Brain cartography: the fly mating dance neurons mapped

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How the bundles of neurons in the brain controls behaviour remains an ongoing mystery. Researchers from the Institute of Molecular Pathology (IMP), in Vienna, Austria, and the Laboratory of Molecular Biology (LMB/MRC), Cambridge, United Kingdom, have mapped neurons of the fruit fly, Drosophila, that controls sexual behavior. "We literally untangled the mess of wires in the fly brain and laid the ground plans for investigating a complex behavior in a simple organism," says Jai Yu, whose doctoral work is published in Current Biology.

Not only do animals come in different shapes and sizes, variety is certainly not lacking when it comes to behavior. Each species is born with its own unique set of behaviours but how this is controlled by the brain is not well understood. This is where the fruit fly, *Drosophila*, can help. Sex is a behaviour the fruit fly does well. Their amazing reproductive prowess has ensured their successful spread throughout the world. Unlike their human counterparts, the male fruit fly is born knowing very well how to impress the female. Its brain is fully equipped with the right neurons that allow it to perform an intricate mating dance to woo the female for copulation.

For his PhD work in Barry Dickson's laboratory at the Institute of Molecular Pathology (IMP), in Vienna, Jai Yu, used clever genetic tricks to see individual types of neurons in the tiny brain of the fruit fly that are known to be important in controlling its mating dance, or courtship dance. These neurons are called *fruitless* neurons because they express a critical gene, fruitless, that is needed for fruitful reproduction. "At the beginning, we knew there's about 2% of the fly brain, which is around 1500 individual neurons, that are important for courtship, but we didn't know how many types or groups of neurons they belong to. We now know there are at least 100 different types based on where they connect to," says Jai Yu, "We think each type of neuron is important in some way and together all the components work together hand in hand to generate the courtship dance."

This work was possible by looking at the miniscule brains, at less than a millimeter across, of thousands of different genetic strains of *Drosophila*, each one having a different group of neurons made visible with a fluorescent protein. "It was like a giant jigsaw puzzle, where we each fly strain provided a piece and we had to put together the complete picture one strain at a time," explains Jai Yu. After meticulously analysing a large collection of images of fruit fly brains using a combination of microscopy and advanced digital imaging software, Jai Yu could connect the pieces and reveal a map of mating dance neurons, "What we did was similar to making an electronic circuit diagram, looking at how the parts are connected."

The findings opens up many avenues of research, particularly it offers a chance to really know how these 100 different types of neurons in the fly nervous system orchestrate the mating dance. "What excites me now is instead of looking at these neurons; we have a way to go back to our selection of fly strain that we have used and try to shut the neurons down, something like pulling out the wires, one by one, to see what happens to the mating dance of the fly," Jai Yu says, "then, we can find which ones do what by looking at the defects during the mating dance."

The implications from this research are wide reaching. Although the fly brain is small and relatively simple, it offers a chance to understand how collections of neurons allow an animal to perceive the environment and interact with it. "I look forward to a time in the near future, where we can understand

what goes on in the brain of the little fruit fly, how it has become so efficient at doing things, eat, sleep and reproduce," says Jai Yu, "I hope through our efforts, the brain will become less of a mystery and more of a tangible entity that we can one day understand."

Visit the Dickson Lab:

http://www.imp.ac.at/research/barry-dickson/research

Attached files

- fru+ neurons in the CNS, shown in green. Synapses are stained in magenta. This is a confocal image of the brain and ventral nerve cord of a fruGAL4 UAS-GFP male.
- Genetic dissection of fru+ neurons in the central brain. Distinct neuronal cell types have been labeled, imaged, and traced in different colours. A synaptic counterstain was used to register individual samples onto a common reference brain, creating a digital atlas of the fru circuit.

Full bibliographic information:
Yu, J.Y., Kanai, M., Demir, E., Jefferis, G.S.X.E. and Dickson, B.J. (2010) Cellular organisation of the neural circuit that drives Drosophila courtship behaviour. Current Biology, September in press.28, 2010, Vol. 20, Nr. 18.