

## Abstractions

### SENIOR AUTHOR

Much of the planet's atmospheric methane comes from bogs, swamps and marshes. In these inhospitable climes, single-celled organisms called methanogens produce huge quantities of the greenhouse gas. But finding out more about these organisms is hard, as they are difficult to culture in the lab. To rectify this, microbiologist Stephen Zinder of Cornell University in Ithaca, New York, and his team joined forces with environmental scientist Joseph Yavitt from the University of Wisconsin in Madison. Together they successfully isolated a methanogen from a bog and cultured it in peat slurry (see page 192). Zinder talked to *Nature* about his experiences in the field.

### Why are these organisms so hard to culture?

Conditions in the bogs are very different from normal culture media. We found that when we added hydrogen to the peat slurry, the methane went up for a while, but then it stopped — another group of organisms was taking over and making acetic acid from the CO<sub>2</sub>, basically pickling the samples. That was a sign of bacteria. So we decided if we could knock out the bacteria we could get at the methanogens. The methanogens also didn't like a lot of salt in the medium. The bog itself is almost all distilled water, because it's fed by rain, so it's got a low mineral content. By a process of adding things, and seeing what they liked, we got the methanogens to grow.

### How would you describe the field work?

We got the samples from McLean Bog, which is about 32 kilometres from Cornell. It's got pitcher plants and all sorts of weird stuff. It's more fun to go there than to contaminated waste sites — which is my other project.

### What was the importance of your collaboration with Yavitt?

He has a real expertise on wetlands and their history and is great with comparative stuff. One bog we studied had a lower layer that was neutral, whereas McLean Bog is acid all the way down. Joe's intimate knowledge of wetlands in the area was really important to get us to look at the whole system; when I started, I didn't know a bog from a fen.

### What's next?

The Joint Genome Institute is doing the genome sequence of our methanogen. That can tell you things about an organism that you could never guess just by growing it in culture. The draft sequence should be completed this year. ■

### Correction

In last week's Author Page, the wrong photograph accompanied the article on Paul Segall (*Nature* 442, xi; 2006). The correct image is on the right. *Nature* apologizes for the error.



## MAKING THE PAPER

John Donoghue

### A link between mind and machine that can turn thought into movement.

Most of us don't give movement a second thought. If we see an object we want to pick up, we pick it up. If we see something we want to move, we simply move it. But for people who have suffered injuries to their spinal cord, the chain of command between eyes, brain and limbs can be broken. They can see what they want to move, but their brain's instructions cannot reach their limbs.

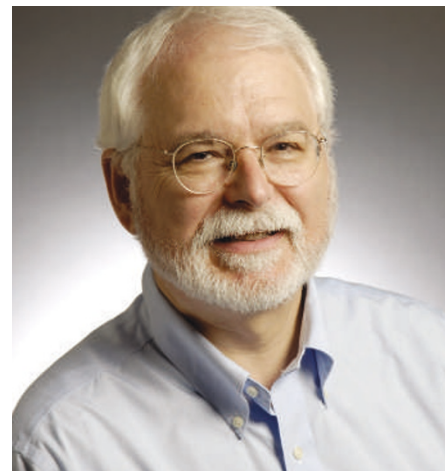
John Donoghue, a neuroscientist at Brown University in Providence, Rhode Island, and his colleagues have devoted their time to understanding how the brain turns thoughts into actions. Working initially with monkeys, the team has studied the activity of brain cells during simple tasks such as using a computer mouse to move a cursor on a screen.

On page 164 of this issue, the researchers take their work one step further, showing how an implant, known as a brain-computer interface, can bridge the gap between brain and movement for a quadriplegic patient.

In their earlier studies, the team had shown that brain signals recorded when a monkey moved a computer mouse could be decoded and then used directly to control the cursor, eliminating the need for the monkey to move its hand. The big question was whether a similar set-up would work in people.

The first task was to adapt the sensor and decoder system for use in humans. "It required close to 30 people working for more than a year on all the necessary regulatory processing and technology development to get the system ready for this pilot study," says Donoghue.

In June 2004, Donoghue and his team began working with a quadriplegic man who had suffered a spinal-cord injury three years earlier. They implanted an interface device into the patient's brain, which would act as a sensor of nerve-cell activity and, ultimately, as



a transmitter of these signals to a computer.

They sought to obtain the appropriate brain signals by asking the man to follow a moving cursor with his eyes while imagining that his hand was actually causing that movement. As they had hoped, the sensor detected signals from brain cells that changed their activity as the patient imagined controlling the cursor.

By repeating the process several times the researchers were able to pinpoint the pattern of neuronal activity that was associated with a particular movement of the cursor. They then translated that signal into computer language.

"We were monitoring signals from a few dozen neurons rather than the few million that are usually active during hand movement," says Donoghue. But despite the small sample size, the experiment worked. Once the brain signals had been decoded, the patient could think about moving the cursor and the brain-computer interface translated this into an instruction that moved the cursor — albeit without the same accuracy or speed as an actual movement. The patient was also able to use the same process to open and close a prosthetic hand and to exert some control over a robotic arm.

Donoghue and his team are encouraged by the results of their pilot study and have now enrolled more patients to test the idea further and to refine their device. ■

## PEER-REVIEW TRIAL AND DEBATE

*Nature's* peer-review trial began at the start of last month. Authors whose manuscripts are sent for peer review can choose to have their submissions posted on a preprint server for open comments, in parallel with the conventional peer-review process. Anyone in the field can then post comments, provided they are prepared to identify themselves.

Since the start of the trial, 20 submitted manuscripts have been posted on the trial's website (<http://blogs.nature.com/nature/peerreview/trial>) encompassing a host of disciplines including immunology, applied physics, neuroscience, astronomy, ecology and structural biology. Twelve comments

on these manuscripts have been published on the site.

*Nature* is also hosting a peer-review debate on all aspects of the topic, highlighting a range of views, practices and suggestions about systems, quality, value, ethics, new technical approaches derived from the Internet, and individual perspectives. The 22 articles in the debate can be seen at [www.nature.com/nature/peerreview/debate](http://www.nature.com/nature/peerreview/debate).

Readers are encouraged to join the commenting forum at <http://blogs.nature.com/nature/peerreview/debate/comments>. So far, 47 comments have been published; we welcome further contributions.