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Quick guide

Zoomusicology

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What is zoomusicology? Zoomusicology is the study of the music-like aspects of sound communication among non-human animals. An interdisciplinary field, it draws on a variety of scientific, musicological, and philosophical methods of inquiry.

Is this a new idea? Speculation about the musical nature of animal song goes back to ancient myths from all over the world, many of which claim that human music came from, or was inspired by, animal song. Imitations of animal songs populate traditional music from numerous cultures, and appear in some of the earliest notated music. Pieces by Vivaldi, Beethoven, and Messiaen, among others, include imitations of animal songs. More recently, North American and European ornithologists, naturalists, and philosophers from the late 19th to mid-20th centuries frequently described birdsong in musical terms.

Although the word 'ornithomusicology' was coined in 1963 by musicologist Peter Szöke, the term 'zoomusicology' was first introduced by composer François-Bernard Mâche in 1983, and popularized by musicologist Dario Martinelli. Other closely related terms include 'biomusicology', 'biomusic', and 'ecomusicology'.

So is animal song music? Not all scholars consider animal song to be conceptually analogous to human music. For instance, Marc Hauser and John McDermott reject this analogy, contrasting the specific functional role of animal song in territorial defense and mate attraction with human music, which they consider to be "characteristically produced for pure enjoyment" (although recent evidence suggests that animal song does sometimes occur in other behavioral contexts, and many human musical behaviors can be understood in functional terms). Other researchers do not see fundamental differences between human music and animal song. To circumvent issues related to the use of the word 'music' with non-human animals, Martinelli therefore defined zoomusicology as the study of the "aesthetic use of sound communication among animals." Although the use of the word 'aesthetics' in relation to non-human animals may itself be controversial, it has a weighty precedent — none other than Darwin attributed aesthetic preferences to birds. Earlier attempts at using musicological approaches to analyze animal song sometimes resulted in improbably anthropomorphic attributions, such as birds being credited with singing major, minor, or pentatonic scales. However, the use of modern acoustical and statistical analytical methods ensures that researchers are now able to describe animal songs more objectively.

What are some common features between animal song and human music? A central research topic in zoomusicology is the search for common features of animal song and human music. While a quest for 'universals', even within human music, is problematic, features that are shared between some kinds of human music and the songs of one or more other species may point to common biological (or cognitive) constraints or functions. One such trait might be the use of discrete pitches and specific melodic intervals (frequency ratios between adjacent pitches) in the songs of some animals. In some cases, the intervals favored by a particular species may even overlap with those used in human musical systems. For example, hermit thrushes base their song on the harmonic series, which is also the basis of many human musical scales (Figure 1). Musician wrens favor 'perfect consonances' — intervals based on the smallest integer ratios of 1:2, 2:3, and 3:4 — which are prominent in a number of human musical systems.

Many animal songs are highly structured, some in ways that overlap with human musical forms. For example, humpback whales sing series of 'rhyming' phrases, which begin differently and end with the same pattern, similar to the way (human musical phrases may come to similar cadence points within a piece.

Figure 1. Do animals make music?
The hermit thrush (*Catharus guttatus*) produces songs that share some features with human music. (Photo: Wikimedia Commons, Magnus Manske.)

Rhythmic entrainment — the ability to synchronize action or sound production to a regularly produced external pulse — was long thought to be a uniquely human ability. In the past 10 years, entrainment has been recognized in a growing list of non-human species, including several kinds of parrots and sea lions. Moreover, just as humans coordinate rhythmically to sing or play in groups, numerous bird species, especially those found in the tropics, sing rhythmically coordinated duets between members of a mated pair.

Are animal songs learned or instinctive? Most animals have a repertoire of instinctive vocalizations — in humans, crying or laughing would be examples. In fact, many species' vocalizations are exclusively instinctive. Chickens around the world make the same types of calls, whether raised in isolation or in the company of other chickens. Similarly, the advertisement calls of frogs, although sometimes quite complex, are mostly genetically determined, and even the elaborate duets of gibbons are innate.

Animal vocalizations are typically categorized as either 'songs' or 'calls', although there is no consensus on how to distinguish between the

two. Ethologist Nikolaas Tinbergen emphasized the functional role of song in mate selection and territorial defense, whereas ornithologist W.H. Thorpe distinguished between songs and calls on the basis of duration and complexity, considering the longer and more complex vocalizations to be songs. More recently, cognitive scientists such as Tecumseh Fitch have focused on whether a vocal behavior is learned or innate, treating all learned vocalizations as songs and all innate vocalizations as calls, regardless of their aesthetic qualities. This 'vocal learning' model has become influential, in part because vocal learning species tend to be those that most frequently display proto-musical behaviors. Moreover, rhythmic entrainment has until now only been reported in vocal learning species.

Only a few animal clades are thus far known to include vocal learning species — among birds, parrots, hummingbirds, and oscine songbirds, and among mammals, humans, cetaceans, pinnipeds, elephants, and bats. Animals of these species must be exposed to representative adult songs in order to develop a typical adult song. One consequence of songs being a learned rather than an innate behavior is that a number of songbird species display geographically-based dialects. This is also the case for humpback whales, whose songs tend to be similar within a group but vary across geographic areas.

What lies ahead for zoomusicology?

Although zoomusicology has already given us many intriguing findings, the field is still in its infancy. There are more than 4000 species of birds, and a growing list of mammals, recognized as vocal learners. Each has its own pattern of song acquisition and structure, and must be studied individually to be understood. Basic pitch and rhythmic analysis constitute an obvious first approach to analyzing animal songs, and more advanced methods of structural, spectral and timbral analysis, including computational approaches originating from the burgeoning field of music information retrieval, potentially hold even greater promise.

A related question is whether animals and humans perceive musical sounds in a similar manner. Although research in this field is still in its early stages, studies on pitch, timbre, and rhythm perception in animals suggest that vocal learning species may have better auditory discrimination abilities than non-vocal learning species, and that, in certain contexts, non-human species do appear to have preferences for some musical sounds over others. Encouragingly, interest for this topic, and more generally for a comparative approach to zoomusicology, is steadily growing.

While it may not be possible to determine conclusively whether animal song is music, getting musicologists, scientists, and philosophers to join forces in zoomusicological inquiry will surely lead to a better understanding of animal song, and to a better understanding of human music as well.

Where can I find out more?

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Vectored antibody gene delivery mediates long-term contraception

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Development of non-surgical methods of long-term or permanent contraception remains a challenge. Towards this objective, we show that intramuscular injection of a replication-incompetent, recombinant adeno-associated virus (rAAV) designed to express an antibody that binds gonadotropin-releasing hormone (GnRH), a master regulator of reproduction in vertebrates, results in long-term infertility in male and female mice. Female mice are also rendered infertile through rAAV-dependent expression of an antibody that binds to the zona pellucida (ZP), a glycoprotein matrix that surrounds the egg and functions as a sperm-binding site. Many proteins known or suspected to be important for reproduction can be targeted, potentially reversibly, using this approach, which we refer to as vectored contraception (VC).

Mature GnRH is a 10-amino-acid peptide of identical sequence in most mammals, produced in the hypothalamus. GnRH is released into the median eminence, from which it diffuses into the hypophyseal portal capillary system, which carries it to the anterior pituitary, where it stimulates the release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) into the general circulation. FSH and LH promote the formation of gametes and the production of sex steroids. Thus, loss of GnRH results in male and female infertility, and loss of other steroid-hormone-dependent traits [1]. Inhibition of GnRH is considered to be an attractive strategy in animals when the goal is to inhibit fertility and sex-steroid-dependent traits, such as aggression and territoriality. Vaccination with GnRH can inhibit

