Syrinx- and vocal tract-related acoustic parameters encode species, individual, and body size information in Banded penguin vocalizations

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Penguin vocalizations have been extensively studied over the past decades, but limited efforts have been directed toward vocal communication in Banded penguins (genus *Spheniscus*). Banded penguins are nesting and territorial species, where vocalizations are important in parent-offspring communication, adult social behavior, and mate choice. We used vocalizations collected from different *ex-situ* colonies of African (*S. demersus*), Humboldt (*S. humboldti*), and Magellanic (*S. magellanicus*) penguins to determine whether acoustic proprieties of calls encode species, individual, and body size information. In particular, using a source-filter theory approach derived from the study of mammal vocal communication, we measured temporal (duration), syrinx (fundamental frequency, f_0), and vocal tract (formants)-related acoustic features on contact calls and display songs (vocalizations uttered during the breeding period). We performed a series of stepwise, cross-validated Discriminant Function Analyses to demonstrate that, in both the vocal types, f_0 and formants are essential vocal features to discriminate among species and individuals. Moreover, using a series of Generalized Linear Mixed Models, we showed that, in the display songs, duration and f_0 are honest indicators of the body size. However, we found that none of the vocal tract-related parameters correlates with skeletal dimension or body weight. Overall, our results demonstrate that information encoded in penguin vocalizations can be studied by considering independent contributions from lungs (determining duration), syrinx (determining f_0) and the supra-syringeal vocal tract (determining formants). We suggest that this approach could be extended to investigate biologically meaningful information encoded in vocalizations of other seabird species.