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## **The arousal-related shifts in call characteristics of the defeated great gerbils *Rhombomys opimus***

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The emotional arousal affects the call characteristics, and the trends of their changes may be similar in different mammals including humans. The purpose of this study was to estimate the arousal-related shifts in call characteristics and the direct effects of a loser's calls to the behaviour of an attacker in male great gerbils.

We conducted 24 1-hour long tests with 23 males, with joining two unfamiliar males on neutral territory (in enclosure 76.5 x 58 x 65 cm), with parallel audio and video registration. After mutual threats and fights, one of the males acknowledged defeat and thereafter only defended himself and produced defensive calls. No one animal did suffer and all of them did breed successfully after the tests.

For analysis, we selected 47 fragments from 12 tests (3 to 7 per test), where a loser male called toward an attacker, of total duration 49.5 min. Thus, we analyzed calls of the 12 losers, 30 to 213 calls per test. Each call was cut into 40 ms segments (corresponding to 1 video frame), and within each segment, we measured the duration and 4 parameters of the call energy distribution. For tonal calls we measured also the fundamental frequency and calculated the depth of frequency modulation. By video, for each frame we measured the least distance between an attacker and a loser. Thus, we could estimate the shifts in call parameter values in relation to arousal, resulted from changes in distance between the subject animals. In total, we analyzed 2968 s of video and 1016 calls (7285 the 40 ms call segments). The decrease of a distance between males evoked the decrease of call durations and the shift of energy to higher frequencies and in tonal calls, the increase of the fundamental frequency and depth of frequency modulation. The calls of a loser showed «the pushing off effect» to an attacker, resulting in increase of a distance between the animals. The comparison with the analogous study on the pallid gerbil (*Gerbilus perpallidus*) showed that the calls of the defeated great gerbils were more effective in repelling of an attacker. It may reflect better elaborated mechanisms for non-contact conflict resolution in the great gerbil, more social species compared with the pallid gerbil. Our data consists with other available data showing that the energy shift to higher frequencies represents the most common indicator of emotional arousal both in nonhuman mammals and in humans.

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