© 2018. Published by The Company of Biologists Ltd | Journal of Experimental Biology (2018) 221, jeb188870. doi:10.1242/jeb.188870

INSIDE JEB

How pit vipers see (infra)red

A western diamondback rattlesnake (*Crotalus atrox*). Photo credit: Tobias Kohl.

Equipped with a pair of heat-seeking infrared-sensitive organs (known as pit organs) located beneath the eyes, pit vipers are dead shots even in the dark. 'Pit organs are simple pinhole cameras', says Tobias Kohl from the Technical University of Munich, Germany, which produce a low resolution, thermal image. Despite the blurry picture, pit vipers, such as western diamondback rattlesnakes (*Crotalus atrox*), are able to precisely target rodents and reptiles that stand out against their thermal backgrounds as they pass within striking distance. However, after decades of research into the role of the pit organs, scientists were uncertain how the serpents interpret the thermal images to land a strike. Kohl adds that the electrical signals generated by the heat-sensitive organ are transmitted by the trigeminal nerve – which usually transmits temperature, pain and touch stimuli, rather than images of the environment. He says, 'It had previously been suggested that a specialised region of the brain, the nucleus of the lateral descending trigeminal tract [LTTD], in the hindbrain region in rattlesnakes has a retina-like function', so he teamed up with Maximilian Bothe, Harald Luksch and Hans Straka to learn more about how snakes process infrared information in the brain when going for a kill.

'We mimicked short, non-moving inputs', says Kohl, who describes how Bothe carefully stimulated individual nerves leaving the pit organ with a minute electric wire before painstakingly measuring the nerve signals as they arrived in the LTTD region of the snake's brain. The measurements showed that the arriving nerve signals switched from blocking (inhibiting) to firing strongly (exciting) as he simulated a warm object occurring at different locations in front of the snake. Also, the strength of the difference between the inhibition and excitation response varied depending upon which region of the pit organ he had stimulated. The team recognised that there were some similarities between the nerve signals produced by the pit organs and the retina when detecting the front of an image moving across the eye. Kohl says, 'This might provide an important mechanism for hunting and help [pit vipers] to aim their strikes precisely'.

Having scratched the surface of how pit vipers perceive heat, Kohl is keen to learn how the venomous creatures combine their visual and thermal perspectives by tracking pit organ nerve signals deeper inside the brain in structures that usually interpret information from the eyes. He says, 'Integrating the prey's infrared profile with the visual input might also strongly enhance strike performance', and he adds, 'Our study represents the first step in the attempt to understand how these snakes process infrared information in the brain at a detailed single-cell and neural network level'.

10.1242/jeb.188870

Bothe, M. S., Luksch, H., Straka, H. and Kohl, T. (2018). Synaptic convergence of afferent inputs in primary infrared-sensitive nucleus (LTTD) neurons of rattlesnakes (Crotalinae) as the origin for sensory contrast enhancement. *J Exp. Biol.* **221**, jeb 185611.

Kathryn Knight
kathryn.knight@biologists.org