

Vocal Signatures of Male Northern Elephant Seals and Differential Responses to Playbacks Predicted by Hierarchical Status

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Northern elephant seals (*Mirounga angustirostris*) are large, highly polygynous mammals that have a breeding system based on the defense of female harems by dominant males. Female reproductive cycles are synchronous and seals gather in large numbers on natal beaches each year to give birth and breed prior to departing for long foraging migrations at sea. Competition among sexually mature males is intense, with only a small fraction of adult males likely to successfully gain access to receptive females. Males establish reliable dominance hierarchies early in the breeding season after which their interactions are mediated primarily by stereotyped vocal signaling and only occasional physical fights. The aim of this study was to examine the acoustic characteristics and functional significance of these male calls in order to improve understanding of communicative behavior and the potential role of associative learning in maintaining social structure.

More than 50 adult male elephant seals were studied throughout the breeding season over two consecutive annual seasons at the Año Nuevo breeding colony in San Mateo County, California. Comprehensive observations of acoustic signaling, behavioral interactions, physical characteristics, and spatial movement patterns were obtained from individually marked and identified males. Male vocal displays were digitally recorded from <20 m and analyzed for spectral, temporal, and sound pressure level characteristics. Dyadic behavioral interactions between identified males were scored and used to determine quantitative ELO dominance rankings. The mass and size of individual males was derived from repeated photometric measurements, and movement patterns and spatial relationships to other males on the rookery were determined by daily GPS sampling. Two field playback experiments (based on Holt et al., 2010) were conducted using calls recorded from individuals of known size, rank, and familiarity directed toward dominant or subordinate associates. Responses were scored as movement relative to the speaker and vocal displays during 2 minute matched baseline and playback exposure periods.

The threat display calls of males comprised repeated units of pulsed transients or modulated guttural pulse trains emitted at highly regular rates (as described by Le Boeuf and Peterson, 1969) and extremely loud levels (120-130 dB peak re 1uPa peak @ 1m). The calls of different males were individually reliable and easily discernable with acoustic features that were not obviously correlated to size or dominance status. Vocal signaling occurred in the majority (78%) of male-male competitive interactions (n=1177), while physical contact between males was rare (6% of interactions) and typically followed repeated vocal exchanges of calls from both individuals. More commonly, conflicts were settled by negative phototaxis from the receiver at distances of several body lengths, thus avoiding costly fights.

To determine if calls alone would elicit the same behavior responses observed during actual interactions between marked individuals, playback experiments tested responses to the calls of individuals with known ELO rank, size, and spatial relationships. The results show strong and predictable differential phonotaxis and calling behavior based on hierarchical status of the receiver relative to the playback (Fig.

1). Therefore, these unique signals are not likely to be honest indicators of resource holding potential, but rather serve to convey information about individuals that is managed through complex associative learning.

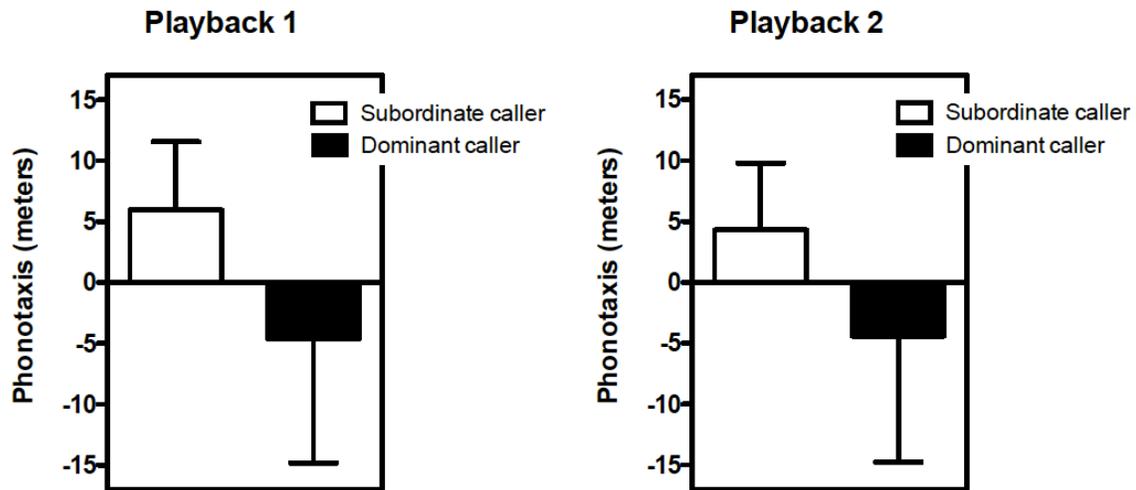


Fig. 1. Phonotaxis observed in male elephant seals during two playback conditions. In Playback 1, 10 males were presented with two playback conditions: calls of a known subordinate individual and a similar set of calls from a known dominant individual. In Playback 2, 20 individuals were tested in 10 reciprocal pairs, with each individual receiving the calls of a known rival. In both plots, mean distance moved in response to the playback are shown with standard deviations. The sample size for each bar is 10 individuals, and a subset of individuals were tested in both Playback 1 and 2. Both plots show significant movement patterns in the direction predicted by previously observed behavioral interactions between the callers and listeners, while no movement occurred during the baseline period prior to playbacks. Vocal responses during playbacks showed similar trends, with listeners calling more often when the playback track was subordinate to the focal animal.

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