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Chairman Culberson, Ranking Member Fattah, and Members of the Committee, I am pleased to be here with you today to discuss the current state of Federal support for neuroscience and related research and our shared interest in improving the efficiency and effectiveness of Federal programs in this domain.

BACKGROUND

Neuroscience is the study of the brain and nervous system, which control every aspect of body and mind, including heart rate, memory, attention, and muscle movement, as well as pain sensation, decision- making, and emotion. Neuroscience research is the key to understanding the biological underpinnings of neurological disorders, traumatic brain injury (TBI), and mental disorders, including Post-Traumatic Stress Disorder (PTSD) that affect millions of Americans and cost hundreds of billions of dollars annually to treat. To develop preventive and treatment methods we will need to discover how the brain's 100 billion nerve cells are created, how they grow and connect through all stages of life, how they interpret input from the external environment through nerve networks extending throughout the body, and why these connections can sometimes result in life-altering problems.

For example, studies supported by the National Institute on Aging (NIA) at NIH estimate that as many as 5.1 million Americans age 65 and older have Alzheimer's disease, with the risk doubling for every 5-year interval beyond age 65. An NIA-funded study showed that the costs of caring for people with dementia in the United States (U.S.), including those with Alzheimer's disease, were estimated at $159 - $215 billion in 2010.[1] The good news is that a 2010 Alzheimer's Association report projected that delaying the onset of Alzheimer's disease by just five years could save $50 billion in annual U.S. health care costs. Neuroscience research holds the key to identifying ways to stave off this devastating disease.

The Centers for Disease Control and Prevention's (CDC) National Center for Injury Prevention and Control (NCIPC) estimates that each year approximately 2.5 million civilians in the U.S. sustain a TBI. Of these TBIs, which can occur alone or in combination with other injuries, about 2.2 million are treated and released from an emergency department, 280,000 are hospitalized, and more than 50,000 die.

[1] The amount varies depending on the estimated cost of informal care.

A recent Department of Defense (DoD) report showed 320,344 medical diagnoses of TBI in U.S. military personnel since 2000, 82.5% of which were mild and the rest more severe, the effects of which can be lifelong. In addition, a VA-DoD funded study showed that approximately 18.5% of service members returning from Iraq or Afghanistan have PTSD or depression. Suicide among veterans continues to be of concern.

The National Institute of Mental Health (NIMH) reported that in 2012, an estimated 16 million adults aged 18 or older in the U.S. had at least one major depressive episode in the prior year. At that time, this represented 6.9% of all U.S. adults. Depression is one of the most common mental disorder and, according to a 2010 World Health Organization report, it carries the highest burden of disability among the mental and behavioral disorders.

The Obama Administration has enhanced Federal support of neuroscience and related research efforts under the auspices of the White House Neuroscience Initiative. The Initiative calls for a broad and comprehensive approach to basic and applied neuroscience research with goals to promote and protect brain health; optimize learning strategies and educational paradigms; and develop treatments for the devastating brain injuries, diseases, and disorders that afflict all age groups and most segments of our society. The goals of the initiative are being achieved through strategic opportunities to work across agencies, promoting collaboration between the Federal government and the private sector, increasing the positive impact of Federal investments in neuroscience to improve physical and mental health, strengthening educational practices that enhance learning, reducing PTSD in our veterans, and addressing the consequences of traumatic injury to the brain.

The activities of the White House Neuroscience Initiative, which encompasses neuroscience and mental health-related activities directed by the White House or supported by the White House Office of Science and Technology Policy (OSTP), includes the activities of the Interagency Working Group on Neuroscience, The Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative, The National Alzheimer's Project, and other programs described in the following sections.

INTERAGENCY WORKING GROUP ON NEUROSCIENCE

With the encouragement of Congress, including members of this Committee, the Interagency Working Group on Neuroscience (IWGN) was chartered by OSTP in June 2012 under the National Science and Technology Council's (NSTC) Committee on Science to "*coordinate activities in neuroscience research across the Federal government with a focus on the fundamental understanding of learning, brain development and plasticity, and brain health and recovery*." Co-chaired by OSTP, the National Science Foundation (NSF), and the National Institutes of Health (NIH), the IWGN membership comprises more than twenty Federal departments and agencies with expertise in neuroscience research with diverse missions that include funding, conducting, and utilizing research related to health, education, public safety, security, intelligence, defense, and more. The hope is that the new knowledge gained from the research supported by these Federal agencies will transform learning and lead to new methods for prevention of dementia, treatment of mental illness, and recovery from substance use

disorders. In February 2014, the IWGN released its report entitled "*Priorities for Accelerating Neuroscience Research Through Enhanced Communication, Coordination, and Collaboration,*" which identified five priority areas for research, policy, and communication: 1. Understanding and applying the brain's information processing capabilities; 2. Understanding and treating brain diseases, disorders, and trauma; 3. Understanding and optimizing interactions between the environment and the brain across the lifespan; 4. Translating research to practice; and 5. Improving communication and engaging the public. The following is a summary of recent activities supported by members of the IWGN aimed at addressing these goals.

Bridging Neuroscience and Learning. On January 23, 2015, OSTP and the IWGN brought together over 50 individuals – including leading researchers in neuroscience and learning, government representatives, philanthropists, and members of the private sector – to brainstorm strategies for how neuroscience research can inform improvements in educational methods that benefit learners of all ages. Several important themes emerged from the discussions: 1. Research in neuroscience is poised to inform educational practices, 2. Specific research on the effectiveness of neuroscience based learning methods is needed before those methods are disseminated, and 3. There are concerns from the scientific community that consumers are unaware that popular learning applications are often disseminated without evidence of their efficacy.

International Collaborations. The IWGN is also working with OSTP to identify opportunities for international communication and collaboration to further the efforts and goals related to the Administration's neuroscience activities. Some IWGN agency activities include:

Follow-Up to G8 Dementia Summit. NIA and the U.S. Department of Health and Human Services (HHS) convened the Alzheimer's disease (AD) Research Summit in February 2015 to build on the foundation laid by the 2012 NIH AD Research Summit, the U.S. National Alzheimer's Project Act /National Plan to Address AD, and the 2013 G8 Global Dementia Summit. This most recent meeting, which included several international participants, addressed 6 themes: 1. interdisciplinary research to understand the heterogeneity and multifactorial etiology of AD; 2. AD therapy development; 3. AD prevention; 4. disease monitoring, assessment, and care; 5. empowering patients and engaging citizens; and 6. enabling U.S. and international partnerships for open innovation. In addition, HHS and NIA staff have participated in several international G7 dementia meetings in 2014; convened an additional U.S. meeting in February 2015 to discuss G7 dementia research collaborations; and, in March 2015, engaged in discussions about future plans at a large global dementia meeting in Geneva, sponsored by the World Health Organization.

National Institutes of Health (NIH). International collaboration in NIH-supported neuroscience research activities occurs across multiple levels, from individual grants that include investigators and research sites outside the U.S., to scientific meetings with international participants, to programs specifically designed to include a component of international collaboration. In addition, The BRAIN Initiative has engaged global interest and encouraged international partnerships. For example, NIH has a non-binding agreement for the National Health Research Council of Australia to jointly support meritorious research projects in support of The BRAIN Initiative involving Australian scientists, and discussions are ongoing for a similar agreement

with the Brain Foundation of Canada. In addition, NIH made awards in fiscal year (FY) 2014 to over 100 investigators in 15 U.S. states and three countries related to The BRAIN Initiative, and NIH leadership has been in frequent dialogue the European Union, China, Israel, and Japan, which have mounted their own large neuroscience research initiatives.

There are other examples of international collaborations in NIH-supported neuroscience. NIH has played a leading role in establishing the International Initiative for Traumatic Brain Injury Research (InTBIR). This collaborative effort of the European Union Research Directorate, Canadian Institutes of Health Research, and the NIH, aims to advance clinical TBI research and care by determining what therapies work best for which patients with TBI. A number of bilateral agreements between the NIH and government funding agencies in other countries facilitate research collaborations between neuroscientists in the U.S. and abroad in which NIH funds the U.S. component and the foreign agency funds the foreign partner. These include a supplement program to promote collaborations with neuroscientists in Japan, a small grant program for collaborations with neuroscientists in India, and a grant program with China that stimulates collaborative research in mental health, Parkinson's disease, and stroke, as well as allergy, immunology, infectious disease, and cancer. Finally, NIH supports a broad range of research to address global health needs and build sustainable research capacity in low- and middle-income countries, including NIH's Global Brain and Nervous System Disorders Research Across the Lifespan Program.

National Science Foundation. NSF, NIH, the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF), the French National Research Agency (Agence Nationale de la Recherche, ANR), and the U.S.-Israeli Binational Science Foundation (BSF), collaborate on a funding initiative for Collaborative Research in Computational Neuroscience (CRCNS). The CRCNS program is facilitating the broad international sharing of brain experimental data, stimuli, and analysis tools. Through data sharing, CRCNS facilitates the translation and dissemination of research results, accelerates the development of generalizable approaches and tools that can be put to wide use by researchers, and broadens the scope of collaboration in computational neuroscience and related communities.

U.S.-Israeli Binational Science Foundation. Dr. Susan Koester, Deputy Director of the Division of Neuroscience and Basic Behavioral Science at the National Institute of Mental Health and Co-Chair of the IWGN, and Dr. Clifford Gabriel, Senior Advisor in the NSF Office of the Director, are serving as members of the Board of Governors of the U.S.-Israeli Binational Science Foundation (BSF). The BSF was founded in 1972 to promote scientific relations between the U.S. and Israel by supporting collaborative research projects across a wide area of basic and applied scientific fields for peaceful and non-profit purposes. NIH hosted the annual BSF winter meeting in February, 2015, where Board members met with leadership of NIH's contribution to The BRAIN Initiative and with leaders of NIH global outreach initiatives.

U.S.-India collaborations. On September 30, 2014, President Obama and Indian Prime Minister Narendra Modi expressed their "intention to expand defense cooperation to bolster national, regional, and global security. The two leaders reaffirmed that India and the United States would build an enduring partnership in which both sides treat each other at the same level as their closest partners, including defense technology transfers, trade, research, co-production, and co-

development."[2] This relationship was reaffirmed during President Obama's January 2015 visit to New Delhi. Developing vibrant defense Science and Technology (S&T) cooperation is one of the steps in building the enduring partnership. In support of these efforts, researchers from the DoD and the Indian Ministry of Defense are discussing potential research collaborations in developing models of cognitive fatigue, artificial cognition, and traumatic brain injury.

THE BRAIN INITIATIVE

Since its launch in April 2013, The BRAIN Initiative has grown to include investments from five Federal agencies, the Intelligence Advanced Research Projects Activity (IARPA), the Defense Advanced Research Projects Agency (DARPA), the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Food and Drug Administration (FDA). These agencies coordinate their efforts to maximize Federal government investments; this coordination includes a November 2014 meeting with NSF- and NIH-funded investigators to share information about their research. In an effort to further facilitate communication and coordination among The BRAIN Initiative partners, OSTP has organized a March 27th meeting of program officers from Federal agencies and private partners who have made financial commitments to The BRAIN Initiative to provide a place for discussion of near and long term goals and to stimulate ideas for cross collaboration. OSTP will work closely with the IWGN whose recent re-charter charged them with facilitating communication about ongoing efforts among the Federal agencies involved in The BRAIN Initiative.

The President's 2016 Budget proposes to increase the Federal investment in The BRAIN Initiative from about $200 million in FY 2015 to more than $300 million in FY 2016. This increased investment will support a wide range of interdisciplinary projects aimed at developing and applying cutting-edge technologies to create a dynamic picture of the brain in action, providing the critical knowledge base for researchers seeking new ways to treat brain disorders. These projects include the following agency efforts.[3]

National Institutes of Health: NIH will support a diverse set of projects, including developing new devices to record and modulate activity in the human nervous system and revolutionizing human neuroimaging technologies to understand how individual cells and complex neural circuits interact in time and space.

Defense Advanced Research Projects Agency: DARPA will focus on leveraging brain-function research to alleviate the burden of illness and injury and provide novel, neurotechnology-based capabilities for military personnel and civilians alike. In addition, DARPA is working to improve researchers' abilities to understand the brain by fostering advancements in data handling, imaging, and advanced analytics.

National Science Foundation: NSF will focus on generating an array of physical and conceptual tools needed to determine how healthy brains function over the lifespan of an organism, including humans. NSF will also focus on the development and use of these tools to

[2] U.S. - India Joint Statement. The White House, Office of the Press Secretary. September 30, 2014.
[3] The FY16 Fact Sheet on The BRAIN Initiative included as Appendix A provides detailed descriptions of each agency's research program.

produce a comprehensive understanding of how thoughts, memories, and actions emerge from the dynamic actions of the brain.

Intelligence Advanced Research Projects Activity: IARPA will focus on applying breakthroughs in neuroscience to advance understanding of cognition and computation in the brain. In addition, IARPA will test and validate non-invasive neural interventions that have the potential to significantly improve adaptive reasoning and problem solving.

Food and Drug Administration: FDA will focus on enhancing the transparency and predictability of the regulatory landscape for neurological devices. FDA also plans to implement a new program that would speed the availability of certain medical devices that address unmet public health needs while ensuring that patients receive high-quality, safe, and effective medical devices, including those that treat brain disorders.

The successful completion of the aims of The BRAIN Initiative will require efforts from a wide variety of organizations. OSTP has been actively involved in securing commitments from a diverse set of stakeholders that provide expertise and resources to support the goals of The BRAIN Initiative in ways that complement the roles of the Federal agencies. This includes major foundations, private research institutions, patient advocacy organizations, universities and several companies who made commitments totaling $134 million in research and development (R&D) investments in FY14 and $384 million in FY15 – over $500 million in just the first two years of this initiative. There is much work to be done and opportunities for others to contribute to this historic initiative through new and expanded commitments. The September 20, 2014 BRAIN Initiative fact sheet in Appendix B provides a complete list of the Initiative's private partners. Highlighted below are just a few examples of commitments from companies investing in The BRAIN Initiative.

The National Photonics Initiative, an alliance of major scientific societies, industry, and academic organizations, is convening a Photonics Industry Neuroscience Group to focus on developing new optics and photonics technologies in support of The BRAIN Initiative. The Photonics Industry Neuroscience Group will work closely with The BRAIN Initiative leadership and with the neuroscience research community to advance optics and photonics research and technology development, investing at least $30 million in existing and future spending over the next three years to advance optics and photonics technology challenges in neuroscience.

General Electric (GE) has launched a new Brain Health Initiative linking numerous entities within the company such as GE Healthcare, GE Ventures & Healthymagination, and GE's Global Research Center to build on and coordinate multiple efforts within the company, including corporate venture capital, open innovation, R&D, and health care lines of business. This includes previously announced efforts at GE, such as a $60 million open innovation challenge, in partnership with the National Football League and Under Armour, to develop both next-generation imaging technology and algorithms and to provide better devices and gear for brain protection. GE also supports the TBI Endpoints Initiative (TED) to better understand, diagnose and treat TBI and concussion. In further support of BRAIN-related efforts, GE is addressing critical public policy needs in neuroscience through its "Brain Trust" meetings of thought leaders.

Google is working closely with the Allen Institute for Brain Science to develop scalable computational solutions to advance scientific understanding of the brain including tools and infrastructure to analyze petabyte- scale datasets generated by The BRAIN Initiative. Their work will help the neuroscience community to better understand the brain's computational circuitry and the neural basis for human cognition.

Major foundations and universities also have committed to align their research efforts with The BRAIN Initiative including the University of Pittsburgh, Carnegie Mellon University, and the University of California, Berkeley. A complete list of institutions can be found in Appendix B.

University of Pittsburgh has announced more than $65 million in funding to its Brain Institute that will support the efforts of more than 150 neuroscientists at the university and create seven new Centers, including the NeuroTech Center, which capitalizes on the University's advances in brain-computer interfaces for paralyzed individuals.

Carnegie Mellon University (CMU) plans to commit more than $40 million over the next five years to support faculty positions, endowed graduate and postdoctoral fellowships through its BrainHub initiative that aims to link brain science to behavior through interdisciplinary collaboration among departments such as computer science, engineering, biology, and behavioral science. CMU is also partnering with institutions across the globe to create and analyze large data sets and train students and postdocs in computational approaches to brain science.

University of California (UC), Berkeley has invested $12 million to create infrastructure for neurotechnology development, including a public-private collaboration with Carl Zeiss Microscopy to support the Berkeley Brain Microscopy Innovation Center, which will fast-track microscopy development for emerging neurotechnologies.

The key private sector foundations that helped launch The BRAIN Initiative in 2013 have made important progress in their commitments, including:

The Allen Institute for Brain Science's commitment of $60 million annually to support projects and partnerships related to The BRAIN Initiative has resulted in completion of the Allen Mouse Brain Connectivity Atlas (a map of the major highways connecting the mouse brain). They have partnered with Google to develop scalable computational solutions to advance our understanding of the brain and have helped to establish an annual conference for the large brain initiatives with Keystone Symposia with the NIH, the Salk Institute, and the Human Brain Project in Europe.

Howard Hughes Medical Institute (HHMI) has invested more than $70 million to support The BRAIN Initiative during the past year at its Janelia Research Campus and in the laboratories of HHMI Investigators at universities throughout the U.S. This investment includes developing new imaging technologies. A similar level of commitment is expected in 2015 for neuroanatomical studies using light and electron microscopy, and for the development of improved sensors of neuronal activity and other genetic reagents.

The Kavli Foundation has maintained its 2013 commitment to spend $40 million over ten years in support of The BRAIN Initiative by establishing two endowed neuroscience institutes and fostering new cross-disciplinary opportunities between neuroscience and the physical sciences. With GE healthymagination, HHMI, and the Allen Institute for Brain Science, it has established a program, "Neurodata without Borders," that promotes the sharing of neuroscience data among scientists.

In September 2014, several new private sector partners made significant commitments to align the work of their organizations with the goals of The BRAIN Initiative, including **The Simons Foundation**, which launched the Simons Collaboration on the Global Brain with a $60 million investment over the next five years. **The Brain and Behavior Research Foundation** committed an increase of $2 million in its annual support for young scientists working on the goals of The BRAIN Initiative. **The Pacific Northwest Neuroscience Neighborhood**, which includes the University of Washington, the Allen Institute, Oregon Health & Science University, and 50 companies based in Oregon and Washington, will pilot a BRAIN Initiative 'regional cluster' to bring together the research, clinical, industry, academic, education, public, and advocacy communities to highlight and build on The BRAIN Initiative themes and goals in the Pacific Northwest. A more complete listing of The BRAIN Initiative's private partners can be found in Appendix B.

OTHER FEDERAL ACTIVITIES

Additional efforts are underway to address the aims of the Neuroscience Initiative in the areas of Alzheimer's disease, brain injury, and mental health services. Below is a brief summary of recent activities.

National Alzheimer's Project. As required by the 2011 National Alzheimer's Project Act**,** the Secretary of the U.S. Department of Health and Human Services established the National Plan to Address Alzheimer's Disease (AD). The 2014 Update to the plan summarized progress in the following areas: prevention and treatment, quality and efficiency of care, supports for people with AD and their families, public awareness and engagement, and improvement in data to track progress.

NCAA-DOD Grand Alliance. The Concussion Assessment, Research, and Education (CARE) Consortium is the first of two components of the National Collegiate Athletic Association (NCAA) and the Department of Defense (DoD) grand alliance to address concussion in athletes and the military. It was established under the leadership of three institutions –Indiana University School of Medicine, University of Michigan, and the Medical College of Wisconsin - to conduct a comprehensive clinical study of concussion and repetitive head impacts. Research infrastructure has been developed at these three primary sites and research awards from both the NCAA and DoD have been made. Twelve sites have started data collection, and an additional three sites will come online in the first half of 2015, including the four Uniformed Service Academies. As of October 30, 2014, more than 1,700 student athletes have voluntarily enrolled in the study.

The second arm of the NCAA-DOD Grand Alliance is the $4 million Mind Matters Challenge, which opened for proposals on November 6, 2014. It consists of two parts: an educational challenge that targets young and emerging adults, and a scientific research challenge for changing attitudes about concussion in young and emerging adults. The purpose of the Mind Matters Challenge is to fundamentally shift the culture and perceived norms of concussion, so that all concussion stakeholders will prioritize the safety and wellness of all student-athletes and all military service men and women.

Department of Veterans Affairs (VA). VA provides care for approximately 71,000 Veterans with Spinal Cord Injury (SCI) and related disorders. Return of function is a high priority for VA's Office of Research and Development, and this is reflected in innovative research programs examining neuroengineering and stem cell approaches to restore motor and sensory function to the chronically injured Veteran. VA also provides care for approximately 308,000 persons with amputation and supports the research and development of interfaces with the brain and peripheral nerves to better control prosthetics and other devices. These interfaces can also deliver feedback signals from the device to the brain to restore the sense of touch to a prosthetic limb.

Improving Mental Health Prevention and Treatment Services. The President's FY 2016 budget request included approximately $2.3 billion in mental health research funded by several NIH Institutes and Centers. This budget will continue to strengthen our understanding and treatment of mental illnesses through basic and clinical research, paving the way for prevention, recovery, and cure.

Executive Actions to Support the Mental Health Needs of Service Members and Veterans. In August 2014 the President announced 19 new executive actions to improve the mental health of service members, veterans, and their families, which build on the progress the Administration has made since the President's 2012 Executive Order on Mental Health. In response to the 2012 Executive Order, VA has increased its mental health staffing, expanded the capacity of the Veterans Crisis Line, and enhanced its partnerships with community mental health providers; DOD and VA worked to increase suicide prevention awareness; and, DoD, VA, and NIH jointly developed the National Research Action Plan on military and veteran's mental health to better coordinate Federal research efforts. The 19 new mental health executive actions fall under the following six categories:

- **Improving Service Members' Transition from DOD to VA and Civilian Health Care Providers:** DOD has made significant progress in the development of methods to automatically enroll all service members leaving military service who are receiving care for mental health conditions in the Department's *inTransition* program, through which trained mental health professionals help these individuals transition to a new care team in VA. Additionally, VA has implemented a new policy to ensure that recently discharged service members enrolling in the VA health care system maintain access to mental health medication prescribed by an authorized DOD provider regardless of whether the medication is currently on VA's formulary, unless the health care provider identifies a specific safety or clinical reason to make a change.

- **Improving Access and Quality of Mental Health Care at DOD and VA:** VA will pilot the expansion of mental health peer support to veterans being treated in primary care settings. In addition, DOD has initiated action to do what they can under its authority and will continue to work with Congress to take action to bring TRICARE, DOD's health care coverage, up to full mental health and substance use disorder parity, making benefits for these conditions generally on par with benefits for medical/surgical conditions.

- **Continuing the Administration's Commitment to Improve Treatments for Mental Health Conditions including PTSD:** The DOD and NIH are launching a longitudinal project focused on the early detection of suicidality, PTSD, and long-term effects of TBI and other related issues in service members and veterans. VA is launching a $34.4 million suicide prevention study involving 1800 veterans at 29 VA hospitals.

- **Raising Awareness about Mental Health and Encouraging Individuals to Seek Help:** VA and DOD are expanding their suicide prevention and mental health training for healthcare providers, chaplains, and employees who work directly with veterans.

- **Improving Patient Safety and Suicide Prevention:** VA and DOD are taking action to provide new opportunities for service members, veterans, and their families to give back unwanted medications, and thereby help reduce the opportunities for abuse. The Departments are also taking action to encourage firearm safety and reduce the risk of overdose.

- **Strengthening Community Resources for Service Members, Veterans, and Their Families:** While all individuals can experience mental health conditions, service members, veterans, and their families may experience stressors unique to their time in the military. Understanding military culture and the experiences of service members and their families can help community providers best serve these individuals. DOD and VA will disseminate their existing military cultural competency training to 3,000 community mental health providers during FY 2015.

National Research Action Plan (NRAP) on PTSD, other mental health conditions, and TBI: Section 5 of the Executive Order highlights how a limited understanding of underlying mechanisms of PTSD, the long-term consequences of TBI, and warning signs for tragic outcomes such as suicide is hampering progress in prevention, diagnosis, and treatment. Therefore, the NRAP includes research strategies to accelerate discovery of underlying mechanisms and rapidly translate this understanding into actionable tools for prevention, early diagnosis, and better treatment. The Executive Order also calls for the establishment of a comprehensive longitudinal study of 100,000 service members focused on PTSD, TBI, and related injuries. The NRAP has directed the DoD and VA to establish two joint research consortia, with a combined investment of up to $107 million. The Consortium to Alleviate PTSD (CAP), a collaboration led by the University of Texas Health Science Center-San Antonio and other medical centers, seeks to discover and develop "biomarkers" that can be useful for diagnosis and for the development of therapies. The Chronic Effects of Neurotrauma Consortium (CENC), a collaboration led by Virginia Commonwealth University, will study the links between concussions, chronic mild TBI, neurodegeneration, and related conditions.

To date, considerable progress has been made in the planning and execution of these actions, particularly with regard to coordination of care between DOD and VA, facilitating peer support to veterans, improving access to mental health services, and training mental health providers to better understand the culture of military service.

CONCLUSION

Thank you for the opportunity to share our progress on the White House Neuroscience Initiative. The Interagency Working Group on Neuroscience has resulted in enhanced coordination and cooperation among our Federal partners in The BRAIN Initiative, progress toward building a bridge between neuroscience and learning, and enhanced collaboration with our international partners in neuroscience – all of which will expedite success toward the prevention and treatment of neurological and related disorders. Great strides have been made over the past year in the care of our service members, Veterans, and their families. Veterans are more assured to experience the continuity of mental health care that they need and deserve, including their ability to continue prescribed medication treatment after separation. Community clinicians and peer counselors have been mobilized in settings that increase access to services for active duty service personnel as well as veterans and to assist in the prevention of suicide. While there is still much to be done on all fronts, the Federal investments in the White House Neuroscience Initiative and the private sector commitments to facilitate the work of The BRAIN Initiative are making steady progress toward of addressing the needs of the American people. I thank the Committee for its continued support and interest in this issue and I look forward to continuing to work with you. I will be pleased to take any questions that the Members may have.

Obama Administration Proposes Over $300 Million in Funding for The BRAIN Initiative

"Last year, I launched the BRAIN Initiative to help unlock the mysteries of the brain, to improve our treatment of conditions like Alzheimer's and autism and to deepen our understanding of how we think, learn and remember. I'm pleased to announce new steps that my Administration is taking to support this critical research, and I'm heartened to see so many private, philanthropic, and academic institutions joining this effort."

- President Barack Obama
  Sept. 2014

Since its launch in April 2013, the President's BRAIN Initiative - Brain Research through Advancing Innovative Neurotechnologies – has grown to include investments from five federal agencies with the Intelligence Advanced Research Projects Activity (IARPA) joining the Defense Advanced Research Projects Agency (DARPA), the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Food and Drug Administration (FDA).

There has been an enthusiastic response to the President's call for an "all hands on deck" effort. Major foundations and private research institutions, including the Howard Hughes Medical Institute, Allen Institute for Brain Science, and the Kavli Foundation, as well as patient advocacy organizations and universities have committed over $240 million to The BRAIN Initiative. In addition, members of the National Photonics Initiative and other companies such as GE, GlaxoSmithKline and Inscopix have joined this effort through commitments of more than $30 million in research and development investments. There is much work to be done and opportunities for others to play a role in this historic initiative through new and expanded commitments.

The President's 2016 Budget proposes to increase the Federal investment in The BRAIN Initiative from about $200 million in FY 2015 to more than $300 million in FY 2016. Proposed investments by the NIH, DARPA, IARPA, FDA and NSF are described below.

National Institutes of Health (NIH): In FY 2016, NIH will provide an estimated $135 million in funding for The BRAIN Initiative. This investment will support a diverse set of projects with ambitious goals, including developing new devices to record and modulate activity in the human nervous system, revolutionizing human neuroimaging technologies to understand how individual cells and complex neural circuits interact in time and space, and modeling and analyzing the complex data that scientists obtain in their quest to understand how the brain works. Together these research efforts aim to develop and apply cutting-edge technologies to create a dynamic picture of the brain in action, providing the critical knowledge base for researchers seeking new ways to treat, cure, and even prevent brain disorders.

A working group of the Advisory Committee to the NIH Director was established to inform planning for The BRAIN Initiative at the NIH, and this group sought broad input from the scientific community, patient advocates, and the general public. In June 2014 the group released a report entitled *BRAIN 2025: A Scientific Vision*, which articulates the scientific goals of The BRAIN Initiative at the NIH and charts a multi-year scientific plan for achieving these goals, including timetables, milestones, and cost estimates. Additionally, NIH has established a BRAIN Multi-Council Working Group of esteemed experts in numerous disciplines who assist in ensuring a coordinated and focused effort across the agency. NIH is also

working in close collaboration with other government agencies and private partners to ensure success through investment in The BRAIN Initiative. In FY 2014 NIH issued 58 awards to develop a variety of new technologies and approaches to understand the brain. These projects include a systematic inventory of the brain's different cell types, approaches for accessing specific cells and circuits, new capabilities for simultaneously recording activity across large groups of neurons, next generation methods for imaging human brains, and interdisciplinary approaches to understanding how brain circuits produce unique brain functions. For FY 2015 and beyond, NIH will issue new awards aiming to build on these initial projects to develop devices to monitor and modulate human neural activity for understanding brain function and treating brain disorders. Informed by an NIH workshop on ethical issues in neuroscience research, NIH will also engage investigators to explore important neuro-ethical issues in modern brain science

Defense Advanced Research Projects Agency (DARPA): In FY 2016, DARPA plans to invest an estimated $95 million to support The BRAIN Initiative. DARPA's investments aim to leverage brain-function research to alleviate the burden of illness and injury and provide novel, neurotechnology-based capabilities for military personnel and civilians alike. In addition, DARPA is working to improve researchers' abilities to understand the brain by fostering advancements in data handling, imaging, and advanced analytics.

In FY 2016, the Restoring Active Memory (RAM) effort will be conducting its first human clinical trials to identify how memories are encoded in the brain during learning and skill acquisition, with the ultimate goal of accelerating warfighter recovery after traumatic brain injury. DARPA's neuro-adaptive technology program, Systems-Based Neurotechnology for Emerging Therapies (SUBNETS), aims to demonstrate the first set of prototype closed-loop medical devices able to measure and modulate networks of neurons in research participants with intractable psychiatric illness and alleviate severe symptoms of diseases such as post-traumatic stress disorder and major depression. DARPA's neuroscience technologies programs have already begun to analyze large datasets of neural signals, allowing investigators to rapidly and transparently solve complex problems of computation, generate new models, and model the brain in multiple dimensions and spatiotemporal scales. In 2016, initial datasets generated through DARPA's programs will be made available for secondary research. New efforts in the Neuro-Function, Activity, Structure, and Technology (Neuro-FAST) program will be testing how new imaging discovery tools using optical and photonic techniques are capable of sensing the structure and activity of thousands of neurons simultaneously in the active brain. Such high resolution in a stable manner over multiple experiments promise new insights into brain function and clues to treat injury. The Hand Proprioception and Touch Interfaces (HAPTIX) effort will develop human-ready implantable electronic microsystems that interact with sensory and motor peripheral nerves, with the goal of enabling amputees to feel with their prosthetic limb through sensory feedback as well as achieve advanced and intuitive limb control. In 2016, HAPTIX users will test a fully implantable wireless recording device, as well as begin the first take-home trial of their prosthetic hand. Finally, the Electrical Prescriptions (ElectRx) program seeks to understand and leverage the function of peripheral nerve and spinal cord neural circuits to advance neuromodulation therapies for immunological and mental health disorders. Parallel investments in physiological research and technology development will yield more complete understanding of the neural circuits involved in regulating health.

National Science Foundation (NSF): In FY 2016, NSF plans to invest $72 million to support The BRAIN Initiative. To attain a fundamental scientific understanding of the complexity of the brain, in context and in action, NSF investments in The BRAIN Initiative are focused on generating an array of physical and conceptual tools needed to determine how healthy brains function over the lifespan of an organism, including humans. NSF will also focus on the development and use of these tools to produce a comprehensive understanding of how thoughts, memories, and actions emerge from the dynamic actions of the brain. NSF is prioritizing research in three areas where the agency's capacities are uniquely strong: integrative and interdisciplinary research; new theories, computational models, and analytical tools that will guide research questions and synthesize experimental data; and the development of innovative technologies

and data infrastructure required to handle the large-scale datasets resulting from this research. Examples of investments that NSF has already made to support The BRAIN Initiative include a new $25 million Science and Technology Center on "Brains, Minds and Machines" at the Massachusetts Institute of Technology, 36 awarded Early Concept Grants for Exploratory Research directed at identifying the emergent properties of neural circuits that underlie behavior, and new Research Coordination Networks (RCNs) to organize the scientific community and increase collaboration. In FY 2016 NSF will begin to discuss and coordinate plans for the potential creation of a National Brain Observatory with other agencies and the National Laboratory Network.

Intelligence Advanced Research Projects Activity (IARPA): In FY16, IARPA plans to invest in at least three research programs in applied neuroscience to advance our understanding of cognition and computation in the brain. The Strengthening Human Adaptive Reasoning and Problem-solving (SHARP) program will test and validate non-invasive neural interventions that have the potential to significantly improve adaptive reasoning and problem-solving, ultimately leading to improvements in human performance in information-rich environments. The Knowledge Representation in Neural Systems (KRNS) program will seek insights into the brain's representation of conceptual knowledge as a step toward building new analysis tools that acquire, organize, and wield knowledge with unprecedented proficiency. Finally, the Machine Intelligence from Cortical Networks (MICrONS) program will begin to reverse-engineer the algorithms of the brain to motivate the design of novel, neurally-derived machine learning algorithms that can perform complex information processing tasks.

Food and Drug Administration (FDA): In FY 2016, FDA plans to continue to support The BRAIN Initiative by enhancing the transparency and predictability of the regulatory landscape for neurological devices and assisting developers and innovators of medical devices, which is so critical to realizing the investments made by our federal, and private sector partners. Moving forward, FDA's Center for Devices and Radiological Health has proposed a new voluntary program for certain medical devices, including devices applicable to The BRAIN Initiative, that demonstrate the potential to address unmet medical needs for life threatening or irreversibly debilitating diseases or conditions. This new program would provide an expedited pathway to market for qualified devices. FDA will continue to take actions to improve the efficiency, consistency, and predictability of clinical studies for investigational medical devices in general, and for devices of public health importance, in particular, under the Clinical Trials Enterprise Initiative.[1] FDA will continue to engage stakeholders to assist developers and innovators in moving safe and effective products to the market. FDA remains committed to continuing its role under The BRAIN Initiative in making as transparent as possible the regulatory framework applicable to neurological devices and thereby helping to bring safe and effective products to patients and consumers.

[1]http://www.fda.gov/downloads/AboutFDA/CentersOffices/OfficeofMedicalProductsandTobacco/CDRH/CDRHVisionandMission/UCM384576.pdf

Appendix B.

Fact Sheet: Over $300 Million in Support of the President's BRAIN Initiative

September 30, 2014

> "Last year, I launched the BRAIN Initiative to help unlock the mysteries of the brain, to improve our treatment of conditions like Alzheimer's and autism and to deepen our understanding of how we think, learn and remember. I'm pleased to announce new steps that my Administration is taking to support this critical research, and I'm heartened to see so many private, philanthropic, and academic institutions joining this effort."
>
> - President Obama

In April 2013, the President announced the launch of the BRAIN (Brain Research through Advancing Innovative Neurotechnologies) Initiative – a bold new Grand Challenge focused on revolutionizing our understanding of the human brain.

The BRAIN Initiative has the potential to do for neuroscience what the Human Genome Project did for genomics by supporting the development and application of innovative technologies that can create a dynamic understanding of brain function. It aims to help researchers uncover the mysteries of brain disorders, such as Alzheimer's and Parkinson's diseases, depression, and traumatic brain injury (TBI).

Today, the Administration is announcing:

- The BRAIN Initiative is growing to five participating federal agencies as the Food and Drug Administration (FDA) and Intelligence Advanced Research Projects Activity (IARPA) join the National Institutes of Health (NIH), National Science Foundation (NSF), and Defense Advanced Research Projects Agency (DARPA). NIH is announcing $46 million in new grant awards and all of the participating agencies are committing to engage in BRAIN Initiative-related work in Fiscal Year 2015 (FY15).

- Members of the National Photonics Initiative, along with other companies such as GE, Google, GlaxoSmithKline, and Inscopix are leveraging their core infrastructure, assets, and more than $30 million in research and development investments to support the BRAIN Initiative.

- Major foundations, patient advocacy organizations, and universities, including the Simons Foundation, University of Pittsburgh, and others, are aligning over $240 million of their research efforts with the BRAIN Initiative.

Today, the Administration is hosting the White House BRAIN Conference to highlight new commitments to the BRAIN Initiative and to explore how the Initiative can continue to advance neuroscience research and its application to the treatment of brain disorders. Attendees will include a range of partners from the research community, federal agencies, foundations, patient advocacy groups, private research institutes, companies, scientific societies, as well as individual scientists. As announced in the White House Factsheet on Executive Actions to Fulfill our Promises to Service Members, Veterans, and Their Families last month, the White House BRAIN Conference will include a focus on Post-Traumatic Stress Disorder (PTSD) and TBI.

Background

In the last decade alone, scientists have made a number of landmark discoveries that now create the opportunity to unlock the mysteries of the brain, including the sequencing of the human genome, the development of new tools for mapping neuronal connections, the increasing resolution of imaging technologies, the maturation of nanoscience, and the rise of biological engineering. These breakthroughs have paved the way for unprecedented collaboration and discovery across scientific fields. For instance, by combining advanced genetic and optical techniques, scientists can now use pulses of light to determine how specific cell activities in the brain affect behavior. Similarly, through the integration of neuroscience and physics, researchers can now use high-resolution imaging technologies to observe how the brain is structurally and functionally connected in living humans.

While these technological innovations have contributed substantially to our expanding knowledge of the brain, significant breakthroughs in how we treat neurological and psychiatric disease will require a new generation of tools to enable researchers to record signals from brain cells in much greater numbers and at even faster speeds. This cannot currently be achieved, but great promise for developing such technologies lies at the intersections of nanoscience, imaging, biological engineering, informatics, and other rapidly emerging fields of science and engineering.

The BRAIN Initiative will accelerate the development and application of new technologies that will enable researchers to produce dynamic pictures of the brain that show how individual brain cells and complex neural circuits interact at the speed of thought. These technologies will open new doors to explore how the brain records, processes, uses, stores, and retrieves vast quantities of information, and shed light on the complex links between brain function and behavior.

This initiative is one of the Administration's "Grand Challenges" – ambitious but achievable goals that require advances in science and technology. Since President Obama announced the BRAIN Initiative in April 2013, dozens of leading technology firms, academic institutions, scientists, and other key contributors to the field of neuroscience have answered his call and made significant commitments to advancing the initiative. Top neuroscientists also have developed a 12-year research strategy for NIH to achieve the goals of the BRAIN Initiative.

"The human brain is the most complicated biological structure in the known universe. We've only just scratched the surface in understanding how it works – or, unfortunately, doesn't quite work when disorders and disease occur," said NIH Director Francis S. Collins, M.D., Ph.D. "There's a big gap between what we want to do in brain research and the technologies available to take us there. These initial awards are focused on developing the tools and technologies needed to make the next leap in understanding the brain. This is just the beginning of a 12-year journey and we're excited to be starting the ride."

Today, the President's Science Advisor Dr. John Holdren highlighted several of these commitments, and called on companies, research universities, foundations, and philanthropists to join with him in continuing to identify and pursue the Grand Challenges of the 21st century.

Today's BRAIN Initiative announcements include:

- **Ongoing and new investments by the Administration:** Since the Initiative's launch, the Defense Advanced Research Projects Agency (DARPA), the National Institutes of Health (NIH), and the National Science Foundation (NSF) have already made significant BRAIN-related grant awards and issued solicitations. In addition, the President's FY15 Budget proposes to double the Federal investment in the BRAIN Initiative from these three agencies from about $100 million in Fiscal Year 2014 (FY14) to approximately $200 million in FY15. Moreover, two new Federal agencies have joined the BRAIN Initiative, with IARPA planning to sponsor several research programs to support the goals of the BRAIN Initiative and with FDA working to enhance the transparency of the regulatory landscape for neurological medical devices that will be developed as part of the BRAIN Initiative.

- **A broad response to the President's call to action:** In response to the President's call to action, a number of companies, foundations, patient advocacy organizations, universities, and private research institutions are making investments to advance the goals of the BRAIN Initiative. Building on a record of accomplishment from the commitments made in 2013, dozens of new partners announced commitments to align more than $270 million in research and development efforts with the goals of the BRAIN Initiative.

- **Maintaining our highest ethical standards:** In May 2014, at the President's request, the Presidential Commission for the Study of Bioethical Issues released the first of two reports exploring core ethical standards to guide the BRAIN Initiative and other recent advances in neuroscience. The Commission emphasized integrating ethics explicitly and systematically into neuroscience research from the start – a critical component for success that will prevent the need for later corrective interventions. The Commission is now examining the ethical and societal implications of neuroscience research and its applications more broadly and has been considering topics including capacity to consent, cognitive enhancement, and direct-to-consumer products, with its second report due out in the spring of 2015.

Key Activities by the Administration Being Highlighted Today

The BRAIN Initiative is growing to five participating federal agencies as FDA and IARPA join DARPA, NIH, and NSF. The NIH is announcing $46 million in new grant awards and all of the participating agencies are committing to engage in BRAIN Initiative-related work in FY15, including:

- *NIH is announcing $46 million in new BRAIN-related grant awards, focusing on new tools and techniques:* The National Institutes of Health announced today its first investment of approximately $46 million in FY2014 funds to support the goals of the President's BRAIN Initiative. Through this investment, more than 100 investigators will work to develop new tools and technologies to gain an understanding of circuit function in the brain and capture a dynamic view of the brain in action. In total, 58 awards were issued to institutions in more than 15 states and several countries. Funded projects focus

on classifying the myriad cell types in the brain, producing tools and technologies for analyzing brain cells and circuits, creating next-generation human brain imaging technology, developing methods for large-scale recordings of brain activity, and integrating experiments with theories and models to understand the functions of specific brain circuits. Planning for the NIH component of the BRAIN initiative is guided by the long-term scientific plan, "BRAIN 2025: A Scientific Vision" that details seven high-priority research areas and calls for a sustained federal commitment over 12 years. Potential new concepts for FY15 BRAIN Initiative funding announcements include human-centered neuroscience, training initiatives, and an initiative using the Small Business Innovation Research (SBIR) program in addition to the possible expansion of themes highlighted in FY14. For more details, see http://www.nih.gov/science/brain.

- *DARPA is supporting four current programs and is planning new investments in support of the BRAIN Initiative, with the ultimate goal of relieving and rehabilitating warfighters and civilians suffering from traumatic injury and neuro-psychiatric illness:* The Defense Advanced Research Projects Agency (DARPA) has launched a number of major efforts to develop breakthrough neurotechnologies that are deepening scientists' understanding of brain function and are supporting the development of novel therapeutic strategies. As part of this effort, DARPA is developing and assessing revolutionary electronic interfaces to the brain, as well as to the peripheral nervous system, that have the potential to provide high-resolution insights into neural circuits, lower the need for and impacts of invasive surgery, and improve neurocognitive and medical outcomes for patients with some of the most challenging disorders of the nervous system. Efforts currently underway at DARPA include the following programs:
    - Neuro-Function, Activity, Structure, and Technology (**Neuro-FAST**), which seeks to decode the behavior and neural activity of higher-order mammals to create a more complete understanding of neuronal activity and the structure and behavior of neural networks.
    - System-Based Neurotechnology for Emerging Therapy (**SUBNETS**), which aims to monitor, decode and alleviate symptoms in patients with otherwise intractable psychiatric and neurological diseases.
    - Restoring Active Memory (**RAM**), which is focused on restoring an individual's ability to form new memories following traumatic brain injury or neurologic disease.
    - Hand Proprioception and Touch Interfaces (**HAPTIX**), which aims to enable improved dexterity and fine motor control and restore the sensation of touch and spatial awareness for prosthetics users.

  DARPA will expand upon these efforts in FY15 with the new **ElectRx** program, which aims to develop new, minimally invasive neurotechnologies that, through targeted stimulation of the nervous system, can enhance the body and brain's ability to heal without surgery. These technologies hold promise to be helpful to service members, veterans, and others for the treatment of a wide range of medical conditions including inflammatory diseases and mental health disorders.

- *NSF continues its support of the BRAIN Initiative by accelerating fundamental research and the development of new technologies for neuroscience and neuroengineering:* Over

the past year, NSF has continued its significant investments in core activities focused on accelerating fundamental research and the development of new technologies for neuroscience and neuroengineering. In FY14, NSF funded 35 Early-concept Grants for Exploratory Research (EAGER) awards for innovative approaches and neurotechnologies to understand the brain. NSF also funded many more interdisciplinary neuroscience projects that span computing, engineering, and the mathematical, physical, life, social, and behavioral sciences, including support for the Science and Technology Center on Minds, Brains, and Machines at MIT. In the next year, NSF will invest in new interdisciplinary and transdisciplinary research and workforce development through a call for research on Integrative Strategies for Understanding Neural and Cognitive Systems and through Ideas Labs. In addition, NSF is announcing a new opportunity to facilitate partnerships among academia, industry, and government to advance the science and engineering of brain imaging and elucidate the relationship between structure and function. For more information, visit www.nsf.gov/brain.

- *FDA is joining the BRAIN Initiative, with the goal to enhance the transparency of the regulatory landscape for neurological medical devices:* In support of the FDA's work to enhance regulatory transparency, predictability, and assistance for developers and innovators of neurological medical devices, the agency will hold a public workshop in November of this year on Brain-Computer Interface (BCI) devices. These devices include neuroprostheses that interface with the central or peripheral nervous system to restore lost motor or sensory capabilities for patients with paralysis or amputations. As part of this workshop, the FDA is posting a discussion paper on its website, which contains information and questions on BCI devices to help facilitate and initiate discussion at the workshop. The FDA will use information and feedback from the workshop to develop an overall strategy that will promote advances in the technology while maintaining appropriate patient protections. This strategy will identify advances in regulatory science and the development of FDA guidance on premarket submissions for BCI technologies.

- *IARPA is joining the BRAIN Initiative and will use multidisciplinary approaches to advance understanding of cognition and computation in the brain:* The Intelligence Advanced Research Projects Activity (IARPA) is an organization within the Office of the Director of National Intelligence that invests in high-risk, high-payoff research to tackle some of the most difficult challenges in the Intelligence Community. As part of this mission, IARPA will sponsor several applied research programs that use multidisciplinary approaches to advance our understanding of cognition and computation in the brain. Programs to be executed in FY15 include: the Knowledge Representation in Neural Systems (KRNS) program, which seeks insights into the brain's representation of conceptual knowledge; the Strengthening Human Adaptive Reasoning and Problem-solving (SHARP) program, which will develop non-invasive neural interventions for optimizing reasoning and problem-solving; and the Machine Intelligence from Cortical Networks (MICrONS) program, which will reverse-engineer the algorithms of the brain to revolutionize machine learning.

Leading Companies are Committing to Support the Goals of the BRAIN Initiative

Leading companies are leveraging their core infrastructure, assets, and investments to support the BRAIN Initiative, including:

- *U.S. Photonics Industry Leaders are committing $30 million to tackle challenges of the BRAIN Initiative:* The National Photonics Initiative (NPI), an alliance of major scientific societies, industry and academic organizations, is convening a Photonics Industry Neuroscience Group to focus on developing new optics and photonics technologies in support of the BRAIN Initiative. This multidisciplinary industry group is comprised of influential U.S. industry leaders including Accumetra, LLC; Agilent, Applied Scientific Instrumentation; Coherent; Hamamatsu; Inscopix, Inc.; Spectra—Physics; and THORLABS. The Photonics Industry Neuroscience Group will work closely with the BRAIN Initiative leadership and with the neuroscience research community to advance optics and photonics research and technology development. The NPI industry group will invest at least $30 million in existing and future research and development spending over the next three years to advance optics and photonics technology challenges in neuroscience, such as:
    - Developing the imaging optics, laser sources, automated scanning technology, and high resolution cameras to provide a ten- to one-hundred-fold increase in the capability of imaging groups of thousands of active neurons;
    - Developing miniature, affordable, and portable/implantable microscopes compatible with high-throughput facilities for therapeutic screening based on neural activity signatures;
    - Using large-scale, high-throughput protein engineering technology, develop a new generation of fluorescent indicators of neural activity with ten-fold improvements in efficiency and temporal response; and
    - Developing automated software for detailed mapping of the human brain, architecture, neuronal wiring geometry, and dynamic activity from three-dimensional data sets generated by MRI, CT, and microscopic imaging.

- *GE has launched a new Brain Health Initiative linking numerous entities within the company such as GE Healthcare, GE Ventures & Healthymagination, and GE's Global Research Center:* The new Brain Health Initiative will build on and coordinate multiple efforts within the company, including corporate venture capital, open innovation, R&D, and health care lines of business. This includes previously announced efforts at GE, such as the work that the company has done to convene the traumatic brain injury community with a $60 million open innovation challenge, in partnership with the National Football League and Under Armour, to develop both next-generation imaging technology and algorithms and to provide better devices and gear for brain protection. GE also supports the TBI Endpoints Initiative (TED), a program that is bringing together multiple academic leaders in the traumatic brain injury field to better understand, diagnose and treat TBI and concussion, as well as other neuroscience-related research collaborations. GE is investing through venture capital in numerous start-up companies with novel neuro-based technologies. In further support of BRAIN-related efforts, GE is addressing critical public policy needs in neuroscience through its "Brain Trust" meetings of thought leaders.

- *Google engineers are building tools and developing infrastructure to analyze petabyte-scale datasets generated by the BRAIN Initiative:* Google is working closely with the Allen Institute for Brain Science to develop scalable computational solutions to advance scientific understanding of the brain. Google has also begun additional collaborations

with the Howard Hughes Medical Institute's Janelia Research Campus and several academic partners. Google is building the software tools and supporting infrastructure needed to analyze petabyte-scale datasets generated by the BRAIN Initiative and the neuroscience community to better understand the brain's computational circuitry and the neural basis for human cognition.

- *GlaxoSmithKline is announcing up to $5 million in new funding for the research community to develop innovative peripheral neurotechnologies:* In 2013, GlaxoSmithKline (GSK) announced its ambition to develop new treatments for disease through neuronal control of visceral organs systems, an area where GSK believes there is opportunity for translation of innovative neurotechnology to create precision treatments for chronic diseases such as asthma, hypertension, and arthritis. Since then, the GSK Bioelectronic Medicines program has furthered work in the research community in this area through multiple efforts, including exploratory funding for academic scientists, a $50 million venture capital fund, and a Bioelectronics Innovation Challenge to rapidly develop peripheral nerve research tools. Today GSK is announcing that within the Innovation Challenge, in addition to the previously announced $1 million award for the solver of the Challenge, GSK will provide up to $5 million of funding to seed and development funding for researchers to de-risk, design, develop, and test technologies. Launching today, the fund will rapidly engage, assess, and fund teams starting work in January 2015. In the spirit of open collaboration, the Challenge requires the funded parties to provide unrestricted, royalty-free access for research purposes to all technologies and tools developed through the program.

- *Inscopix is doubling the number of grants that it will award to advance the mechanistic understanding of the brain*: Inscopix is a provider of end-to-end solutions for imaging and interpreting large-scale neural activity during natural behavior. This past summer, in response to the BRAIN Initiative**,** Inscopix launched a $1 million scientific grant program, Deciphering Circuit Basis of Disease (DECODE), to catalyze the mechanistic understanding of the brain in health and disease. DECODE is an "in-kind" grant program designed to incentivize researchers to pursue transformative neural circuit research by coupling state-of-the-art technology access with comprehensive training. To better serve the response from the neuroscience research community to DECODE, Inscopix will double its commitment to $2 million and support up to ten laboratories for a period of two years.

Major Private Research Efforts are Announcing Plans to Align with and Support the BRAIN Initiative

Major foundations and universities are aligning over $240 million of their research efforts with the BRAIN Initiative, including:

- *University of Pittsburgh is announcing more than $65 million in funding for the University of Pittsburgh Brain Institute:* In January 2014, the University of Pittsburgh announced the creation of a Brain Institute focused on unlocking the mysteries of normal and abnormal brain function. The Brain Institute will support the efforts of more than 150 neuroscientists at the university and create seven new Centers, including the NeuroTech Center, which capitalizes on the University's advances in brain-computer

interfaces for paralyzed individuals, and the NeuroDiscovery Center, which will provide unique resources to enable innovative basic science research. The University has committed at least $45 million to support this effort and has received upwards of $20 million from public and private donors to fund its Brain Institute's endeavors.

- *The Simons Foundation is announcing alignment of $62 million Simons Collaboration on the Global Brain with the goals of the BRAIN Initiative:* In the spring of 2014, the Simons Foundation launched the Simons Collaboration on the Global Brain with a $60 million investment over the next five years. The goal of this collaboration, directed by David Tank, is to uncover patterns of the neural activity that produce cognition by combining analyses of internal mental states with studies of sensory and motor processing. Little is known about the internal states that represent motivation, decision bias, remembered events, and other cognitive functions; this work aims to define neural correlates of internal mental states by determining the principles of coding and dynamics within large populations of neurons recorded at single cell resolution in alert, behaving animals using advanced statistical analysis and modeling.

- *The Carnegie Mellon University is announcing a $40 million commitment to support the goals of the BRAIN Initiative:* The Carnegie Mellon University (CMU) BrainHub initiative spans across CMU's colleges and schools, involving nearly 50 faculty and over 150 scientists. A major facet of this initiative is increasing collaboration among faculty from disciplines such as computer science and engineering with those taking biological and behavioral approaches to neuroscience. Linking brain science to behavior via the application of machine learning, statistics, and computational modeling will be a hallmark of CMU's efforts, along with commercialization of the new technologies and applications. CMU plans to commit more than $40 million over the next five years to support several activities in the initiative, including 8 to 10 faculty positions, 10 endowed graduate fellowships, at least 6 new postdoctoral fellowships, $2 million in new seed funding, and support for an executive director position for this initiative. CMU is also partnering with institutions across the globe including the Indian Institute of Science, Sun Yat-sen University in China, and partners in Europe to create and analyze large data sets, and to train students and postdocs in computational approaches to brain science.

- *University of Texas System is announcing alignment of more than $20 million in equipment, faculty resources, and seed grants with the goals of the BRAIN Initiative:* In 2013, the University of Texas (UT) System organized a multi-campus Neuroscience Council in response to the BRAIN Initiative. The Council brings together top researchers from UT's 15 academic and health institutions to explore new convergent research that takes advantage of faculty expertise in disciplines such as engineering, computer science, mathematics, materials science, physics, and chemistry, along with cutting-edge resources such as the 10-petaflop supercomputer at UT Austin. The UT System has also created a Neuroscience and Neurotechnology Research Institute that will promote transdisciplinary, collaborative research projects focused on neurotechnology development and the creation of innovative tools and techniques that will transform the fields of imaging, neurocomputational techniques, molecular mapping, and the development of neuro-devices. In August 2014, The UT Board of Regents committed $20 million over two years for equipment, faculty recruitment, and seed money in the form of

peer-reviewed grants for multi-institutional, collaborative, and research projects to advance the BRAIN Initiative's goals.

- *University of California, Berkeley and Carl Zeiss Microscopy are announcing $12 million to create infrastructure for neurotechnology development:* The University of California, Berkeley (UC Berkeley) has invested in the Helen Wills Neuroscience Institute to create a program that will generate innovative devices and analytic tools in engineering, computation, chemistry, and molecular biology to enable transformative brain science from studies of human cognition to neural circuits in model organisms. The goal is to create new neurotechnologies that rapidly become accessible to the entire scientific community. The UC Berkeley BRAIN Initiative has invested $12 million to create infrastructure for neurotechnology development, including a public-private collaboration with Carl Zeiss Microscopy. This collaboration with Carl Zeiss Microscopy will support the Berkeley Brain Microscopy Innovation Center (BrainMIC), which will fast-track microscopy development for emerging neurotechnologies and will run an annual course to teach researchers how to use the new technologies.

- *University of Utah is committing $10 million to launch a Neuroscience Initiative to support the goals of the BRAIN Initiative:* The University of Utah Health Sciences has committed $10 million to launch a Neuroscience Initiative that will catalyze interdisciplinary approaches to neuroscience research. The goal is to deepen the understanding of the function and disorders of the nervous system and to improve patient care through innovation and integration of basic, translational, and clinical research efforts. This targeted investment by the university will lay the foundation for an expanded effort to enhance neuroscience research and advance the goals of the BRAIN Initiative. Initial funds will be used to create a "neuroscience hub," including space for collaborative research and neuroscience training. Funds will also be committed for priority investments, including recruiting new faculty in key areas to link basic, translational, and clinical neuroscience; seed funding to stimulate new projects and collaborations across departments and colleges; and programmatic efforts to educate the community and coordinate researchers in diverse disciplines across campus. The strategy will align neuroscience research in disease-focused pillars with a focus on those with high impact on Utah populations. The disease pillars will be linked by foundation elements, which represent critical areas of expertise or enabling technologies, in line with the priorities of the BRAIN Initiative.

- *Boston University is announcing alignment of new neuroscience centers with the goals of the BRAIN Initiative:* In 2014, Boston University announced a commitment of $140 million for the creation of the Center for Integrated Life Science and Engineering (CILSE), a new and unique facility for interdisciplinary research which will bring together outstanding scientists and engineers from across the University to work collaboratively in the areas of neuroscience and biological design. CILSE will comprise 170,000 square feet and support approximately 20 faculty and some 400 students and staff. Its core resources will include a shared equipment facility for Cognitive Neuroimaging. Three new research Centers will be launched including the Center for Systems Neuroscience and the Center for Sensory Communication and Neural Technology. The University has committed an additional $4 million over 5 years to the

launching of these Neuroscience Centers and they will focus on addressing the goals of the BRAIN Initiative.

- *The Brain & Behavior Research Foundation is committing to a $2 million increase in its annual support for young scientists working on the goals of the BRAIN Initiative:* The Brain & Behavior Research Foundation invests in cutting-edge research projects to understand, treat, and ultimately prevent and cure mental illness. In recognition of the critical role that basic research plays in understanding the brain, the Foundation is committing to a $2 million increase in its annual support for the most promising young scientists nationwide conducting neurobiological research to support the goals of the BRAIN Initiative through its Young Investigator Grants. The Foundation also continues to support the public television series "Healthy Minds," which this season will include episodes highlighting The BRAIN Initiative and the importance of research.

- *The Children's Neurobiological Solutions Foundation is committing to expanding their Pediatric Brain Mapping Project and to developing mechanisms to connect their patients with ongoing or future clinical trials:* The Children's Neurobiological Solutions Foundation (CNS Foundation) seeks to expedite the search for treatment and cures for children with neurological disorders as well as to provide important information to parents and patients on recent advances in pediatric neurology. CNS Foundation's Pediatric Brain Mapping Project aims to identify all children living with pediatric neurological disorders and CNS Foundation is committing to doubling the population in the project in the next year, from approximately 5,000 to 10,000 children. With this information, CNS Foundation will be positioned to connect patients with scientists and researchers who are working on the goals of the BRAIN Initiative. This opportunity for active collaboration between patients, patient advocacy groups, biotechnology and pharmaceutical companies, doctors, and researchers will help lead to the discovery of the next generation of treatments and cures for the diseases and disorders these children face.

- *The Pacific Northwest is announcing plans to develop a vibrant neurotechnology regional cluster:* The Pacific Northwest Neuroscience Neighborhood (University of Washington, the Allen Institute for Neuroscience, Oregon Health & Science University, and 50 companies based in Oregon and Washington) will pilot a BRAIN Initiative 'regional cluster' in the spring and summer of 2015 to bring together the research, clinical, industry, academic, education, public, and advocacy communities to highlight and build on the BRAIN Initiative themes and goals in the Pacific Northwest. By aligning a series of neuroscience events and conferences, this "BRAIN BRIDGE" aims to be an innovative model for engaging multiple stakeholder groups in the Pacific Northwest to create opportunities for more effective advocacy, targeted policy development, improved research investment, stimulated entrepreneurial enterprise, new educational practice dissemination, and public engagement. The BRAIN BRIDGE will also establish a strategy for developing a vibrant neurotechnology cluster that will connect scientists, technology developers, and funders.

- *The Neurotechnology Architecting Network is committing to mentoring and training innovators who will develop new technologies to meet the goals of the BRAIN Initiative:* The Neurotechnology Architecting Network is an open organization of innovators across many for- and non-profit institutions who are developing tools and technologies to reveal

how the brain works. In support of the goals of the BRAIN Initiative, the Neurotechnology Architecting Network is committing to mentoring and training innovators who will design, prototype, assess, and distribute at least a dozen technologies for mapping, recording, and controlling neural circuits. This network will aim to create a distributed "neurotech valley" that will disseminate these tools to further both the basic understanding of the brain, as well as its repair.

Building on a Record of Accomplishment

The key private sector partners that helped launch the BRAIN Initiative in 2013 made important progress in their commitments, including:

- *The Allen Institute for Brain Science*: The Allen Institute, a nonprofit medical research organization, engages in large-scale brain research and the public sharing of data and tools. Consistent with its 2013 commitment to spend $60 million annually to support Allen Institute projects and partnerships related to the BRAIN Initiative, in 2014 the Institute completed a multi-year, large-scale project: the Allen Mouse Brain Connectivity Atlas (a map of the major highways connecting the mouse brain). The Institute has also partnered with Google to develop scalable computational solutions to advance our understanding of the brain. Finally, the Allen Institute helped establish an annual conference for the large brain initiatives with Keystone Symposia with the NIH, the Salk Institute, and the Human Brain Project in Europe.

- *Howard Hughes Medical Institute invested more than $70 million to support the goals of the BRAIN Initiative during the past year, and plans a similar level of commitment in 2015:* Howard Hughes Medical Institute (HHMI) has invested more than $70 million to support the BRAIN Initiative during the past year at its Janelia Research Campus and in the laboratories of HHMI Investigators at universities throughout the United States. This investment has been focused on developing new imaging technologies and understanding how information is stored and processed in neural networks. A similar level of commitment is expected in 2015, including large-scale efforts at Janelia for neuroanatomical studies using light and electron microscopy, and for the development of improved sensors of neuronal activity and other genetic reagents.

- *The Kavli Foundation is continuing its support for the goals of the BRAIN Initiative and for innovative brain research:* Consistent with its commitment in 2013, The Kavli Foundation intends to spend $40 million over the next ten years in support of the BRAIN Initiative. The Kavli Foundation will establish two new endowed neuroscience institutes by the end of 2015, which will join an existing worldwide network of Kavli Institutes. The Kavli Foundation is also fostering new cross-disciplinary opportunities between neuroscience and the physical sciences through regular meetings on campuses nationwide. With GE healthymagination, HHMI, and the Allen Institute for Brain Science, it has established a program, "Neurodata Without Borders," that promotes the sharing of neuroscience data among scientists. Recognizing the critical importance of a diversity of funding sources, the Foundation is leading efforts to forge new alliances among scientists, philanthropy, and industry through pilot projects.

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