Sexually antithetical song structure in a duet singing wren

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(Accepted: 8 February 2007)

Summary
Black-bellied wrens (Thryothorus fasciatoventris) use loud songs to communicate sex over long distances. We compared male and female songs recorded from a central Panamanian population of black-bellied wrens. All nine measured features differed significantly between the sexes. Males sang lower fundamental frequencies than females, but this difference cannot be explained by simple body size-frequency scaling. A discriminant function analysis correctly discriminated the singer’s sex for all songs in the analysis. When viewed as sonograms, the terminal syllables of male and female songs exhibited opposite structure – all male songs ended in V-shaped syllables, and all female songs ended in arc-shaped syllables. The degree and character of dimorphism lead us to describe song structure in this population as ‘sexually antithetical’. Variation in song dimorphism throughout this species’ range provides an excellent opportunity to test the hypothesis that signal degradation during transmission selects for divergent signal structure.

Keywords: Darwin’s Principle of Antithesis, bird song, female song, acoustic adaptation hypothesis, sex differences, animal communication, signal evolution, Pheugopedius fasciatoventris.

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Behaviour 144, 331-350
Also available online - www.brill.nl/beh
Introduction

Two animals are said to communicate when one (the ‘sender’) emits a signal that affects the behavior of the other (the ‘receiver’, Bradbury & Vehrencamp, 1998, pp. 2-3). A signal’s effectiveness is determined largely by its structure (Marler, 1955). Selection tends to optimize signal structure, up to the point that further optimization is constrained. For a signal to function optimally, it must be recognized by a receiver. In nature, the probability of correct recognition is diminished by processes beyond the sender’s control: signals degrade during transmission (Morton, 1975) and both senders and receivers make mistakes (Wiley, 1994). For a signal to be evolutionarily stable, it must elicit beneficial behavior on average from receivers in spite of normal levels of random variation during signal production, transmission, and reception – otherwise non-signaling mutants will enjoy a selection advantage over signalers. In cases where a single receiver must attend to two classes of signals and signalers benefit from different responses to the two classes, optimization will select for signals that remain sufficiently distinct after transmission that receivers consistently distinguish one from the other. The degree of distinctiveness is expected to correlate positively with both (a) the degree of random variation during signal production, transmission and reception, and (b) the relative payoff to the sender for correct versus incorrect discrimination.

Signal distinctiveness can be achieved by structural divergence along one or more axes of variation. Darwin’s (1872) Principle of Antithesis describes the theoretical limit of signal divergence, in which two signals are structural opposites. His most famous example of the Principle involves visual signaling in the domestic dog (*Canis lupus familiaris*). Darwin explained that a hostile dog “walks upright and very stiffly; his head is slightly raised, or not much lowered; the tail is held erect and quite rigid... the pricked ears are directed forwards and the eyes have a fixed stare” (p. 50). He contrasts this posture with that of a submissive dog, in which “the body sinks downwards or even crouches, and is thrown into flexuous movements; his tail, instead of being held stiff and upright, is lowered and wagged from side to side... his ears are depressed and drawn backwards, but not closely to the head; and his lips hang loosely” (p. 51).

Research since Darwin suggests that the Principle of Antithesis describes a special case of a broader evolutionary pattern. Namely, that two signals selected to elicit different responses from a given class of receivers will evolve