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Why fruitflies know their beer

Competing neuronal pathways help adults to choose locations with just the right amount of alcohol for their offspring to thrive.

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Fruitflies get blissful from lying eggs on rotting fruit that is about as alcoholic as beer — the ideal concentration for their larvae to thrive.

Fruitflies know exactly how much alcohol will be good for their young. Larvae living on a food source with the right concentration of ethanol will grow into heavy, healthy adults and will be protected against parasites — which explains why the insects are attracted to rotting fruit or the crate of empty beer bottles in your kitchen but not to the vodka or gin.

Now researchers have uncovered the neural mechanism that allows the fruitfly *Drosophila melanogaster* to choose the best place to lay its eggs. The work is published today in *Proceedings of the National Academy of Sciences*[1].

A team led by Ulrike Heberlein, a molecular biologist at the Howard Hughes Medical Institute's Janelia Farm Research Campus in Ashburn, Virginia, found that clusters of neurons, working in opposition to each other, help the flies to choose the place with the most beneficial concentration of ethanol in which to lay their eggs. The neurons all release the neurotransmitter dopamine, a key player in the brain's reward circuitry. Neurons of the PAM and PPM3 clusters encourage the flies to seek out ethanol, whereas PPL1 neurons apply the brakes, preventing the flies from laying their eggs on food containing high levels of ethanol that could harm the larvae.

"They can discriminate among ethanol concentrations that are very similar — 3% versus 5% — so the system evolved to have great sensitivity," says Heberlein. Their favourite booze strength is 5%, similar to that of a typical beer.

Rewarding memories

Heberlein's team also traced the neurons involved in ethanol preference to specific brain regions. Both the pro-ethanol PAM and anti-ethanol PPL1 neurons were active in the mushroom body, whereas the pro-ethanol PPM3 ones were active in the ellipsoid body. Both of these brain structures are involved in decision-making and memory, and mushroom body neurons also play a part in ethanol-reward memory.

"These are some of the same neurons that signal reward or punishment in much more complex learning and memory tasks," says

Heberlein. “Using this incredibly simple assay of egg-laying choice, we may be able to move forward quite quickly in mapping reward circuits more generally.”

William Bendena, a molecular biologist at Queen’s University in Kingston, Canada, says the work is an exciting example of how specific neural circuits can be dissected to explain behaviours. A study reported earlier this year used the same technique to map the dopamine neurons that promote aggression in *Drosophila*[2].

These competing sets of neurons could be useful in studying how addiction can override rational decisions, in insects but also in humans. “Dopamine is a key component of reward motivation, which is associated with many types of addiction,” Bendena says. “This work has begun to tease apart two opposing circuits which may one day lead to uncovering new drug targets for addiction intervention.”

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References

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2. Alekseyenko, O. V., Chan, Y.-B., Li, R. & Kravitz, E. A. *Proc. Natl Acad. Sci. USA* **110**, 6151–6156 (2013).