Uncovering the plastic brain of a fruitfly—new study

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Genetic mechanisms that govern brain plasticity—the brain's ability to change and adapt—have been uncovered by researchers at the University of Birmingham.

The work was carried out using the fruit-fly *Drosophila*, an important organism in neuroscience because it enables researchers to study an entire nervous system. That means genes can be identified and linked all the way from to specific neurons, to neural circuits, brain structure and behaviour.

This fundamental research could pave the way to a deeper understanding of how the human brain adapts over time, and the links between plasticity and neurodegeneration.

Scientists have known for some time that human brains are adaptable and plastic. For example, our brains change as we learn new things, or enable us to adapt and compensate after an amputation or if part of our brain becomes damaged. The mechanisms behind this plasticity, however, are not well understood.

In a new study, published in the journal *eLife* on 18 February 2020, researchers in the University of Birmingham's School of Biosciences have identified a particular set of genes that regulate brain plasticity.

The genes encode proteins called Toll receptors—responsible for receiving and transmitting signals within cells. Tolls are known to play a central role in the body's immune system, but the Birmingham team, led by Professor Alicia Hidalgo, had shown that they also influence nervous system formation. Now, linking Tolls to brain plasticity is a further significant and surprising development.

Professor Hidalgo explains: "The specific molecules we identified are well known for the role they play in regulating the body's immune system. Perhaps in evolution the nervous system and the immune system shared a common origin, as they share similar functions—for example, the immune system helps to protect us from microbes, while our nervous system through behaviour plays a role in protecting us from larger dangers, like reacting to threats. And it seems that brain plasticity re-activates the mechanisms that operate during the formation of the brain in development."

The researchers found that the Toll receptors, of which there are 9 in the *Drosophila* brain and 11 in the human brain, are present across different areas of the brain dedicated to different functions. From here they regulate neuronal number and brain size.

"This arrangement of the Tolls suggests they can work independently of each other, perhaps to control the response to different sensory stimuli such as smell, or vision," says Professor Hidalgo. "These can then be modulated to influence the formation and maintenance of particular types of neurons in response to experience."

It is not yet known how closely these mechanisms, identified in *Drosophila* will match those in the human brain, but the work gives us important clues into what to look for in the human brain to understand brain plasticity.

"*Drosophila* is a powerful model organism because we can show that brain plasticity has a genetic basis and identify how genes control this process," says Professor Hidalgo. "This gives us a really useful set of clues and insights into the molecular mechanisms of plasticity also in human brains."

More information: Guiyi Li et al, A Toll-receptor map underlies structural brain plasticity, *eLife* (2020). DOI: 10.7554/eLife.52743

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