New understanding of fly behavior has potential application in robotics, public safety

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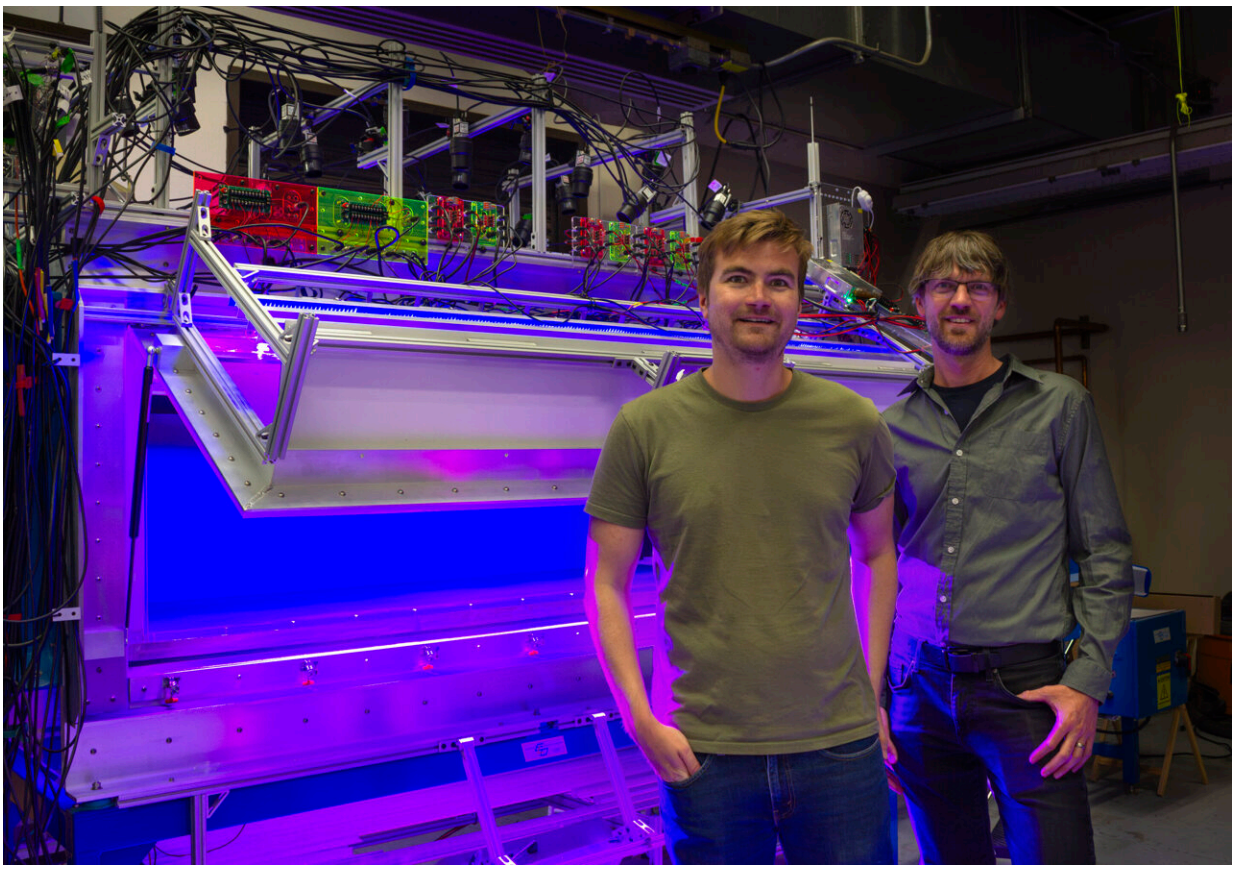

Assistant Professor Floris van Breugel and postdoctoral researcher David Stupski have uncovered an automatic behavior in flies, sink and circle, which involves lowering altitude and repetitive, rapid turns in a consistent direction. It shows that flying flies are able to assess the conditions of the wind before deploying a strategy to find a odor (which leads to a food source) using a strategy that will work well under those conditions. Flies aren't just reacting to an odor with a

preprogrammed response: they are responding in context-appropriate manner. This knowledge potentially could be applied to train more sophisticated algorithms for scent-detecting drones to find chemical leaks. Credit: Chris Moran

Why do flies buzz around in circles when the air is still? And why does it matter? In a paper published in *Current Biology*, University of Nevada, Reno Assistant Professor Floris van Breugel and Postdoctoral Researcher S. David Stupski respond to this previously unanswered question. Their answer could hold a key to public safety—specifically, how to better train robotic systems to track chemical leaks.

"We don't currently have robotic systems to track odor or chemical plumes," van Breugel said. "We don't know how to efficiently find the source of a windborne chemical. But insects are remarkably good at tracking chemical plumes, and if we really understood how they do it, maybe we could train inexpensive drones to use a similar process to find the source of chemicals and chemical leaks."

A fundamental challenge in understanding how insects track chemical plumes—basically, how does the fly find the banana in your kitchen?—is that wind and odors can't be independently manipulated.

To address this challenge, van Breugel and Stupski used a new approach that makes it possible to remotely control neurons—specifically the "smell" neurons—on the antennae of flying fruit flies by genetically introducing light-sensitive proteins, an approach called optogenetics. These experiments made it possible to give flies identical virtual smell experiences in different wind conditions.

What van Breugel and Stupski wanted to know: How do flies find an

odor when there's no wind to carry it? This is, after all, likely the wind experience of a fly looking for a banana in your kitchen. The answer is in the article titled, "Wind Gates Olfaction Driven Search States in Free Flight."

Flies use environmental cues to detect and respond to air currents and wind direction to find their food sources, according to van Breugel. In the presence of wind, those cues trigger an automatic "cast and surge" behavior, in which the fly surges into the wind after encountering a chemical plume (indicating food) and then casts—moves side to side—when it loses the scent. Cast-and-surge behavior has long been understood by scientists, but according to van Breugel, it was fundamentally unknown how insects searched for a scent in still air.

Through their work, van Breugel and Stupski uncovered another automatic behavior, sink and circle, which involves lowering altitude and repetitive, rapid turns in a consistent direction. Flies perform this innate movement consistently and repetitively, even more so than cast-and-surge behavior.

According to van Breugel, the most exciting aspect of this discovery is that it shows flying flies are clearly able to assess the conditions of the wind—its presence, and direction—before deploying a strategy that works well under these conditions. The fact that they can do this is actually quite surprising; can you tell if there is a gentle breeze if you stick your head out of the window of a moving car?

Flies aren't just reacting to an odor with the same preprogrammed response every time like a simple robot; they are responding in a context-appropriate manner. This knowledge potentially could be applied to train more sophisticated algorithms for scent-detecting drones to find the source of chemical leaks.

So, the next time you try to swat a fly in your home, consider the fact that flies might actually be a little more aware of some of their natural surroundings than you are. And maybe just open a window to let it out.

More information: Wind Gates Olfaction Driven Search States in Free Flight, *Current Biology* (2024). DOI: 10.1016/j.cub.2024.07.009. www.cell.com/current-biology/f … 0960-9822(24)00912-6

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