

One of the drawbacks of BSC is that although it focuses on reproduction—an important element in the engine that drives evolution and thus a good candidate for something that makes a species—it focuses solely on *sexual* reproduction. Consequently, we are forced to conclude that until sexual reproduction evolved on Earth, there were no species present. What, then, was evolution working on for the likely one to two billion years that life was around before sexually reproductive organisms *evolved*? Furthermore, there are problems accounting for creatures that are inherently nonreproductive (such as some worker ants and drone bees) as well as creatures that tend not to mate but can do so under the right circumstances (such as tigers and lions that produce tigrons and ligers). Not everyone accepts BSC as the answer to what constitutes a species.

There are other alternatives, including cladistics (closely related to BSC but arguing that the only natural group is one that includes all the descendants of a common ancestor), genetic species concepts, environmental species concepts, and those theories that argue for the irreality of species. But the important point is this: the species concept is both theoretically and practically important to our understanding of the world and our relationships to other animals. And, unsurprisingly, it speaks to the tension and duality in our conception of those relationships. It at once suggests both how the world is divided, ordered, separated, and compartmentalized, while at the same time how we are all alike, how *Homo sapiens* are simply one species among many others—changing, adapting, always unfinished, and intimately connected with all other life.

Further Resources

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■ Communication and Language

Birdsong and Human Speech

Millions of years before humans spoke—or produced music of any kind—birds produced thousands of tuneful whistles and rhythms. We will never know how much these sounds influenced our aesthetic perception of sound, but we can speculate that we might not have produced or appreciated music as much as we do unless birds had done so first. Most of our favorite instruments yield pure tones—as do our singers—but songbirds generate the

most varied and conspicuous tonal sounds in nature. We would have had very few models for the development of our own melodies, were it not for the birds.

If this is the case, it is not surprising that in many languages, words originally used for human vocal music were extended to the sounds of certain birds. In English, for instance, the first literary reference we have for the word "song" refers to the human voice (in *Beowulf*), but by 1000 CE, the term was first used with regard to birds in the following stanza (translated from Old English):

When they can hear the piping choir
Of other song-birds; then do they send
Their own notes forth. All together
The sweet song raise; the wood is ringing.

—Anonymous, *Metres of Boethius* xiii. 47–50

Much more recently, ornithologists discovered that most of the world's best melody-producing birds are close evolutionary relatives of each other. They are classified in the suborder *Oscines* in the order *Passeriformes*, and the term "songbirds" is now reserved for this group alone.

Birdsong has often been related to human speech and expression. Female singers (whose voice pitch is closer to that of birds) are called "songbirds" as a compliment. Birdwatchers use spoken phrases to describe bird songs; Thoreau, for instance, thought the song sparrow's song sounded like, "Maids! Maids! Maids! Hang up your teakettle-ettle-ettle." Poets such as Byron and Keats imagined that the songs of birds convey human sentiments. Less romantically, Hawthorne wrote: "Language—human language—after all, is but little better than the croak and cackle of fowls, and other utterances of brute nature—sometimes not so adequate" (*American Notebooks*, 14 July, 1850).

In the next century and a half, Hawthorne's cynical statement would prove truer in some senses than he could have guessed. Three areas of scientific progress have vastly expanded the relationship between birdsong and human speech: the function of vocal communication, the development of learned birdsong, and the way song changes over time in a population.

What Vocal Communication Is For

First, Darwin's work instigated the realization that humans evolved along with the rest of nature and that our complex traits have been maintained by natural selection. Not surprisingly, then, research investigating the function of birdsong has shown that birds make noises for many of the same reasons that we humans do. Both birds and humans beg for food as young; they coo to maintain pair bonds and soothe agitated offspring; they call to keep track of each other and even (in highly social species) to distinguish between individuals; and they squawk and yell to intimidate competitors, scold intruders, and warn kin of danger. If we limit discussion to what biologists (and the most recent edition of the *Oxford English Dictionary*) refer to as *birdsong*, as opposed to *birdcalls*, two functions are overwhelmingly important: attracting mates and competing with members of the same sex (often by ordering them out of one's territory). In most temperate birds, only the males sing. In species where females sing as well, especially in the tropics, the male and female often cooperate to exclude other males or pairs from the territory. In humans, social life is far more complex than in any bird, and we use our language for a multitude of advanced social functions, such as conveying information about third parties, coordinating exchanges, and facilitating effective networks of cooperation and

competition. These functions are probably much less important—and may often be non-existent—in birdsong. Human language is also far richer in meaning, symbolism, and reference than birdsong, which appears to be primarily “about” the singer. But as Hawthorne’s statement above hints, we humans, too, perhaps much more often than we care to admit, use our language for the typical functions of birdsong: envious antagonism, self-aggrandizement, and, particularly, making favorable impressions on members of the opposite sex.

Learning How to Sing or Speak

A second area in which science has found parallels between birdsong and human speech is vocal learning. Most vocal organisms produce sounds without imitating models around them; however, together with hummingbirds, parrots, and a few mammals (including humans), songbirds are vocal learners. Birdcalls, which are usually simpler and are routinely delivered in nonmating contexts, may often be unlearned. Almost all human vocalizations involve significant learning, although laughing, crying, and gasping in surprise may be unlearned (or nearly so).

Linguists and psychologists have argued for decades as to whether human language is acquired primarily by instruction (a model associated with B. F. Skinner) or by the maturation of a core body of knowledge that is *inherited* rather than learned (a position championed by Noam Chomsky). Since the 1960s, experimental studies (by Peter Marler and others) on song learning in birds have shown that neither extreme view captures the complexity of vocal development in birds. These insights inspired human language researchers to think less simplistically about their own subject, and subsequent work has revealed a number of striking parallels between birds and humans in the development, and even the neurobiology, of vocalization.

Both birdsong and human speech are copied from older individuals in the beginning of life, most readily during a short window of time at a certain stage in brain development. In several sparrow species, this window is very strict, and the birds learn very few—or no—new sounds after the first few months of life. In humans, and in some birds such as the zebra finch, learning is fastest and most pronounced in early life, but additional learning can happen later. (It is probably not a coincidence that zebra finches are more social than the sparrows, and that, in several respects, their song-learning process is more like that of humans.) The learning process in both songbirds and humans can be divided into two broad phases: the *perceptual* phase and the *sensorimotor* phase. In the perceptual phase, individuals listen to their elders and store what they hear as a collection of neural representations (which in birdsong is called a “template”). In the sensorimotor phase, individuals gradually develop their ability to produce appropriate sounds based on the templates stored in their brains. The young at first produce gibberish that only vaguely resembles song or speech (called “subsong” in birds, “babble” in humans). The learners then refine their output through a process in which one’s own vocal output is repeatedly heard, compared to the template, and modified to achieve increasingly accurate copies. Both birds and humans inherit predispositions to learn only the “correct” sounds—only the sounds of their own species. As individuals develop, these predispositions affect what they hear and how they hear it, and then, later, what they produce. With experience, individuals also whittle away irrelevant parts of their repertoires. Swamp sparrows, for instance, will initially produce a broad variety of songs, but only a fraction of these will be perfected and “crystallized” into final form to be used throughout their lives. Likewise, infant humans are able to learn phonetic distinctions found in any language, but by one year of age they have lost the ability to distinguish sounds that are not contrasted in their native language (such as the Spanish /b/ and /p/

among English speakers and the English /r/ and /l/ among Japanese speakers). Other similarities between song and speech learning are: the surprisingly small number of repetitions that are required to learn species-typical sounds, several features of the elemental structure of songs and sentences, the importance of social input during learning, the preference of learners for familiar over unfamiliar sounds, and the physiological mechanisms underlying the onset and offset of learning. Of course, several aspects of the learning process are very different in the two groups, usually deriving from the greater degree of sociality and complexity that characterizes human psychology and communication.

Consistent with the similarities in vocal development, neurobiological studies have uncovered similar control systems in the brain for vocalization in humans and songbirds. In both groups, two general neural networks have distinct functions, and they are not found in vocal nonlearning species. One, the posterior descending pathway, carries substantive information about song or language; the other, the less-understood anterior forebrain pathway, is important for flexibility or plasticity in learning. So far, at least six specific brain regions have been found in humans and songbirds that appear to have analogous functions in vocal communication.

Several differences in the organization of the vocal learning centers arise because birds do not have the layered cortex of mammals and do not exhibit the degree of hemispheric lateralization (the division of labor between halves of the brain) that humans do; and, of course, humans do not exhibit the sex differences that most birds exhibit in the neural basis for vocal behavior. Nevertheless, the similarities between the two groups are striking, considering that the ancestors of songbirds and humans diverged over 300 million years ago. Vocal learning evolved independently in the two lineages (we are separated in the evolutionary tree by thousands of vocal nonlearners), but many of the same structures evolved in parallel. This situation resembles the evolution of flight in birds and bats, where many of the same structures (pectoral muscles, metabolic rate) changed in similar ways, despite the independent evolution of flight in the two groups.

Dialects and Cultural Change

After function and development, the third scientific achievement that intensified the interaction between birdsong and human speech over the last few decades was the study of cultural traditions and change. Culture is the accumulation of social learning over time. It is a rare phenomenon in nature; most organisms do not learn their parents' solutions to old problems, but have to "reinvent all of the wheels" themselves. Both humans and birds, however, learn their vocalizations with slight imperfections and innovations, and they generally learn from local individuals. This results in gradual local changes that eventually produce geographical differences in both birdsong and human language—differences that are referred to in both groups as "dialects." From extensive work on indigo buntings, Bob Payne found that, as in human languages, song traditions arise, split, influence each other, and go extinct.

Changes in bird songs and human languages do not appear to be progressive, but they *do* open up a world of social cues that is much more diverse than that of vocal-nonlearning species. In some social contexts, these cues can have important consequences; for example, one's repertoire of vocal signals can be a hallmark of experience or ability. In great tits, a male survives better—and is reproductively more successful—the more song themes he knows. Likewise, in humans, a large vocabulary can be perceived as indicative of intelligence. As another example, an individual songbird or human can often be identified by voice and then can be treated as a native or a foreigner. Song sparrow males are more aggressive, and females less sexually receptive, toward foreign song sparrow songs than local song sparrow songs. In humans, a regional dialect can be an avenue

to social acceptance among those who speak it, but can seem provincial or carry other negative connotations among nonspeakers.

Conclusion

Because of the many parallels, and because of ethical restrictions on human experimentation, studies on birds have provided some of our most valuable empirical insights into human language and speech development. Recently, clinicians have begun to request bird studies in order to understand aphasia, stuttering, and other speech pathologies. Despite all that is still unknown, birdsong is the best understood communication system in nature. In fact, the relevance of birdsong research extends beyond vocal communication to behavior in general. We understand the complex interactions between "nature" and "nurture" (between unlearned and learned factors) more thoroughly in the songs of birds than in any other behavior in any species—including humans. Evidently, birds can teach us much about ourselves. As Democritus said over two millennia ago, "We are pupils of the animals in the greatest matters; of the spider in spinning and mending, of the swallow in building houses, and of the songbirds, the swan and the nightingale, in singing, by imitation."

See also

Communication and Language—*Similarities in Vocal Learning between Animals and Humans*

Further Resources

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■ Communication and Language Great Apes and Language Research

Language research with nonhuman great apes (chimpanzees, bonobos, gorillas, and orangutans) allows for unique interaction between nonhuman animals and humans. In principle, it offers a distinctive window to the understanding of their mental lives;