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Inside JEB

BATS FOCUS ON FOOD BY CUTTING OUT CLUTTER



James Simmons

Echolocating animals like bats broadcast calls, then listen for echoes bouncing off objects to build up a picture of their surroundings. But how do bats distinguish between echoes bouncing back from distractions like tree branches and those revealing the location of a tasty morsel (p. 394)?

Big brown bat cries contain two main harmonics called FM1 and FM2, which both sweep down from high to low frequency, explains Mary Bates of Brown University, USA. If a target such as a moth is straight ahead and nearby, the bat hears equally strong echoes of FM1 and FM2; but if an object is far away or off to the side, the echo of FM2 becomes softer than that of FM1. As a result, the bat's ear responds later to the echo of FM2. 'We know that the neurons in the bat's brain respond later to quieter sounds than louder ones,' says Bates. Working with James Simmons, she reasoned that bats might use this auditory mechanism to 'tune out' clutter such as tree branches, since these are more likely to be far off or on the periphery.

To demonstrate that this mechanism exists, Bates and Simmons needed to show that bats can no longer tell how far away objects are when there is a delay between FM1 and FM2. First, they needed a way to determine how the bats perceive echo delay (which reveals how far away something is), so they devised a setup that allowed the bats' behaviour to tell them what the bats perceived. Bates caught big brown bats in Rhode Island and trained them to sit on a Y-shaped platform, call out, listen for echoes from both arms of the platform, then walk to the echo they considered to be closest.

Having trained the bats, Bates was ready to assume control and test how well they detect delay when their FM1 and FM2 harmonics are misaligned. 'We were able to create phantom echoes by picking up the bats' calls, manipulating them electronically to introduce a delay between FM1 and FM2, and then playing them back to the

bats,' she explains. When Bates played back the bats' calls without any delays between FM1 and FM2, they correctly judged which echo was closer 90% of the time. But sure enough, when Bates introduced a 300 μ s delay between the harmonics, the bats' accuracy dropped to 75%, revealing that they were not able to detect distances as well as before. And when she tested the bats with incremental differences in the introduced delay, Bates was pleased to find that the bats continued to get it wrong, and even made mistakes 25% of the time when echoes were misaligned by only 2.6 μ s. These results suggest that some auditory mechanism detects even tiny delays between harmonics and then defocuses the resulting images, Bates concludes.

'We have shown that bats have a perceptual mechanism for rejecting echoes from clutter that is off to the side or some distance away in order to focus on more important targets directly in front of them,' says Bates. She likens the bats' ability to ignore misaligned echoes to our peripheral vision: just as we can vaguely distinguish objects on our periphery but not see them in high resolution, big brown bats don't perceive far-off clutter as accurately as a juicy moth right in front of their noses.

10.1242/jeb.054924

Bates, M. E. and Simmons, J. A. (2011). Perception of echo delay is disrupted by small temporal misalignment of echo harmonics in bat sonar. *J. Exp. Biol.* **214**, 394-401.

Yfke Hager

BIRD MUSCLE POWER NOT LIMITED SOLELY BY WINGBEAT FREQUENCY



When birds need to get out of a tight spot quickly, smaller birds fair better than larger ones. Brandon Jackson and Kenneth Dial from The University of Montana explain that bird manoeuvrability decreases as size increases. The mechanism behind this scaling effect isn't clear; however, it has been suggested that 'burst performances' may be limited by the amount of power the flight muscles can produce and that this power output is limited by frequency of the bird's wing beat. Curious to find out if this is true, Jackson and Dial measured the wing beat frequency and muscular mechanical power produced by the pectoral muscles of members of the crow family ranging in size from a 69 g gray jay to a 0.89 kg common raven to find out how they varied with size (p. 452).

Plotting the maximum muscle-mass-specific power against the birds' masses, Jackson and Dial calculated the gradient of the graph and found a weak scaling relationship between the birds' maximum muscle-mass-specific power and their masses, with the smaller birds producing slightly higher maximum muscle-mass-specific powers than the larger birds. And when they plotted the birds' wingbeat frequencies against the body masses, they found a stronger scaling relationship, with the smaller birds beating their wings much faster than the larger birds. However, plotting the muscle strain from the pectoral muscles against the birds' masses, Jackson and Dial found that the relationship switched: this time, the largest birds produced the largest strains. This led them

to conclude that the birds' muscle power was 'not limited solely by wingbeat frequency' and they speculate that large birds may benefit from having longer muscle shortening durations, thus maintaining average muscle stresses for longer, resulting in the positive scaling relationship between muscle strain and body mass that they found.

10.1242/jeb.054932

Jackson, B. E. and Dial, K. P. (2011). Scaling of mechanical power output during burst escape flight in the Corvidae. *J. Exp. Biol.* **214**, 452-461.

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