The elephant in the room: Elephant vocal folds may hold clues to human sound production

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African Bush Elephant in Mikumi National Park, Tanzania. Taken by Oliver Wright, via Wikipedia.

Up until a year ago, how an elephant made its guttural infrasonic calls was still a matter of debate, as Christian Herbst, from the University of Vienna, Austria, points out: 'Some people suggested it's just like in us humans, so a passive, flow-induced vibration of the tissue in the larynx, and others suggested it's like purring in cats [requiring neural control].' Unfortunately, unlike in humans, it's a little difficult to slide an endoscope down an elephant's vocal tract to see what's happening. However, in 2010 an opportunity to settle the mystery arose, when an African elephant sadly passed away at Berlin Tierpark zoo. A collaborator based in Berlin quickly seized the opportunity and collected the larynx from the elephant on behalf of Herbst and Angela Stoeger, also from the University of Vienna. Back in Austria, Herbst and Stoeger were then able to reproduce elephant-like sounds by simply blowing air through the voice box, causing the two vocal folds on either side of the trachea to flap passively in the air, just as they would in humans. Their results were published in 2012; however, as elephant larynxes are few and far between, Herbst decided to dig a little deeper to find out just how similar they are to ours, publishing the results in *The Journal of Experimental Biology*.

From the outset of his second study, Herbst could already clearly see that the elephant's vocal folds were very different to ours. Comparing CT-scans of both the elephant's larynx and a human's, Herbst noted that the elephant's vocal folds were orientated at a very acute angle in relation to the air stream, whereas in humans the vocal folds were almost perpendicular to the air stream. This meant that the anterior two-fifths of the vocal folds were sheltered from the airflow. What's more, even when normalised to tracheal diameter, the elephant's vocal cords were much longer than a human's and 180% thicker.

Herbst then went on to film how the two vocal folds moved and clapped together as warm humidified air was blown through them, correlating the vibrations with sound production. As before, he saw that, just as in humans, the vocal cords were vibrating passively in the airflow, and as expected, most of the time the vocal folds vibrated within the infrasonic range (anything below 20 Hz). However, the timing of sound generation was unusual: 'In humans, most of the sound is created when the vocal folds clap together, but we observed that in the elephant, interestingly, most of the sound was generated when the vocal folds separated', explains Herbst.

This wasn't the only difference; the patterns of vocal fold vibration also varied compared with human vocal folds. Herbst explains that as the air pressure builds up beneath the closed vocal folds, they will eventually pop open, and in humans this usually produces two transverse travelling waves that travel back and forth in opposite directions along the length of the vocal folds. In doing so, they become superimposed on each other to form a standing wave. In elephants, whilst this happened most of the time, when the vocal fold was taut only a single isolated travelling wave was observed, which moved back and forth along the vocal folds. 'Looking at transverse travelling waves offers us an alternative way to study and appreciate the physical phenomenon that is going on in voice production', says Herbst.

In short, Herbst's study has shown that although elephants are in some ways the same as us when it comes to sound production, they can also be subtly different, but these differences may in turn help us understand how our own vocal folds make our human repertoire of sound.

More information: Herbst, C.T., Svec, J. G., Lohscheller, J., Frey, R., Gumpenberger, B., Stoeger, A. S. and Fitch, W. T. (2013). Complex vibratory patterns in an elephant larynx. J. Exp. Biol. 216, 4054-5587. jeb.biologists.org/content/216/21/4054.abstract

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