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Cues to a direction of movement in biphonic calls of the dhole (*Cuon alpinus*)

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Dholes regularly produce calls with two fundamentals. Recently we showed that in 14 individuals 20 to 92% calls produced in peaceful interactions consisted biphonation, and that combination of the lower frequency yap (range 0.6 to 1.4 kHz) and the higher frequency squawk (range 5.5 to 10.7 kHz) encodes individuality in the dhole. Here we study if biphonic structure provides cues to a direction of movement of a caller as well. This idea was inspired by Miller's findings (Miller, 2002, Behav. Ecol. Sociobiol., V. 52, P. 262-270) that the faster damping of the higher frequency provides information on directionality of a movement in the killer whale *Orcinus orca* biphonic calls. We test a hypothesis that the biphonic structure (yap-squawk) provides better estimation of a movement direction of a caller in comparison with yap only (non-biphonic call consisting singly the low frequency with it's harmonics).
From 15 to 25 January 2004, in Moscow Zoo, we recorded calls and movements of three male dholes, running forward and back in their individual outdoor enclosures 4x8m. An audioman and a cameraman were filming a calling dhole standing close to each other using the tape-recorder Sony-WM-D6C with dynamic microphone Tesla-AMD-411N and camera Sony-TRV-65E. The recorded calls were digitised with sampling frequency 22.05 kHz. We selected 5-6 continuous records per animal, each 7 to 20 min in duration, and subdivided calls into two groups: »toward« (produced when moving toward a microphone in sector ±45° to microphone axis) and »from« (produced when moving from a microphone in sector 135-225° to microphone axis). Calls recorded under other angles, noisy or superimposed by other calls, were rejected. Totally, 1130 calls were analysed: 800 »toward« (542 yaps and 258 yap-squawks) and 330 calls »from« (298 yaps and 32 yap-squawks). After high-pass filtration 500 Hz we measured a mean spectrum for a 20.3 ms time fragment taken within in a centre of each call (FFT 256; frame 50%, Hamming window), that provided call spectra with 128 successive filters with a step 86.13 Hz. The sum of values for 53 filters (from 516.8 to 4995.7 Hz) reflected energy of the lower spectrum, whereas the sum of values for 69 filters (from 5081.8 to 10938.9 Hz) - energy of the higher spectrum. Then we counted ratio Eh/El (high-to-low energy) for each call.
For yaps and yap-squawks in total, the ratio Eh/El was significantly higher for »toward« group than for »from« group (Wilcoxon matched pairs test, n = 16, T = 19, p<0.05). For yaps and yap-squawks separately results were similar: for both Eh/El were significantly higher for »toward« than for »from« group (Wilcoxon test, n = 9, T = 0, p<0.01, and n = 15, T=13, p<0.01 respectively). Comparison of Eh/El ratios among dholes showed significant interindividual differences both in preference of a particular call type and in reliability of encoding directionality. Two of three dholes called mainly yaps, but only one of these twin showed higher Eh/El ratio for calls »toward« than for calls »from« (Mann-Whitney U-test, nl=90, n2 = 105, U = 2690, p< 0.001); whereas the second one showed almost coinciding values (M-W U-test nl = 240, n2 = 143, U = 16854, p = 0.77). The third dhole called both yaps and yap-squawks, and for both call types Eh/El ratio was significantly higher for »toward« calls (M-W U-test nl = 212, n2 = 50, U = 3291, p<0.001 for yaps, and nl = 219, n2 = 26, U = 1831, p<0.01 for yap-squawks).
Thus, both biphonic yap-squawks and non-biphonic yaps can encode a direction of movement in the dhole, however, yaps of one dhole lacked codes to directionality. In summary, the second high frequency is not obligate to encode directionality in the dhole, however, it is »actively involved« into this process when it is presented in a call.
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Oral presentation