Dolphin sonar: Using their heads to click

To locate food and elude predators, many species of dolphins emit rapid sequences of clicks in tightly focused beams of high-pitched sound. Echoes of these sonar-like bursts provide dolphins with a rich source of information about their environment. However, precisely where and how these sounds are generated has long eluded researchers.

Now, a computer model of sound propagation in a dolphin's head lends credence to the recent conjecture that the animal's clicks emanate from a small packet of tissue near the top of its head, close to its blowhole. Researchers had previously suggested that these sounds originate farther down in the head, near a set of nasal air sacs or even in the larynx.

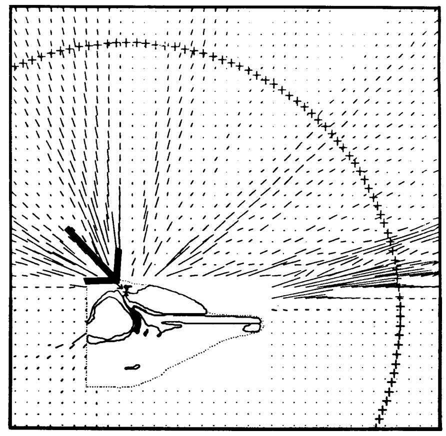
Reporting in the November JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA, physics graduate student James L. Aroyan of the University of California, Santa Cruz, and his co-workers also note that a dolphin's skull-supported air sacs appear to act together as an acoustical mirror, focusing sound from this source into a highly directed beam that emerges from the dolphin's forehead.

The initial suggestion that clicks originate in the rather small, inconspicuous knobs of fatty tissue near a dolphin's blowhole came from marine biologist Ted W. Cranford, now at the Naval Ocean Systems Center Hawaii Laboratory in Kailua. Looking at X-ray scans of dolphin heads, Cranford discovered that every species he examined contained similar structures.

These flaps of tissue may act somewhat like the vibrating lips of a trumpet player, Cranford contends. In a dolphin, "when air is pushed past the lips and the lips flap together, there's a little quivering of the fatty structure," he says. "That little pulse is what is transmitted out into the water as the echolocation signal."

To produce his simplified, two-dimensional computer model, Aroyan derived the basic geometry of a dolphin's head from one of Cranford's X-ray images, added data concerning tissue density and speed of sound at various points, and computed the paths followed by high-frequency sound waves as they traveled outward from their source. Only when the sound source was put at the spot where Cranford had found the fatty structures did the simulation show a directed beam matching experimental measurements of emanations from a dolphin's head.

"I think we've actually pinpointed the right location, the right structures," Cranford says. "It's a matter of coming up with the proof, and that's going to take a while."



Computer simulations of sound propagation in the head of Delphinus delphis *suggest that the high-frequency pulses a dolphin uses to locate objects underwater are generated near the top of its head (arrow), close to its blowhole. A dotted line marks the dolphin's head. Solid lines outline skull bones and an elongated region of fatty tissue in the forehead often described as the "melon." Black areas represent air sacs. Line segments around the dolphin's head show the direction and intensity of sound waves emerging from the skull.*

Meanwhile, Aroyan is trying to refine his results by developing a three-dimensional computer model of a dolphin's head. *– I. Peterson*

Infants signal the birth of knowledge

Don't let a baby's wide-eyed, sometimes vacant gaze fool you. Infants possess innate knowledge about the physical properties of objects that allows them to reason in basic ways about what they see, according to new research.

The findings challenge the theory that knowledge about the physical world emerges only after an infant has had at least several months to observe and explore the environment.

"[Thinking] capacities may be as much a part of human endowment as are capacities to perceive and to act," assert psychologist Elizabeth S. Spelke of Cornell University and her colleagues in the newly released October PSYCHOLOGICAL REVIEW.

Their contention coincides with a growing consensus among developmental psychologists that infants think in surprisingly complex ways (SN: 8/29/92, p.132). Still, the argument for innate knowledge provokes debate, notes psychologist Patricia Bauer of the University of Minnesota in Minneapolis.

Spelke and her co-workers studied how young infants reason about the motions of objects by relying on the well-established observation that babies look longer at something new or unexpected than at something familiar.

In one experiment, 16 babies, all about 2½ months old, watched a researcher roll a foam rubber ball across a platform. The ball disappeared behind a screen, which the researcher then raised to show the ball at rest against a wall. After becoming accustomed to this maneuver over several trials, the babies viewed two new displays. In one, the ball rolled behind the screen, which was then raised to show the ball resting against the near side of a box placed to the left of the wall; in the other, the screen was raised to show the ball resting against the wall after having apparently rolled through the box.

A group of 2½-month-old "controls" saw a researcher manually place a ball behind the screen, then raise it to show the ball either on the near side of the box or against the wall.

Infants looked much longer at instances in which the rolling ball ended up next to the wall. They inferred that a hidden ball comes to rest in front of an obstacle in its path and cannot pass through or jump over the obstacle, Spelke's group asserts.

The team also found that when a ball falls behind a screen, 4-month-olds look longer if the object reappears on the lower of two surfaces in its path. In a third experiment, they found that when a ball falls behind a screen toward a platform with a gap and then reappears below the gap, 4-month-olds look longer if the ball is larger than the gap.

However, two additional experiments indicate that 3- and 4-month-olds do not yet realize that, without support of some type, objects will fall. Babies showed no preference for instances in which a falling ball was revealed at rest in midair (held up by a hidden rod) or in which a rolling ball apparently traveled over a gap in a platform.

Knowledge of gravity's effects may develop slowly, Spelke and her associates hold. Even adults make many blunders regarding gravity, such as reporting in some cases that an object moving along a surface will fall on a straight-down path if it loses its support.

In the same journal, psychologist Jean M. Mandler of the University of California, San Diego, rejects the notion of innate knowledge. By about 5 months of age, babies begin to develop concepts about the world, such as how objects should move through space, based on what they have seen and otherwise perceived, Mandler contends.

Whatever the case, the "mechanism of thought" appears to develop in parallel with perceptual skills during infancy, Bauer says. *– B. Bower*