13.1.5: Animal Sounds

Many animals use sounds either to attract mates or warn away competitors. A few animals use sounds to navigate (discussed in Chapter 16: Acoustics). In general, smaller animals make higher frequencies and larger animals make lower frequencies but there are plenty of exceptions. Elephants and whales use infrasound (below 20 Hz) to communicate over long distances but both mammals can also make higher frequency sounds.

Most mammals have vocal cords much like humans. Some marine mammals such as dolphins have phonic lips in their nasal cavities instead of vocal cords in their throats. These phonic lips act the same way vocal cords do, vibrating when the dolphin exhales and are controlled by muscles in the nasal passage. Whales do not have vocal cords but can pass air between two large internal cavities in their bodies and the passage way vibrates, allowing the whale to make sounds while submerged without exhaling.

Most insects and some crustaceans make sounds by rubbing body parts together. This form of making sound is called stridulation. Insects also use resonating body parts such as wings and hollow body cavities to amplify the sound. Cicadas have an air filled abdominal cavity ribbed with cartilage and muscles and it is the contraction of these muscles which makes the sound we hear. Cicadas are much louder than other insects which generate sound by stridulation because of their unique method of making sound. A few insects such as crickets use leaf structures or tunnels in the ground to amplify their calls. The treehopper, an insect, communicates to others of its species by sending vibrations through the branches of the plant it is on.

Fish generally make sounds by contracting the muscles around their swim bladder if they have one. This typically produces a broad spectrum of low frequency sounds (under 1000 Hz) and is called drumming. At least one type of herring emits gas through its anus to produce sounds.

Most birds have two sets of syrinx, one on each of their two trachea. These small areas of the trachea can vibrate and because there are usually two regions, some birds can make two sounds at the same time. This is part of the reason birdsong can be very complex. This arrangement also allows birds to produce short sounds with durations of $1/200\text{th}$ of a second, 10 times faster than humans. This is probably why birds also have absolute pitch (their ear/brain system hears exact frequencies) whereas humans have relative pitch. Some birds and some frogs have resonating sacs that amplify the sounds being produced by vocal cords or syrinx.

Video/audio examples:

- Snapping shrimp, and more snapping shrimp.
- Ant communication.
- Recordings of soundscapes (natural ambient sound- there is more there than you think!).

Summary

Like all instruments, the human voice relies on resonance to emphasize a particular fundamental frequency and overtones. For talking, humans use the mouth and larynx to form two resonance cavities which produce vocal formants that shape the buzzing of the vocal folds into distinct sounds. Other phonemes require attack and ending frequencies produced by starting or stopping the air flow with the lips or tongue. Singers train their vocal folds, larynx and mouth to have very clear resonances. They are helped by being gifted with nasal and lung cavities that accentuate pleasant overtones.

Questions on Voice:

1. Describe the vocal cords and explain how they work.
2. Explain how the Bernoulli effect relates to the movement of your vocal chords.
3. How are the muscles of the vocal chords similar to a brass player's lips buzzing?
4. What range of frequencies (in Hz) do your vocal cords make?
5. List the main parts of the vocal tract and their function.
6. What actually happens when you swallow and something "goes down the wrong pipe?" Do we actually have two different "pipes" in our throats?
7. Musical instruments all have a vibrating part that acts as a source of sound and resonators that enhance certain frequencies. For the human voice, what acts as the vibrating sound source and what acts as resonators?
8. What other parts of the body function as resonating cavities for the human voice?
9. What is pink noise?

10. What are vocal formants?
11. Explain, in terms of formants, what is occurring when a Mongolian throat singer sings.
12. What happens to the human voice if you inhale helium? Why?
13. What happens to the human voice if you inhale sulfur hexafluoride? Why?
14. Why is inhaling sulfur hexafluoride more dangerous than inhaling Helium?
15. Would helium and/or sulfur hexafluoride change the sound of a stringed instrument? What about a tube based instrument? Explain.
16. The distinct sounds that make up the words spoken in a particular language are called _____.
17. What is a diphthong?
18. Name the six categories of phonemes in the English language and how they are formed.
19. Describe the difference in what we do with our mouths when we say a long o, an ah, and an ee sound.
20. Without a tongue or lips, are we able to create all phonemes needed for speech? Explain.
21. What are plosives and fricatives? Give three examples of each.
22. How are the phonemes used by opera singers different from ordinary speech?
23. Why are the phonemes used by opera singers different from ordinary speech?
24. What factors allow an opera singer to be heard over an orchestra, even without electronic amplification?
25. How does impedance matching apply to operatic singing?
