routines, NSF-funded research may point the way towards strategies to improve people's moods. In a study conducted before the pandemic, participants wore GPS trackers for several months and reported on their mood throughout each day. The researchers found a correlation between a more positive mood and days when participants went to more locations outside of their daily routine. When people had more variability in their day, they were more likely to report feeling "happy," "relaxed," or "excited." A follow-up study looking at functional magnetic resonance imaging (fMRI) scans of participants' brains found these positive changes in mood are driven by communication between the hippocampus, the part of the brain that maps the environment, and the striatum, which plays a key role in reward. This work suggests adding a variety of experiences, even something as simple as a walk around the neighborhood, to our daily lives may be critical to maintaining a positive outlook.

*Understanding the origins of creativity*

Music, art, and other creative activities are fundamental endeavors to the human experience. Where this creativity comes from in the human brain and how it is controlled, however, is a question of great debate. Researchers funded by the NSF sought to answer this question by studying jazz guitarists performing while wearing electroencephalography (EEG) caps to measure their brain activity. These guitarists, who ranged in experience from novices to professionals, were asked to improvise several performances, which were recorded and judged by experts. Brain-activity data showed less-experienced guitarists relied more on right frontal hemisphere structures associated with conscious control over activity, while more-experienced participants had more activity in structures associated with the default

mode network, suggesting their performances require less active control. This suggests as a creative endeavor is improved, the brain switches from conscious monitoring of the activity to a more automatic reliance on what has already been learned. This baseline knowledge reduces the active concentration an expert will need for these learned skills, allowing for more cognitive resources to be devoted to the creativity of their output.

**COVID-19 is a Challenge and Opportunity for Neuroscience Research**

Unfortunately, the COVID-19 pandemic has slowed progress in neuroscience research, with social distancing requirements hampering ongoing research related to the brain. Investment in neuroscience research, including on the neurological aspects of the SARS-CoV-2 virus and the COVID-19 pandemic itself is needed though cannot be allowed to eclipse or replace regular funding for neuroscience research. We urge you to identify ways to ensure the funding surge needed to address the COVID-19 emergency does not slow progress on other important and innovative research, including the groundbreaking research in neuroscience and mental health. SfN encourages the Subcommittee to fund basic research on the biology of how COVID-19 impacts brain function as well as impacts the virus has on the nervous system in preclinical models and, by extension, on humans. In doing so, SfN encourages Congress and the NSF to prioritize intentional collaboration and coordination to effectively allocate scarce resources so researchers can investigate all facets of infectious and non-infectious disease.

Ongoing research already demonstrates the need for scientists to examine the neurological impacts of COVID-19. While mortality due to SARS-CoV-2 may be primarily due to its effects on the lungs, it is now apparent the virus damages many other organs, including the central nervous system. We need to understand how these direct and indirect effects on other organ systems are producing chronic diseases and long-term disability, making people more susceptible to other chronic disorders covered by the different NIH Institutes. A recent study (Lancet article, Taquet et al 2021) shows an increased risk of anxiety, depression, post-traumatic stress disorder, and insomnia were reported after COVID-19 diagnosis. These data, though incomplete, suggest brain impairment may be associated with COVID-19 infection. Furthermore, it was found people with two copies of the risk gene for Alzheimer's disease were more likely to have severe COVID-19 (Kuo et al J. Gerontology 2020). These findings, coupled with incidents of memory loss, brain fog and hallucinations reported in the *New York Times* (3/23/21) illustrates a need for increased resources to study the impact of this virus on the peripheral and central nervous systems, as well as the immune and inflammatory systems. The COVID-19 public health emergency provides an important example of the critical need for collaborative research and coordinating data and resources across institutes. A balanced and collaborative research effort across institutes will likely be the path toward solving these multiple issues.

**Congress & NSF Must Support Access to Models Necessary for Neuroscience Discovery**

Adequate NSF funding is necessary to advancing our understanding of the brain; however, full realization of this funding's promise requires appropriate access to research models, including non-human primate and other animal models. Animal research is highly regulated to ensure ethical and responsible care and treatment of the animals. SfN and its members take their legal and ethical obligations related to this research very seriously. While SfN recognizes the goal of the reduction, refinement, and eventual replacement of nonhuman primate models in biomedical research, much more research and time is needed before such a goal is attainable. Premature replacement of non-human primate and other animal models may delay or prevent the discovery of treatments and cures—not only for neurological diseases like Alzheimer's disease, addiction, and traumatic brain injury, but also for communicable diseases and countless other conditions. There are currently no viable alternatives available for studying biomedical systems advancing our understanding of the brain and nervous system; or when seeking treatments for diseases and disorders like depression, addiction, Parkinson's Disease, and emotional responses. This research is critically important and presents an opportunity to benefit

countless people around the world. SfN urges Congress to work with the NSF to ensure this important research can continue.

**Funding in Regular Order**

SfN joins the biomedical research community supporting an increase in NSF funding to at least $10.2 billion, a $1.7 billion increase over FY21. This proposed increase is necessary to provide certainty to the field of science, allowing for the exploitation of new scientific opportunity, additional training of the next generation of scientists, increased economic growth and further improvements in the public's health. Equally as important as providing a reliable increase in funding for biomedical research is ensuring funding is approved before the end of the fiscal year. Continuing Resolutions have significant consequences on research, including restricting NSF's ability to fund grants. For some of our members, this means waiting for a final decision to be made on funding before knowing if their perfectly scored grant would in fact be realized or operating a lab with 90 percent of the awarded funding until appropriations are final. This negatively impacts all the positive benefits research provides the field. SfN strongly supports the appropriation of NSF funding in a timely manner which avoids delays in approving new research grants or causes reductions in funding for already approved research funding.

SfN thanks the subcommittee for your strong and continued support of biomedical research and looks forward to working with you to ensure the United States remains the global leader in neuroscience research and discovery. Collaboration among Congress, the NSF, and the scientific research community has created great benefits for not only the United States but also people around the globe suffering from brain-related diseases and disorders. On behalf of the Society for Neuroscience, we urge you to continue this critical cooperation and support of biomedical research.