How flies set their cruising altitude

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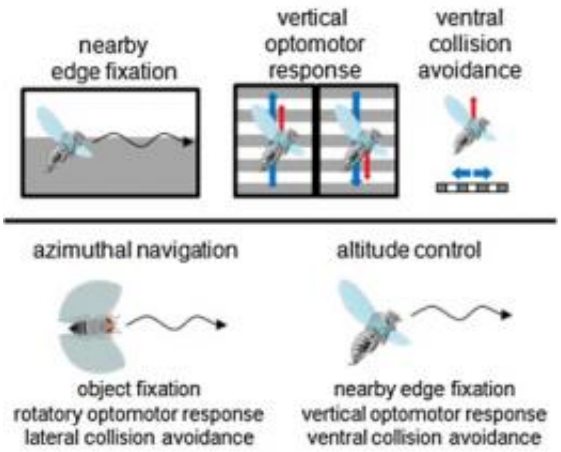

Insects in flight must somehow calculate and control their height above the ground, and researchers reporting online on August 19 in *Current Biology*, have new insight into how fruit flies do it. The answer is simpler than expected.

The flies establish an altitude set point on the basis of nearby horizontal edges and tend to fly at the same height as those features, the researchers report.

"Flying at a horizontal edge formed by local features—the top of a bush or a tree, say—could be a good way to lead into the perch," said Michael

Dickinson of the California Institute of Technology. "This is a good mechanism for landing at the tops of things as flies do—something you can confirm with a glass of wine."

Researchers had earlier suggested that insects might control their cruising altitude by maintaining a fixed value of what's known as optic flow beneath them as they fly. To understand what this means, imagine how fast the ground moves beneath you when you are taking off in an airplane and how that motion of things beneath you slows as you make your way up into the air.

"There are simple means by which an insect could know whether it is falling or rising," Dickinson said, "but by measuring the optic flow beneath it, an insect could choose to fly at a specific altitude." The strategy has been shown to work on a tiny model helicopter, but it turns out the fruit flies don't use it, or at least not under the conditions tested.

The researchers figured this out thanks to a sophisticated "gizmo" built by Andrew Straw, also of Caltech, that allowed them to track the movements of free-flying fruit flies using multiple digital cameras as they moved through a 3D virtual-reality space in which the researchers had complete control over what the insects saw. The researchers could even cancel out the effects of the flies' own movement on what they saw as they flew through space, allowing them to put the optic ground flow theory to the test in a rigorous way.

"All of us set out thinking that the ground flow model was probably right," Straw said. "We thought we would end up quickly verifying that it worked, but when we found it didn't apply, we began to think about other mechanisms."

So the researchers tried something else, presenting the flies with a simple horizontal edge while they flew. It turned out the flies used that visual

reference point to select their altitude. Experiments that pitted the edge tracking and optic flow models against each other confirmed that the insects didn't care how fast the ground moved beneath them.

The results also provide confirmation of two other strategies that flies use to keep themselves stable and avoid collisions. If they see the world around them "moving"—for instance, if they are pushed down by a gust of wind—they will alter their flight to compensate. If the world beneath them appears to rapidly expand, as it would if they were hurtling toward the ground, they veer up to avoid crashing. Both of these mechanisms help maintain stability, but they don't set a specific altitude, the researchers said.

It's possible that other insects use different flight strategies. Even fruit flies might use different methods for flight control depending on the circumstances, the researchers said. For instance, edge tracking might be what they depend on to explore a local environment. When migrating across a desert, they might do something else entirely.

There is still plenty of exploring left to do. "We have identified one specific set of reflexes, but we still don't understand the neural mechanisms responsible," Straw said.

The findings might have practical applications, he added. For example, they could come in handy for working out the ideal rules of operation for flying robots.

More information: Dickinson et al.: “Report; Visual Control of Altitude in Flying Drosophila.” Publishing in Current Biology 20, 1-7, September 14, 2010. DOI 10.1016/j.cub.2010.07.025

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