to learn about the intelligence of other animals, and yet, tragically, many of the most intelligent species, including African Grey parrots, are now endangered in the wild. Greys and other threatened species of parrots are still being captured and exported for the pet trade; tens of thousands may die in the process every year. And many people who purchase parrots as pets are unable to deal with a parrot's demanding social needs, causing a growing problem of abandoned parrots, with limited sanctuaries for their long-term care. Hopefully, learning about N'Kisi's abilities will help inspire people to protect these intelligent species and their habitats, so that their wild societies can survive for future generations. Language-using animals are like animal ambassadors, bridging the worlds of other species with our own. At the heart of every successful study in interspecies communication is an extraordinary human-animal relationship.

See also

Communication and Language—*Telepathic Communication Systems between People and Animals*

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To see N'Kisi on video, see *Jane Goodall's When Animals Talk.* (2005). Discovery/Animal Planet.

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Aimee Morgana

Communication and Language
Similarities in Vocal Learning between Animals and Humans

Human parents are ceaselessly fascinated by their children's acquisition of language. In two to three years—just a fraction of the human juvenile period—most individuals progress from simple, nonverbal distress communication (crying) to the expression of complex thoughts in long series of words. These words are assembled and inflected according to specific rules and are selected from a learned vocabulary that quickly numbers into the thousands. Learning a language—and speaking it—comprises one of the most outstanding indications of the power and versatility of human intelligence. Thus, for over a thousand years, "dumb" has meant not only "mute," but also "stupid."

For nearly as long, humans have referred to animals as "the dumb beasts." We have not thought that animals are quiet, of course, but we have often considered their sounds to be devoid of real communication. (Otherwise, as Descartes wrote with a hint of sour grapes, the animals would have found a way to let us know what they were saying!) Starting there, we would naturally conclude that animal sounds are automatic and unlearned, and require no cognition.

Behavioral scientists know better. For one thing, even unlearned vocalizations can be effective in communication. Second, we should take animal cognition seriously, whether or not animals learn their sounds. Third, many animals do learn their sounds, as well as when to make them and what they mean. This does not make human language any less phenomenal, and there are many aspects of human language that still appear to be unparalleled. However, we must be very careful when we talk about the uniqueness of human language, because the study of vocal learning has established several links between humans and other animals.

Vocal plasticity is the ability of an organism to change something about its vocalizations over time. All vocalizing animals have some plasticity. Crickets, for instance, provide the best-studied example of unlearned, automatic animal communication (though it is not vocal). But even crickets will stop singing when a large animal approaches them, which demonstrates plasticity in the timing of their song. So we humans share vocal plasticity, at its basic level, even with the insects.

The most expedient and versatile sort of vocal plasticity is known as *vocal learning*. Most of this learning is social, meaning that the animal gets its information from other animals. There are two classes of social learning in animal communication: *contextual learning* and *production learning*. Contextual learning is when an animal learns either how to use its sounds (such as when to make them) or what certain sounds mean. Production learning is when an animal learns how to produce its sounds properly. Humans are highly dependent on both contextual and production learning. When an infant learns that "milk" refers to the drink, or that saying this word to a parent helps milk to appear, this is contextual learning. When an infant actually learns to say the word—to make the sound "milk"—this is production learning. In nature, contextual learning is much more common than production learning. Any animal that can be trained to vocalize on demand or respond to a particular word is using at least a rudimentary form of contextual learning. Any species with individual recognition on the basis of voice, as when king penguin (*Aptenodytes patagonicus*) chicks and parents locate each other, uses a more advanced form of contextual learning. Young vervet monkeys are using contextual learning when they discover that a particular call in their repertoire should be given whenever a predatory bird flies overhead, whereas another is appropriate when a dangerous snake is observed on the ground. Despite its commonality, contextual learning has only recently been an explicit focus of communication research, but some fascinating examples have been discovered so far. It has been demonstrated in monkeys and apes, whales and dolphins, seals, bats, dogs, cats, horses, and many birds.

Most of this entry focuses on production learning, since that is what is more specifically meant by "vocal learning"—literally, learning to vocalize. The discovery of instances of production learning continues: at last count, it has evolved independently at least eight times, but only in birds and mammals. In birds, it is apparently ubiquitous in the Oscine Passerines ("songbirds") and parrots, and it is also found in hummingbirds; future research is needed to confirm suggestions that it exists in a few fowls, toucans, and sub-Oscine Passerines. Among mammals, at least some cetaceans (whales and dolphins), seals, bats, elephants, and humans show production learning. The elephant case is based on a single sample of imitated sounds by adult African elephants. Some animals rival humans in their mastery of vocal learning, mimicking an astonishing variety of sounds—including human voices and machinery. Examples are mynahs (*Gracula religiosa*), lyrebirds

(*Menura superba*), grey parrots (*Psittacus erithacus*), and harbor seals (*Phoca vitulina*). Communication in three groups of animals has been studied extensively enough to explore similarities between human and nonhuman vocal learning.

Primates

Humans are unique among primates in the widespread and clear use of learned vocalizations. The calls of several primates differ between social groups—or change while the animal is developing—but other processes besides learning might explain these situations. For instance, a social group might share similar songs because of the influence of a common physical environment or shared genes. In chimpanzees (*Pan troglodytes*) and Japanese macaques (*Macaca fuscata*), the calls of two individuals can be more similar when they are communicating with each other than when they are communicating with other individuals, a phenomenon known as vocal convergence; whether this involves production learning is unclear. Surprisingly, our closest relative, the chimpanzee, is unable to imitate new sounds like humans do after nine months, even though the chimp and the other great apes can imitate various other kinds of actions. These differences are reflected in the different ways the brain controls vocalization in humans versus other primates. Lesions to certain parts of the brain, such as the primary motor cortex, lead to speech disorders in humans, but do not produce similar effects in monkeys. This suggests that they use different parts of their brains in vocalizing than we do, despite our close evolutionary relationship. Moreover, certain genes—such as *FOXP2*—that are involved in vocalization have evolved since our divergence from the chimpanzee.

Dolphins

Bottlenose dolphins (*Tursiops truncatus*) are the only nonhuman mammal that is known to interact by matching each other with learned sounds. Dolphins use several kinds of whistles to communicate. An individual's most common whistle type, its "signature whistle," is used in matching, usually when the other dolphin is out of sight. Signature whistles are thus thought to function in group cohesion and individual recognition. Dolphins appear to converge with other members of their social group in certain aspects of their whistles, so the whistle may also signal group membership. A few other whistle types also have known functions, such as mother-calf communication. Like humans, dolphins have a period early in their life (usually within the first two months in dolphins) when vocal learning is very important and basic communication skills develop in the presence of other individuals. Also like humans, dolphins remain open to learning and producing new whistles throughout their lives.

Songbirds

Vocal learning is better understood in songbirds than in any other animal; in some ways, we know more about how birds learn song than about how humans learn language. A fuller account of the relationship between birdsong and human speech can be found elsewhere. In general, although the functions and significance of songbird and human vocalization can be very different, the process of learning is very similar and uses much of the same neural equipment. Some of the more striking of these similarities are as follows:

- Two pathways in the brain are important to vocal learning that are apparently absent from birds or mammals that do not learn their vocalizations. A posterior

pathway appears to be directly involved in vocal production, whereas an anterior pathway is a loop that involves thinking centers and is probably more responsible for flexibility or plasticity.

- Young individuals imitate the sounds produced by older individuals, often parents.
- Two developmental periods can be distinguished: an early *perceptual* phase where the young are listening and remembering, but not yet making sounds, which guides a later *sensorimotor* phase where the learner is practicing out loud, as well as listening.
- Early experience is crucial, and the tendency to learn declines as an individual gets older.
- Early vocalizations are diverse ("babbling" in humans, "subsong" in birds) compared to the fewer and more refined sounds that are ultimately preserved in the repertoire for life.
- Auditory feedback, where a young individual hears itself vocalize, is necessary. Its importance decreases as the individual gets older.
- Social stimulation—interaction with other members of the species beyond hearing them sing—aids learning.
- An instinctive tendency to listen for and imitate the "right" sounds. Development is a process of selecting, or shaping, the repertoire according to what the individual hears in its models.

Considering the diversity of vocal learners both avian and mammalian, some similarities appear to be widespread. First, within a species, the fastest learners are the individuals that experience the most social interaction and information such as what a vocalization is about or when to do it. Second, individuals often develop distinctiveness in their vocalizations, resulting in the ability to tell each other apart. Third, vocal convergence within groups is common, resulting in "dialects," or different vocal styles between groups. Many birds, and a few mammals, have been found to exhibit this phenomenon, including humpback whales (*Megaptera movaeangliae*), bottlenose dolphins, greater spear-nosed bats (*Phyllostomus hastatus*), and greater horseshoe bats (*Rhinolophus ferrumequinum*). Fourth, dialects can change through time by cultural evolution, as has been studied in depth in indigo buntings (*Passerina cyanea*) and humpback whales. Fifth, vocal learning is usually an indicator of social status or membership. When they open their mouths, individuals proclaim what group is theirs, as well as how socially proficient they are.

Why did vocal learning evolve, in humans as well as in other animals? One hypothesis is that social species that are also highly mobile need to learn local dialects in order to communicate well in local conditions. These conditions might include the acoustic properties of the environment, as well as the nature of social interactions. Individual recognition is often important, for instance, when the social system is fluid and the group members need to constantly update each other as to who is around. In these cases, the small genetic differences between individuals result in differences in vocalization without learning, and this is the extent of the variation for most animal species. But learning can diversify vocalizations far beyond what genetic differences alone could accomplish. Perhaps the extent to which vocal qualities can change via genetic differences is particularly constrained in animals with certain traits or lifestyles. For instance, the structure of organs in small animals might not be able to change very much without compromising function; and the rigors of powered flight might impose limitations, as well. These factors might explain why vocal learning has evolved as an alternative means of vocal diversity in hummingbirds, songbirds, and bats. One hypothesis for why there

are so many vocal-learning marine mammals as compared to terrestrial mammals is that water pressure changes the nature of the vocal organs at different depths and speeds of movement, obscuring small genetic differences and rendering vocal learning more important if individuals need to be distinctive. As for us humans, we have a fluid social system, where groups are very important to our survival. In this situation, we find it important to know and to convey our group membership and status, and to communicate a multitude of other social facts to one another. These social facts, and many other less central aspects of human culture, change during our lifetimes and over the generations. Perhaps only by learning our speech can we be flexible enough to adjust our communication to such changes.

See also

Communication and Language—*Birdsong and Human Speech*

Further Resources

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