Abstractions

LAST AUTHOR

The textbook definition of friction often describes it as the force that resists relative motion between two bodies in perfect contact at a planar surface — conditions seldom found in nature. In reality, many discrete contacts form at the interface between two imperfect sliding bodies. On page 76, Jay Fineberg and his colleagues at the Hebrew University of Jerusalem in Israel show that frictional strength is governed by the behaviour of this ensemble of microcontacts. Fineberg tells *Nature* how this curiosity-based physics experiment may aid earthquake modelling.

How did you begin this line of research?

I was investigating the physics of how bodies fracture when I realized that friction is basically a system of fractures between two bodies. The laws of friction simply say that the force you must apply to any body is proportional to the force pressing down on it. But this makes sense only if you consider the behaviour of the contact area that exists, although is often not visible, at the interface between this body and another. As a result, I started experiments aimed at monitoring how the many frictional contacts that form between surfaces break and reattach.

What was the hardest part of the work?

Developing an appropriate experimental system, which took five years. It consisted of two blocks of acrylic glass and a laser-based method for measuring block movement. Using this system, we were able to see how small frictional contacts making up the interface break and reattach over microseconds, drastically changing the behaviour of the contact area.

Does this work apply to the real world?

Our table-top experiment yielded several insights that may be relevant to the real world. In fact, as we did this work, I realized that the same frictional forces control the movement of tectonic plates. Our empirical findings suggest that there is a reduction in contact strength, caused by the breaking of microcontacts, just before the two blocks move relative to one another. The speed at which microcontacts reattach depends on how fast the sliding occurs. Understanding this behaviour may help us to better predict earthquakes and their potential for damage.

Do you expect your results to be controversial?

I would be disappointed if they weren't. The most controversial research is often the most important because it disrupts preconceptions. That said, sceptics may point out that we've only conducted experiments using acrylic glass. Time will tell if our findings are also true for the rocks that make up a fault. ■

MAKING THE PAPER

Elizabeth Phelps

Training helps people forget some fearful memories.

Memories that trigger fear can last for years. In some cases they can be overwhelming, for example in post-traumatic stress disorder. A team at New York University, led by psychologist Elizabeth Phelps, now shows that fearful memories in humans can be eliminated through simple behavioural manipulation.

In studies of fearful memory processes, tones or lights are typically paired with electric shocks, and in time the tone or light alone elicits a fear response; in rats this manifests as freezing, in humans by a change in skin conductance. If at a later date study subjects are re-exposed to the tone or light, the stored memory is called up and experienced anew. The memory is then re-stored in a process called reconsolidation, which occurs over minutes to hours.

A wealth of animal studies has shown that reconsolidation can be blocked by drugs, such as protein-synthesis inhibitors — essentially wiping out memories. Although similar effects have been found for some drugs in humans, Phelps has not been able to replicate the work.

One way to lessen fearful memories without drugs is through extinction training. Here, the association with the fear memory — for example, the light or tone previously paired with the shock — is repeatedly presented without the fearful stimulus (the shock) until the fear response abates. But the effect is only temporary and the fear response can return.

An experimental disparity led Phelps and her colleagues to a clue to making extinction training more effective. Marie Monfils, then a postdoc in the New York University laboratory of Phelps' long-time collaborator Joseph LeDoux, was trying to show that drug blockade of reconsolidation is mediated by a different brain region from extinction. A procedural variation between her rat study groups troubled her, however. The drug group received a reminder of the fearful memory — a tone — a few minutes before the reconsolidation-blocking drug was administered. But the extinction group did not receive such a reminder before training began.

To remove the variable, Monfils repeated the experiment, giving both groups the reminder. Unexpectedly, the conditioned fear response was virtually eliminated in both groups. Monfils was perplexed: how could a tone block protein synthesis? Daniela Schiller, Phelps's postdoc, helped Monfils to interpret the results. "If you view reconsolidation as an adaptive mechanism, then new learning serves to update the memory, not block it," Phelps says. In other words, extinction training was as effective as drug treatment when the training took place during the reconsolidation triggered by the reminder. "In retrospect," Phelps says, "it makes perfect sense."

To test the idea, the postdocs embarked on parallel studies — Monfils in rats (M.-H. Monfils *et al. Science* **324,** 951–955; 2009) and Schiller in humans (see page 49). Schiller found that, with the new training approach, conditioned fear responses were eliminated for at least a year.

Phelps is cautiously optimistic about how the discovery might inform therapy. "I feel like we've done this light-paired-with-shock paradigm: a simple memory trace in the laboratory where the fear is, for obvious reasons, mild. I don't want people who are truly suffering to have false hopes." Having said that, Phelps says the work shows that timing therapeutic interventions to fall within the reconsolidation window could bring about more durable positive effects. ■

FROM THE BLOGOSPHERE

"Freelancing, I have discovered, is not for the faint of heart," writes Anna Kushnir on her Nature Network blog, Lab Life. "It's really time consuming, the deadlines are strict, the time to complete each task is frequently far too short and the monetary rewards far too slim." (http://network.nature.com/people/U2929A0EA/blog/2009/12/20/pleasure-and-pain).

So why does anyone stick with it? Especially in cases such as Kushnir's, for whom it is a moonlighting gig on top of her day job as a senior analyst at a government consulting firm in Washington DC.

She explains to Nature Network readers — and her perplexed partner — that she enjoys reading papers and summarizing them in a controlled way, following the rules of grammar and style, and not least, she says, "I like seeing my name in print. Don't judge."

She describes the recent task of composing a 160–180-word research highlight about a published paper as an "involved process, with multiple checks and balances" by the writer, editors and the author of the paper, which takes 8–10 hours of her time. "It's a pain, but it's also fun," she concludes. ■

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