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Optimization of the characteristics of receiving echoes by
free-flying echolocating bats, revealed by onboard pulse-echo
recordings

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To understand complex sensory-motor behavior underlying echolocation by bats, we need to precisely measure acoustic characteristics of echoes that the bats actually listen to during flight. However, it has been technically-difficult to develop a small and light enough microphone set at the position of the bat's ear, and information about the echoes is so far virtually lacked. Here, we have successfully monitored these returning echoes by means of an onboard telemetry microphone mounted on the bats, and we confirmed that the free-flying horseshoe bats compensated for Doppler-shifts by adjusting their call frequency, thus maintaining the echo frequency at constant. Furthermore, we found that the bats also adjusted pulse amplitude with the distance to maintain the echo intensity within the narrow range. Receiving echoes with stable amplitude could help the bats to sustain consistent analysis of successive echoes, and combined frequency and amplitude compensation may be for optimization of successive echoes for target range estimation to control approach and landing. [Supported by a grant to RCAST at Doshisha Univ. from MEXT of Japan: Special Research Grants for the Development of Characteristic Education from the Promotion and Mutual Aid Corporation for Private Schools of Japan and the Innovative Cluster Creation Project.]