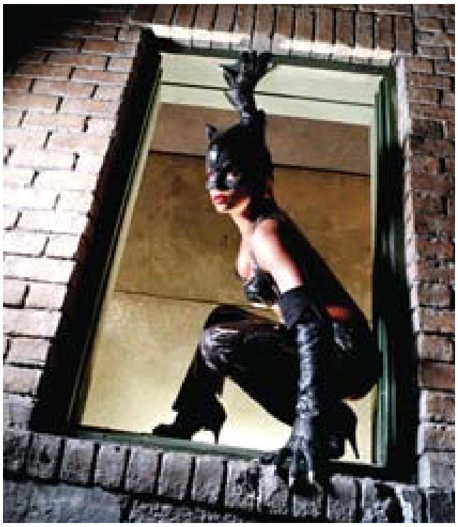
news SCAN

BRAIN

One Face, One Neuron

STORING HALLE BERRY IN A SINGLE BRAIN CELL BY DIANE MARTINDALE

When you spot a celebrity on a magazine cover, your brain recognizes the image in an instant—an effect that seems to occur because of a single neuron. A recent study indicates that our brains employ far fewer cells to interpret a given image than previously believed, and the findings could help neuroscientists determine how memories are formed and stored.



BIG MEOW: The concept of Halle Berry (here disguised as Catwoman), not her visage per se, sets off a neuron that enables recognition.

Exactly how the human brain works to record and remember an image is the subject of much debate and speculation. In previous decades, two extreme views have emerged. One says that millions of neurons work in concert, piecing together various bits of information into one coherent picture, whereas the other states that the brain contains a separate neuron to recognize each individual object and person. In the 1960s neurobiologist Jerome Lettvin named the latter idea the "grandmother cell" theory, meaning that the brain has a neuron devoted just for recognizing each family member. Lose that neuron, and you no longer recognize grandma.

Experts long ago dismissed this latter view as overly simplistic. But Rodrigo Quian Quiroga of the University of Leicester in England and his colleagues decided to investigate just how selective single neurons might be. The team looked at eight patients who each had 64 tiny electrodes implanted in their brains before epilepsy surgery (a procedure to pinpoint the source of their seizures). Many of the electrodes were placed in the hippocampus, an area critical for the storage of long-term memories.

While each participant was shown a large number of images of celebrities, animals, objects and landmark buildings, electrodes recorded the brain cells' firings. This screening stage determined which images elicited a strong response in at least one neuron. The team then tested the responses to three to eight variations of those images from the narrowed list.

In one patient, a single neuron responded to seven different photographs of actor Jennifer Aniston, while it practically ignored the 80 other images of animals, buildings, famous or nonfamous people that were also presented. "The first time we saw a neuron firing to seven different pictures of Jennifer Aniston—and nothing else—we literally jumped out of our chairs," Quian Quiroga recalls.

Similar results occurred in another patient with a neuron specific for actor Halle Berry; the neuron responded not only to photographs but also to a drawing and an image of her name. What is more, even when Berry was costumed as the masked Catwoman, if the patient knew it was Berry, the neuron still fired. "This neuron is responding to the abstract concept of Halle Berry rather than to any particular visual feature. It's like, 'I won't recall every detail of a conversation, but I'll remember what it was about.' This suggests we store memories as abstract concepts," Quian Quiroga adds. Besides celebrities, famous buildings, such as the Sydney Opera House and the Tower of Pisa, elicited single-neuron firing.

"Not many scientists would have predicted such explicit single-neuron signals associated with individual people," says Charles Connor, a neuroscientist at Johns Hopkins University. "It should now be possible to look at precisely what information is represented by those cells—a clear starting point for studying how memories are encoded."

Although the "Jen" and "Halle" neurons behave much like a grandmother cell, the findings do not mean that a given brain cell will react to only one person or object, notes Christof Koch, one of the study's researchers at the California Institute of Technology. These cells probably respond to a wide range of items (some neurons responded to more than one person or object). "We are not saying that these are grandmother cells, but for familiar things, like your family or celebrities, things you see frequently, the neurons are wired up and fire in a very specific way—much more so

MIND OVER OBJECT

Think of a place, person or thing; then watch the word instantly appear on a computer screen. Such "brain reading" is far into the future. But Cyberkinetics in Foxborough, Mass., has developed an implant, called the BrainGate, that detects neural firing, permitting the control of objects with thought. In June 2004 surgeons implanted the firm's tiny chip containing 100 electrodes into the motor cortex of a 24-year-old quadriplegic. Each electrode connected directly into a neuron and allowed the patient to play computer games and check e-mail with his thoughts.

than previously thought," Koch explains.

The findings, in the June 23 *Nature*, could influence research into illnesses such as dementia, but Quian Quiroga sees a more practical application: implantable prosthetic communication devices, so-called brain readers. "We may be able to help patients communicate with the outside world, where their thoughts are interpreted by a computer," he predicts.

Diane Martindale is based in Toronto.

ASTROPHYSICS

A Force to Reckon With

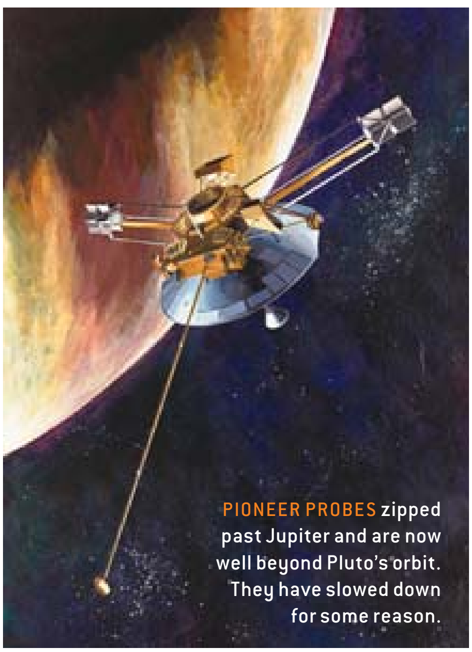
WHAT APPLIED THE BRAKES ON PIONEER 10 AND 11? **BY ALEXANDER HELLEMANS**

One of the most intriguing mysteries in physics is the "Pioneer anomaly," the slowing down of two spacecraft by an unknown force. NASA launched Pioneer 10 and 11 in 1972 and 1973, respectively, and the craft returned stunning images of Jupiter and Saturn. But as both spacecraft continued their voyages at speeds of roughly 27,000 miles per hour, astronomer John Anderson of the Jet Propulsion Laboratory in Pasadena, Calif., noticed anomalies in telemetry data dating from as far back as 1980. With continued analysis, researchers determined that the spacecraft had been slowing down at a constant rate: each year they fell 8,000 miles short of their calculated positions. The strange behavior sparked several theories, but the lack of data made culling the ideas difficult. Now a proposal to analyze telemetry from the early years could literally point toward the correct explanation.

The most obvious theory was that something on the spacecraft themselves created a braking force—leaking gas or heat radiation, perhaps. Over the years, however, researchers increasingly viewed this hypothesis as less likely, and some physicists began to explore possible flaws in Newton's laws and relativity. Others posited that dark matter was the culprit: it might exert a gravitational or drag force. A third theory embraces the idea that a minute acceleration exists in the velocity of light, which might result in the appearance that the probes are slowing down: if light travels faster, telemetry signals arrive faster, and the craft seem to be closer.

Anderson and theorist Michael M. Nieto of Los Alamos National Laboratory have proposed a way to filter the ideas, noting the interesting fact that the direction of the anomalous force would be different for each theory. If the force points toward the sun, then it should be a gravitational effect. If it points toward Earth, it should be an anomaly relating to the velocity of light. If it points in the direction of motion, it should be a drag force or a modification of inertia. And finally, if it points along the spin axis of the probes, it should indicate a force generated by the craft.

But determining the force's direction means studying telemetry when the Pioneer craft were closer than 20 astronomical units (1 AU equals the distance between Earth and



PIONEER PROBES zipped past Jupiter and are now well beyond Pluto's orbit. They have slowed down for some reason.

NASA AMES RESEARCH CENTER

FOLLOWING THE PIONEER TRAIL

To solve the Pioneer anomaly, many scientists have been calling for a dedicated mission. (Other deep-space probes, such as Voyager 1 and 2, conducted too many thruster maneuvers to provide clear data about the anomaly.) Hopes are high that the European Space Agency (ESA) will include such a mission in its Cosmic Vision program for 2015–2025. NASA's New Horizons Pluto–Kuiper Belt mission, to be launched next year, may also furnish rough data. In fact, any future mission to Pluto or the Kuiper belt would be suitable to test the anomaly if the craft can be allowed to ride without corrections to its trajectory for longer times, says Dario Izzo of ESA's Advanced Concepts Team at the European Space Research and Technology Center in Noordwijk, the Netherlands.