Researchers solve mystery of Tuvan throat singing

March 10 2020, by Jeff Renaud

Huun-Huur-Tu are a music group from Tuva, a Russian federative republic situated on the Mongolia–Russia border. The most distinctive characteristic of

Huun-Huur-Tu's music is throat singing, in which the singers sing both the note and the drone's overtone, thus producing two or three notes simultaneously. Credit: University of Western Ontario

An international research team has uncoupled the mystery of how Tuvan throat singers produce distinctive sounds in which you can hear two different pitches at once—a low rumble and a high whistle-like tone.

Fascinated with how this form of throat singing, known as Khoomei, creates this dual tone, researchers from Western, York University and the University of Arizona studied members of the Tuvan performing group Huun Huur Tu to examine first-hand how they do it.

"They can produce two different pitches, which goes against the typical way we think about how speech sounds are produced," says lead researcher Christopher Bergevin from York's Faculty of Science. "It was a bit of a mystery how they did it and it's something researchers have wondered about for the last two decades."

The researchers found that the Tuvan singers were able to uniquely constrict their vocal tract in two key spots simultaneously—one at the front of their mouth using their tongue and another at the back of their throat. This had the effect of creating the dual sounds.

The paper, Overtone focusing in biphonic Tuvan throat singing, was published in full today in the journal *eLife*.

To figure out the mechanisms involved, researchers at York, including Bergevin and Chandan Narayan from the Faculty of Liberal Arts, recorded the singers in a sound booth and shot a series of images of one the Tuvan performers singing while in an MRI scanner.

Those images were sent to Western Science professor Natasha Mhatre, who helped reconstruct the vocal tract shape using a 3-D-reconstruction software called 3DSlicer. Mhatre is a world-leading expert in acoustic and vibratory communication, predominantly in insects and spiders.

"In bioacoustics, morphology can be very powerful in producing unexpected effects and so imaging and understanding the vocal tract was one of our main goals," said Mhatre, the Canada Research Chair in Invertebrate Neurobiology.

Once the vocal tracts were reconstructed, Brad Story of Arizona's Speech Acoustics and Physiology Lab, modelled and simulated the singing in all the configurations observed in the vocal tract.

Birds and some frogs can produce two distinct tones, but it's unknown in humans except in throat singers from Tuva and Mongolia.

In humans, vocal folds make sound by vibrating creating a buzzing noise. How fast or slow the vocal cords vibrate determines whether a high- or low-pitched sound is produced. The faster they vibrate, the higher the pitch of the voice. But they also produce a series of harmonics or 'overtones.' The mouth and tongue shape theses overtones, creating resonances at certain frequencies called formants.

Vowels in human speech are determined by the first three formants—F1, F2 and F3. Each formant is usually distinct, but Tuvan singers can merge multiple formants to create one exceedingly sharpened formant and this forms the higher pitched melody with the lowest formant forming the lower rumbling register.

More information: Christopher Bergevin et al. Overtone focusing in biphonic tuvan throat singing, *eLife* (2020). DOI: 10.7554/eLife.50476

Provided by University of Western Ontario