Hummingbirds see motion in an unexpected way

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Male Anna's hummingbird near the UBC campus. Credit: Benny Goller

Have you ever imagined what the world must look like to hummingbirds as they zoom about at speeds of up to 60 miles per hour? According to new evidence on the way the hummingbird brain processes visual signals reported in *Current Biology* on January 5, you can't. That's because a key area of the hummingbird's brain processes motion in a unique and unexpected way.

"In all four-limbed vertebrates studied to date, most of the neurons in

this [motion-detecting] brain area are tuned to detect motion coming from behind, such as would occur for an impending collision or when being attacked from behind by a predator," says Douglas Altshuler of the University of British Columbia. "We found that this brain area responds very differently in hummingbirds. Instead of most neurons being tuned to back-to-front motion, almost every neuron we found was tuned to a different direction. We also found that these neurons were most responsive to very fast motion."

The brain area in question is known in birds as the lentiformis mesencephalic, or LM for short. (In mammals, it's called the nucleus of the optic tract.) The LM is responsible for processing visual signals sent to the brain as images move across the retina.

The primary interest of the Altshuler lab is in understanding flight. To understand how birds fly, the researchers needed to understand how they see the world. Hummingbirds were of special interest because of their remarkable ability to zoom quickly and then stop to hover in place while sipping nectar in midair.

Earlier studies showed that the LM in hummingbirds is enlarged in comparison to that of other birds. Scientists also knew that hummingbirds monitor and correct for any minor drift in their position as they hover. Those findings had led researchers to suggest that the hummingbird brain might be specially attuned to pick up on slow movements.

To test that hypothesis in the new study, post-doc and first author of the new study Andrea Gaede recorded neural activity in the LMs of six Anna's hummingbirds and ten zebra finches as the birds watched computer-generated dots move in various directions. Contrary to expectations, the recordings showed that hummingbirds are most sensitive to fast visual motion. What's more, unlike other birds, the

hummingbirds responded to movement in any direction about equally. That is, their LM neurons aren't specially attuned to movements in the forward direction as in other animals. The researchers suggest that their visual abilities may play a role in dynamic behaviors, including competitive interactions, high-speed courtship displays, and insect foraging.

"This study provides compelling support for the hypothesis that the avian brain is specialized for flight and that hummingbirds are a powerful model for studying stabilization algorithms," Gaede says.

Gaede says her next step is to investigate the response properties of other nuclei involved in this visual motion-processing pathway, with the ultimate goal of understanding how neural activity in the hummingbird brain is translated into specific flight behaviors.

More information: *Current Biology*, Gaede et al.: "Neurons Responsive to Global Visual Motion Have Unique Tuning Properties in Hummingbirds" www.cell.com/current-biology/f … 0960-9822(16)31394-X , DOI: 10.1016/j.cub.2016.11.041

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