Keeping track of the literature isn't easy, so Outside JEB is a monthly feature that reports the most exciting developments in experimental biology. Short articles that have been selected and written by a team of active research scientists highlight the papers that JEB readers can't afford to miss.

Outside JEB

FEELING THE HEAT

A locust can make a tasty morsel for a hungry predator, so being able to notice potentially dangerous looming objects and trigger the correct response could save a locust's life. In locusts, a visual neuron called the descending contralateral movement detector (DCMD) spikes in response to looming objects and could therefore be the trigger for escape responses. Tomas Money and colleagues at Queen's University in Canada knew that nervous systems in cold-blooded animals like locusts can be severely affected by temperature and can even fail at high temperatures. But the effects of very high temperature can be lessened if a creature has experienced a prior heat shock at a high, but sub-lethal, temperature. Money and his colleagues wondered if heat shock protects the DCMD neuron from soaring temperatures. If it does, then the behaviours that are guided by this neuron should be unaffected in heat-shocked locusts, even when the going gets hot.

To test this, the authors divided locusts (*Locusta migratoria*) into two groups: control animals and those that received a heat shock at 45°C for 3 h before experiments. Recording from the DCMD, the team explored how the neuron responded to looming objects when they kept the locusts at a range of temperatures from 25 to 45°C. As they boosted the temperature, they saw that the number of spikes in control animals' DCMD in response to a looming object decreased and the first spike occurred later. But in heat-shocked animals, the DCMD's response stayed the same across temperatures, which suggests that the prior heat shock had indeed protected the DCMD.

Looking more closely at the DCMD's firing frequency during the early phase of a threatening object's approach, they saw that spike rate decreased with temperature, but to a lesser degree in heat-shocked animals. However, in heat-shocked animals, the peak of the DCMD's response – which occurs close to the time when an object would be expected to collide with the locust – is higher at 45°C than at 25°C, due to brief, high-frequency bursts of spikes. This does not happen in control animals. Possibly, the higher peak firing rate in heat-shocked animals is a compensation for the lower firing rate earlier in the response, and the differences earlier in the response could cause different behavioural outcomes in control and heat-shocked animals.

The properties of the DCMD neuron also change as the temperature rises: action potentials in DCMD diminish in height, although in heat-shocked animals action potentials are bigger than in controls. The membrane potential of the neuron is more hyperpolarized (more negative) in heat-shocked animals, which also affects how quickly the neuron can recover and transmit the next action potential. In effect, heat shock makes the action potentials in DCMD more robust.

Another factor affected by heat shock was an afterdepolarisation (ADP); a rise in the membrane potential seen in the neuron after the action potential. This ADP occurred more frequently and was bigger in heat-shocked animals at all temperatures than in control animals. Although the authors did not investigate the nature of the ADP, in other animals it has been shown to make neurons more excitable, meaning that they are more likely to spike and elicit a response. A similar mechanism could be operating in the heat-shocked DCMD.

The effect of heat shock on the properties and response of DCMD is important because it helps reliably maintain the neuron's response in the face of high temperatures. This makes it more likely that DCMD will trigger an escape response if a looming object is detected. So, rather than being overwhelmed by an extreme heat wave, a locust might be less likely to end up as lunch.

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Money, T. G. A., Anstey, M. L. and Robertson, R. M. (2005). Heat stress-mediated plasticity in a locust looming-sensitive visual interneuron. *J. Neurophysiol.* **93**, 1908-1919.

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