Medical Xpress

Sex on the brain: 'Doublesex' gene key to determining fruit fly gender

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fruit fly

The brains of males and females, and how they use them, may be far more different then previously thought, at least in the fruit fly *Drosophila melanogaster*, according to research funded by the Wellcome Trust.

In a paper published today in the journal Nature Neuroscience, researchers from the University of Glasgow and the University of Oxford, have shown that the gene known as 'doublesex' (dsx), which determines the shape and structure of the male and female body in the fruit fly, also sculpts the architecture of their brain and nervous system, resulting in sex-specific behaviours.

The courtship behaviour of the fruit fly has long been used to study the relationship between genes and behaviour: it is innate, manifesting in a series of stereotypical behaviours largely performed by the male. The male chases an initially unreceptive female, and 'woos' her through tapping and licking and using wing vibration to generate a 'courtship' song. If successful, the female will slow and present a receptive posture, which allows copulation to occur.

For some time now, the gene 'fruitless' (fru), which is specific to the adult male fruit fly, was thought to be the key to male behaviour and the development of male specific neural circuitry of flies.

However, the researchers have shown that fru does not explain the complete repertoire of male behaviours in the fly: female flies in which the fru gene has been activated demonstrate some, but not all, of the characteristics usually associated with courtship behaviour in males. The researchers have also shown that dsx plays an important role in shaping the neural circuitry involved in this behaviour.

"The dogma was that dsx made fruit flies look the way they did and fru made them behave the way they did," explains Dr Stephen Goodwin from the University of Oxford, who led the research. "We now know that this is not true. dsx and fru act together to form the neuronal networks - the wiring - for sexual behaviour."

fru has so far been found only in insects; dsx, however, is found throughout the animal kingdom, where it plays a fundamental role in sex determination, and so is of particular interest to researchers.

Using a transgenic tool generated in his lab, Dr Goodwin and colleagues were able to map dsx throughout the fly's development using a fluorescent protein marker that illuminates areas where DSX is active. This highlighted profound differences in neural architecture between the sexes. In males, the researchers were able to show that dsx complements fru activity to create a 'shared' male-specific neural circuit; in females (where fru is inactive), dsx forms a female-specific circuit.

Importantly the researchers were able to manipulate these cells, impinging their ability to function, and show that these circuits are responsible for behaviours unique to the individual sexes.

"It has been suggested that there are only minor trivial differences between the neural circuits that underlie behaviour in males and females," explains Dr Goodwin. "We have shown that in fact there is quite a bit of difference in the number of neurons and how these neurons connect, or 'talk', to each other. These differences can have big consequences on the structure and function of the nervous system."

In addition, while dsx was known to establish the gender of the adult fly, the pattern of dsx activity in the adult was unknown. Dr Goodwin and colleagues have shown that this pattern is not ubiquitous, but rather is restricted in a specific and telling manner.

Some tissues, such as blood cells, may not require a defined gender in order to function. However, others such as the 'fat body', which in the adult fly functions in part to produce hormones, and the oenocytes, which produce sex-specific pheromones, require a specified sexual identity. It was unsurprising to Dr Goodwin and colleagues to find dsx expressed in these tissues in both males and females, as they would be key to establishing a normal sexual physiological state.

"Determining gender in a fruit fly seems to be about adding different splashes of ''colour' here or there," he says. "It's not like the canvas, meaning the nervous system, needs to be all blue or pink, just a little bit of blue over here or a little bit of pink over there. Not all cells need to know what sex they are, but those that do need to know will be ones that are important for sex-specific behaviours."

The research performed by Dr Goodwin and colleagues allows greater insight into how a male and female nervous systems may be established and how this may then coordinate the sex-specific physiology needed to create the complete, integrated adult sexual state.

More information: Rideout, E. et al. Control of Sexual Differentiation and Behavior by the doublesex gene in Drosophila melanogaster. *Nature Neuroscience*, e-pub 21 March 2010.

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