Tierphysiologie
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Guidance behavior of commuting Greater Horseshoe bats

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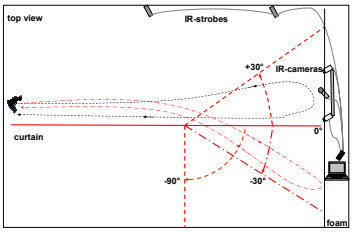
Introduction

All bats use echolocation for spatial orientation. Many bats commute to their foraging areas on stereotyped flight paths along the contour of background structures (e.g. tree lines). While commuting horseshoe bats keep a constant distance to the ground and to vertical background structures.

To understand the mechanisms which guide Greater Horseshoe bats (*Rhinolophus ferrumequinum*) on their commuting flights we trained two individuals to fly on a stereotyped flight path in a flight room.

Methods



Training of the bats

Two horseshoe bats were trained to fly a distance of 13 m along a straight curtain hanging from the ceiling in a flight room. After the bats had developed a stereotyped flight behavior we changed the alignment of the curtain every ~10th flight by deflecting its terminal section at angles of + 30°, -30 and -90° relative to the first part.

Recording of echolocation and flight behavior

The flying bats were recorded with two IR-video cameras. The scene was illuminated with IR strobe lights. Echolocation signals were recorded and synchronized with the videos.

Three dimensional reconstruction of flight paths

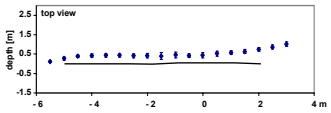
Simi motion® software was used to reconstruct the flight routes of the bats accuracy of reconstruction: width (x) 1.7 %, depth (y) 2.7 %, height (z) 1.0 %.

Sound analysis

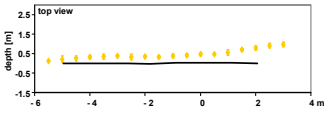
A custom made program (Selena) was used to analyze the echolocation signals (FFT of 256). Pulse duration and pulse interval were measured.

Results

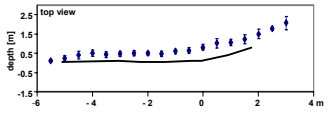
Bat 1

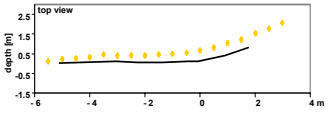


Bat 2

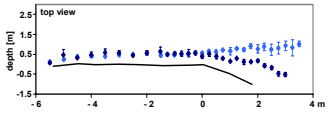


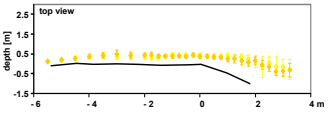
Curtain 0°: Both bats flew on a similar stereotyped flyway of a width of 20 cm at a distance of about ~35 cm to the curtain. The echolocation behavior of both bats was similar with pulse intervals of ~100 ms and pulse durations between 40 and 50 ms.



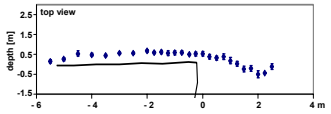


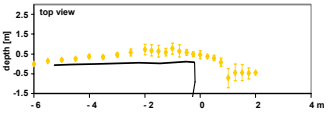
Curtain +30°: The bats were forced to fly a slight curve. Both bats showed a similar flight behavior. While flying the curve the bats shortened their pulse intervals to about ~50 ms and the pulse durations to about ~20 ms.





Curtain -30°: Bat 1 did not react during the first 9 trials (light blue) but followed the alignment of the curtain during the next 6 trials (blue). Bat 2 followed the alignment of the curtain in all flights (1-9 light yellow, 10-20 yellow). The echolocation behavior was similar to that during the straight flights.





Curtain -90°: Both bats followed the alignment of the curtain only partly. The bats showed no reaction in their echolocation behavior.

Deviation from flyway

Deviations from the normal flyways at angles of -30° and -90°. The black lines indicate the angular orientation of the alignment . At -30° both bats followed the curtain and reached a deviation angle of ~ -25°: bat 1 in trial 10-15, bat 2 in trial 1-20. At -90° both bats reached a deviation angle of ~ -45°.

Conclusions

Flight behavior:

- The new alignment guided the bats in a new direction. -30° resulted in a deviation of -25° and -90° in a deviation of -45°.
- **The reactions in flight behavior indicate that commuting horseshoe bats use a contour following mechanism (guidance) which keeps them at a constant distance to the background contour even if the alignment changes.**

Echolocation behavior:

- In the +30° situation the bats decrease pulse durations and pulse intervals which we interpret as an avoidance reaction. At -30° and -90° the bats showed no significant change in echolocation behavior to the new situation.

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