Researchers discover how bats avoid collisions (w/ Video)

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A Brown University-led team strapped microphones onto heads of big brown bats and recorded the sounds they emitted and the echoes that returned to learn how bats detect objects in space and successfully maneuver around them. Credit: James Simmons Lab, Brown University

For years, Brown University neuroscientist James Simmons has filmed bats as they flew in packs or individually chased prey in thick foliage. All the while, he asked himself why the bats never collided with objects in their paths or with each other.

"You wonder, how do they do it?" he said.

After a series of innovative experiments designed to mimic a thick

forest, Simmons and colleagues at Brown and in Japan have discovered how bats are so adept at avoiding objects, real or perceived. In a paper published in the Proceedings of the National Academy of Sciences early edition, the scientists report that echolocating bats minimize sound wave interference by tweaking the frequencies of the sounds they emit — their broadcasts — to detect and maneuver around obstacles. The scientists also found that bats make mental templates of each broadcast and the echo it creates, to differentiate one broadcast/echo set from another.

The research is important, because it may lead to the design of better sonar and radar systems by capitalizing on the bats' natural ability to ferret out duplicative echoes in environments that otherwise could produce "phantom" objects.

The group created a 13-row long by 11-row wide U-shaped grid of ceiling-to-floor chain links to test big brown bats' ability to locate obstacles at various distances in their flight path and to make nearly instantaneous adjustments. The researchers ussed a miniature radio microphone created by the Japanese authors and attached it to the bats' heads to record their sounds (which are made in pairs). Other microphones placed in the room recorded the echoes produced from the bats' broadcasts, giving the researchers a comprehensive, accurate recording of the bats' echo-processing methods. The scientists also filmed the bats with high-resolution video cameras.

The team noticed almost immediately that the bats were confronted with overlapping echoes to their rapid firing of broadcasts. That could create confusion where obstacles were located and even produce objects that weren't really there.

"When there are a lot of obstacles in the environment, a bat needs to emit sounds quickly," said Mary Bates, a fourth-year graduate student at

Brown and a contributing author on the paper. "It can't wait for another sound to return before updating its image" (of the scene in which it's flying).

An echo from the bat's first broadcast could masquerade as the echo from a subsequent broadcast. The bat overcomes this potentially confusing cascade of signals by making a template, or mental fingerprint, of each broadcast and corresponding echo, the team learned. That way, the bat needs only to slightly alter the frequency of its broadcast to create a broadcast/echo template that doesn't match the original. The team found that bats change the frequency of their broadcasts by no more than 6 kilohertz. That's a good thing, as bats' frequency range covers only roughly 20 to 100 kilohertz.

"They've evolved this, so they can fly in clutter," said Simmons, professor of neuroscience. "Otherwise, they'd bump into trees and branches."

Provided by Brown University