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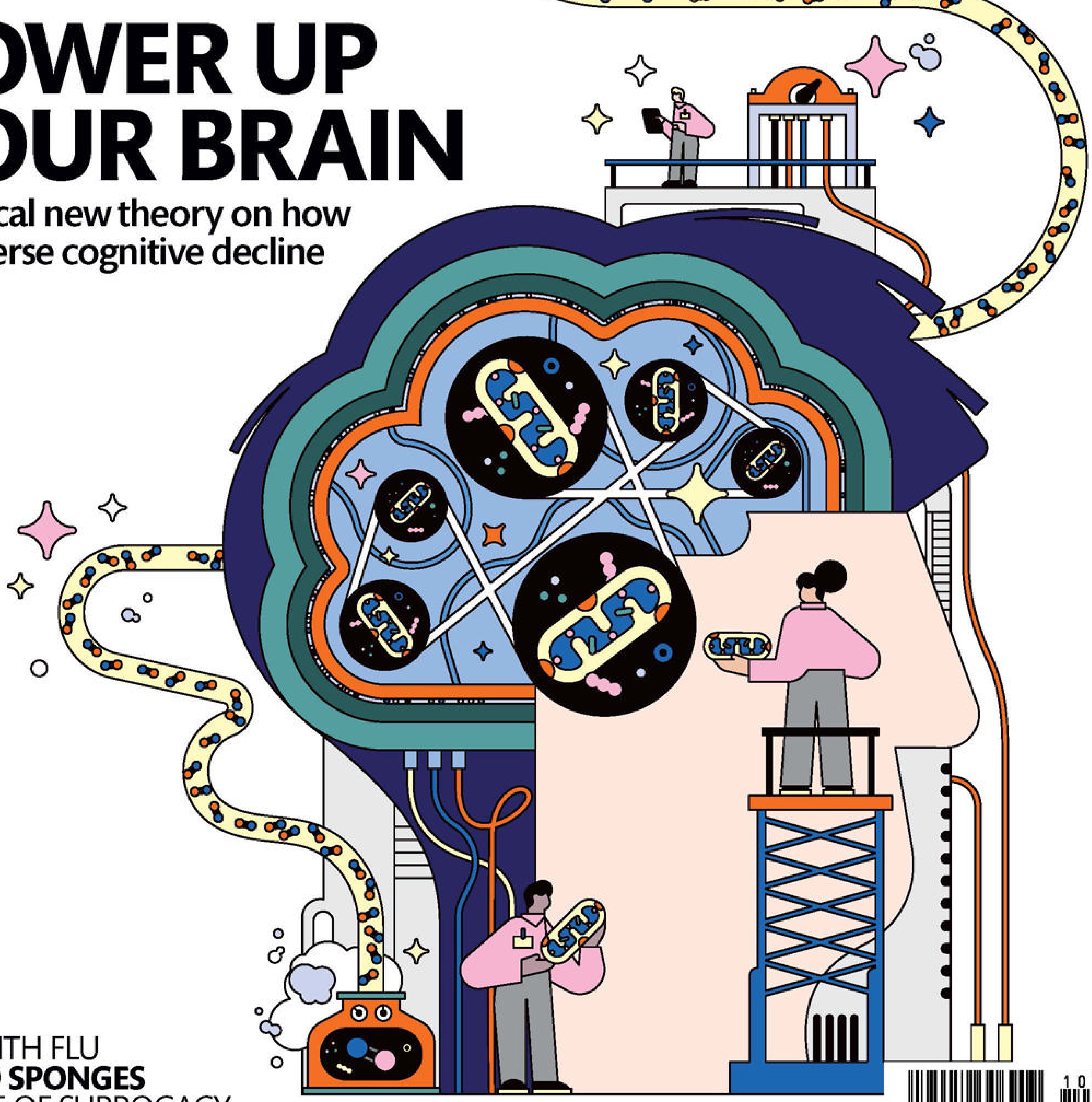

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Space

What we learned from NASA's asteroid-smashing DART mission

Leah Crane

NASA crashed a spacecraft into an asteroid in 2022 in an attempt to move it, and the collision had more effect on the asteroid's orbit than predicted. An analysis of the aftermath has revealed why, and the results could teach us more about how to protect our planet.

The Double Asteroid Redirection Test (DART) sent a probe careening into a small asteroid called Dimorphos, which orbits a larger one called Didymos. Five groups of researchers have now analysed different aspects of the collision, which pushed Dimorphos closer to Didymos, making every orbit about 33 minutes shorter than before the smash – more than 25 times the change in orbital period required for the mission to be a success (*Nature*, doi.org/jzgg, doi.org/jzgn).

That was helped by DART being right on target. "The spacecraft hit very close to the centre… of Dimorphos, which is where you want to hit in order to maximise the momentum transfer," says Carolyn Ernst at Johns Hopkins University in Maryland.


NASA/JOHNS HOPKINS APL

Dimorphos as seen by the DART spacecraft seconds before impact

But perhaps more importantly, parts of the asteroid flew off after the collision, giving it an extra push. "People may think of the DART mission as a fairly straightforward experiment that is similar to playing billiards in space – one solid spacecraft impacts into one solid asteroid," says Cristina Thomas at Northern Arizona University.

But most asteroids – including Dimorphos, as it turns out – are rubble piles tenuously held together by gravity. When DART hit it, between 0.3 and 0.5 per cent of the asteroid's mass came flying off in a huge plume of ejecta. This plume amplified the momentum transferred from the spacecraft to the asteroid by a factor of 3.6 (*Nature*, doi.org/grvjkh, doi.org/grvptp).

Understanding that extra push will be crucial to any future DART-like missions. "Ejecta is going to give a larger push to the asteroid than the spacecraft itself, so that means in the future if we have to use this technology to divert an asteroid from hitting Earth, then we don't necessarily need a huge spacecraft," says Jian-Yang Li at the Planetary Science Institute in Arizona.

The plume of ejecta also puts Dimorphos in a strange category of asteroids called active asteroids, which have tails like comets. It has long been thought that these tails might form from collisions with smaller space rocks, and DART has shown that idea to be a good fit (*Nature*, doi.org/grvjkd). "We can now really nail down what's going on with active asteroids, and that helps us figure out what they're made of, which ties back to the birth of the solar system when they formed," says Ariel Graykowski at the SETI Institute in California.

"The best way to apply what we've learned is to do it again on something bigger"

After DART, we know that we can change the trajectory of a small asteroid like Dimorphos, but all asteroids are different, so we can't be sure that a similar mission would work on anything that might be headed our way. "I think the best way to apply what we've learned is to do it again on something bigger," says Graykowski. ▮

Biology

Insects shoot drops of urine using an anal catapult

TINY sharpshooter insects produce so much urine that they catapult it out of their bodies in energy-efficient, high-speed droplets instead of streaming it out.

Sharpshooters, which are a kind of leafhopper and are only a few millimetres in length, feed on the sap in plants' xylem tubes. This sap has a very low concentration of nutrients, meaning that the insects have to consume a lot and eliminate up to 300 times their body weight in liquid waste each day.

Saad Bhamla at the Georgia Institute of Technology in Atlanta and his colleagues wondered how the tiny insects could afford to spend the additional energy needed to urinate as much as they do.

"If you were only drinking diet lemonade, and that was your entire diet, then you really wouldn't want to waste energy in any part of your biological process," he says. "That's sort of how it is for this tiny organism."

To understand the insect's secret, the researchers analysed 22 waste ejections from five glassy-winged sharpshooters (*Homalodisca vitripennis*). In particular, they observed the movement of a pointy, hairy appendage called the anal stylus as it rotated and opened to squeeze out a droplet. Each droplet grew for about 80 milliseconds, then the stylus rotated slightly more to create a spring-load.


BHAMLA LAB, GEORGIA TECH

A glassy-winged sharpshooter with a droplet of urine on its anal stylus

At that point, the stylus made a fast twist, catapulting the droplet into the air. Remarkably, the droplets moved 40 per cent faster than the squeezing stylus did when it propelled them – a phenomenon known as superpropulsion (*Nature Communications*, doi.org/jzf8).

Larger animals and humans don't need to have such an energy-efficient urination system because – when compared with their energy intake, muscular strength and urinary output – the cost of producing streams is negligible. "But making jets when you're as small [as a sharpshooter] is very hard," says Bhamla. ▮

Christa Lesté-Lasserre