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A "roadmap" of the fruit fly brain

For the first time, researchers at Leipzig University and other institutions have gained comprehensive insights into the entire nervous system of the fruit fly (Drosophila melanogaster). The findings were recently published in Nature, marking the first study to describe in detail the neurons that span the entire nervous system of the adult fruit fly. The researchers also, for the first time, compared the complete set of neural connections (the connectome) in a female and a male specimen – and identified differences.

"At present, there are only a few electron microscopy data sets of the fruit fly's connectome. None of them has so far included the entire central nervous system – that is, both the brain and the ventral nerve cord, the functional equivalent of the vertebrate spinal cord. Until now, the data sets have ended at the neck due to technical limitations," explains lead researcher Dr Katharina Eichler from Leipzig University, describing the current state of research.

However, the neurons that run through the neck connective – the link between brain and nerve cord – are essential for transmitting the decisions made in the insect's brain. These neural circuits have so far remained unknown. "We have now identified these neurons in three connectomes and analysed their pathways. We studied one female brain data set as well as a male and a female nerve cord data set," says Eichler, who previously conducted research on the topic at the University of Cambridge before continuing her work at Leipzig University.

The paper describes all the neurons in the neck of the fruit fly that could be identified using light microscopy data. This allowed the researchers to analyse the circuits formed by these cells in their entirety. When comparing male and female neurons, the scientists identified sex-specific differences for the first time. Previously unknown cells were found that exist only in one sex and are absent in the other. The researchers also discovered that a descending neuron known as aSP22 communicates, in females, with neurons that are present only in females. This finding provides the first explanation for the behavioural differences observed when this neuron is active. Female flies extend their abdomen, probably to lay eggs, while males curl theirs forward in order to mate.

"The study provides an overview of the entire fruit fly connectome. It serves, in a sense, as a kind of roadmap that scientists can use for orientation. Based on this, experiments can be intelligently designed to investigate the function of individual neurons or entire circuits – saving considerable time and resources," explains the biologist. Now that the technical challenges in analysing the fruit fly's nervous system have been overcome, Katharina Eichler's research group is working on two new data sets covering the entire central nervous system of both a female and a male specimen.

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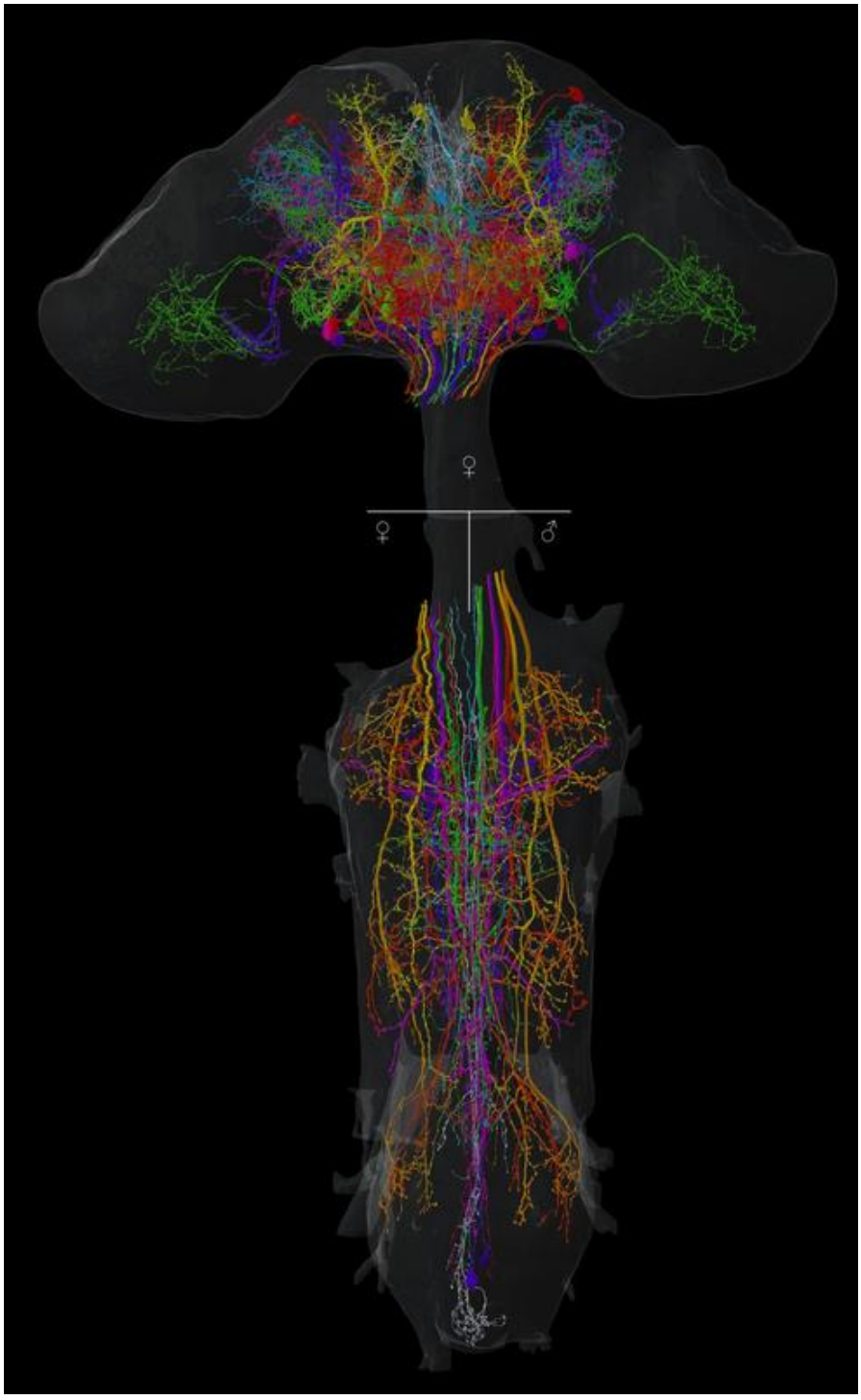

The images show example neurons from the study. Each colour represents a cell identified in the female brain, in the female (bottom left) and male (bottom right) nerve cord.
Photo: Tomke Stürner
Uni Cambridge and LMB Cambridge