Stress is a slippery concept, difficult to grasp. Biology took it from physics, and in its broadest sense uses it to describe a body’s unspecific reaction to any kind of demand. This definition encompasses, for example, the water stress found in desert regions. Cacti and other succulent plants can withstand it well because they have adapted to aridity over the course of their evolutionary history.

In the case of animals – such as man – the emphasis is on physical and mental responses to impending danger. When it’s a matter of life or death, the body shifts into a different gear. Hormones place the organism in a state of alarm, the pulse quickens and the pupils dilate. The question, ultimately, is: fight or flight?

“Stress mobilises energy reserves” says Carmen Sandi, who runs the Laboratory of Behavioral Genetics at EPFL. This extra energy helps us to perform at a higher level than normal and to master difficult situations. Stress can stimulate us and give us a feeling of success, and all this has a positive impact (here we mean not just our productivity at the workplace but, for example, the fact that bowel cancer spreads less rapidly in mice that are kept in a varied environment than in mice that are kept in bare cages). We don’t all need the positive effect that a sense of achievement can offer, however. “There are people who can very easily take failures in their stride”, says Sandi.

Energies exhausted

It is still largely unclear why some rats and human beings can deal particularly well with stress, while others are especially susceptible to it, and this is currently the subject of intense research. What is clear, however, is that too much stress causes damage. We suffer when we gradually exhaust our energies on account of long-term exposure to stress, or when we cannot fully put to use the energy that stress generates. “The result of chronic stress is depression”, says Sandi.

The biology of violence

In their reactions to stress, rats and humans are more similar than we might usually expect. This is also of significance for our understanding of acts of violence.

By Ori Schipper

People suffering from depression often have fits of rage, she says, and she has observed similar tendencies during the experiments that she carries out on rats to try and shed light on the impact of stress on social behaviour. Her research interests have in recent years shifted from the impact of stress to how we think about the origins of violence. People who in their youth have experienced traumatic events have a greater tendency to violence than those who have grown up in a loving, caring environment – and the behaviour of rats is similarly affected by stressful experiences.

In Sandi’s experiments, rats aged between four and seven weeks – i.e., during puberty – are exposed to two different types of stress for a total of half an hour spread over seven days. The researchers either place the rats on an open platform almost a metre high, or they put a small cloth in their cage that has been impregnated with drops of trimethylthiazoline – a scent found in fox droppings. The former causes stress because rats are afraid of heights and have an innate aversion to exposed spaces; the latter also triggers an inborn fear response.

Abnormally aggressive

When compared with rats that were stroked for half an hour over seven days, the rats subjected to stress showed less interest in their own kind when they reached adulthood. They also showed less interest in objects and were shyer and less social. At the same time, however, they behaved far more aggressively to intruders placed in their cages by the researchers. The rats that had grown up in a stress-free environment became involved in conflict with the newcomers just under 60% of the time, but the rats that had been subjected to stress fought with them more than 80% of the time. Furthermore, it was noted that the stressed rats displayed “abnormally aggressive behaviour”, demonstrated by biting their opponents on particularly vulnerable parts of their anatomy more often than was the case with the ‘non-stressed’ test group. They even did so when the newcomers behaved submissively, or were placed into the cage in an inert, anaesthetised state.

“The behaviour of stressed rats is similar to human psychopaths in one other respect”, says Sandi. As adults, these animals reacted only marginally to renewed stress (for example, to the smell of fox faeces). “They have become blunted”, she says, like...
many people who have an aggressive personality disorder and who also lack empathy and compassion.

Naturally, we have to be cautious when comparing rats and people, says Sandi. But she is convinced that the commonalities observed are not accidental, and instead show that violence triggered by traumatic events during youth can also be traced back to biological components. “The prevailing psychosocial explanatory models have to be expanded and complemented by the biology of violence”, thinks Sandi.

This perspective would make it easier for society to see perpetrators as victims. “Such as Anders Behring Breivik, for example”, says Sandi. The right-wing extremist placed a bomb in the government quarter of Oslo in 2011 and then, dressed as a policeman, drove to a holiday island and shot 69 youngsters at a holiday camp being run by a social-democratic youth organisation. He was 32 years old at the time. But back in 1983, when Breivik was four years old, a child psychiatrist, called upon to examine him after the early divorce of his parents, found that he was “so neglected that there is a danger that he will develop a severe mental disorder”.

**Hereditary behavioural patterns**

Sandi does not believe that conflicts can always be solved by a rational approach. “Aggressive behaviour is linked to fear. And fear is often irrational”, she says. But perhaps her most disturbing finding is the fact that aggressive behavioural patterns are hereditary. The offspring of stressed male rats are just as asocial and aggressive as their fathers, even if they have had no contact with them (and thus have not been able to learn from them by observing them). For Sandi, problems of violence are therefore not just a matter of the cultural environment, but also have to do with adjustment mechanisms in the brain.

“In the brain, there is a balance between stimuli and inhibitors for nerve impulses. Chronic stress shifts this balance towards the stimuli”, says Sandi. She and her team have shown that treating the adult stressed rats with an anti-depressant can alleviate abnormal behaviour. This cure allows the circuits in the brain that have been damaged by trauma to be reprogrammed, she says.

Recently, however, Sandi’s team has been pursuing another track. If stress results in more stimulation than inhibition in the brain, it would mean that the brain would need more energy - because stimuli make the nerve cells more active. But nerve cells are dependent on small, specialised cellular components for their energy supply. These so-called mitochondria are often described as cellular batteries or cellular power plants.

Is it possible that a susceptibility to stress might depend on the efficiency of these ‘power plants’, and thus on how well the brain can produce energy? And could acts of violence ultimately be triggered not by stress alone, but also by the biophysical capacity of the brain? Sandi has found initial proof for this supposition in the work of other research groups who have examined prison inmates. The aggressive behaviour of prisoners was reduced when they were given dietary supplements - pills with vitamins, minerals and essential fatty acids.

But it remains to be proven whether such pills can one day help to prevent violent excesses. It also remains uncertain just how desirable this would be.

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**Literature:**
