

## Collicular Responses to the Frequency Modulated Final Part of Echolocation Sounds in *Rhinolophus ferrum equinum*

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*Summary.* Collicular evoked potentials in *Rhinolophus ferrum equinum* show very prominent responses to the final frequency modulated part of a acoustic stimulus, simulating the natural echolocation sound.

The Greater Horseshoe Bat (*Rhinolophus ferrum equinum*) emits echolocation sounds consisting of a long part of constant frequency (cf) and a shorter final frequency modulated part (fm) sweeping down 14–16 kHz. Flying bats lower the frequency in order to compensate for Doppler-shift (Schnitzler, 1968). The echofrequency is therefore kept constant at about the frequency of the cf-part emitted by resting bats. The long cf-part is thought to be used for relative velocity measurements by Doppler-shifts, whereas it is still unknown if the short final fm-part renders any usefull information to the bat.

Nembutal anesthetized Horseshoe Bats (3 mg Nembutal/100 g body-weight) were stimulated by sounds of their own echotype simulated electronically by a trapezoid pulse generator (HP 8002 A), VCG-function generator (Wavetek 112) and an electronic switch. The ultrasonic speaker was placed 30° above the plane of the bat's upper jaw and 30° laterally to the body axis. Evoked potentials were recorded from the contralateral and ipsilateral colliculus inferior by Ag-AgCl-electrodes. The recorded signals were amplified by a differential amplifier (Tektronix 2A61). For every set of stimulus parameters 100 cycles were summed up by a signal averager (Didac 800 Intertechnique) in order to improve signal to noise ratio.

The recorded collicular evoked responses show typical on-responses to the beginning and a very prominent off-response to the end of the simulated echolocation sound (Fig. 1 b). In potentials evoked by pure cf-tones of 83.3 kHz the off-response is hardly detectable or even missing (Fig. 1 a). Thus the prominent off-response must be caused by the final fm-part of the echolocation sound.

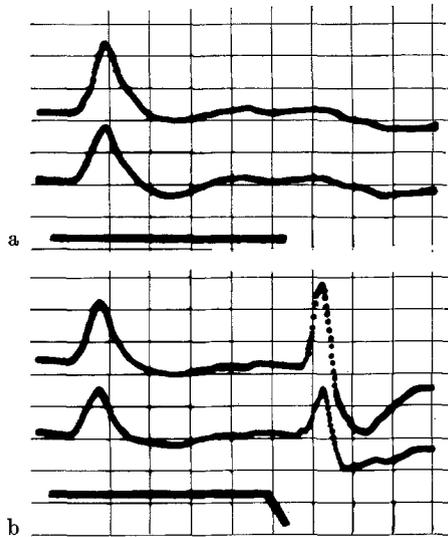


Fig. 1 a and b. Responses of the colliculus inferior to echolocation sound without (a) and with (b) a final fm-part. Upper trace: contralateral; lower trace: ipsilateral. Stimulus: Cf-part 83.3 kHz, 30 msec duration; fm-part sweep from 83.3 to 67.3 kHz, 3 msec duration

This result contradicts the statement of Grinnell (1970) that in *Chilonycteris*, another bat using echolocation sounds with a long cf-part and a final fm-sweep, a sharp response to the final fm-part is absent. Grinnell explains the off-responses to echolocation sounds in *Chilonycteris* by two alternatives: 1. the off-response is the true off-response to the terminal constant frequency portion of the signal. As Fig. 1 shows this hypothesis is rejected by the results in *Rhinolophus*. 2. The off-response is elicited by the beginning of the fm-sweep. Our results in *Rhinolophus* indicate that the off-response is evoked not only by the beginning but by a substantial portion of the final fm-sweep.

In any case the terminal fm-part of the echolocation sound in *Rhinolophus* causing such clear cut responses in the acoustical center cannot be considered as a mere by-product of sound generation. Vespertilionid bats use for echolocation only fm pulses resembling the fm-part of *Rhinolophid* sounds in duration and intensity. We suppose that Horseshoe Bats get substantial echoinformation out of the final fm-part of the sound.

A detailed analysis of collicular responses to frequency modulated parameters is currently undertaken.

**References**

- Grinnell, A. D.: Comparative auditory neurophysiology of neotropical bats employing different echolocation signals. *Z. vergl. Physiol.* **68**, 117–153 (1970).
- Schnitzler, H.-U.: Die Ultraschall-Ortungslaute der Hufeisen-Fledermäuse (Chiroptera-Rhinolophidae) in verschiedenen Orientierungssituationen. *Z. vergl. Physiol.* **57**, 376–408 (1968).

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