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a stereotypic change in echolocation behaviour, called terminal phase, or buzz, characterized by decreasing call duration and increasing call repetition rate. Here, we tested the hypothesis that bats flexibly adapt the spectro-temporal call structure even during the terminal phase to their task and environment. We quantified the echolocation behaviour of three bat species (long-fingered bat, Myotis capaccinii; Schreiber's bat, Miniopterus schreibersii; greater horseshoe bat, Rhinolophus ferrumequinum) in two different contexts, namely when approaching a standard reflective object (prey, wall) and when approaching a water surface for drinking. Echolocation during drinking has been scarcely investigated, yet might be very different due to the unique specular reflection properties of water surfaces. We recorded the echolocation behaviour during object approach in three to six individuals from each species (871 approaches in total) and measured temporal and frequency call parameters in ten echolocation sequences per individual and context. When approaching standard reflective objects, the bats produced typical approach and terminal call sequences, with species-specific differences. For example, M. schreibersii continuously decreased its pulse interval and then emitted the buzz II part of the terminal phase. M. cappaccinii produced grouped approach phase calls and both a buzz I and II in the terminal phase. In contrast, most bats completely omitted any terminal phase calls when approaching water. Our results show that bats can control their biosonar emissions also during the last moments of object approach and flexibly adapt them to their sensory needs.

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Estimating discomfort in a fat-tailed gerbil by ultrasonic joint-calls

ABSTRACT Ultrasonic vocalizations often attend discomfort states in rodent pups. For estimating levels of discomfort, only call number per time unit is commonly estimated, whereas other acoustic variables are often neglected. In this study, we applied the approach based on joint-calls, for estimating vocal discomfort of pups of the fat-tailed gerbil Pachyuromys duprasi. Calls of 35 pups from 9 litters were recorded a few times along ontogeny from 8 to 40 days. During a recording trial, a pup was initially isolated on the table surface for 4 min (isolation context), and immediately after this was handled for 4-5 min (handling context). We supposed that the handling context provoked stronger discomfort compared to the isolation context, so we expected that variables of ultrasonic calls might reflect the increase of discomfort at transition between these contexts. Only trials where pups produced ultrasonic calls in both contexts (n=73 trials) were included into analysis. Joint-calls were prepared for each context of each recording trial, by cut of intercall intervals. In total, 146 joint-calls contained 3955 ultrasonic calls. From each joint-call, we measured 4 power variables: the peak frequency and 3 quartiles, covering respectively 25, 50 and 75% of call energy. The values of the peak frequency and of all the three quartiles were significantly higher at handling compared to isolation context (repeated-measures ANOVA, $p<0.001$ for all comparisons). The most prominent differences were found between 20 and 32 days of life. These results, indicating higher values of power variables with increase of discomfort in ultrasonic calls of gerbil pups are similar to data obtained previously with the same method for audible joint-calls of fur-farmed red foxes Vulpes vulpes. Thus, power variables might encode discomfort in both ultrasonic and audible calls of mammals. Financial support: The Russian Scientific Foundation, grant No 14-14-00237.

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Great tits stay on pitch even as vocal amplitudes and background noise levels increase