New study finds dolphins produce sounds in a similar way to humans

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It has long been thought that dolphins produce sounds by means of "whistles," but a new analysis of a data gathered in the late 1970s has revealed that instead, dolphins make sounds by means of tissue vibrations, in a similar way to the way humans and other mammals use vocal cords (also known as vocal folds) and birds use the syrinx.

Scientists at Aarhus University in Denmark, led by Peter Madsen, analyzed data gathered in 1977 by scientists working with the US Navy Marine Mammal Program. The researchers, Sam Ridgeway and Don Carder, were studying a trained bottlenose dolphin (Tursiops truncatus). They recorded the sounds made by the dolphin, which they interpreted as whistles, while the animal was breathing air and while breathing Heliox, which is a mixture of helium (80%) and oxygen (20%). The Heliox was delivered to the dolphin via a mask over the animal's blowhole. The aim of using Heliox was to find out if the dolphin sounds would rise in pitch in the presence of helium, as the human voice does (since the speed of sound in heliox is 1.74 times faster than in air).

The scientists at the time thought the dolphin sounds were made by resonance of air in their nasal cavities. If that were true, the pitch of the sounds would change as the dolphin moved deeper, since the increased pressure in the nasal air cavities would also raise the pitch of their sounds.

The data gathered by the Navy team could not be fully analyzed because at the time an analysis of a single whistle would have taken several hours. Now, with the benefit of digital technologies, Madsen's team were able to digitize the old recordings and use advanced computing and visualization scripts to analyze them for the harmonics and frequencies of each recorded whistle. They found that the sounds did not change pitch when the dolphin was breathing Heliox.

Dr Madsen said the results of the analysis suggest the sounds were not made as whistles at all (which would be made by expelling air out rapidly) but were the result of "pneumatically induced tissue vibrations," and this would explain why the sounds did not change in the presence of Heliox. He said this makes sense because using tissue vibrations would allow the dolphins to communicate more effectively at depth. Madsen and the team suggest the most likely tissues for producing the sounds are the "phonic lips" in the nasal air cavities. They also think that toothed whales might communicate in the same way.

The paper is published in the Royal Society's *Biology Letters*.

More information: Dolphin whistles: a functional misnomer revealed by heliox breathing, *Biology Letters*, Published online before print September 7, 2011, doi:10.1098/rsbl.2011.0701

Abstract
Delphinids produce tonal whistles shaped by vocal learning for acoustic communication. Unlike terrestrial mammals, delphinid sound production is driven by pressurized air within a complex nasal system. It is unclear how fundamental whistle contours can be maintained across a large range of hydrostatic pressures and air sac volumes. Two opposing hypotheses propose that tonal sounds arise either from tissue vibrations or through actual whistle production from vortices stabilized by resonating nasal air volumes. Here, we use a trained bottlenose dolphin whistling in air and in heliox to test these hypotheses. The fundamental frequency contours of stereotyped whistles were unaffected by the

higher sound speed in heliox. Therefore, the term whistle is a functional misnomer as dolphins actually do not whistle, but form the fundamental frequency contour of their tonal calls by pneumatically induced tissue vibrations analogous to the operation of vocal folds in terrestrial mammals and the syrinx in birds. This form of tonal sound production by nasal tissue vibrations has probably evolved in delphinids to enable impedance matching to the water, and to maintain tonal signature contours across changes in hydrostatic pressures, air density and relative nasal air volumes during dives.

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