Robber flies track their beetle prey using tiny microbursts of movement

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Robber flies visually track their prey before spearing it with their proboscis. Credit: Paloma Gonzalez-Bellido, CC BY-ND

April in the Florida Panhandle. It was hot, humid, and a thunderstorm was lurking. But as a fresh graduate student, I was relieved for the escape from my first brutal Minnesota winter. I was accompanying my adviser, Paloma Gonzalez-Bellido, on a project that would end up dominating my Ph.D. work. Out in the scrubland, my eyes darted at every movement, on the alert for an insect that likes shiny beads.

Laphria saffrana, also known as robber flies, are chunky black and yellow flies. Most of a laphria's head is made up of its large eyes, between which sits a formidable proboscis—a long, tubular mouthpart that can deliver a potent venom capable of incapacitating prey in a heartbeat.

The photos Paloma showed me before we got there, though stunning, were of no help in looking for the fly. There were insects flying in every direction, their movements a blur, making it impossible to pick out any details. I only had a split second to figure out whether the thing I was seeing was a laphria, a similarly colored yellowjacket wasp, or something else entirely.

Despite their relatively crude vision, the flies I was looking for are far more adept than I am at picking out the insects they're targeting. Somehow they're able to zero in on their prey of choice: beetles. Based on her field observations the previous year, Paloma thought they did this by looking for the flash of beetle wings.

If she was right, laphria have hit upon an ingenious trick that balances the need for speed, accuracy and specificity. Here are some of the clues we've found to the secrets of their success.

Following the flash

Paloma had previously studied other predator insects such as dragonflies and killer flies. Their compound eyes don't provide a lot of detail about the visual world, making it possible to trick them into chasing simple beads as if they were their prey insects.

But when Paloma tried the same sleight of hand on laphria, they wouldn't go for the regular black beads. They chased only clear beads.

The one important difference between laphria and the other predators Paloma had studied is that they're picky eaters. Their prey of choice are beetles. So, Paloma and our collaborator, Jennifer Talley, speculated that the reason laphria are attracted to shiny beads is because they reflected light and flashed like the clear wings of a beetle.

In Florida, we tested this idea by swapping out the plain black beads for a panel of LED lights that we could program to flash in sequence at a frequency that matched the wing beats of beetles, which can be anywhere from 80 to 120 beats per second.

In an outdoor enclosure, Paloma placed previously caught robber flies one after the other on a log. Outside, Jennifer and I controlled the LED panel in front of the log and the high-speed cameras that captured the action.

The LED pixels flashed in sequence, simulating a moving target. Laphria tracked the lights with keen interest only when they flashed at the same frequency at which beetles flapped their wings.

But even as our initial experiments began confirming the hypothesis, a new puzzle presented itself. How do the flies accurately track their prey?

Unique strategy to track and identify

Before they give chase, all visual predators, including laphria, need to accurately track their prey's movements. Although many animals have this ability, what we found in laphria was, to our surprise, a slightly tweaked formula compared with other predators. Their strategy allows them not only to accurately track but also count those flashes from their prey's wing movements.

When I looked at the high-speed videos of laphria tracking the flashing

LEDs and actual beetles, I noticed that they primarily moved their head in short bursts, called saccades, interspersed with little or no other movements. These saccades are extremely quick, lasting less than 40 milliseconds, and the time between them is only slightly longer. To the naked eye, this looks like continuous motion, but our high-speed videos show otherwise. The degree to which the flies moved their heads during each burst depended on the speed of the target and how far off center it was from the direction of the fly's gaze.

What our findings told us is that instead of continuously moving their heads to maintain the position of the target within the most sensitive parts of their eyes, laphria allow it to pass over their retina, moving only when it slips out of focus. We think this strategy helps them count the flashes of the prey's beating wings, which determines their continued interest.

That is, the laphria know the wingbeat frequency of their most tasty prey and so pay attention to flashes that match. If the flash count matches their expectations, they will continue to track the target after it slips out of the sensitive zone of their eyes.

To bring it back into focus, though, they have to account for its speed and the position where they last saw it. Because the size of the saccade matches the speed of the prey, we think the laphria are keeping track of how fast the prey moves while at the same time counting the flashes from its wingbeats. So once a beetle slips out of focus, the predator knows how much to move its head to refocus.

Even though people track moving objects all the time—like while playing sports such as baseball or tennis or even just while watching a bird fly by—it's a complex process. It involves dynamic cross-talk between the visual and muscular systems.

Regardless of the motivation, the goal while visually tracking a target is the same—to train the most sensitive zone of the eyes, known as the fovea, onto the item of interest. Laphria saffrana have seemingly tweaked that rule so they can learn more about the target. Their customized prediction strategy allows them to accurately locate and quickly chase down their very specific dietary needs.

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