U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH

HEARING CHARTER

The Frontiers of Human Brain Research

Wednesday, July 31, 2013
11:00 a.m. - 12:30 p.m.
2318 Rayburn House Office Building

1. Purpose

On Wednesday, July 31, 2013, the Subcommittee on Research and Technology will hold a hearing to understand the frontiers and challenges of brain science research, including its potential and limitations for curing brain diseases and rehabilitating those with brain-related injuries and disorders. The hearing will also aim to understand any policy implications from this research, including any implications for the America COMPETES reauthorization.

2. Witnesses

Dr. Story Landis, Director, National Institute for Neurological Disorders and Stroke (NINDS) at the National Institutes of Health (NIH)

Michael McLouglin, Deputy Business Area Executive, Research and Exploratory Development, Applied Physics Laboratory at Johns Hopkins University and **U.S. Air Force Master Sergeant Joseph Deslauriers Jr.**

Dr. Marcus Raichle, Professor of Radiology, Neurology, Neurobiology and Biomedical Engineering, Washington University in St Louis

Dr. Gene Robinson, Professor in Entomology and Neuroscience and Director of the Institute for Genomic Biology, University of Illinois at Urbana-Champaign

3. Hearing Overview

Understanding the human brain remains one of the most complex tasks facing the medical sciences community. Throughout the 19th and 20th century, much progress was made by breaking the brain down into various components, with individual neurons viewed as the fundamental unit for human brain activity. The number of these neurons is roughly a hundred billion; the number of contacts between neurons is a hundred trillion. The brain is a complex organ that processes and receives electrical, chemical and mechanical inputs and outputs. The average neuron receives thousands of distinct inputs, with each neuron connecting to many other neurons; however the exact physical "circuitry" of these individual components is unknown.

Taxpayer funded research in neuroscience, the scientific field that studies the nervous system, has been crucial to advancing our understanding into the workings of the brain. During

FY 2013, the National Institutes of Health (NIH) spent over $5.6 billion in supporting neuroscience-related research. Brain science is an inter-disciplinary field, with important contributions from fields as diverse as electrophysiology, imaging, molecular biology, biochemistry, physics and applied mathematics. Each of these disciplines has enriched our understanding of the brain, thereby allowing researchers to move towards an integrated picture of the brain's behavior through translational research and medicine.

Attempts to map the brain into distinct areas, each with its specific function, is a scientific approach that has existed for over a century. In the mid-1800s, brain science focused on discovering and "mapping" the functions of the cerebral cortex using a variety of methods and techniques that were available at that time. This field is called phrenology, and the mapping paradigm of localizing cerebral functions within the brain was its primary focus. Today, one of the main challenges is moving from a static to a more dynamic view of the brain. Other challenges include finding accurate and repeatable medical tests for diagnosing brain disorders.[1]

The experimental tools available to the biological sciences are rapidly growing, with many in the brain research community viewing them as the key to unlocking the next breakthrough. This evolving experimental and computational toolkit, much of it funded by federal science agencies, is addressed at understanding the brain at various time and length scales. This includes the Human Connectome Project, a $30M NIH-funded endeavor to map long-distance neural pathways in the brains of 1,200 healthy adult humans using functional magnetic resonance imaging (fMRI). Other advances include two-photon functional imaging and next generation brain-machine interface using integrated neurophotonics and nanoparticles.

The Defense Advanced Research Projects Agency (DARPA) has recently been funding research projects that aim to diagnose and develop therapeutic responses for brain and spinal cord injury. In particular, DARPA has sponsored the development of robotic arms that are allowing returning veterans, who have lost limbs, to lead functioning lives. For example, sensors on the skin can detect the brain's signals from the nerves and use those signals to control a robotic arm, without an invasive surgical procedure. Other neuro-prosthetic technologies include implanting sensors inside the human brain to control remote robotic appendages with only a person's thoughts.

Economic Impact

The economic implications for this research are significant. The monetary cost of dementia, including Alzheimer's disease, in the United States ranges from $157 billion to $215 billion annually. Dementia is more costly to the nation than either heart disease or cancer.[2] As our nation's population grows older, the costs of dementia related diseases could double by 2040. In a 2008, Dr. Thomas Insel, the director of the National Institute for Mental Health, estimated that the total cost of serious mental illness in the US exceeds $317 billion per year.[3] These annualized costs include: an estimated $193 billion in lost earnings, roughly $100 billion in direct health care costs, and another $24 billion in disability benefits. This estimate ignores other major factors that increase the cost burden to our nation, including: homelessness, incarceration, substance abuse and other addictions, all of which are associated with mental illness. The US

[1] http://www.npr.org/blogs/health/2013/07/08/198086616/MENTAL-ILLNESS-BIOMARKERS
[2] http://www.rand.org/news/press/2013/04/03.html
[3] http://ajp.psychiatryonline.org/article.aspx?articleid=99862

National Bureau of Economic Research has estimated that 38 percent of all alcohol, 44 percent of all cocaine, and 40 percent of all cigarettes are consumed by people with a mental illness.[4]

BRAIN Initiative

In April, the Obama Administration announced the Brain Research through Advancing Innovative Neurotechnologies (BRAIN) Initiative prior to presenting his FY 2014 budget request; this is a joint research program between federal science agencies— NSF, NIH, and DARPA —and private sector partners in research of brain disorders ranging from Alzheimer's and Parkinson's disease, epilepsy, autism, and injuries. The initiative has been met with some skepticism by the research community for its intent and how it might divert funds from other research.[5] While the NSF's FY 2014 budget presentation to the Committee did not highlight the Foundation's contribution to the Administration's BRAIN Initiative as a priority, $14 million in additional spending is requested for Cognitive Science and Neuroscience. The NIH and Defense Advanced Research Projects Agency (DARPA) will each receive $40 million and $50 million in funding respectively. Private organizations are also involved with this program, including $60 million from the Allen Institute for Brain Science, $30 million from the Howard Hughes Medical Institute, $28 million from the Salk Institute for Biological Studies, and $4 million from the Kavli Foundation.

Supporters of the BRAIN Initiative have compared the project to the Human Genome Project, whose main benefit has been the development of technologies to quickly and accurately screen the genomes of individual clients. However, the actual benefit from the Human Genome Project has been limited so far in that no diseases have yet to be cured as a result of the human genome map. Critics of the BRAIN Initiative have mentioned that this investment needs more specific goals or end-points. The central question is not about the technology, but whether what the BRAIN initiative's goal of "mapping the human brain" provides an accurate reflection of how the brain works, and whether brain-mapping is a valid or outmoded paradigm to make progress in the field. Further, advocates for the BRAIN Initiative need to communicate the long-term nature of such promising research and when they can reasonably expect certain breakthroughs, especially given the level of public investment.

European Commission's Human Brain Project

There is world-wide interest in understanding the brain. The Human Brain Project has been officially selected as one of the European Commission's two *Future and Emerging Technologies Flagship Projects*. The goal of the EU's Human Brain Project is to consolidate existing knowledge about the human brain and to reconstruct the brain using a combination of modeling and computational simulations; the project will rely heavily on the use of supercomputers. The models offer the prospect of a new understanding of the human brain and its diseases and of completely new computing and robotic technologies. The Human Brain Project is planned to last ten years (2013-2023).

[4] http://www.nber.org/digest/apr02/w8699.html

[5] http://www.npr.org/2013/04/05/176303594/researchers-question-obamas-motives-for-brain-initiative

Issues for Consideration

The hearing will examine the latest developments in the area of brain science research, and stress the interdisciplinary approach that is necessary for understanding the complexities of the human brain. Witnesses have been invited to give demonstrations of their technologies and discuss the future of brain science research. They will also comment on current and future federal initiatives in the area of brain science research.