



S. Schmidt

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Current Research

The study group for sensory biology and psychoacoustics focuses on the behavioral characterization of acoustic perception and communication in bats. Bats are ideal models to study acoustic behavior, for two reasons: their sonar constitutes a unique active acoustic orientation system, and acoustic communication is essential for social interactions in these nocturnal mammals.

1. Bioacoustics of communication

Although vocalizations occur in most social interactions between bats, the social call repertoire has only been recorded and analysed in very few species. Moreover, very little is known about the contexts in which the different call types are used. The aim of our research is twofold: to give a thorough functional description of social calls by relating the different call types to the respective behaviors, and to extract the various information bearing parameters carried by a given call. To address the first question, we record the behavior with the concomitant vocalizations in spontaneous and induced interactions of social groups of our model species, the Indian False Vampire (*Megaderma lyra*), in the field as well as in controlled experiments in the laboratory. In addition, we perform playback experiments with various species-specific calls including sonar calls, and socially neutral stimuli, to test our hypotheses about the role of the different call types. Multiparametric sound analysis is applied to calls recorded from identified individuals in well-defined situations to identify the call characteristics coding for a specific message or meaning. Thus we could show individual- and population-specific signatures in the call establishing contact between individuals of *M.lyra* at their night roosts. At present, we study changes in social call structure as a function of the emotional state of the animal.

2. Call classification and perceptual constraints

A second field of research addresses the question to which extent the recognition and classification of social calls is determined by psychoacoustic discrimination thresholds only, or by higher cognitive categories, respectively. In two-alternative forced choice, behavioral experiments we determine the classification performance for natural calls and synthetic stimuli with modified time-frequency structure and relate them to the relevant discrimination thresholds. The synthetic stimuli are designed based on the information bearing parameters isolated in the multiparametric sound and subsequent statistical analysis. Our field playbacks with synthetic stimuli of contact calls revealed that the bats are fairly tolerant to modifications in the frequency-time course of single call elements, whereas the overall time structure seems to be essential for call recognition, and to elicit a behavioral response. At present, we study the classification of synthetic contact calls which differ in rhythm in an operant conditioning paradigm.

3. Constraints of echolocation on habitat use

The habitat use of bats is limited by their maneuverability. The latter depends on the animals' anatomy, e.g. the shape of the wings, as well as on the species-specific echolocation signals and their plasticity. These determine the quality of the acoustic images obtained by the sonar system and thus the chances of survival in a given habitat. Our studies focus on the plasticity of the echolocation system in a given behavioral situation, e.g. when a bat hunts for different types of prey, or in acoustically diverse settings, and on the constraints of echolocation on the performance in different behavioral

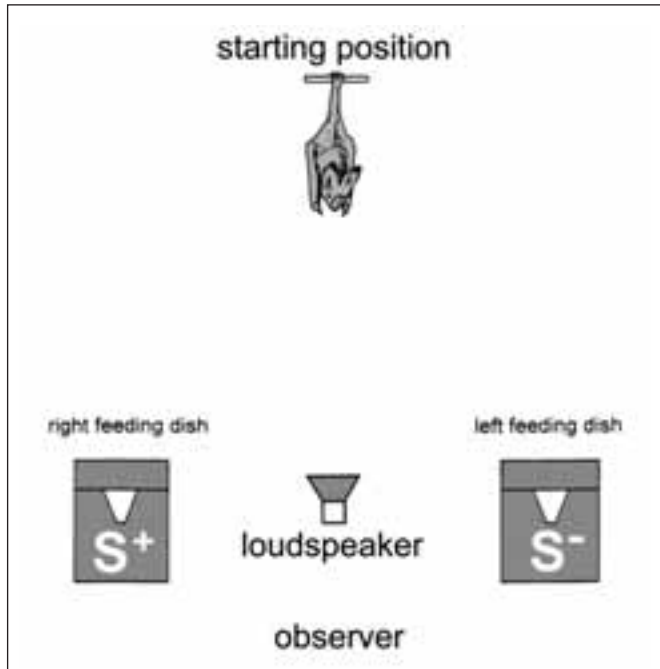


Fig. 1: Setup for classification experiments in *M. lyra*. To get a reward, the bat has to select one of the feeding dishes according to the stimulus ($S+$, $S-$) presented via the loudspeaker.

situations, e.g. when entering a perch through different openings or when avoiding obstacles. At present, the echolocation behavior of the Northern bat (*Eptesicus nilssonii*) is related to its habitat use in a field project.

Future Projects and Goals

It is a major goal of our group to understand the perceptual processes relevant for the recognition and classification of social and sonar call sequences by bats. Whereas sonar call sequences are strictly determined by functional constraints, social calls transmit the emotion of the caller in addition to their referential content. Therefore bats are ideal subjects for comparative studies on the evolution of emotional versus referential information perception in mammals. In the interdisciplinary DFG research group on the acoustic communication of emotion in man and nonhuman mammals (for details, cf. research profile E.Zimmermann) we aim at a comprehensive analysis of universals in emotion-coding call parameters, and emotion perception.

Selected Publications

[1] Krumbholz K and Schmidt S (1999) Perception of complex tones and its analogy to echo spectral analysis in the bat, *Megaderma lyra*. *J Acoust Soc Am* 105: 898-911

[2] Schmidt S, Hanke S and Pillat J (2000) The role of echolocation in the hunting of terrestrial prey - new evidence for an underestimated strategy in the gleaner bat, *Megaderma lyra*. *J Comp Physiol A* 186:975-988

[3] Krumbholz K and Schmidt S (2001), Evidence for an analytic perception of multiharmonic sounds in the bat, *Megaderma lyra*, and its possible role for echo spectral analysis. *J Acoust Soc Am* 109:1705-1716

[4] von Stebut B and Schmidt S (2001) Frequency discrimination threshold at search call frequencies in the echolocating bat, *Eptesicus fuscus*. *J Comp Physiol A* 187:287-291

[5] Siewert I, Schillinger T and Schmidt S (2003) Forward masking and its consequences for echo perception in the gleaner bat, *Megaderma lyra*. In: Thomas J, Moss C and Vater M (Eds) Echolocation in bats and dolphins. University of Chicago Press, Chicago, 266-268

Group Structure

Group leader:	Sabine Schmidt
Graduate students:	Moritz Haupt, Simone Janßen
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