'Fly brain' idea explores memory, learning disabilities

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They are a pesky nuisance to many. However, for one Western researcher, the thousands of fruit flies lining the shelves of his lab could reveal important secrets about memory and learning disabilities, thanks to similarities we share with the tiny insects.

Jamie Kramer, a professor in both the Faculty of Science and the Schulich School of Medicine & Dentistry, and his team are looking at the biological processes that switch genes on and off – a field known as epigenetics – and at chromatin, the combination of DNA and proteins that comprise chromosomes.

Kramer who was recently appointed the new Tier 2 Canada Research Chair (CRC) in Neuroepigenetics, has previously shown chromatin regulation frequently disrupted processes underlying neurodevelopmental disorders like Intellectual Disability. With further research, he hopes to provide a better understanding of the role epigenetics and chromatin play in learning and memory, which will improve fundamental knowledge of those biological processes important to the cause of Intellectual Disability.

"Memory requires the gene regulation. Certain genes have to be turned on or off in order for memory to happen," said Kramer. "And it's not just memory. A lot of processes, like addiction and neural development, are related to epigenetic gene regulation. We want to understand more about how these mechanisms work. We know gene regulation is important, but we don't know which genes are regulated specifically.

"It's a challenging problem because the brain is very complex. We need to look in specific regions of the brain and find out what's going on in specific neurons and how genes regulate these circuits."

Focusing on neural development and memory in humans, one might wonder how a fruit fly fits into Kramer's research.

A specific region of the fly brain – known as the 'mushroom body,' the learning and memory centre – is quite similar to that of humans. The fly brain is a lot more complex than most think, Kramer said, with 75 per cent of their genes similar to ours.

"Many of the genes mutated in individuals with neurodevelopmental disorders are involved in epigenetic gene regulation," he continued. "It looks nothing like a mammalian brain, but the cellular molecular mechanisms of learning and memory are also the same in flies and humans. They are a good model for studying genes."

Male flies court female flies by vibrating their wings as a courtship song. However, the effort is all for naught if the female fly had recently mated, as she will reject all his attempts.

"After a male is paired with a pre-mated female, and he's not successful in mating for a while, he kind of learns it's not worth the investment to keep pursuing," Kramer said. "If you then take that male, who has had that negative experience, and test them later, they have a lower level of courtship because they remember. Flies that have mutations in their genes just don't learn and keep courting no matter what."

He wants to study that latter group – the ones that 'can't take a hint' – to understand the mechanisms underlying that decision-making process.

"This is a starting point to understand these disorders and how they regulate gene activity in the brain in the context of learning and memory," Kramer said. "These (human) disorders are very rare and don't get a lot of attention. It's one step at a time. We will find something."

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