

Who Talks and Who Listens

The Question of Whether Whales Possess Language

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From the Interspecies Newsletter

Interspecies is deeply involved in the process of how to test cetacean calls for their language potential. Like everything else we do, we conduct this research from an artist's perspective, which assures that our own lingual exploration offers a radical departure from the controlling techniques developed by cognitive scientists, John Lilly and Lou Herman, whose work focused exclusively on captive animals.

To test whale communication among wild, free-swimming animals, we draw rather insistently on the interactive techniques developed by Interspecies director Jim Nollman. Our whale of choice is the beluga. Hearing belugas converse in the wild makes it easy to believe they possess a true language. Locating the mechanism for this language —for instance, is it time-based like human language or is it frequency-based like the internet — is an extraordinary challenge. Some believe it has to be holosonic, essentially a logical analog to echolocation. Whatever it is, proving it to the scientific community is a daunting task.

To even start, Interspecies needs first to produce an oceanic expedition to gather a new technical level of field recordings to document the entire beluga whale sonic range of 5 Hz to 160 kHz. To put this wide-sonic-spectrum into perspective, realize that until just the past year, almost all scientific research into whale communication was based on recordings made with equipment limited to the human audible spectrum of 20 Hz to 20 kHz. Yet how futile it is for acoustic researchers to study whale communication by examining only 12% of the whale's known frequency range.

What's mostly changed in the past year is the gradual evolution of a new generation of inexpensive digital audio tools that permit the full spectrum recording and analysis of sound in a field situation. In this case, "inexpensive" is a relative term, because it still costs five to ten thousand dollars to purchase the gear. Two years ago, the cost was astronomically higher, and therefore not accessible to researchers like ourselves, unaffiliated with either the military or big-budget university acoustics departments.

Providing

Our task includes the construction of this recording system, the making of the recordings, and the development of a highly skilled multi-disciplinary network of international specialists to test the best hypotheses which try to explain the difficult, fantastic, often arcane and esoteric task of unraveling intra-specific whale communication. Over the past year, a diverse group of whale research professionals including Finnish physicist Rauno Lauhakangas, American digital programmer Mark Fisher, and Norwegian cognitive scientist Preben Wik, have joined this project to help expand the greater network we need to test various theories of cetacean communication. Basically, Interspecies will provide the network with full-spectrum sound recordings, graphic analysis, and an open Internet-based forum for discussion.

Translating Fugues

The late John Lilly devoted several years and millions of dollars trying to develop a “halfway” inter-specific language composed of dolphin whistles and human words. His legion of critics were probably correct in contending that discrete dolphin whistles are not actually words, but something else, perhaps something closer to music, and therefore, attempting to translate dolphin whistles into English is like trying to translate a Bach fugue into English. Nonetheless, Lilly was the foremost pioneer of this field. His research, his speculative writing, and his formidable promotion of both cetacean intellect and soulfulness, has galvanized a new generation to get involved.

The Russian beluga specialist, Anton Chernetsky, believes that belugas vocalize in discreet phonemes, of which he has already isolated twenty-four. Phonemes comprise the acoustic analogue to the letters of an alphabet, the actual sounds we make to communicate through language. Focusing on phonemes as the building blocks of cetacean communication strongly implies that whales have evolved a language similar in structure to human language, comprised of sounds that merge into words, and then sentences. The consensus in our own network is that this idea explains only a part of the process of cetacean communication. One problem with focusing on discovering a parallel with human language, is that cetaceans vocalize their signals through their blowholes not their mouths. Likewise, many of the beluga whale's most prevalent signals actually resemble white noise suggesting an equal harmonic emphasis on a huge swath of the frequency spectrum. Other sounds seem organized around rhythmical structures, patterns in time, rather than sets of differentiated signals, which contradicts the concise phonemic content that humans utilize.

Canadian biologist Peter Beamish argues that communication researchers err to give so much attention to the signals themselves, and offers a different theory called Rhythm-Based Communication (RBC) that attempts to explain not only communication between cetaceans, but between all non-human species. RBC postulates that the actual sounds any animal produces are arbitrary to what is being communicated. In certain instances, animals don't even need to produce audible sounds because, in Beamish's own words, there is nothing “para” about the so-called paranormal. In other words, Beamish believes telepathy is the norm within nature. What matters most is the rhythm or the timing of animal calls.

Beamish offers this example to explain his theory. If whale A makes a sound, followed by a 15 second lapse, then another sound, followed by a 45 second lapse, it will usually prompt any whale B within earshot to lift its head above the water. RBC might be comprehended as the bio-acoustic analog to physics quantum theory, a wildly innovative worldview offered to behavioral biologists in an attempt to explain insurmountable difficulties in whale communication that always arise when the problem is confronted using the old “Newtonian” focus on signals, phonemes, and halfway languages. Like Lilly's ideas from thirty years ago, Beamish's approach remains misunderstood, and universally discredited by mainstream biologists who possess neither the imagination nor the courage to test it. We plan to do just that.

Cognitive scientist, Lou Herman has been studying communication and intellect among captive bottlenose for twenty five years at Kewalo Basin in Hawaii. He focuses almost entirely on *interspecies* communication, relying on a subset of Ameslan hand signals used by the deaf. Yet while Herman's captive dolphins have learned to perform many complex tasks involving the sophisticated abstract concepts of creativity, improvisation and multiple choice, the promise of language ultimately falls short because his code fails to recognize the obvious—that dolphins don't have any hands of their own and can never participate as peers in the discussion. A more subtle complaint is levied against Herman's persistence to base his language studies on young captive dolphins which have never had the opportunity to learn the communication skills this species obviously uses among its own kind in the wild.

Herman's approach is probably best understood as a brilliantly sophisticated training program, based on the awarding of a food reward of dead fish for answering correctly. Despite the fact that this long term study precludes any real chance of a dialogue between species, the basic form of focusing on interspecies relations to learn about dolphin language has much merit. Herman's research remains a prime example of the anthropocentric attitudes of traditional cognitive science in its insistence that research on captive cetaceans is legitimate so long as the distress it causes the animals increases human knowledge.

Echoes as Objects

Bats and toothed whales use echolocation (or sonar) as their main tool for perceiving the own dark or murky environment where vision simply does not work. Sound clicks echo off objects, providing its producer with a three-dimensional kinetic image of, for instance, its prey, even granting precise information about bone structure, which echoes differently than soft tissue. Scientists agree that whales echolocate to perceive their world.

The communication hypothesis we are most keen to explore was developed last summer by Interspecies own Jim Nollman, and bio-acousticians Roman Belikov of the Russian Shirshov Institute as well as Liz von Muggenthaler of the North Carolina-based Fauna Institute. The basic idea is that the common “creaky door” sound produced by several dolphin and whale species is an adaptation of echolocation which has evolved for communication within a social context.

The three researchers postulate that certain species of cetacean are able to retain echoed “pictures” in memory, which they can vocalize to other whales. It can not be overstated that these echoes are not precisely “pictures”, but something unique, closer to holograms displaying three-dimensional, X-ray, and kinetic information. Because the original echoes are almost inconceivably dense with information, and because the same echolocation “images” may be altered by such attenuating factors as current, tide, and spatial distance, the actual communication of social echoes may not consist of simply mimicking the original sonar. One plausible idea is that whales encode the dense, overlapping beats of social echolocation, not within phonemes, but within the similarly dense, overlapping pulses of the harmonic progression.

The human ear hears these same pulses as timbre, the unique quality that distinguishes an oboe from a flute even when both are playing the same note. The fact that the cetacean ear can obviously discriminate exceedingly fast pulses that sound like a single continuous tone to the human ear, and that they perceive a much wider frequency spectrum than humans, suggests that they probably also hear the harmonic beats that comprise vocal timbre.

These beats are actually quite easy to see, to graph, and to analyze on a computer. Belikov believes that the same immense brainpower that whales use to process echolocation, certainly allows for the processing of an echoed language.

This hypothesis seems especially viable because we already know that a large percentage of the social communication between sperm whales and between beluga whales is based on clicks. In fact, the beluga recordings we produced last summer in Russia sometimes sound like radio static. When the static is slowed down electronically, it immediately becomes clear that the perceived white noise is formed of exquisitely precise pulses across a vast harmonic spectrum. Clearly, these pulses are utilized in a social situation. Because echolocation is essentially rhythm-based, our own hypothesis also suggests that Beamish’s unconventional reliance on temporal pattern rather than signal to explain whale communication, offers a feasible technique to find the content within this very incredible form.

The Spanish whale researcher Michel Andre has been studying sperm whale vocalizations for several years in the Canary Islands. In a recent paper, he offers documentation that the individual whales in his study group usually initiate a communication by vocalizing a highly-syncopated variation of its usual social clicks. Andre has demonstrated that these introductory phrases are the sperm whale’s equivalent of the signature whistles other cetaceans use to identify themselves as the speaker of the moment. One of Andre’s assistants is an African drum master who is the only person on their team who can identify, by ear alone, individual whales by their unique rhythm patterns. By a bizarre process of convergent evolution, the sperm whales signature whistles are identical to the rhythmical patterns developed in West African drum communication.

How To Communicate

Demonstrating communication among wild animals involves several difficult problems that must be solved almost simultaneously. First we must be able to identify the participants in a dialogue as

animal A and Animal B. Then we must decipher what Animal A is articulating to Animal B. And third, we need to show that Animal B made the anticipated response to the information communicated by Animal A. The problems are daunting when one realizes that these animals live 95% of their lives underwater. That explains why almost no one has ever undertaken the task with wild animals.

That whales vocalize a good deal of the time ultrasonically, beyond human ears as well as the standard lot of audio recording tools, is another problem awaiting solution. Another problem involves identifying individuals just by their voices. Biologists have solved this last one by setting up expensive hydrophone arrays that permit triangulation on a sound source. If the whales they are studying happen to be orcas from the visually-identifiable Puget Sound population, it's occasionally possible to match a specific call with a specific surfacing animal. Using that same triangulation with all-white, dorsal finless, beluga whales that can not be so easily identified by obvious visual characteristics remains impossible.

To solve the problem, we propose the development of "voice printing" technology for whales. This operates on the common technology that now allows a person to speak a command to start up his computer in the morning although the same command spoken by somebody else gets no response. It's a trivial miracle, handled by the timbre-graphing mathematics known as *Fast Fourier Transform*. Every individual's timbre, whether human or whale, displays its own unique characteristics which a computer can map and possibly track as well. As long as the timbre remains vaguely constant, we know it's the same whale speaking. If two whales are identified, calling and responding several times in succession, then we know we have a dialogue. Unlike triangulation, we never need to actually see the whales we are identifying.

Studying echolocation as a potential basis for beluga whale language also involves confronting dynamic issues that do not occur in other forms of communication. Knowing the distance between an echolocating whale and the echolocated object is critical because it determines both the frequency and the repetition rate of the click train. Since echolocation is an issue of physics as much as perception, we hope to measure the relationship between distance, pitch, and click rate by documenting how these ratios vary as whales click on an underwater camera we suspend in their domain.

It has also been suggested that we consult with programmers of submarine sonar and commercially available fish finders. We are already doing this. One of our colleagues has speculated that one day in some plausible future, we will be able to record echolocating whales and simultaneously watch the sonar get translated into objects on a video screen. Even more science-fiction, is the opposite idea that we someday we can draw objects on a screen which a computer will translate into a click stream identical to a whale's own echolocation.

Animal B

Demonstrating the fundamental aspects of cetacean communication may not prove as technically daunting as this discussion otherwise implies. Framing our challenge in its simplest terms, what we seek initially is clear verification that animal A and B can and do engage in an acoustic call and response, and that this communication between individuals causes a predictable alteration in each other's behavior. In fact, Interspecies has already developed working methods to test this form of acoustic relationship. The way we do it, a human musician takes on the role of animal B. For one example, hearing an orca vocalize a melodic call anchored in the key of C, a guitarist precisely mimics the call but in the key of D. It is hardly uncommon that the orca will likewise respond to the guitarist with his call modulated up a whole step to D. Once in a great while, an orca will actually respond in the key of E, suggesting that the initiated communication is not a basis for rather mindless mimicry, but for pattern recognition and therefore, the appropriate response is another whole tone shift.

Unfortunately, a guitar can neither mimic a whale's timbre, nor emulate its incredibly wide-band frequency spectrum. But a computer can. A number of the latest generation of software samplers can easily be programmed to mimic a whale's timbre across the varying notes of the chromatic

scale, and even modulate its reflected response in any of several logical ways. Using a Macintosh "virtual sampler" called the EXS24 developed by Emagic, Interspecies Inc has begun developing sophisticated procedures for call and response. We tried it last July, working with beluga whales in Russia, and in September with a vast herd of 300 Pacific white Sided dolphins, humpback whales, and orcas off the northern tip of Vancouver island. Our sampler based call and response relies on ideas based in everything from game theory to advanced harmony to Indian raga song structures, and even to the wildly eccentric idea of closely emulating whale calls with bird song.

— Jim Nollman, December 2001