Can magnetism help us control the brain, remotely?

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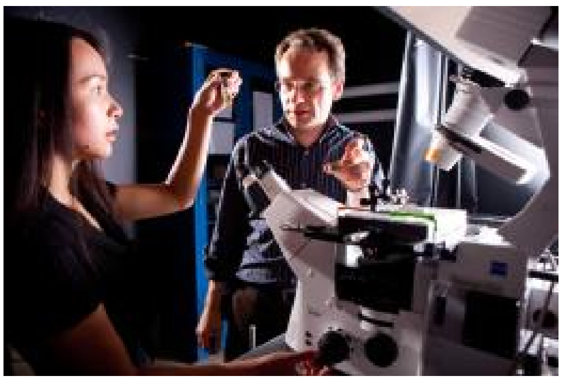

Research by UB physicist Arne Pralle, (right) shown with his student, will help reveal how the brain's complicated neuronal circuitry controls behavior.

University at Buffalo scientists have used magnetic nanoparticles to remotely control ion channels, neurons in cell culture and even the movement of a tiny worm.

Scientists at the University at Buffalo have received $1.3 million from the National Institute of Mental Health (NIMH) to test how tiny, magnetic particles can be used to remotely control neurons in the brains of mice.

If the work is successful, the research team will have given neuroscientists a powerful, new tool: a non-invasive technique for triggering activity deep inside the brain.

This kind of remote, neuro-stimulation would help researchers learn more about how the brain's complicated neuronal circuitry controls behavior, leading eventually to better understanding and possibly treatment of ailments that involve the injury or malfunction of specific sets of neurons. Traumatic brain injuries, Parkinson's disease, dystonia and peripheral paralysis all fall into this category.

"Our early understanding about the brain's functional regions came from patients who showed changes in their behavior after losing a part of their brain to traumatic brain injury or a tumor," said Arnd Pralle, the assistant professor of physics who is leading the new UB study. "The ability to now reversibly turn individual cells off or on and to observe the animal's behavior brings us finally to the level of the actual neurological circuit, which is extremely exciting."

The new NIMH funding, which comes from the National Institute of Health's program for Exceptional, Unconventional Research Enabling Knowledge Acceleration (EUREKA), is a testament to the promise of Pralle's work.

He and his colleagues have already succeeded in using their remote control technique to open calcium ion channels, activate neurons in cell culture, and even manipulate the behavior of C. elegans, a tiny worm.

The approach involves the use of heated, magnetic nanoparticles in conjunction with some clever genetic engineering.

Here's how it works in the brain: First, scientists employ harmless viruses to carry a special strand of DNA into the brain. The new genetic material induces specific, targeted cells to build a special ion channel containing a receptor that magnetic nanoparticles will recognize.

When the nanoparticles latch onto these ion channels, scientists apply an alternating magnetic field to the brain that causes the particles' magnetization to flip rapidly, generating heat. That heat then stimulates the ion channels to open, depolarizing the neurons and causing them to fire.

With the new NIMH funding, Pralle's research team plans to test this method on neurons in the olfactory bulb, which lies in the forward region of the brain and controls how animals perceive odors.

Specifically, the scientists will see if they can use the nanoparticles' localized heating to activate specific neurons in the olfactory bulb, causing the mice to "smell" a particular odor even when no actual chemicals are present.

As neuroscientists search for better ways to probe the brain, Pralle's method is particularly attractive because magnetic fields are able to penetrate tissues without harming them. Other methods for remotely controlling brain cells are more invasive, including a state-of-the-art technique involving the use of an implanted optical fiber to stimulate light-activated ion channels.

Pralle's prior work on magnetic nanoparticles was supported by the UB 2020 Interdisciplinary Research Development Fund, which provides start-up money to projects with the potential to receive larger, external grants.

That seed funding enabled Pralle and his collaborators to complete a number of studies, including one in which they attached magnetic nanoparticles to cells near the mouth of C. elegans.

When the scientists used their remote technique to heat the nanoparticles, most of the worms began reflexively crawling backward in an attempt to escape the heat when the temperature hit 34 degrees

Celsius.

The university is in full compliance with mandates of state and federal regulatory agencies pertaining to the humane use and care of research animals.

More information: *Nature Nanotechnology* paper: www.nature.com/nnano/journal/v … /nnano.2010.163.html

Provided by University at Buffalo