R & D Tax Credit Aspects of Brain Mapping

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Charles R. Goulding, Andrea Albanese and Charles G. Goulding explain the many university research projects devoted to brain mapping and discuss the R & D tax credit available to taxpayers for qualified research activities.

With a $3 billion U.S. commitment announced in 2013 called BAM (Brain Activity Mapping) and a $1 Billion EU effort called the Human Brain Project, the race to map the 100 billion neurons of the human brain has begun.

This effort follows the Bush administration "Decade of the Brain," which provided important technology advances but also demonstrated that major advances are foreseeable and achievable. Just as the global effort to map the human genome required massive governmental, university and private industry effort, this is already supporting a similar effort.

It is particularly important to understand the incredible amount of university research now occurring since this basic R & D tax credit will drive the ensuing wave of commercial R & D.

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The Research & Development Tax Credit

Many of the private industry and industry-supported university R & D efforts will be eligible for federal research and development tax credits.

Federally enacted in 1981, the Research and Development (R & D) Tax Credit allows a credit of up to 13 percent of eligible spending for new and improved products and processes. Qualified research must meet the following four criteria:

- new or improved products, processes or software;
- technological in nature;
- elimination of uncertainty; and
- process of experimentation.

Eligible costs include employee wages, cost of supplies, cost of testing, contract research expenses and costs associated with developing a patent.

On January 2, 2013, President Obama signed the bill extending the R & D tax credit for 2012 and 2013 tax years.

The Human Connectome Project (HCP)

Sponsored by the National Institute of Health (NIH), the Human Connectome Project is a five-year project divided between two consortia of research institutions. The first of three Grand Challenges of the NIH's Blueprint for Neuroscience Research began in July 2009.

In September 2010, the NIH announced that it would award two grants which include $30 million over five years to a consortium led by Washington University and the University of Minnesota and $8.5 million over three years to a consortium led by Harvard University, Massachusetts General Hospital and the University of California.

The HCP is focused on creating a "network map" that will explain the anatomical and functional connectivity of the human brain. In addition to creating a network map, there is a focus on generating a body of data that will facilitate research into brain disorders like dyslexia, autism, Alzheimer's disease and schizophrenia.

The Washington University and University of Minnesota Consortium

The Washington University and University of Minnesota team initiative will map the connectomes in 1,200 healthy adults on a macro-scale using twin pairs and their siblings from 300 families. The maps will illustrate the anatomical/functional connections between the parts of the brain for each person and will correlate to behavioral test data.

Comparing the connectomes and genetic data of identical twins to fraternal twins will help identify the roles of genes and environment in shaping brain circuitry and reveal relevant genetic variation. Brain network organization will also be illustrated within this brain mapping effort.

Numerous leading institutions will be contributing to this project through investigation and research. These institutions include: Washington University, the Center for Magnetic Resonance Research at the University of Minnesota, Oxford University, Saint Louis University, Indiana University, University d'Annunzio in Chieti, Ernst Strungmann Institute, Warwick University, Advanced MRI Technologies and the University of California at Berkeley.

The data that results from this HCP research effort will be made public and will be accessible by web *via* neuroinformatics platform.

Massachusetts General Hospital (MGH), Harvard and UCLA Consortium

"The MGH/Harvard-UCLA consortium will focus on optimizing MRI technology for imaging the brain's structural connections using diffusion MRI, with a goal of increasing spatial resolution, quality, and speed."[1]

For this initiative, a new scanner was designed and is expected to be four to eight times as powerful as current imaging systems. This system will enable imaging of human neuroanatomy with much greater sensitivity and detail than currently possible.

The two consortia described above will also be sharing data and results with each other.

University Brain Mapping Efforts

Major U.S. research universities are engaged in a wide range of brain mapping R & D activities, as briefly summarized below:

- **Duke University**: Has recorded brain signals from electrons implanted in 2,000 neurons in a monkey.
- **Yale University**: Sense/Lab Project: founded in 1993 as part of the original human brain project, the Sense/Lab project is essentially a bio informatics approach to creating databases and database tools[2] for collecting and analyzing neuroscience information.
- **Stanford University School of Medicine**: Utilized a state of the art imaging system to quickly and accurately locate and count numerous neural connections in unprecedented detail.
- **Emory**: A new study completed in November 2012 demonstrates the crucial role cilia (tiny hair like structures on the surface of cells) plays in the migration of neurons.
- **Brown University**: Braingate clinical trial has enabled patients to control computer curses and robot arms by transmitting motion signals with implants utilizing only 100 electrodes.
- **Rice University**: The Brain and Language Lab, in a continuing study, is focusing on cognitive neuro-science, short-term memory, speech production, reading disorders and language processing.[3]
- **Harvard University**: The Boston Retinal project has developed a bionic eye that restores basic vision with an ophthalmic implant involving 256 electrodes.

- **University of California** & **University of Illinois**: Jointly developing a new generation of computer interfaces called "tattoo electronics" to process external skull on invasive interfaces.
- **MIT**: Mini Brains: Utilizing photolithography technology emanating from the semi-conductor industry to seed neural stem cells to build a model bionic brain.

Interdisciplinary Approach

The brain mapping project is a massive interdisciplinary endeavor that will require the integration of behavioral psychology, imaging, electrical engineering, genetics, bio chemistry, anatomy, computer science, robotics and numerous other technical disciplines. The next 10 years are anticipated to be the "Golden Age of Brain Research."

Brain mapping will advance knowledge related to disease causes, prevention and cures, including Alzheimer's.[4] This large amount of basic research and development at the university level will lead to large amounts of commercial R & D necessary to convert the results to market-ready products and services.

Recent research findings have linked certain DNA pathways to autism, ADHD, bipolar disorder, major depressive disorder and schizophrenia. Scientists believe that these disorders share common genetic roots, and Dr. Anil Malhotra said, "DNA pathways common to all five have been clearly traced in the brain."[5] The continued initiatives in brain mapping combined with this potential DNA link could accelerate the path to reductions and cures for these conditions as well as others.

Of Mice and Men

In early 2012, a $300 million award was made by Microsoft co-founder Paul Allen to the Allen Institute in Seattle to fund the first three years of a 10-year project to study mouse brains.

Why start by mapping a mouse brain rather than a human brain? The concept is that it should be much easier to map a simpler brain first. A mouse brain is only .5 grams while a human brain is 3,000 times larger. A mouse brain has 70 million neurons a fraction of the neurons in a human brain. Although this is a personal commitment by Mr. Allen, it is anticipated that knowledge gained brain mapping will also eventually lead to the design of more sophisticated computers.[6]

The major brain-mapping-related funding commitments discussed above are summarized in the following Table 1.

Table 1.

Brain Mapping Major Funding Summary

Funder	Amount
United States—Brain Activity Map (BAM)	$3 billion
European Union—Human Brain Project	$1 billion
Paul Allen of Microsoft	$300 million
U.S. National Institutes of Health	$40 million

Conclusion

Thinking tax professionals have an opportunity to be one of the many technical disciplines contributing to this important effort. R & D tax credits are an important part of this thinking.

Endnotes

1 "Human Connectome Project," accessed at *http://en.wikipedia.org/wiki/Human_Connectome_Project.*

2 Charles R. Goulding, Charles G. Goulding and Jacob Goldman, *The R & D Tax Aspects of Big Data,* Corp. Bus. Tax'n Monthly, May 2013, at 23.

3 *"Brain and Language Lab at Rice University,"* accessed at *http://psych.rice.edu/brainandlanguagelab/.*

4 Charles R. Goulding, Andressa Bonafe and Charles G. Goulding, *The R & D Tax Credit Aspects of Alzheimer's,* Corp. Bus. Tax'n Monthly, Nov. 2013, at 15.

5 Delthia Ricks, *Brain Disorders Linked,* Newsday, March 10, 2013, at A26.

6 Charles Q. Choi, *Microsoft Co-Founder Gives $300 Million to Build "Brain Observatories",* TechNews Daily, March 21, 2012, accessed at *www.technewsdaily.com/5604-microsoft-founder-300-million-build-brain-observatories.html.*