

Obama's brain project: A hall of mirrors?

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One of the famous line drawings of the artist M. C. Escher portrays a realistically drawn hand holding a pencil. The line drawn by the pen turns out to be the cuff of a shirt sleeve, from which emerges a second hand ... which grows out of the paper somehow and holds a pencil, whose line is the cuff of a shirt sleeve, from which emerges the first hand. Escher's "Drawing Hands" came to mind when I read of a planned initiative by the Obama administration to promote a decade-long project to map the human brain.

Officially, the project is still under wraps until the President announces his budget priorities later this month. But according to a *New York Times* report by John Markoff, plans include increased federal funding for neurological research directed at mapping increasingly complex brains, ranging from those of a fruit fly up to the world's smallest mammal, a type of shrew. But the ultimate goal is to learn how essentially every neuron in the human brain is connected, and how the whole thing works: a wiring diagram of the brain, if you will. Hopes are that such knowledge could lead to new therapies for presently incurable brain disorders such as Alzheimer's disease and other forms of dementia.

Inevitably, this project has been compared to the Human Genome Project, which was completed about a decade ago at a cost of under \$4 billion. Some estimates say that the information gained from that project has returned up to \$140 for every dollar spent. Aside from the purely economic results, the mapping of the human genome was a landmark scientific achievement in its own right, which has led to further questions and discoveries in an already burgeoning field.

Does the human-brain mapping project hold the same amount of promise, either economically or scientifically? The first question that should be asked is, "Can it work?" And some scientists are already voicing doubts.

Markoff quotes neuroscientist Donald G. Stein as saying, "I believe the scientific paradigm underlying this mapping project is, at best, out of date and at worst, simply wrong." Apparently, the old analogies of the brain as a massive kind of

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telephone switchboard, or even a “wet computer,” fail to capture essential aspects of an organism which can develop new neurons in response to external stimuli, and has recently proved to be much more plastic than earlier theories supposed. To the extent that the project imposes an outdated brain model on researchers, it will not succeed. But every researcher knows that what you say you are going to do in order to get research money, is not necessarily the thing you actually end up doing, so this concern is probably not as great as you might think.

What is of greater concern now is the question of basic feasibility. When Dr. Rafael Yuste of Columbia University was asked at a September 2011 conference about what he would really like to be able to do with the brain, he replied, “I want to be able to record from every neuron in the brain at the same time.” Simply storing the data that would result from such an instrument is a brain-boggling proposition. One estimate is that you would need the data-storage equivalent of about 600 million hard drives the size of the one on my personal computer (500 gigabytes) to store all the neurological activity that goes on in only one brain for a year. The next time you say “nothing’s on your mind,” think about that.

Of course, data storage has been getting more efficient for decades, and it will probably continue to do so for a while. But storing the data is nowhere near as hard as obtaining it in the first place. Right now, the only way to monitor individual brain neurons is to connect wires to them, which requires opening the skull. There are various means to monitor the brain non-invasively, but at present they have a fairly poor resolution, on the order of a millimeter at best. And there are thousands of neurons in each cubic millimeter of brain. Futuristic plans to send molecule-size data recorders into the brain and record the results on DNA are still purely drawing-board notions, and it is not clear they will ever work.

When the Human Genome Project began, we knew that DNA sequencing was possible—it was just very slow and tedious. Rapid advances in technology enabled the project to finish ahead of schedule. It is by no means clear that massive monitoring of individual brain neurons is even theoretically possible. And unmentioned so far is the question brought up by the Escher drawing: Can the brain really understand itself? In particular, what would happen if Dr. Yuste gets his wish and one day he sits down at a computer monitor that shows him the output of his own brain in some meaningful way. If you’ve ever pointed a TV camera at a monitor showing the camera’s own field of view, you have seen some weird patterns show up. It’s not pleasant to contemplate what it might mean for your own brain to watch itself in action.

As with any great leap in scientific knowledge these days, the rationale for it is that it may lead to practical benefits such as cures for diseases like Alzheimer’s and autism. While we can’t discount these possibilities, neither can we discount the notion that once it’s possible to exhaustively monitor the activity of the human brain, it may be possible to read thoughts in a way that would amount to the ultimate invasion of privacy. At the very least, this possibility raises concerns that should be taken seriously. So far, everyone whose brain has been monitored has given consent to the process, we hope. But the molecule-size brain monitors could be delivered without the patient’s knowledge or consent.

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So far, this kind of thing is in the realm of science fiction rather than fact. But before it becomes fact, let's hope that we have a full public discussion of the potential downsides as well as the benefits of a map of the human brain, assuming such a thing is even possible.

Sources: John Markoff's article "Obama Seeking to Boost Study of Human Brain," appeared in the online edition of the New York Times on Feb. 17, 2013, at <http://www.nytimes.com/2013/02/18/science/project-seeks-to-build-map-of-...> [1] He followed it with an analysis piece on the same subject on Feb. 24 at <http://www.nytimes.com/2013/02/26/science/proposed-brain-mapping-project...> [2] I relied on both of these pieces for this article. The M. C. Escher work "Drawing Hands" can be viewed at http://kafee.files.wordpress.com/2009/10/drawing_hands.jpg [3]

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[3] http://kafee.files.wordpress.com/2009/10/drawing_hands.jpg

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