

# Keen sense of touch guides nimble bat flight

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A brown bat in flight maneuvers in search of prey. Credit: Johns Hopkins University

Bats fly with breathtaking precision because their wings are equipped with highly sensitive touch sensors, cells that respond to even slight changes in airflow, researchers have demonstrated for the first time.

Caption: A brown bat maneuvers in search of prey.

Scientists from Johns Hopkins University, as well as Columbia University and the University of Maryland, determined how the sense of touch plays a key role in powered flight. In a paper published April 30 in the journal *Cell Reports*, they show how sensory receptors in bat [wings](#) send information about airflow to neurons in the brain, enabling the bat to make split-second flight control adjustments.

"Until now no one had investigated the sensors on the bat's wing, which allow it to serve as more than a propeller, a flipper, an airplane wing or any simple airfoil," said Johns Hopkins neuroscientist Cynthia F. Moss, one of the senior authors and a professor in the Department of Psychological and Brain Sciences in the Krieger School of Arts and Sciences. "These findings can inform more broadly how organisms use touch to guide movement."

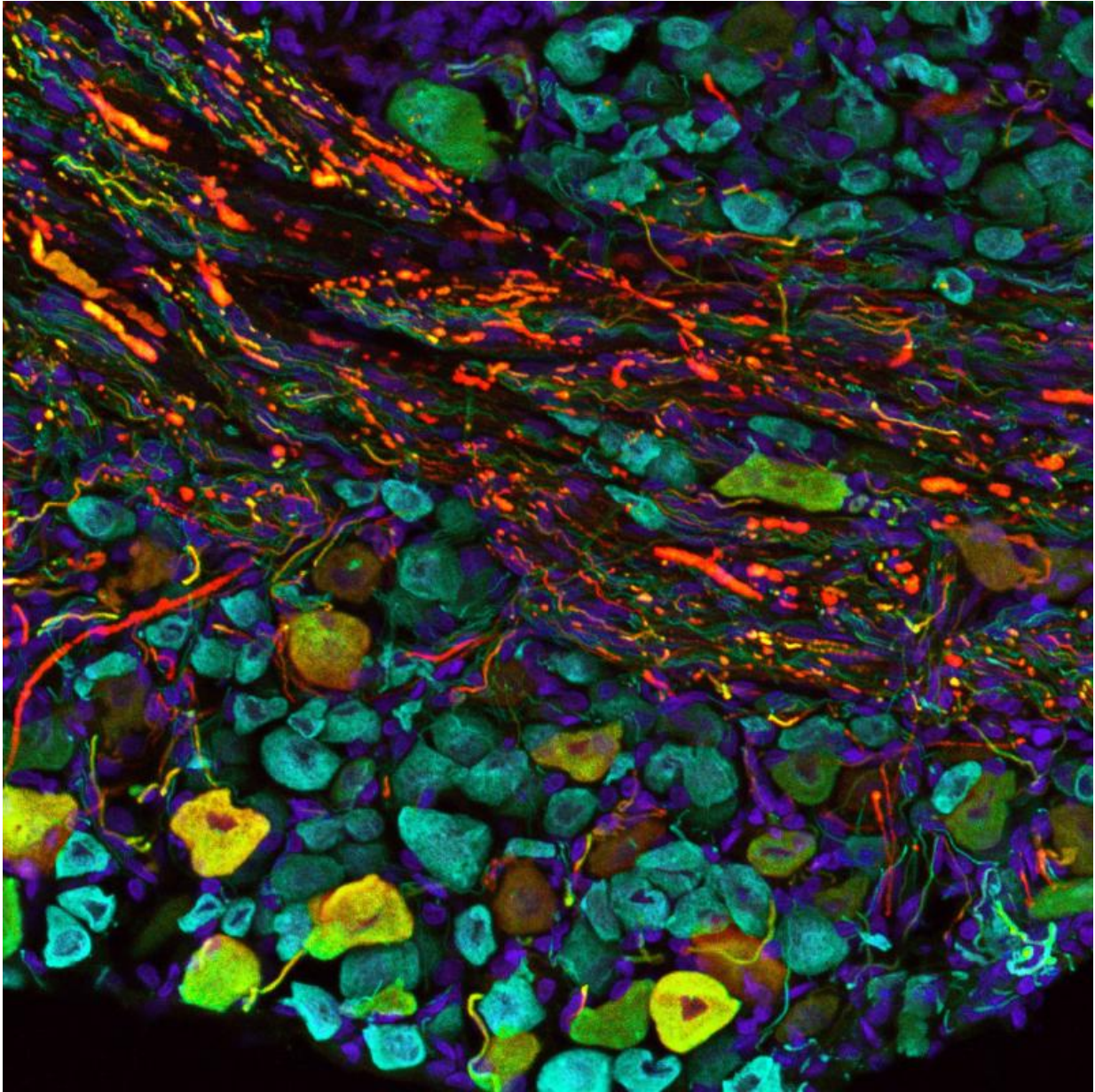
Moss and the team studied the big brown bat, a common species found throughout North America. Bats are the only mammals capable of true powered flight, able to reach speeds of 7 to 20 mph with the sort of aerial maneuverability humans only wish they could engineer.

The team found that the evolutionary process that allowed bats to form wings resulted in unusual tactile circuitry that not only enhances control

during flight, but also allows bats to use their wings to climb, cradle their young and capture insects.

First, they discovered an array of sensory receptors in bat wings—a significant number of which are clustered at the base of tiny hairs that cover the appendages. That placement of these touch cells, both lanceolate endings and Merkel cells, allows the bat, while flying, to sense changes in airflow as air ruffles the hairs.

When the team stimulated these hairs with brief air puffs, neurons in the bat's primary somatosensory cortex responded with precisely timed but sparse bursts of activity, suggesting this circuitry helped guide bats during fast, dynamic flight.



Bat sensory neurons. Credit: Kara Marshall

The team also found that the innervation of bat wings - the distribution in and supply of nerves to the wings - is unlike that of other mammalian forelimbs, a clue into how wings grew in bats during evolution. The researchers were surprised to discover that neurons in the wing skin

connected not only to the higher parts of the spinal cord where forelimbs typically connect, but also to lower parts of the spinal cord that would normally only innervate an animal's trunk.

These findings lay the groundwork for understanding how [bats](#) use sensory information to fly with precision in the dark and catch prey midair. The information, researchers say, could eventually help people design air vehicles that better negotiate obstacles by sensing and adjusting to air turbulence.

**More information:** *Cell Reports*, Marshall et al.: "Somatosensory Substrates of Flight Control in Bats"  
[dx.doi.org/10.1016/j.celrep.2015.04.001](https://doi.org/10.1016/j.celrep.2015.04.001)

Provided by Johns Hopkins University

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