IMP Press Release

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Mind alteration device makes flies sing and dance

Researchers at the Institute of Molecular Pathology (IMP) in Vienna present novel method to study the activity of specific brain regions in moving flies.

In a joint effort with collaboration partners from the Vienna University of Technology and a lab in the USA, the team of Andrew Straw at the IMP developed a special device for the thermogenetic control of flies. This tool, called FlyMAD, enabled the scientists to target light or heat to specific body regions of flies in motion and to analyse the animals' brain cells. Compared to other techniques, FlyMAD allows highly improved temporal resolution. Using the new technology, Straw and his colleagues got new insight into the role of two neuronal cell types in courtship behavior of flies. The results of the study will be published online in Nature Methods on May 25 (doi 10.1038/nmeth.2973).

The fruit fly *Drosophila Melanogaster* represents an ideal experimental system to analyse circuit functions of brain cells (neurons). In the past, it was not possible to specifically control the activity of neurons in moving flies. Andrew Straw and his team have now overcome this barrier.

Rapid mind alteration in moving flies

Straw and his co-workers are interested in the mechanisms underlying cell circuits in the fly brain. Straw's group concentrates on the control of complex behaviours such as courtship. In order to better understand how different neuronal circuits work together, Straw and his team developed FlyMAD (Fly Mind Altering Device), an apparatus using a video camera to track the flies' motion in a box. FlyMAD allows simultaneous observation of several flies and targeted irradiation of specific body regions of these animals. By combining the sensitive methods of optogenetics and thermogenetics, the researchers were able to specifically alter neural pathways in the fly brain with FlyMAD.

The novel technology of thermogenetics uses genetically modified, temperature-sensitive flies. Upon irradiation with infrared light and the concomitant rise in temperature to 30 degrees Celsius, these animals change certain aspects of their behaviour. This does not happen at a control temperature of 24 degrees Celsius. Compared to other commonly used methods, FlyMAD applies a highly improved temporal resolution. Infrared-induced activation or repression of specific neurons and the following change in the animals' behaviour occur within the fraction of a second.

The application of visible light to certain genetically engineered flies can also induce alterations in their brain. FlyMAD thus represents an absolute novelty for fly research, as optogenetics has been most useful in mice so far.

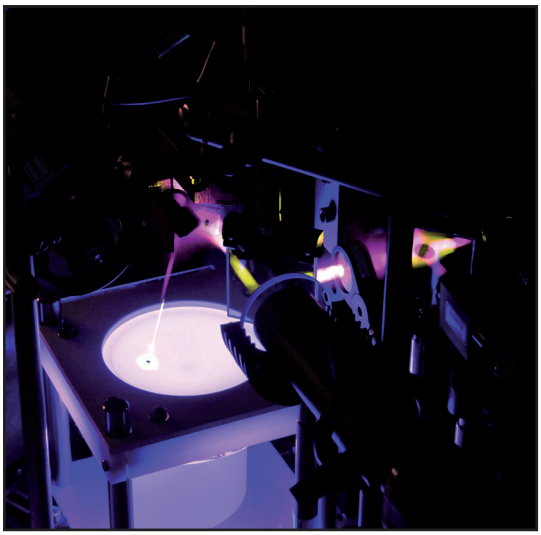

Photo: Matt Staley und Dan Bath, JFRC, HHMI

New insight into courtship behaviour of flies

Straw and his co-workers tested FlyMAD by analysing already known reactions of genetically modified flies to light and heat. As this proof-of-principle showed that FlyMAD worked reliably, the researchers went on to use their method to tackle new scientific questions. In a thermogenetic set up, they investigated a certain type of neurons that had been linked to the flies' courtship song in earlier experiments. Taking advantage of the better temporal resolution of FlyMAD, the scientists were able to characterise the role of two neuronal cell types in the brain in more detail. They could show that activity of one type of neurons correlated with a persistent state of courtship, whereas the other cell type

was important for the action of “singing”. In the experiment this became obvious when males tried to mate with a ball of wax, circled it and vibrated their wings after stimulation with the laser beam.

FlyMAD allows combination of optogenetics and thermogenetics

In the future, Straw wants to combine the activation of flies both by light and by heat in one experiment – that is feasible with FlyMAD. This would allow the activation or repression of different genetic elements in one fly. „FlyMAD offers the phantastic opportunity to address many of our questions. We could, for example, analyse how single neurons function in a cascade withhin the neuronal circuit“, Straw emphasises the potential of his work. Ultimately, new insight into the function of the fly brain can also be applied to the network of cells in the mammalian brain.

Original Publication

Daniel E. Bath, John R. stowers, Dorothea Hörmann, Andreas Poehlmann, Barry J. Dickson and andrew D. Straw. FlyMAD: Rapid thermogenetic control of neoronal activity in freely-walking *Drosophila*. Nature Methods advance online publication, May 25, 2014.
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Illustrations

The illustrations can be used free of charge in connection with this press release can be downloaded from the IMP website: *www.imp.ac.at/pressefoto-flymad*

About Andrew Straw

Andrew Straw studied biology in Los Angeles, USA, and obtained his PhD in Adelaide in 2004 for his dissertation in the field of neurobiology. He worked as a Postdoc and Senior Postdoc at Caltech in Pasadena, USA, and became Senior Research Fellow there in 2010. Since 2010, Straw holds a position as Research Fellow at the IMP in Vienna where he has his own independent research group. His work is partly funded by an ERC Starting grant

About the IMP

The Research Institute of Molecular Pathology (IMP) in Vienna is a basic biomedical research institute largely sponsored by Boehringer Ingelheim. With over 200 scientists from 37 nations, the IMP is committed to scientific discovery of fundamental molecular and cellular mechanisms underlying complex biological phenomena. Research areas include cell and molecular biology, neurobiology, disease mechanisms and computational biology.

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