Neuroscientist Inbal Ben-Ami Bartal studies rats to learn about the evolutionary roots of human empathy

MORE THAN A FEELING

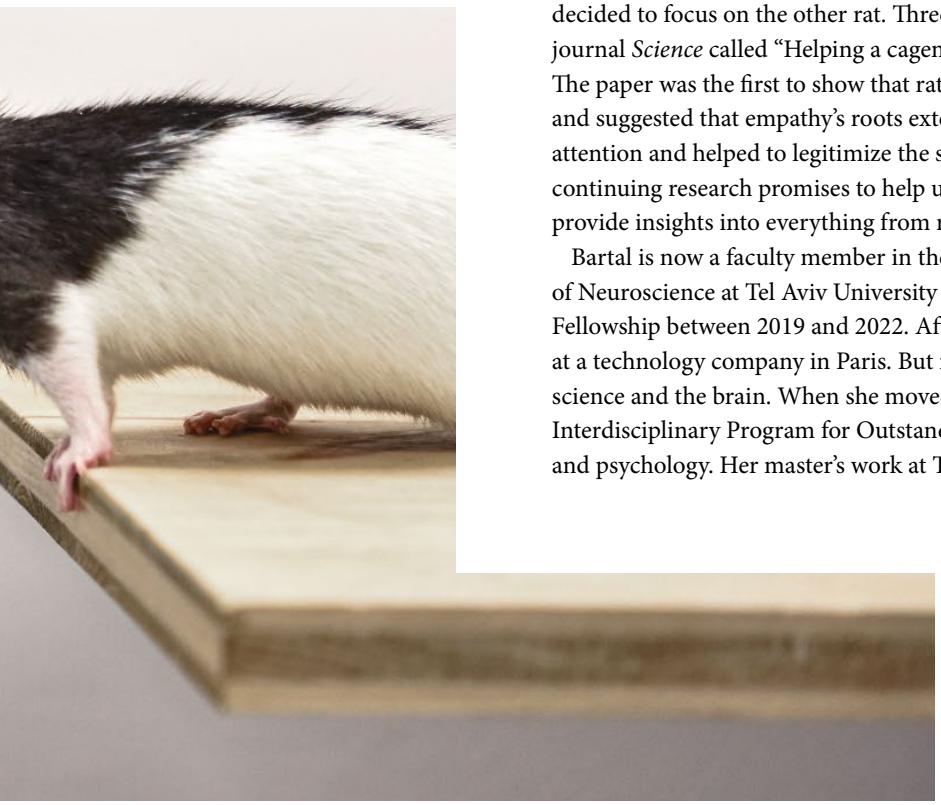
By Kurt Kleiner
Photographs by Boaz Perlstein

Fifteen years ago, when she was working toward her PhD at the University of Chicago, Inbal Ben-Ami Bartal had to figure out how to stress a rat. Rummaging around among the equipment in the lab, she found a small plastic tube-shaped enclosure. To see how well it worked, she went to a cage containing rats and put one inside the tube. Sure enough, the confined rat didn't seem to like it, squeaking and showing other signs of distress.

What surprised Bartal, however, was the reaction of the trapped animal's unrestrained cagemate. It scampered around and dug and bit at the plastic enclosure, to all appearances trying to help the rat inside. "The cagemate started just going nuts," she recalls. "I got really excited and said, 'You know, this rat really seems to care that the other rat is trapped.'"

Instead of studying the rat in the tube, Bartal decided to focus on the other rat. Three years later she was the lead author on a paper in the journal *Science* called "Helping a cagemate in need: empathy and pro-social behavior in rats." The paper was the first to show that rats are motivated by empathy to help others in distress and suggested that empathy's roots extend far into the evolutionary past. It gained international attention and helped to legitimize the science of animal emotions. Just as important, Bartal's continuing research promises to help us understand how empathy works in humans and could provide insights into everything from racism to psychopathy.

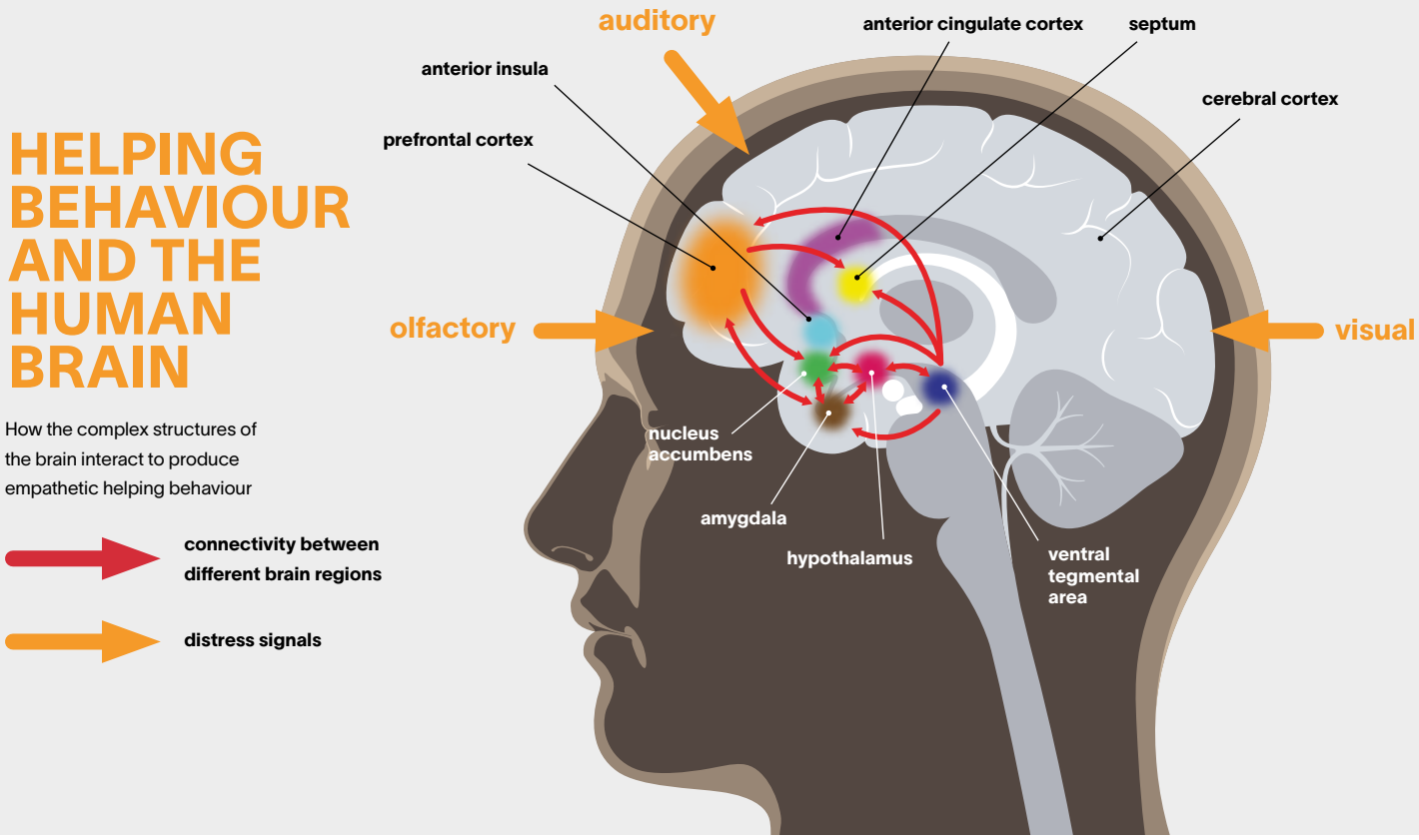
Bartal is now a faculty member in the School of Psychological Sciences and the Sagol School of Neuroscience at Tel Aviv University (TAU), where she held an Azrieli Early Career Faculty Fellowship between 2019 and 2022. After high school and her military service, she took a job at a technology company in Paris. But in her spare time she became fascinated by cognitive science and the brain. When she moved back to Israel, she won a scholarship to the Adi Lautman Interdisciplinary Program for Outstanding Students at TAU and studied neuroscience, biology and psychology. Her master's work at TAU used rats to examine the effects of stress on the



When Inbal Ben-Ami Bartal saw how an unrestrained rat appeared to be trying to help a rat inside a small plastic enclosure during her PhD research, she got excited about studying the science of animal emotions

HELPING BEHAVIOUR AND THE HUMAN BRAIN

How the complex structures of the brain interact to produce empathetic helping behaviour



Although Bartal's research is on rats, the rat brain has similarities with the human brain, including a "reward system" that involves the neurotransmitter dopamine and motivates us to do things that are beneficial for our survival. In humans, as well as in rats, the reward system takes part in prosocial behaviour. This system is connected to the empathetic response network, whose central parts include the anterior insula and the anterior cingulate cortex, which are active when we experience pain or distress and also when we see someone else experience pain or distress. When the sensory cortex — which receives and processes sensory information and is dispersed throughout the brain — perceives signals of distress, it initiates a cascade of emotional and behavioural responses.

immune system. For her PhD she wanted to study complex cognitive processes and found herself again working with rats, because "humans are really, really complicated," she says, laughing.

For the aforementioned empathy experiment, Bartal designed a restrainer that could be opened from the outside by a rat. Over multiple trials with multiple pairs of rats, she found that about 70 per cent of the rats would keep trying until they learned how to open the restrainer. After they learned, they would immediately free a trapped cagemate. (Based on their behaviour, it seems likely that the other 30 per cent just couldn't figure out how the latch worked.)

To confirm that their motivation was to help the trapped rat, Bartal tried various controls, including placing an empty restrainer and a restrainer containing a plush toy in the cage. The rats ignored these. When they were faced with two restrainers, one containing a trapped rat and one containing chocolate, they would open both and, more often than not, share the chocolate with the other rat. To see if the free rat just wanted a playmate, Bartal set up an arrangement where the trapped rat was released into a separate cage. Even with no promise of social interaction, the free rat still opened the restrainer. By carefully eliminating these and other explanations, Bartal showed that the rats' behaviour fit a specific definition of empathy — prosocial behaviour in response to another's distress.

At first glance, this did not seem overly surprising. We routinely project emotions and motivations onto animals. Assuming a jumping, barking dog is "happy to see me," or that a purring cat "loves being petted," seems natural and obvious. Scientists, on the other hand, have been reluctant to assume anything about what's going on inside the heads of animals. They have been more comfortable recording objective observations of behaviours. Even saying that a rat seeking food was "hungry" could be a problem.

"This idea of empathy in non-human animals was very new and contentious," says Bartal. "At the time it was really taboo to talk about animal emotions at all."

But attitudes were shifting. Primatologist Frans de Waal had argued that if a member of a closely related species behaved like a human —

Bartal's research has showed that rats do not attempt to free trapped rats that are both strangers to them and come from a different strain. They will release rats from a different strain if they already know them, and they'll release strange rats from a different strain if they've been raised with other rats from that strain, a finding that raises interesting questions about empathy and perceptions of group membership.

Compared to other animals, humans have a much more developed cerebral cortex, the part of the brain associated with cognitive functions like problem-solving. But the cerebral cortex is layered over evolutionarily older brain structures, and their functions are similar among all mammals. This comparable brain circuitry makes it possible to use rats as models for human empathy experiments.

say, when a rhesus monkey seemed to comfort a distressed family member — their emotions were probably similar too. Bartal has been heavily influenced by de Waal, Jaak Panksepp and other researchers who studied the biological basis of emotions, but her primary interest is to understand humans.

When we think of human empathy, we tend to think of a fairly sophisticated emotional and intellectual response, such as feeling what another person feels, intentionally adopting their perspective, and feeling sympathy and compassion, according to Bartal. But underlying these complex thoughts and emotions seems to be a simpler version of empathy that consists of the basic ability to recognize distress in others, sometimes coupled with the desire to relieve it.

In this form, empathy seems to be a trait selected for through evolution and conserved across related species. It likely originated in parenting instincts in animals such as birds and mammals that have to care for their young. From there, the sense of empathy gradually expanded to other kin and community members, buffering aggression and increasing social ties.

Compared to other animals, humans have a much more developed cerebral cortex, the part of the brain associated with cognitive functions like problem-solving and conscious thought. But the cerebral cortex is layered over evolutionarily older and more basic brain structures, and their functions are similar among all mammals. This comparable brain circuitry makes it possible to use rats as models for human empathy experiments and as a tool to understand conditions where human empathy is impaired, such as psychopathy, or perhaps even racism and xenophobia.

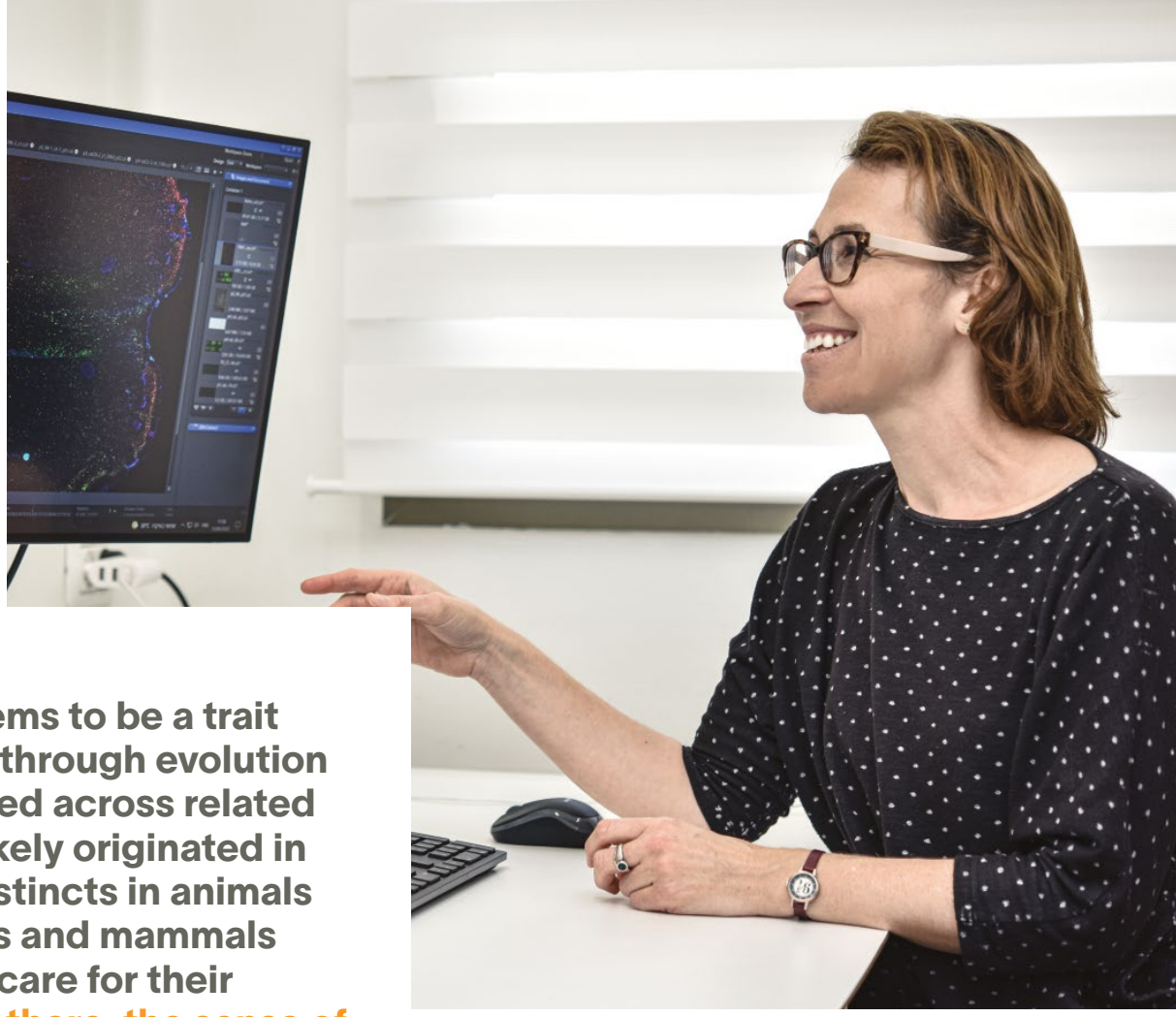
Once Bartal discovered that rats showed empathy, she had to figure out a situation where they didn't so she could compare the brain behaviour of empathetic rats with the non-empathetic ones. She discovered that rats do not free trapped rats that are both strangers to them and come from a different strain. They will release rats from a different strain if they already know them, and they'll release strange rats from a different strain if they've been raised with other rats from that strain, a finding that raises interesting questions about empathy and perceptions of group membership. (Interestingly, in a paper published earlier this year, Bartal showed that young rats are not biased in this way and help strangers from unfamiliar strains. Young rats also showed less activity in part of the hippocampus linked with social memory, raising questions about the role of identity categorization in prosocial behaviour.)

To untangle what was happening at a molecular level, Bartal used a technique called immunohistochemistry to "tag" specific cells with tiny fluorescent markers. Using this technique, active brain cells will literally light up under a microscope.

Bartal expected to see some differences in the so-called "empathy network" of the brain, which is known from human and animal studies to be active while processing the pain of others. To her surprise, activity in this network was about the same in both the helping and non-helping rats. What was different in the helping rats was activity in another brain system associated with the chemical dopamine, part of the reward system that gives us a pleasurable feeling when we do things like eat or have sex. Using another imaging method called fibre photometry, Bartal recorded neural activity in part of the reward system called the nucleus accumbens in rats while they were helping and indeed found neural activity only when rats approached a trapped rat with prosocial intentions.

These findings suggests that in rats — and probably in humans — what we thought was the brain's "empathy network" isn't enough by itself to motivate helping, Bartal says. Instead, the empathy network is good at recognizing pain or distress in others, but something else needs to kick in before we decide to help.

Bartal and her colleagues found a subpopulation of cells that project from the anterior cingulate cortex to the nucleus accumbens, essentially connecting the empathy network with the reward system. It seems to be involved in translating the recognition of distress into the motivation to help.



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For now, Bartal's research goal is to keep doing the basic work to understand how the complex structures of the brain interact to produce empathetic helping behaviour. Eventually, her work with rats could lead to insights and treatments for human conditions that are affected by problems with empathy. But it's possible that the most important step was in accepting that animals might have something to teach us about what we used to assume was a purely human capability.

"This whole area of research has been so neglected because of our unwillingness to make this presumption on the internal states of other species," Bartal says. "We're slowly developing ways to be sure that what we're looking at are comparable mechanisms to those that drive our human experiences." ▲●■