Neuroscientist shows bats feel their way through the air using tiny hair sensors

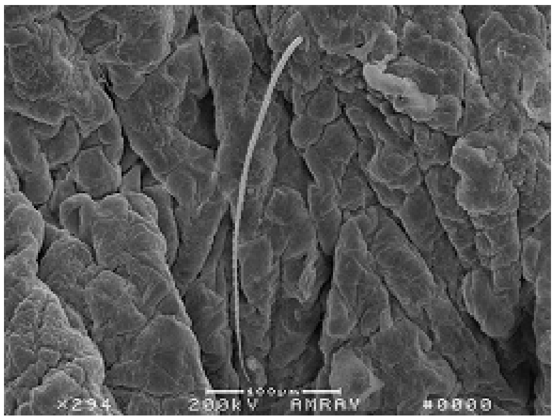
21 June 2011, by Bob Yirka

(PhysOrg.com) -- Susanne Sterbing-D'Angelo, has shown, along with her colleagues from the University of Maryland, that bats use tiny hairs on their wings to feel the air around them as they fly, which allows them to adjust to conditions almost instantly and that this feature of their anatomy helps them to perform the intricate acrobatic feats that they are known for. Their findings have been published in the *Proceedings of the National Academy of Sciences*.

It's long been known that bats use echo-location to find their way around in the dark, but what hasn't been so well understood was the purpose of the tiny hairs bats have covering their wings; spaced slightly apart, they clearly aren't meant for warmth. Sterbing-D'Angelo decided to look a little deeper.

After slicing open some bat wings, she and her team discovered that each wing hair is connected to a nerve sensor, meaning that each was clearly part of a sense organ. Next, they inserted electrodes into the brains of several bats to study their brain waves as puffs of air were applied across their wings, and in so doing discovered that the bats' brains responded the same way brains do in all other animals when exposed to stimuli; their primary somatosensory cortex lit up when the puffs blew across the tiny hairs, but in different ways depending on which way the puffs were applied, suggesting that they were sensitive to changing air conditions, especially those that could cause a flight problem.

They next used a chemical to remove the hairs off the wings of some bats and then set them loose in an obstacle course that they'd already been trained to traverse. The bats flew faster, were more cautious and made much wider turns. Engineers on the project suggested that the faster flying was due to a fear of stalling; without the feedback from the tiny hairs, the bats had no way of knowing if they were about to fall out of the air.



Scanning electron micrograph of a bat wing hair. Photo credit: Susanne Sterbing-D'Angelo, University of Maryland.

The results of this study are already leading to questions about the possibility of applying mechanical sensors to the wings of airplanes to give them the same benefits, though it's not clear how such an approach could be used due to the differences in flexible winged flight, versus the fixed wings of modern aircraft.

More information: Bat wing sensors support flight control, *PNAS*, Published online before print June 20, 2011, doi: 10.1073/pnas.1018740108

Abstract
Bats are the only mammals capable of powered flight, and they perform impressive aerial maneuvers like tight turns, hovering, and perching upside down. The bat wing contains five digits, and its specialized membrane is covered with stiff, microscopically small, domed hairs. We provide here unique empirical evidence that the tactile receptors associated with these hairs are involved in sensorimotor flight control by providing aerodynamic feedback. We found that neurons in bat primary somatosensory cortex respond with directional sensitivity to stimulation of the wing hairs with low-speed airflow. Wing hairs mostly preferred reversed airflow, which occurs under flight conditions when the airflow separates and vortices form. This finding suggests that the hairs act as an array of sensors to monitor flight speed and/or airflow conditions that indicate stall. Depilation of different functional regions of the bats' wing membrane altered the flight behavior in obstacle avoidance tasks by reducing aerial maneuverability, as indicated by decreased turning angles and increased flight speed.

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