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Roaring Lions and Crying Babies

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It seems preposterous that two vocalizations that are rarely compared side-by-side, the roar of a lion or tiger and the cry of a human infant, could have anything in common. One is the sound of strength and dominance, the other the sound of pure helplessness. The commonality is that they are both maximally attention getting. Both are loud, and both have a harsh, grating quality that cannot easily be ignored. The attention grab is for totally opposite messages, however. The baby broadcasts, "Come to me now, I need your help," while the lion broadcasts, "Stay away from here, this is my territory."

The similarity in the attention getting aspect of roars and cries suggests that aperiodic (nonharmonic) sounds provide maximal auditory stimulation. A large spectrum of frequencies is stimulated in the cochlea of the ear. Although the roar or cry may begin with a more tonal sound, when full respiratory effort is applied, the tone becomes distorted and irregular. This "bearing down," or overblowing, is also used to a limited degree in musical instrument playing, and certainly in rock singing.

It is interesting to compare the size of the vocal folds of human infants to those of the great cats. From cadaver larynges, we know that the vibrating vocal fold length in infants is about 2–3 mm, whereas that of lions and tigers is on the order of 2–3 cm, an approximate 10:1 ratio. This ratio of this anatomic dimension alone predicts the difference in the frequencies produced. Vocalization is on the order of 50 Hz for the great cats and around 500 Hz for infants, with considerable variation in both.

It is also interesting to compare the morphology of the internal vocal fold tissues. To our limited knowledge, infants have a simple structure, an epithelium (skin) that encapsulates a soft, gel-like material. A vocal ligament is not yet developed to allow tension to be applied along the length of the vocal fold for pitch control. The thyroarytenoid muscle is also not developed, further restricting control of pitch. The gel-like material, however, can withstand large tissue deformation, and if any injury occurs from large tissue deformation or large mechanical stress, repair is rapid because fluids, cells, and nutrients are abundant in the gel.

The vocal folds of lions and tigers may have developed a structure that has similar advantages for loud bursts of sound. A layer of fat is part of what would be ligament in the adult human. This layer of fat is easily deformed (squished) when vocal fold vibration is large in amplitude.[1] The fat may also be a storehouse for cells that produce repair materials if rapid repair is needed. Lastly, the medial surface of the vocal folds is very flat, forming two nearly parallel plates when they are adducted for phonation. This parallel-plate configuration has been shown to have the lowest phonation threshold pressure, both by theory[2] and by experiment.[3] Low threshold pressure allows large amplitudes of vibration without excessive lung effort.

We don't know the tissue morphology of smaller house cats. They obviously have a cry and a hissing shriek, but the "meow" is the best known vocalization. It is more tonal and may serve other communicative purposes.

Perhaps the entire comparison of vocalizations across species and ages has little bearing on voice pedagogy, but is does bear out the hypothesis that structure follows function in the larynx. In spite of the fact that the primary function of the larynx is airway protection rather than phonation, a morphology does evolve that supports phonatory function. Unfortunately, singing styles change too rapidly to expect any benefit from long-term morphological adaptation.

NOTES

1. Sarah A. Klemuk, Tobias Riede, Edward J. Walsh, and Ingo R. Titze, "Adapted to Roar: Functional Morphology of Tiger and Lion Vocal Folds," *PLoS ONE* 6, no. 11; e27029. doi: 10.1371/journal.pone.0027029 2011: http://dx.plos.org/10.1371/journal.pone.0027029
2. Ingo R. Titze, "The Physics of Small-Amplitude Oscillation of the Vocal Folds," *Journal of the Acoustical Society of America* 83, no. 4 (April 1988): 1536–1552.
3. Roger Chan, Ingo R. Titze, and M. Titze, "Further Studies of Phonation Threshold Pressure in a Physical Model of the Vocal Fold Mucosa," *Journal of the Acoustical Society of America* 101, no. 6 (June 1997): 3722–3727.