Abstractions

FIRST AUTHOR
The twin Voyager spacecraft, launched in 1977 to travel to and explore Jupiter, Saturn, Uranus and Neptune, have made many intriguing discoveries, including a possible ocean of liquid water on one of Jupiter's moons. On page 71, long-time Voyager project scientist Edward Stone of the California Institute of Technology in Pasadena and his colleagues detail Voyager 2's latest finding — that the 'bubble' formed around the Solar System by supersonic solar wind is asymmetrical and dynamic. Stone tells *Nature* that the Voyager crafts will deliver more 'firsts' when they reach interstellar space.

What was Voyager 2's recent discovery?
The supersonic wind from the Sun blows at 400 kilometres per second, and creates a bubble called the heliosphere. We already knew that this wind slows abruptly as it approaches the heliosphere's boundary and comes up against interstellar wind, resulting in a sonic shock. In 2004, Voyager 1 crossed that shock in the northern part of the Solar System at about 94 astronomical units (AU). [1 AU is the distance from Earth to the Sun.] Then, in 2007, Voyager 2 crossed the shock at 84 AU in the southern Solar System. So the heliosphere must be asymmetrical. This is probably due to an interstellar magnetic field pushing inwards more in the south than the north.

Did the shock crossing hold surprises?
Yes. We expected the solar wind ions to be heated, possibly to 1,000,000 °C, by the kinetic energy generated when the wind suddenly slows. Instead, the bulk of the kinetic energy heated interstellar ions in the heliosheath — the outer layer of the heliosphere. These data also suggest that the shock is dynamic and constantly reforms itself, rather than being a stable, permanent structure as most models assume.

Why is it important to map the heliosphere?
The complex interaction between the solar wind — which changes during the solar cycle — and material outside the Solar System determines how large the bubble is and how well we are protected from galactic cosmic rays in interstellar space.

Has Voyager surpassed expectation?
Yes. We hoped to reach interstellar space, but didn't know how long it would take or how long the spacecraft would last. They have enough power to last until 2025. Models suggest that Voyager 1 will reach interstellar space first, in about 5–10 years. But we don't know how thick the heliosheath is, nor how strongly the interaction with the interstellar wind affects the solar wind. ■

See also pages 24 and 38, and online video at www.nature.com/nature/videoarchive/voyager.

MAKING THE PAPER

Marina Wolf

Unusual brain receptors weaken resistance to cocaine cravings.

Addicts quitting cocaine are more likely to relapse after several weeks of abstinence than within the first few days: the cues that spark cravings for the drug somehow grow stonger over time. Now there's a physiological explanation for this phenomenon. Marina Wolf at Rosalind Franklin University of Medicine and Science in Chicago, Illinois, and her colleagues show that an uncommon type of receptor forms in rats' brain cells after cocaine withdrawal and that these amplify the response to drug cues.

The dominant thinking in the early 1990s was that dopamine neurons drive addiction. Wolf began her career studying how these neurons self-regulate. When she began to study addiction, the theory that it was driven by dopamine didn't make sense to her. "I thought of the dopamine system in terms of its incredible capacity for homeostasis, not as an instigator of profound change, such as that seen in addiction," she says. She then came across studies showing that the brain chemical glutamate helps to rewire the brain in response to experience, so she shifted her focus onto glutamate.

To find out how glutamate receptors might change during cocaine withdrawal, Wolf worked with pharmacologist Michela Marinelli to train rats to self-administer the drug by poking their noses into a hole when given a cue. As expected, the rats' cocaine-seeking behaviour was more pronounced 45 days after the cocaine supply was cut off than after the first day.

Wolf's team next examined glutamate receptors within the nucleus accumbens of these rats, a part of the brain involved in motivation and learning. Compared with rats in early withdrawal, rats deprived of cocaine for 45 days had incredibly high levels of a glutamate receptor containing an unusual subunit composition — one that promotes a stronger response to glutamate. The obvious conclusion, says Wolf, was that the neurons were making new receptors in response to withdrawal, which explains the increased response to cocaine cues (see page 118).

But characterizing the subunits wasn't enough to prove the hypothesis; reviewers of the paper demanded evidence that these new receptors were functional. The neuron patch-clamp experiments needed to provide this evidence are notoriously tricky to perform on adult rats, says Wolf. "I think the reviewers believed the paper was dead because the electrophysiology they wanted was so difficult." A colleague, Kuei Tseng, volunteered his lab's expertise. "We thought that either he was crazy, or he was going to work some magic," recalls Wolf. "Fortunately, it was the latter."

Further experiments showed that if the new glutamate receptors were blocked in rats 45 days after cocaine withdrawal, their response to drug cues was almost halved. The results might lead to treatments to help recovering cocaine addicts to stay clean. Unlike other models of addiction, these rats have not been genetically modified. "Hopefully we're studying something that might really happen in people," says Wolf.

However, testing this approach in humans will be tricky. To block the rats' receptors, the researchers injected a synthetic form of a spider toxin directly into their brains, an approach that can't be used in humans. No one has yet identified a non-toxic small-molecule drug that has similar effects. But Wolf says she intends to keep this concept moving forward. "My next job," she says, "is to educate myself in drug discovery." ■

FROM THE BLOGOSPHERE

A misconduct survey stirs the pot. An Editorial and Commentary in the 19 June issue of *Nature* (*Nature* **453,** 957, 980–982; 2008) are hotly debated at Nature Network's News and Opinion forum (http://tinyurl.com/5onqpl). In the Commentary, Sandra Titus, director of intramural research at the US Office of Research Integrity, and her colleagues report a survey indicating as many as a thousand unreported instances of misconduct a year.

Could better policies stem this seeming flood? Lynn Howard Ehrle of the Organic Consumers Association writes of the "Faustian pact" in which many university presidents and deans have "accepted posts on corporate boards of directors where they have a primary legal fiduciary responsibility to their stockholders that is in conflict with the mission of the university, their students and patients".

Other forum participants provide heartfelt personal evidence to support the *Nature* Editorial's view that "misconduct investigations all too often focus solely on an individual offender, and fail to diagnose the environment that has allowed the misconduct to flourish". ■

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