The ABC's of animal speech: Not so random after all

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The calls of many animals, from whales to wolves, might contain more language-like structure than previously thought, according to study that raises new questions about the evolutionary origins of human language.

The study, published today in the journal *Proceedings of the Royal Society B*, analyzed the vocal sequences of seven different species of birds and mammals and found that the vocal sequences produced by the animals appear to be generated by complex statistical processes, more

akin to [human language](#).

Many species of animals produce complex vocalizations – consider the mockingbird, for example, which can mimic over 100 distinct song types of different species, or the rock hyrax, whose long string of wails, chucks and snorts signify male territory. But while the vocalizations suggest language-like characteristics, scientists have found it difficult to define and identify the complexity.

Typically, scientists have assumed that the sequence of animal calls is generated by a simple random process, called a "Markov process." Using the Markov process to examine animal vocalization means that the sequence of variables—in this case, the vocal elements—is dependent only on a finite number of preceding vocal elements, making the process fairly random and far different from the complexity inherent in human language.

Yet, assuming a Markov process exists raises questions about the [evolutionary path](#) of animal language to human language—if animal vocal sequences are Markovian, how did human language evolve so quickly from its animal origins?

Indeed, the study found no evidence for a Markovian process. The researchers used mathematical models to analyze the vocal sequences of chickadees, finches, bats, orangutans, killer whales, pilot whales and hyraxes, and found most of the vocal sequences were more consistent with statistical models that are more complex than Markov processes and more language-like.

Human language uses what's called "context-free grammars," whereby certain grammatical rules apply regardless of the context, whereas animal language uses simple or "regular" grammar, which is much more restrictive. The Markov process is the most common model used to

examine animal vocal sequences, which assumes that a future occurrence of a vocal element is entirely determined by a [finite number](#) of past vocal occurrences.

The findings suggests there may be an intermediate step on the evolutionary path between the regular grammar of animal communication and the context-free grammar of human language that has not yet been identified and explored.

"Language is the biggest difference that separates humans from animals evolutionarily, but multiple studies are finding more and more stepping stones that seem to bridge this gap. Uncovering the process underlying vocal sequence generation in animals may be critical to our understanding of the origin of language," said lead author Arik Kershenbaum, a postdoctoral fellow at the National Institute for Mathematical and Biological Synthesis.

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