How animals holler

May 21 2018

Credit: University of Utah

While humans can only broadcast about one percent of their vocal power through their speech, some animals and mammals are able to broadcast 100 percent. The secret to their long-range howls? A combination of high pitch, a wide-open mouth and a clever use of the body's shape to direct sound—none of which are factors that humans can replicate.

"Will humans ever be able to call to each other over long distances in an emergency situation, as wild-life has evolved to do well over millions of years?" asks Ingo Titze, director of the National Center for Voice and Speech at the University of Utah.

The research is published in the *Journal of the Acoustical Society of America* and was funded by the National Institute on Deafness and Other Communications Disorders.

Moving air efficiently

Animals produce sound by moving air from the lungs, through the throat, and out of the mouth. The slow-moving air has to be converted to rapid back-and-forth movement to produce sound. At each stage, some of that sound power is lost. Only about 10 percent of the aerodynamic power produced in the lungs makes it to the throat. And the soft tissues in the throat absorb sound further, Titze says. But then there's the radiation efficiency—the amount of sound that is transmitted out of the mouth.

It's this calculation that Titze and Anil Palaparthi, a doctoral student in biomedical engineering are introducing in this study. "We went back to mathematics that were available 100 years ago," Titze says. "We looked at a more modern way of computing it and came up with an efficiency formula."

Some birds and mammals smaller than a volleyball can shout as loud as a human—largely because of high radiation efficiency. But what's the difference between how—and why—humans and animals holler?

Why they can do it and we can't

In calculating the factors that play into radiation efficiency, Titze and Palaparthi found that animals have three major characteristics that improve their efficiency: wide mouths, high frequencies and the ability to turn their entire body into an acoustical reflecting chamber.

The frequency of the sound can tell us more about its purpose, Titze says. "Human speech involves a large variety of vowels and consonants made by using a lot of variation in your lips, tongue, and jaw. For that you need a low pitch, to make that variation very clear and separate for vowels from consonants." But animals who need to send a long-range signal don't need the same discrimination of sounds and can use a higher pitch. "Radiated power rises dramatically," the researchers write, "when the wavelength of the sound is on the order of the diameter of the mouth or beak."

(If you're wondering, the average diameter of a human mouth opening is around 2 inches or 50 millimeters. Do the math, and that yields an optimal frequency of 6,860 hertz. Humans typically produce fundamental frequencies up to 300 hertz in speech—well below the optimum.)

Animals, particularly small birds and mammals, can also use their entire body as a baffle. A baffle is like the box that contains an audio speaker or the curved surface behind a choir on stage—it's a reflecting surface that points the sound forward. "The person who is in front of the baffle hears much better than the person who is behind it," Palaparthi says.

To become a baffle, an animal cocks its head back and sometimes retracts its head into its body. (To see examples, follow the links near the top of the story). Humans, unfortunately, have a relatively inflexible neck that doesn't allow that same baffle function. Combine that with our inability to hit the needed higher frequencies, and about the only thing we can do to improve our radiation efficiency is "open wide."

"There's not much that can be done if you want to improve," Palaparthi says. "The biology doesn't support it."

Making emergency calls

But that doesn't mean that humans can't learn lessons from animals' powerful calls. Titze has conducted a soon to be published study to test how far and how intelligibly humans can issue a call for help. Learning how to call more efficiently could become a matter of life or death in an emergency situation when the electronic methods we currently use to signal others far away—our phone networks—aren't available.

"And not just once or twice," Palaparthi says, "but over a long period of time, in a way that you conserve your energy until help arrives."

"If we lose the ability to electronically amplify our voices and we have to go to natural production," Titze adds, "what could humans do to get their messages to further distances?"

More information: Ingo R. Titze et al, Radiation efficiency for long-range vocal communication in mammals and birds, *The Journal of the Acoustical Society of America* (2018). DOI: 10.1121/1.5034768

Provided by University of Utah