Transposons could be rewiring our brains

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A new study by neuroscientists at the University of Oxford shows that mobile genetic elements that were active in the genomes of our ancestors could be closely linked to important functions in our brain and might help diversify our behavior, cognition and emotions.

The human genome contains the instructions to build and maintain all cells in our body. We inherit this "cell manual" from our parents and pass it on to our children. Errors in this manual can change cell properties and trigger diseases, including cancer. More than half of our genome is made up of 'junk' DNA, a large part of which is composed of potentially mobile pieces called transposons, or "jumping genes," which are believed to have evolved from ancient viruses.

Transposons can be viewed as "loose pages" within our cell manual because they can change their position, and their distribution differs within each person's genome. Transposons inserted in genes can disrupt their function and impair important cell processes. However, more recently it has been proposed that transposons might also play more beneficial roles in our body, such as in the communication between different cells in our brains.

Researchers in the Centre for Neural Circuits and Behavior in Oxford have now used state-of-the-art single-cell sequencing on the brains of fruit flies, a well-established model organism in neuroscience, to investigate transposon activity in the brain at an unprecedented level of detail. This new analysis revealed that transposons were not uniformly active throughout the entire brain of flies, but rather showed highly distinct patterns of expression. Moreover, these patterns were tightly linked to genes located near transposons. This indicates that transposons might play an important altruistic role in our body.

To further investigate, lead author Dr. Christoph Treiber created new software tools for an in-depth analysis of transposon expression. Together with Prof Scott Waddell, Treiber found that segments of transposons were frequently parts of messenger RNAs from neural genes, which suggests these "jumping genes" may frequently alter neural function. Transposons changed genes which have known roles in a wide range of properties and functions of brain cells, including the sleep-wake cycle and the formation of memories. Crucially, individual transposons created many additional versions of these genes that differed between animals.

Dr. Treiber said: "We know that animal genomes are selfish and changes that are not beneficial often don't prevail. Since transposons are parts of hundreds of genes in every fly strain that we looked at, we think these physical links likely represent an advantage for the fly.

"We now want to understand the impact of these new alleles on the behavior of individual animals. Transposons might broaden the range of neuronal function in a fly population, which in turn could enable a few individuals to react more creatively in challenging situations. Also, our preliminary analyses show that transposons might play a similar role in our brain. Since every person has a unique transposon "fingerprint," our findings could be relevant to the need to personalize pharmacological treatments for patients with neurological conditions."

More information: Christoph D Treiber et al. Transposon expression in the Drosophila brain is driven by neighboring genes and diversifies the neural transcriptome, *Genome Research* (2020). DOI: 10.1101/gr.259200.119

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