Scientists 'plug in' to circuitry behind sex in male fruit flies

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Fruit fly. Credit: John Tann/Wikipedia

Researchers from the University of Oxford have identified a small neural circuit in male fruit flies that has evolved to allow them to perform the complex mating ritual.

The findings pave the way for deeper, circuit-level studies into sexual behavior and how it can be modified by social experience.

"Male fruit flies court females with a series of 'hard-wired' or genetically programmed behaviours, and failure during any part of the process may prevent reproduction," says senior author and Wellcome Trust Senior Investigator Stephen Goodwin, from the Centre for Neural Circuits & Behaviour at the University of Oxford.

A gene known as doublesex generates differences in the anatomy and behaviour of males and females in many animal species. This gene is so called as it transforms male and female fruit flies into intersexes, where they each have the characteristics of both sexes (hence 'doublesex'). The male doublesex gene is active in around 650 neurons, with specific groups of cells controlling distinct steps in the courtship ritual. What is unknown is how these different steps are coordinated to ensure successful mating.

In their study, Goodwin and his team identified a circuit of doublesex-expressing neurons in males that controls the act of sex itself. Located in the fruit fly's equivalent of the spinal cord, this circuit is made up of three key types of neurons: motor neurons, inhibitory interneurons, and mechanosensory neurons.

"We found the exact motor neurons that control the male penis and enable sex to take place, in addition to a second group of inhibitory neurons that oppose the motor neurons and are involved in the uncoupling following sex," says Hania Pavlou, lead author of the study and MRC Career Development Postdoctoral Fellow in Computational Genomics.

"Using sophisticated genetics, we are able to perturb the activity of these neurons and stop males from mating. We also show that the mechanosensory neurons on the genitals feedback and potentially coordinate the activity of the other neurons to generate the correct balance of excitation and inhibition that is needed for copulation."

These results suggest the doublesex gene configures a circuit specific to males, which allows them to successfully execute the correct action sequence for both the initiation and termination of sex.

The findings also indicate that the mechanics of copulation are separate from those of reproduction. It has previously been discovered that sperm transfer in fruit flies is controlled by a group of neurons that supply the reproductive glands with nerves and promote ejaculation. The current study reveals that the circuit controlling the act of sex is distinct from that involved in sperm transfer, although it may still help to modulate it. This suggests a mechanism for separating the pleasant sensation of sex from reproductive function.

"We next want to understand how command centres in the brain combine the signals that control sex with feedback from the male's internal state, the female, and the environment, to enable males to execute and modify their sexual behaviours," says Pavlou.

"Identifying the neural circuits that drive behaviours in fruit flies provides us with insight into the universal principles by which a nervous system can coordinate complex motor behaviours, such as walking, flying and, of course, sex."

More information: Hania J Pavlou et al, Neural circuitry coordinating male copulation, *eLife* (2016). DOI: 10.7554/eLife.20713

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