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BEHAVIOURAL NEUROSCIENCE

In hunt mode

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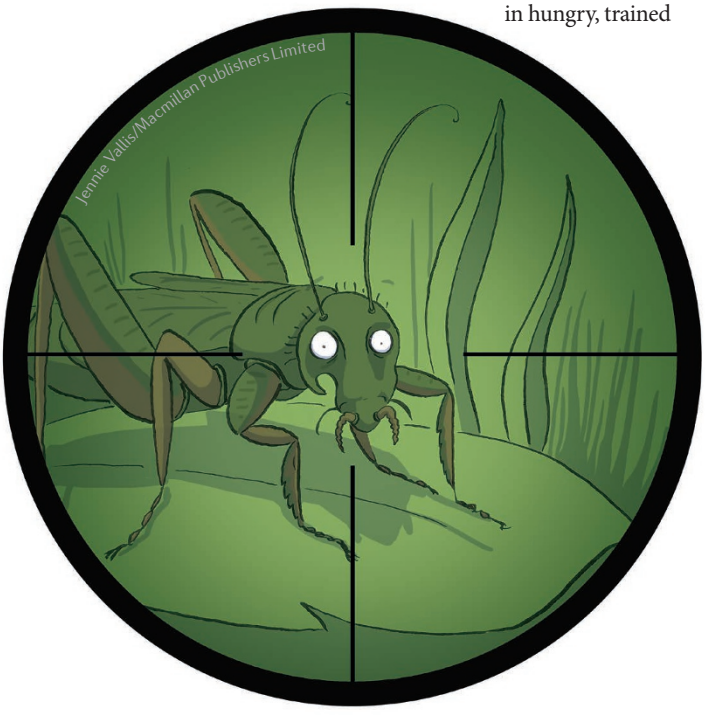
The periaqueductal grey (PAG) has been implicated in hunting behaviour, but this region has many inputs — including from the lateral hypothalamus (LH) and medial preoptic area (MPA) — and so the circuits mediating hunting have been difficult to define. Now, two studies describe inputs to the PAG from the LH and MPA that each drive hunting-like behaviour in mice.

Yi *et al.* used patch-clamping experiments in brain slices to determine that most (61%) of the PAG-projecting LH neurons (LH→PAG neurons) are GABAergic. Calcium imaging revealed that there was an increase in the activity of GABAergic LH neuron terminals in the PAG when mice that had been trained to hunt crickets started to chase a cricket. Optogenetic inhibition of GABAergic LH→PAG neuron terminals suppressed hunting in hungry, trained mice. By contrast, photostimulation of such terminals in non-trained, satiated mice immediately caused these mice to chase, catch and repeatedly bite the cricket. Thus, PAG-projecting GABAergic LH neurons may regulate predatory behaviour.



Next, Yi *et al.* moved a disc along the floor of the arena either away from or towards the mouse to mimic prey or an attacker, respectively. Without light stimulation, the mice did not attack the disc if it moved away from them, but they did run away from the disc if it moved towards them. Light-induced activation of LH GABAergic neurons caused mice to attack the disc, irrespective of the direction of disc movement, suggesting that these neurons can trigger a switch in behaviour from evasion to predation.

Last, Yi *et al.* showed that, in contrast to the GABAergic LH neurons, light-induced suppression of PAG-projecting glutamatergic LH neurons made mice less likely to run away from the attacking disc, and optogenetic activation of these projections caused mice to run and jump, even in the absence of an attacker. Thus, glutamatergic and GABAergic projections of LH→PAG neurons regulate evasive and predatory behaviours, respectively.

In the other study, Park *et al.* examined ventral PAG (vPAG)--projecting MPA neurons that express Ca^{2+}/calmodulin-dependent protein kinase IIα (CAMKIIα$^+$ MPA→vPAG neurons). Calcium responses increased in these cells while mice explored an object, and optogenetic stimulation of a subset of CAMKIIα$^+$ MPA→PAG neurons caused mice to touch and carry the objects more (as assessed by measuring dislocation of the object).

Park *et al.* noted that these play-like interactions with the objects resembled predatory behaviours. They therefore photostimulated CAMKIIα$^+$ MPA→vPAG neurons when (non-trained) mice were near to a cricket; this stimulation caused mice to chase, grab and bite the insect and to carry it in their mouths, suggesting that these neurons might promote play-like and hunting behaviours in a continuum.

In addition, Park *et al.* observed that the optogenetically induced hunting of crickets depended on whether the cricket was in front of the mouse. The authors designed a system in which a head-mounted object was suspended ahead of the mouse, and created an algorithm based on real-time tracking of the animal's head direction and object position in order to automatically direct the orientation of the head-mounted object. Using this algorithm, the authors were also able to optogenetically stimulate CAMKIIα$^+$ MPA→vPAG neurons only when the object was aligned with the intended route, leading the mouse to 'chase' the object along a specific route around a novel complex maze. Thus, the activity of these neurons when directed in pursuit of a visual object can motivate navigation of a new environment.

Together, these studies provide evidence that the projections of GABAergic LH neurons and excitatory CAMKIIα$^+$ MPA neurons in the PAG regulate predatory behaviour.

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ORIGINAL ARTICLES Li, Y. *et al.* Hypothalamic circuits for predation and evasion. *Neuron* https://doi.org/10.1016/j.neuron.2018.01.005 (2018) | Park, S.-G. *et al.* Medial preoptic circuit induces hunting-like actions to target objects and prey. *Nat. Neurosci.* https://doi.org/10.1038/s41593-018-0072-x (2018)