Sci-Tech - Sunday Jan. 10, 2010

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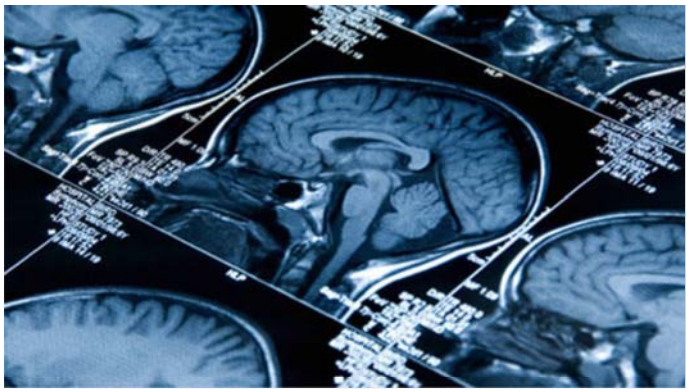
Neuroscientist discovers light switch for the brain



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Jonathan Fahey, Forbes.com
Date: Saturday Jan. 9, 2010 7:25 AM ET

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Some of the most important advances in neuroscience have been made thanks to a pair of gruesome cases a century apart that left their victims alive, coherent and missing big portions of their brains.

In 1848 an iron spike three-and-a-half-feet long exploded through the face of a railroad worker named Phineas Gage and out the top of his head, landing 80 feet away. He lived and worked for a dozen years; the changes to how regions of the brain controlled specific functions.

In 1953, Henry Gustav Molaison, known to science as the patient H.M., lost a huge section of his brain to a lobotomy meant to treat his severe epilepsy. He quickly forgot every new thing he learned after the operation--he would have to be re-introduced to caretakers daily--and in the process taught science an extraordinary amount about memory until he passed away last month.

Here's a new tool for silencing brain regions, just a wee bit more subtle than an iron spike or a lobotomy: Ed Boyden, a neuroscientist at the Massachusetts Institute of Technology, has developed a way to shut down parts of a brain just by shining light on them. When the light is turned off, the brain switches back on--a luxury not available to Gage or H.M.

"We can now digitally turn off regions of the brain," says Boyden. "We can alter the information in the brain in a strategically useful way."

Boyden's discovery, published in the journal Nature this week, is a powerful new tool for neuroscientists struggling to understand the complexity of the brain. With it, researchers will be able to probe how the circuitry of the brain works by silencing certain very specific areas or types of brain cells and studying the effects.

What's especially useful about the method is that it allows researchers to re-activate the brain regions instantaneously by simply turning off the light.

While early work will be done in animals, Boyden thinks that his discovery will also soon be used as a prosthetic device in humans. It could quickly, and temporarily, shut down overactive brain regions implicated in conditions like epilepsy and depression. An animal experiment funded by the U.S. Army is now looking into whether the method could be used to treat post-traumatic stress disorder.

Boyden and colleagues developed the concept of using light to change brain activity in 2005, when they showed they could stimulate brain cells with light by introducing genes into neurons that make them fire signals when hit with light. He's been working since to find a way to silence neurons instead.

He combed databases of genes in nature that help produce proteins that react to light, and found a pair in bacteria and fungi. Using what appears to be a harmless virus, he delivers a gene into specific brain cells. The gene instructs the cells to make pumps that pump protons out of the cell when hit with a certain color of light. This changes the electrical charge of the cell, and prevents it from sending signals.

These protons were a surprising target: Protons are not thought to play any role whatsoever in neural activity. They are basically everywhere in the body because they are simply ionized hydrogen atoms found in water. Previous attempts to silence neurons focused on pumping chloride, which is negatively charged, into the cell, mimicking normal neuron behavior. "It's out of left field that you could use these ubiquitous protons to actually do something," says Boyden.

Boyden found a gene called "arch" in an ancient type of bacteria, which responds to

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