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Not Exactly Rocket Science

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# Mind control goes wireless

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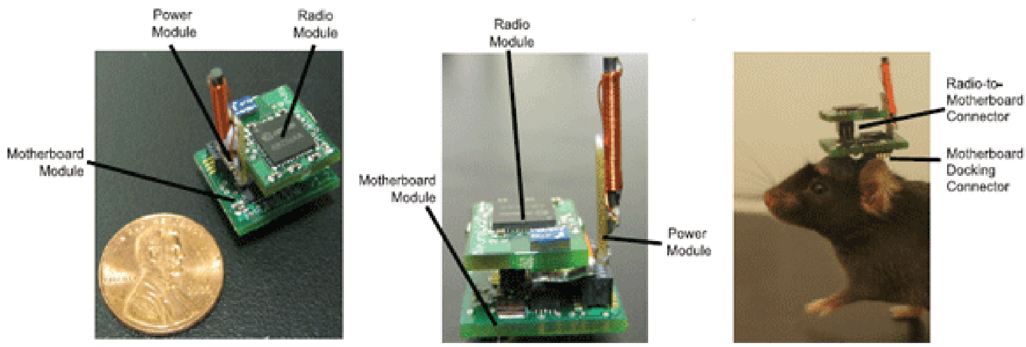


Christian Wentz from MIT has designed a hat that wouldn't look out of place at a horse race or a royal wedding. It consists of two circuit boards and an antenna, and it's being modelled by a mouse. Wentz has wired the hat directly to the mouse's brain and he can use it to control the animal's behaviour with flashes of light. And most importantly, he can do it from afar.

The wireless helmet is the latest innovation in the exciting field of optogenetics, where scientists can use light to control the behaviour of both cells and entire animals. The typical set up involves loading cells – usually neurons – with a light-sensitive gatekeeper protein. When the protein sees the light, it opens up and allows ions to enter the neuron, making it fire.

By introducing the proteins into the right spot, scientists can switch on specific parts of the brain, or even individual neurons. They can turn on aggressive or sexual behaviour or make animals walk in circles. The technique promises to revolutionise our understanding of the way the brain works. It could even help to develop treatments for diseases.

But optogenetics has always had a problem – there has to be a way of delivering the light to the altered neurons. Most people do it with optic fibres, tethered to a laser or an LED. But these have obvious drawbacks. You can only work with a few animals at a time because the fibres might tangle and break. You can't do long-term studies for the same reasons. And you need to handle their animals at the start of each experiment, which could distress them and change their behaviour.

Ideally, there would be some way of remotely turning on the lights at will. Ed Boyden, one of the founders of optogenetics and the leader of this study, says that some groups have tried to create battery-powered devices that emit light from LEDs. But these have generally failed. "The problem is that light sources are quite energy-inefficient," says Boyden. "LEDSs and lasers dissipate a lot of their energy in heat, so you need quite high currents or power levels in order to get them to go." This means that you need a large battery, one that typically weighs as much as the mouse itself! "I don't think that any of these devices have been used in scientific papers in the last 5 years," says Boyden.

Instead of batteries, Wentz has created an optogenetics hat that runs off wireless power. A nearby transmitter, that isn't connected to the mouse, creates a magnetic field that is picked up by antennae on the rodent's helmet. The field induces an electric current, which can power a set of 16 LEDs in the helmet. These provide the necessary light to set off the genetically altered neurons in the mouse's brain.

Meanwhile, an intelligent piece of software in the helmet stores up energy in a supercapacitor when it's not needed. When Wentz starts his experiments, the capacitor discharges its stored power and lights up the LEDs. "For these experiments, you need enormously high amounts of power but only for brief amounts of time," says Boyden. "The system stores the extra when there's extra around and lets it out when there's demand, like the power grid for regular electricity.

The helmet can be controlled by a base-station that plugs into a computer's USB socket. To test this in practice, Wentz programmed a pulse of blue light to shine on only one side of the mouse's motor cortex – the part of the brain that controls movement. When this happened, the mouse turned to that side. Wentz could steer the animal from his laptop.

There were no signs that the helmet harmed or distressed the mice, which behaved normally even three months later. "The device is really small, and we have even smaller versions now, down to about a gram," says Boyden. It's also electrically insulated from the mouse itself, and the software shuts everything down if it gets one degree hotter than the mouse's normal temperature. And everything but the LEDs can be unplugged between experiments, so the mouse gets hatless days when it's not at work.

This wireless headset greatly expands the type of experiments that scientists can now do. "If you've got a cable attached to an animal, that would essentially ruin the experiment," says Boyden. "Here you can pop on this little tiny device and it'll enable all sorts of things."

They could focus on aspects of biology where neurons change over a matter of hours, such as sleep or epilepsy. They could even look at developing bodies or diseases like Parkinson's where brain circuits change over years and decades. They could also do large-scale experiments, where they alter the behaviour of many animals at the same time. "I've always envied the genomics folks where you can do things in a very systematic, large-scale way," says Boyden. "By comparison, neuroscience has always been a bit of an art form. Allowing people to control multiple animals simultaneously will allow us to scale up our efforts."

Finally, Boyden wants to add a recorder to the helmet that can measure the activity of nearby neurons rather than simply activating them. "If we can record a neural event, like a sleep pattern or a reward signal, we could perturb it at that very instant."

Some people with Parkinson's disease can successfully control their symptoms using implants, rather like pacemakers, that deliver electric currents via electrodes. Optogenetic devices could be the next stage in the evolution of these implants. And if Boyden gets his recorders working, such implants could even provide us with valuable information about what happens in the brains of people with Parkinson's, epilepsy or other conditions. "Many neural implants try to keep their power low, so they can't do any computation," he says. "If the power is being radioed in from afar, those power limits might be overcome."

Indeed, the technology will only get more sophisticated with time. "Nearly all of the underlying technologies enabling this device are being improved daily… By riding technology development curves, the system described here may eventually be miniaturized to a few square millimetres."

**Reference:** Wentz, Bernstein, Monahan, Guerra, Rodriguez & Boyden. 2011. A wirelessly powered and controlled device for optical neural control of freely-behaving animals. Journal of Neural Engineering http://dx.doi.org/10.1088/1741-2560/8/4/046021

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June 27th, 2011 by Ed Yong in Neuroscience and psychology, Technology | 5 comments | RSS feed | Trackback >

## 5 Responses to "Mind control goes wireless"

1. 1. *AxonPotential* Says:
   June 27th, 2011 at 12:24 pm

   What's really cool and somewhat erie about this technology is the implications that it holds for how we humans might use brain stimulation in the future. It's obviously way out there in the future, but the potential for direct brain stimulation to enhance performance or control behavior is fascinating. I wrote a little about this research and the future of sports performance enhancment here: http://axonpotential.com/way-out-into-the-future-performance-enhancing-brain-stimulation/

2. 2. *Sadrice* Says:
   June 28th, 2011 at 4:22 pm

   Is there any reason they couldn't just use a larger animal, like maybe a rat, that could carry a battery?

3. 3. *Niall* Says:
   June 29th, 2011 at 6:31 am

   Bet the other rats were thinking "Cool hat brah!".

   But in all seriousness the future potential for alleviating degenerative conditions like dementia is vast.

4. 4. *toker* Says:
   July 4th, 2011 at 3:43 pm

   maybe soon we can send armored gorillas with some heavy artillery into warzones^^
   or a great tool for some crazed communist dictator or something :d

5. 5. *haversham* Says:
   July 6th, 2011 at 5:32 pm

   Niall, people do this in rats too. Not wirelessly, yet, but I bet this setup will proliferate pretty quickly around the many labs doing this kind of thing. Current methods usually have the extra baggage of either trailing wires or having the wires suspended above the animal. Either way it is movement prohibitive for the test subject and may influence decision making. This new smaller and lighter setup will alleviate these possible confounders.

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Ed Yong is an award-winning British science writer. His work has appeared in New Scientist, the Times, WIRED, the Guardian, Nature and more. Not Exactly Rocket Science is his attempt to talk about the awe-inspiring, beautiful and quirky world of science to as many people as possible.

My personal website with biography, other writing, speaking engagements, and more

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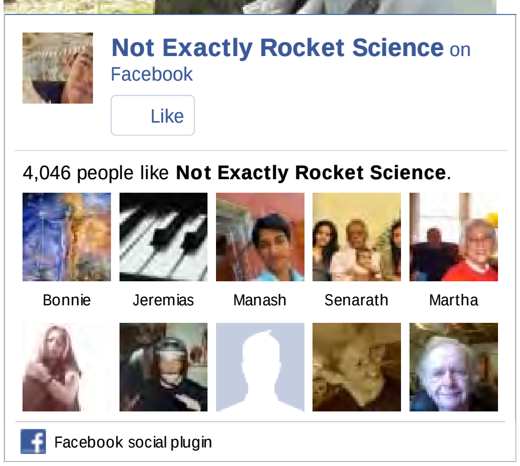
- 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