# Lovebirds ace maneuvers in the dark

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Ferrari the lovebird during flight training in the bird wind tunnel in David Lentink's lab. Credit: L.A. Cicero

While pilots rely on radio signals, advanced computations and tools to keep them on course during strong crosswinds, birds can naturally navigate these demanding conditions—and do so in environments with little visibility. To understand how they accomplish this feat, researchers in the lab of David Lentink, assistant professor of mechanical engineering at Stanford University, studied lovebirds flying in a crosswind tunnel which features customizable wind and light settings.

This research, published July 9 in the *Proceedings of the National Academy of Sciences*, could inspire more robust and computationally efficient visual control algorithms for autonomous aerial robots.

This is the first study of how birds orient their bodies, necks and heads to fly through extreme 45-degree crosswinds over short ranges—both in bright visual environments and in dark, cave-like environments, where a faint point of light is the only visual beacon. To the researchers' surprise, the lovebirds navigated all environments equally well.

"It's amazing that lovebirds navigated 45-degree crosswinds even in our cave environment, because in their natural environment they fly in open habitats during the day," said Daniel Quinn, who worked as a postdoctoral fellow with Lentink and is now an assistant professor at the University of Virginia. "Even well-trained pilots rely on runway lighting, radio beacons and guidance from air traffic controllers to land safely on windy nights."

"The conditions we studied can cause spatial disorientation in pilots, yet the lovebirds aced their maneuvers in the dark as if there was no challenge," Lentink added. "This was a big surprise to the entire team because we studied 'naïve' lovebirds. They were bred and kept in an indoor cage and had no experience with flying in the wind. Their ability may thus well be innate."

The researchers found that lovebirds navigate by stabilizing and fixating their gaze on the goal, while yawing their bodies into the crosswind. Staying on course requires them to actively contort their necks by 30 degrees or more. A computer-simulated model informed by the experimental data indicated that, while neck control is active, body reorientation into the wind is achieved passively. Further tests with a simple mechanical bird model in a wind tunnel showed how well it works.

"Airplanes have a vertical tail to orient stably into the wind. We discovered why birds don't need one: their flapping wings don't only offer propulsion, they also orient into the wind passively like a weathervane" Lentink said.

But this is only half of the story. Simultaneously, the lovebirds actively twist their necks to orient their heads toward the light beacon. The amount of neck twist then gives the relative wind angle with respect to their goal direction. This twist angle is all the lovebirds need to control their flight toward the beacon. While doing this, they stabilize their heads remarkably well.

"Apparently, the direction of gravity sensed by the bird's vestibular system helps compensate for the missing wide-field visual horizon," Quinn said.

High-speed videos of the birds flying in the dark, filmed under infrared light, as well as the models explaining the behavior showed that birds don't need a wide-field visual horizon nor optic flow (motion of image intensity over the retina) to maneuver in crosswinds. This finding runs contrary to decades of lab-based locomotion and neuroscience studies in still air that suggested both were critical. The researchers still think that rich visual information, when available, plays a key role in the way birds combine all their sensory inputs, but the study revises the idea that it is essential.

**More information:** "How lovebirds maneuver through lateral gusts with minimal visual information," by Daniel Quinn et al. *Proceedings of*

*the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1903422116 , www.pnas.org/content/early/2019/07/08/1903422116

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