How bats 'hear' objects in their path

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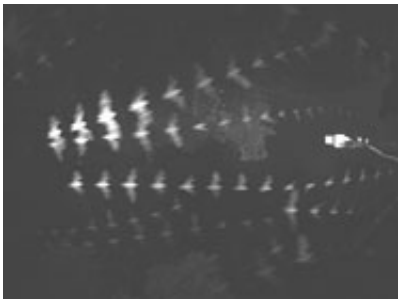

Overlay of 20 video images showing the flight paths of bats passing the loudspeaker used for virtual object presentation. Image by University of Bristol School of Biological Sciences

(PhysOrg.com) -- By placing real and virtual objects in the flight paths of bats, scientists at the Universities of Bristol and Munich have shed new light on how echolocation works. Their research is published today in *Behavioural Processes*.

The researchers found that it is not the intensity of the echoes that tells the bats the size of an object but the 'sonar aperture', that is the spread of angles from which echoes impinge on their ears.

Echolocating bats emit calls for orientation. These calls bounce off objects in a bat's environment, carrying information about the object back to the bat – for example, the echoes of large objects are louder than those of small objects. Analysing echoes when surrounded by a cacophony of calls and echoes from other bats, however, makes this a

difficult task for the auditory system.

The Bristol and Munich researchers first wanted to know whether bats are able to use echolocation in such a crowded situation at all. The team filmed the flight paths of hundreds of bats of 13 different species while the bats were emerging from a cave, and then placed a small novel object in the flight paths.

Dr Holger Goerlitz, now a Research Fellow at Bristol's School of Biological Sciences, was amazed by the experience: "The videos clearly showed curves in the bats' flight paths after we introduced the small novel object. This means that the bats were able to use echolocation in this familiar and crowded situation to detect the object, which measured only 5x8 cm, and to guide their evasive flight."

But how do bats perceive the size of an object from the echoes bouncing off it? To test whether bats use echo intensity, the team used echoes of virtual objects, which could be manipulated in size, from a loudspeaker. This method records the calls of passing bats and simulates in real time the echoes of objects that are not present physically – just like a projector can show visual images of absent objects. Using this method for the first time with wild bats, the researchers could manipulate a single echo parameter – intensity – and study its effect on the perception of object size.

Although the size of the virtual object, and thus its echo intensity, was more than ten times larger than the small, real object used before, the bats did not show any evasive flight.

Dr Goerlitz said: "This result suggested that the virtual object was lacking a crucial feature for object size perception. We think that bats use another echo parameter beside intensity: the sonar aperture, which is the spread of angles of incidence from which echoes impinge on a bat's

ears. The sonar aperture directly correlates with the size of real objects. And in contrast to real objects, virtual objects presented from a single loudspeaker lack a wide sonar aperture."

A second study, just published in the *Journal of Neuroscience* by Dr Goerlitz's colleagues in Munich, confirms this finding. Using loudspeaker arrays, Melina Heinrich and colleagues trained bats in the lab to chose the larger of two objects. The results show that the bats were able to choose the larger object using the sonar aperture only, independently of echo intensity. This behaviour was reflected in the activity of nerve cells that reacted specifically to echoes of a given sonar aperture.

Together, these studies have uncovered a novel mechanism for object size perception in bats, which employs the small echo differences between both ears generated by echoes arriving from different directions. In contrast, our eyes can measure object size directly from the two-dimensional retinal image. By perceiving the intensity and sonar aperture of object echoes, however, the auditory system has evolved its own solution for the perception of object features – giving bats access to comparable information about objects as we obtain with our eyes.

More information: Holger R Goerlitz, Daria Genzel & Lutz Wiegrebe (2011): Bats' avoidance of real and virtual objects: implications for the sonar coding of object size. *Behavioural Processes*, online first. www.sciencedirect.com/science/ … ii/S0376635711002245

Melina Heinrich, Alexander Warmbold, Susanne Hoffmann, Uwe Firzlaff & Lutz Wiegrebe (2011): The sonar aperture and its neural representation in bats. *Journal of Neuroscience* 31(43), 15618-15627. www.jneurosci.org/content/31/43/15618.short

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