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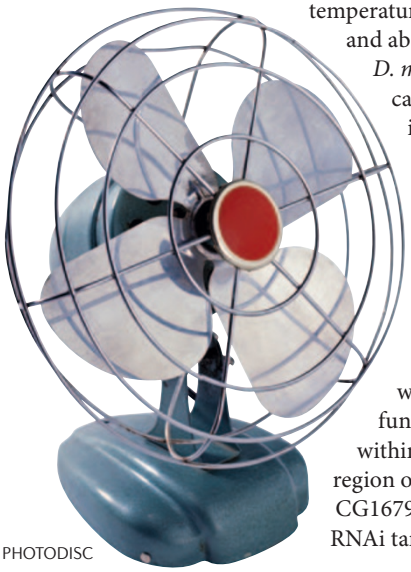
hot- and cold-sensing neurons project to distinct but adjacent regions in the protocerebrum, forming a thermotopic map

SENSORY SYSTEMS

Mapping thermosensation

In mammals, several members of the transient receptor potential (TRP) ion channel family detect hot or cold stimuli, but how thermal stimuli are represented and processed in the brain is still unclear. In a study published in *Cell*, Zuker and colleagues showed that in *Drosophila melanogaster*, hot- and cold-sensing neurons project to distinct but adjacent regions in the protocerebrum, forming a thermotopic map.



PHOTODISC

Wild-type flies avoid temperatures below 24°C and above 27°C, but a *D. melanogaster* line carrying a P element insertion 2 kb downstream of a gene encoding a predicted TRP channel (CG9472) exhibited a deficit in cold temperature avoidance. Flies with other loss-of-function mutations within the coding region of this gene, in CG16793 or expressing RNAi targeted to CG13762 (two additional, related TRP genes), showed similar deficits, leading the authors to conclude that these channels, which they named brivido 1, brivido 2 and brivido 3, are necessary for cold-temperature sensing.

Brivido 1 is expressed in a subset of cells in the fly antenna, most notably in three ciliated neurons at the base of the arista and in ~15 neurons in the sacculus region of the third antennal segment. These neurons are activated by temperature drops of as little as 0.5°C, suggesting that they function as cold-temperature 'receptors'. The arista comprises a total of six neurons, and the three neurons that did not respond to temperature drops were in fact activated by small temperature increases. Thus, these cells seem to work together in the antenna to detect changes in temperature.

To determine how temperature information in the periphery is relayed to the brain, the authors tracked the projections of the cold- and hot-sensing antennal receptors. They found that both types of cell target a previously uncharacterized region of the fly brain, the proximal antennal protocerebrum (PAP). Notably, the projections from the hot- and cold-sensing neurons target two distinct but adjacent glomeruli, forming a thermotopic map in the protocerebrum. Using two-photon calcium imaging, they confirmed that the PAP glomerulus targeted by the cold-sensing cells displayed robust calcium transients in response to cold stimuli and that the PAP glomerulus targeted by the hot-sensing cells was selectively activated by temperature increases. In both cases, and similar to mammalian thermoreceptive cells, the scale of the calcium transients was proportional to the magnitude of the temperature change.

Inactivation of the hot- or cold-sensing neurons by targeted expression of tetanus toxin light chain in these cells led to the loss of hot- or cold-avoidance behaviour, respectively. These findings confirm that the spatially segregated projections of the cold- and hot-sensing antennal receptors translate into a discrete functional representation of temperature in the brain. How this information is processed upstream to trigger the appropriate behavioural response remains to be elucidated.

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ORIGINAL RESEARCH PAPER Gallio, M. *et al.* The coding of temperature in the *Drosophila* brain. *Cell* **144**, 614–624 (2011)