

SENSES

17. Cetacean Sensations

Objective: To learn the differences between how whales and humans perceive their environment.

Level: K-3, 4-7

Background:

Hearing

Whales have excellent hearing, which is helpful in the low light environment of the ocean where vision is less dependable. Whales are thought to hear very well at low-frequency ranges, but some whales may lack the ability to hear higher frequency sounds. They have been observed to respond to sounds such as cameras clicking underwater and boat-engine noise.

Baleen whales have a small external ear opening on each side of the head. These openings lead to an auditory canal that is completely closed by a waxy plug. It is not known how effective sound reception is through this ear canal. Toothed whales do not have a waxy ear plug, and the ear bones are not directly connected to the skull, as they are in baleen whales and other mammals. The middle and inner ear follow the basic mammalian structure. Surrounding the ear bones is a foamy liquid that contains air. The air is responsible for stopping the sound waves travelling through water and living tissues. This layer of air may acoustically isolate the whale's ear, enabling the whale to detect which direction the sound is coming from. In water, it is difficult to determine the direction of sound if the ear bones are attached to the skull, because of the disturbing vibrations coming from the skull.

Both toothed whales and baleen whales have the ability to emit sounds, although toothed whales are more developed in this skill. Baleen whales broadcast sounds widely, whereas toothed whales emit sounds in a directional manner. Baleen whales emit primarily low frequency sounds, whereas toothed whales emit a wide range of frequencies, from below 20 to 200,000 Hertz. Humans have the ability to detect sounds in the range of 20-2000 Hertz.

Vision

The sun's light cannot penetrate very far below the ocean waves, especially when it is blocked by abundant plankton near the surface. Like many fishes, whales have adapted to seeing in the dim light. First, the eye of the baleen whale is flatter than that of land mammals and the cornea is less curved. This allows better vision in low-light conditions. But a whale is nearsighted in air. A whale's eye also has a reflective layer behind its retina, called the *tapetum lucidum*, which reflects light back to the retina a second time. This takes advantage of the scarce light at ocean depths. A cat also has this adaptation, and it is this *tapetum lucidum* that causes the eye to reflect yellow when light is shined on it. A whale's retinas contain mostly rods, cells that gather more low-intensity light. Cone cells, which are responsible for colour vision, are much less abundant. The Sperm Whale has very small eyes relative to its size, which is associated with its feeding at great depths in the darkness of the sea. Whales also have no tear ducts, as their eyes are constantly bathed in water, but glands at the outer cornea and eyelids secrete an oily substance that cleans and lubricates the eye.

Smell

During the foetal stage, baleen whales have olfactory nerves and bulbs, but they are greatly reduced in the adult brain. Scientists have not yet discovered whether these structures are functional. Toothed whales have none, so they likely have no sense of smell.

Touch

Toothed whales have the sense of touch over the entire surface of the body, but they are most sensitive around the head, flippers, belly and genitals. A whale's skin is thin, sensitive and well supplied with nerves and blood vessels. Whales do not have hair, but they do have vibrissae, which are similar to the whiskers found on the upper lip of a domestic cat. In whales, however, the vibrissae are much smaller and shorter than those found on terrestrial mammals. In some species, vibrissae are present as a juvenile, and then fall out; some are retained for life; and some are present only in the embryo. Baleen whales have a well developed sense of touch. Vibrissae are usually located at the end and sides of the lower jaw and on the top of the head. They range from just a few to as many as 250 (on the head of the Northern Right Whale). Baleen whales also have dermal sensors that look like small lumps scattered over the head and snout, as well as a few distributed over the body.

Taste

The sense of taste has not been well studied. Whales have taste buds on their tongues, though not many, and those present have atrophied or degenerated. It could be that whales have no need for refined tasting ability because the constant flow of water through the mouth makes everything taste the same, like briny water. It could also be that because whales eat basically the same kinds of food, taste discrimination is not important.

Materials: blindfolds, objects for students to taste, touch, smell, and listen to.

Procedure:

- 1) Divide the class into small groups, and ask the students to take turns wearing the blindfold. Have each blindfolded student use one sense at a time to identify various objects:
- 2) Taste - have one student feed the blindfolded student an unknown piece of fruit. (check with students for allergies first).
- 3) Hearing - play a recorded sound, or blow up a balloon and have students guess what made the sound.
- 4) Touch - present each blindfolded student with an unknown object, and have them guess what it is by using only their hands.
- 5) Smell - have each student smell a well known scent, such as peppermint or freshly cut grass, and have them guess what it is.
- 6) Once every student has had a turn to use his/her senses, put away the blindfolds and discuss the activity. Which objects were the easiest/hardest to guess? Which senses were the easiest/hardest to use? Why?
- 7) Using the background information above, make a list of differences and similarities between whale senses and human senses. Discuss the reasons for the differences.