

**Press Release No. 15/2018**

Press Office
Universitätsstraße 10
D-78464 Konstanz
+49 7531 88-3603
Fax +49 7531 88-3766

kum@uni-konstanz.de
www.uni-konstanz.de

19 February 2018

Spatial perception of odorants in cockroaches

A recent study involving researchers from the University of Konstanz has described the first neural architecture capable of encoding the spatial location of odorants

A rose constitutes a three-dimensional arrangement of petals, leaves and a stem that generates a corresponding spatial representation in the brain. Because neighbouring cells work together, objects close to each other in the real world are represented close to each other in the brain. Similarly, when someone touches someone else's hand, a tactile sensation is projected onto the somatosensory cortex, faithfully representing the original location of the stimulus on the body. This inner representation of the outer body surface has been described as a visual or sensory "homunculus". What remains unclear is whether there is also something like an "olfactory homunculus", i.e. whether our sense of smell can convey spatial information to the brain via a spatial neuron structure. A recent study conducted by researchers from Japan and by Professor Galizia's neurobiology working group was able to show – for the first time – the existence of a spatial representation of the olfactory space in the brain of a cockroach. The results have been published in the online edition of *Current Biology*.

The research collaboration, which brings together scientists from Konstanz and from the Japanese Universities of Sapporo and Tokyo, examines odour perception in the nocturnal American cockroach. As for most animals, olfactory information is very important to cockroaches. The American cockroach has two exceptionally well-developed antennae that enable it to take sequential probes of its olfactory environment. They are equipped with olfactory receptors that interact with specific olfactory molecules. Via the position of the receptors on the antennae – which can grow to a length of four to five centimetres, which is the size of the cockroach's body – the insects obtain information about the spatial position of an odorant. Since all receptor neurons of the same type converge onto the same glomerulus, it was thought that spatial information linked to their location on the antenna was therefore lost.

The researchers focused on the odour of the female cockroach's sexual pheromone. When they examined the male macroglomerulus – a large glomerular structure dedicated to receiving and relaying female sexual pheromone-related information – the scientists found that it mirrors the spatial arrangement of the receptor for sexual pheromones on the antennae. Using various imaging methods, Dr Marco Paoli from the University of Konstanz was able to chart the brain of the cockroach, thus documenting the spatial structure that enables it to process olfactory molecules. Neurons from the distal part of the antenna innervate the medial part of the macroglomerulus,

whereas neurons from the more proximal part of the antenna innervate the more lateral portion. The researchers were thus able to show that the spatial information generated on the antenna is maintained in the macroglomerulus and conveyed to the mushroom body, a putative centre for spatial memory formation. Receptors ranged next to each on the antenna can also be found next to each other in the macroglomerulus.

The study describes the first neural architecture capable of encoding the spatial location of odorants. It not only confirms that cockroaches have access to spatial representations of their own inner worlds, but it also suggests that they can internally build a spatial representation of the surrounding olfactory landscape. Giovanni Galizia's working group examines if these findings can also be applied to other insects such as flies and bees, which have very short antennae. Ultimately, all of this will supply important information about the basic information processing mechanisms in the brain - the human brain included.

Facts:

- Original publication: Hiroshi Nishino, Masazumi Iwasaki, Marco Paoli, Itsuro Kamimura, Atsushi Yoritsune, Makoto Mizunami: Spatial Receptive Fields for Odor Localization, *Current Biology* (2017): DOI: <https://doi.org/10.1016/j.cub.2017.12.055>
- Study documenting the neural architecture capable of encoding the spatial location of odorants in the brain of an insect for the first time.
- Cooperation between scientists from the Universities of Sapporo and Tokyo and the University of Konstanz's neurobiology working group.
- Funded by the mentorship programme of the University of Konstanz's Zukunftskolleg.

Contact

University of Konstanz
Communications and Marketing
Phone: + 49 7531 88-3603
E-Mail: kum@uni-konstanz.de

- uni.kn