

## Reappearance Diversity: Quantifying Musicality in Primate Vocalizations

David Schruth, University of Washington  
Darryl Holman, University of Washington

Musical behavior predates the emergence of *Homo sapiens* and primitive song could have originally evolved in our order 65 MYA, convergent with and independent of its emergence in Aves and Cetaceans. The avian display call literature uses quantitative metrics such as *trill rate*, *consistency*, *repertoire size*, *song bout length*, and *complexity* to evaluate songs. There have been few analogous efforts to quantify aesthetic qualities of display calls in our own order. We developed a novel method to quantify the elaborateness of acoustic displays using published spectrograms of primate vocalizations ( $n=832$  calls). These spectrograms (plots of acoustic energy across both frequency and time) were visually scored along the following ethnomusicologically universal acoustic parameters: *tone*, *interval*, *transposition*, *repetition*, *rhythm*, and *syllabic diversity*. Principal components analysis was used to reduce the scores to a single univariate measure of musical elaborateness. The resulting index is mathematically defined as the expected number of syllables reappearing within a call. Specifically it is the count of unique syllables multiplied by the probability that any given unit reoccurs over time or at different frequencies. This “*reappearance diversity*” index was verified as correlating well with display contexts. The utility of the index was demonstrated by testing it against popular co-evolutionary theories on the function of song such as group and pair level signaling as well as the acoustic [habitat] adaptation hypothesis. Species who group into monogamous family units (2-5 individuals) had higher index values. We found no direct support for the acoustic adaptation hypothesis.