A post-coital switch: Mapping the changing behaviors in the female fruit fly's mind

May 31 2012

If men are from Mars and women are from Venus, then it shouldn't be surprising that their neural circuits differ. In research published today in the journal *Current Biology*, researchers have used dramatic changes in the behaviour of the female fruit fly after sex to help map these often very different circuits.

The fruit fly is an established model for mapping the underlying neural elements that direct behaviour. Courtship and reproduction in particular lend themselves to the identification of the neural circuitry responsible for individual sex-specific behaviours. These studies have almost exclusively focused on the male, with the female's role largely ignored or marginalised to a somewhat passive recipient of the male's attention.

"The male fruit fly is a big show off, always trying to impress the female with his elegant courtship display," explains Dr Stephen Goodwin from the University of Oxford. "During courtship, the female is somewhat 'coy' and her behaviours are more enigmatic, so she has tended to be overlooked. But she behaves very differently after mating, and we have exploited this complex behavioural change to explore how chemical signals passed between the sexes can trigger complex behaviours."

Reproduction in the fly comprises a wide spectrum of sophisticated, inter-linked behaviours, all of which, from pre- to post-copulation, are focused on producing offspring. But it is after copulating that the female comes into her own, evidenced by a dramatic shift in her physiology as well as her behaviour after mating.

Once successfully mated, a female moves from a highly sexually-receptive to a non-receptive state, actively rejecting further advances from males while altering her feeding and activity patterns. All these changes have evolved to support the pivotal behaviour of accelerated ovulation and laying of fertilised eggs.

Previous studies have shown that these behavioural changes are triggered by the male 'sex peptide' protein, a pheromone within the fly's semen. More recently, it has been shown that this peptide mediates the behavioural changes via a small group of sensory neurons in the female genital tract.

In research published today, Dr Goodwin and colleagues at the University of Oxford, in collaboration with scientists from the Harvard Medical School and University of Glasgow, have not only defined the set of neurons that sense and respond to sex peptide, but also the neural circuitry involved in processing this information and generating post-copulatory behaviours. This has allowed them to begin mapping a complete female-specific behavioural circuit, from initial sensory input

to higher-order processing through to final motor outputs. The work was funded by the Wellcome Trust and the Biotechnology and Biological Sciences Research Council (BBSRC).

In their study the researchers showed that stimulation by sex peptide of just two neuronal clusters on the uterus is sufficient to initiate the dramatic post-mating behavioural switch in the female. Furthermore, they identified neurons in the abdominal ganglia (the fly equivalent of the spinal cord in humans) that are required to transmit information from the uterus to the brain, and thus alert the female about the new mating status. When researchers artificially stimulated these neurons in unmated virgin females, the flies then exhibited behaviours usually only seen in successfully mated females. They demonstrated that the signal triggered in response to copulation is not transmitted directly to the brain, as was previously thought, but rather initially to neural circuits in the abdominal ganglia before undergoing higher-order processing.

The researchers also showed that the female modifies her behaviour depending on both how much attention she is being shown by a prospective mate and how receptive she is to copulation. Her behaviour can in turn affect that of the courting male. In other words, the female's sexual 'state' not only affects her own behaviour, but can also modify the behaviour of potential male suitors.

Dr Rezával, the lead post-doctoral researcher, adds: "Mating-induced behaviours are important to ensure the propagation and survival of the species. In flies, once the female has mated, something about her demeanour changes to make her less attractive to the male and focus on more maternal activities. We have now identified more elements of the fly circuitry that underlie this change in behaviour and shown that it is more sophisticated than was previously thought."

The research should help to propel investigations of the female into the

spotlight, as researchers seek to understand the neural circuitry that underwrites the remarkable changes determined by, and dependent upon, the female's sexual state.

More information: Rezával, C. et al. Neural circuitry underlying Drosophila female postmating behavioral responses. *Current Biology*, e-pub 31 May 2012. www.cell.com/current-biology/abstract/S0960-9822%2812%2900518-0

Provided by Wellcome Trust