Talking to Whales

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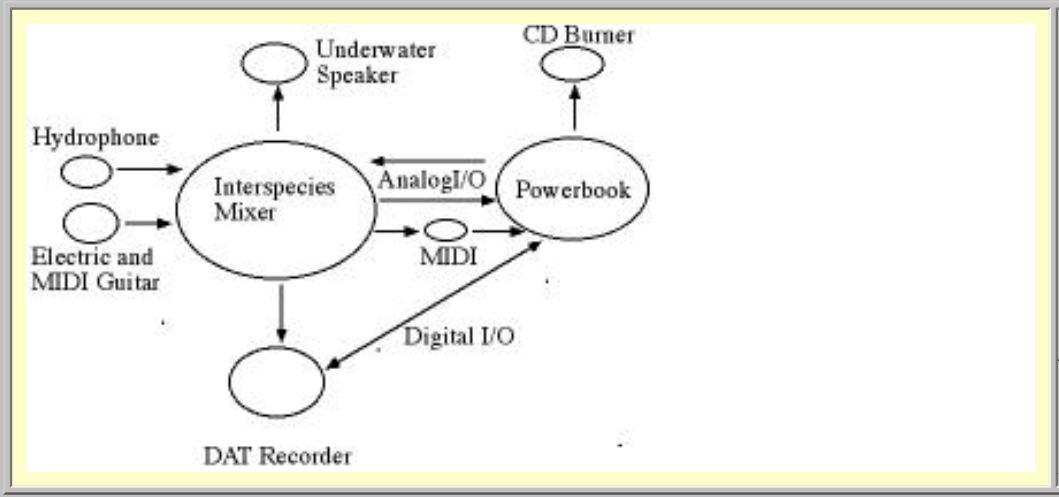

All the most interesting speculation about whether whales possess true language remains largely ignored by the scientific community.

Despite stunning advances in recording and audio analysis technology, almost no one in the mainstream is even researching the question of whether certain species of toothed whales possess true language. What is being studied, is woefully inadequate, suffering on two fronts. One is technical, the other reflects an outdated paradigm.

1. Communication research with toothed whales is basically a folly unless the full frequency spectrum of the whale's calls is recorded and analyzed. What researchers get when they rely on technology (DAT, computer sound cards, audio cassettes) geared to record human audible sound (15 hz.-20 khz) is about 10% of the frequency spectrum that the whales themselves are using. It is somewhat like trying to learn a new language by deleting nine out of ten words in a text.

2. In a display of illogical anthropocentrism, many biologists still insist that if a cetacean possesses a genuine language, this language must possess characteristics analogous to human language. So the researchers primarily look for words and sentences, and when they find none, conclude there is no language. Or in another well-known example, cognitive scientists conduct consciousness research on captive dolphins using sign language based on hand signals, although, of course, the dolphins do not have hands. Relying on captive animals is also folly, since the use of language is probably tied to social groups possessing common history.

The best hypotheses to emerge over the past few years pay attention to the unique attributes of whale perception. Unlike humans, these species — dolphins, belugas, orcas, cachalot — perceive the world primarily through echolocation, not sight. They vocalize to each other using a frequency spectrum twenty times wider than humans can hear. They perceive pulses of sound measured in the thousandths of a second. If there is a language, it is very likely to be grounded in these sonic capabilities. If there is a language, it is likely to be modeled on echolocation. We might think of a whale's brain as a computer with an extra, sophisticated chip for processing audio information, while scientists are still listening to them as they listen to communicating humans, relying on a brain/processor with its own sophisticated chip that processes visual information.

Researchers for the Russian Academy of Science have been studying the acoustic behavior of beluga whales in the White Sea for ten years, accumulating evidence that the local pods consistently use hundreds of identifiable sound strings (described as "words") based on at least 24 different phonemes. Interspecies.com consulted with the Academy's research team over two recent summers. We concluded that the phonemes are clearly present. But the idea that these phonemes might produce "words" is wishful thinking.

The Problem of Whales

Correlating behavior with sound syntax is a key task to researching communication with any species. This correlation becomes an immensely difficult task when the species are cetaceans:

1. Whales spend most of their lives underwater which makes it hard to correlate vocalizations with social behavior.

2. Toothed whales vocalize across a broader frequency range than humans. In the beluga's case the range goes from the infrasonic up to at least 150 khz. We can't hear all the sounds they produce. Specialized audio equipment to handle the task is expensive and often unfieldworthy.

3. Whales generate most of their socially based sounds through the blowhole rather than the mouth. This produces exotic phonemes difficult for humans to distinguish.

Vertical language

Consider an audio graph that displays frequency on the vertical y axis, and time on the horizontal x axis. The hypothesis proposes that whale language is very likely frequency-based, and is thus defined as a vertical language. Human language is, by contrast, primarily time-based: a horizontal language. Why? Because the frequencies of human communication are quite secondary to the stringing together of sounds into words into

sentences into paragraphs, all of which demands the element of time to resolve meaning. To confuse matters further, there may also be a third coordinate — amplitude or volume — which so far, no one knows how to fold into a meaningful hypothesis. However, three coordinates offer the possibility of three dimensions, which would be especially useful to a cetacean moving easily within water's three dimensions (up/down, sideways, forward/back).

The vertical language hypothesis considers that a beluga whale might be communicating a vast amount of information in almost no time, vocalizing a few very-wide-spectrum clicks in a hundredth of a second or faster. In fact, beluga whales do communicate with one another using a sound that human ears hear as a kind of dense radio static. A better metaphor than static is what the internet sounds like when we hear it on a telephone handset. This beluga sound can be resolved on a computer screen as individual bursts of very dense clicks beating as quickly as .002 seconds. It has been suggested that instead of looking for a whale language that is similar to human language, we ought to be looking at whale language as an analog to the way wide-spectrum audio is used to carry internet information over phone lines.

(Hear beluga sounds)

If this static is a language, then where within any beluga whale call is the information encoded? One of the best answers is that it is pulse-based, a function of the beats that occur within harmonic interference patterns (HIP). Harmonic interference is the basis of timbre, the physical action that "colors sound", as pure tones across octaves alter each other when sounded together. You can hear these beats for yourself whenever you turn the tuners on a guitar. The easily noticeable beats disappear as two strings come into tune.

Employing such a wide bandwidth of calls, a beluga whale has hundreds, perhaps thousands of octaves at their disposal. With the potential of so many beats occurring simultaneously, if indeed this species has evolved the skill to control the interference patterns that produce timbre, then vast amounts of information can conceivably be communicated in split seconds.

Michel Andre, is the chairman of the European Cetacean Society, and a long time researcher of communication in cachalots or sperm whales. Cachalot social ommunication is comprised almost entirely of wide-spectrum clicks. In a personal conversation in 2003, Michel confided to me that he believes the information is somehow encoded within the silence between these clicks. When I pressed him to qualify his statement, he acknowledged that because the information is nowhere evident, at least as a function of time, cachalot language may also be vertical.

There are now some younger scientists who are excited to test the key concepts in this essay. So we believe that a new generation of biologists and cognitive scientists will start to produce full-spectrum recordings, woith the intent of analyzing toothed whale calls , searching for the language we sincerely believe resides within those calls.

New technology to aid the study of whale language

Despite the many inherent difficulties, recent advances in digital signal processing (DSP), pattern recognition based on Fast Fourier Transforms (FFT), and MIDI technology offer the creative researcher sophisticated computer tools to analyze animal calls for content and structure. This audio technology also lets us develop a dynamic interface keyed to the sonic signature of individual whales. The function is similar to voice recognition software that lets a person turn on a computer by speaking the words "turn on". In this case a voice serves as a trigger, whereas if another person speaks the same words, nothing happens.

Being able to recognize individual whales by voice signature is in itself a breakthrough in whale research. Up until now, the only way it's been possible is by employing hydrophones in a triangular array, pinpointing the position of the vocalizing individual, which can then be correlated with a surface identification of that whale.

Triangulation hardware is expensive to develop and maintain, and demands a trained observer devoted entirely to identifying whales by their markings. Even then, it's hit and miss for the simple reason that cetaceans spend 95% of their lives underwater, and the system ultimately depends on identifying vocalizing whales on the surface.

Who's talking?

However impressive a first step it may be to identify vocalizing individuals entirely from audio data, it is not just the isolated voice a language researcher seeks, but the social interactions triggered by that vocalizing whale. If another animal vocally responds to that initial call, what attributes of the first call determines the attributes of the second animal's change in behavior? Asking those questions out on the water, a researcher begins to piece together the structure of dialogue between individual whales. If they can map a conversational syntax, they may learn how to engage the whales in a dialogue with themselves.

Recent acoustic studies with bottlenose dolphins off the coast of Scotland and with Michel Andre's cachalots In the Canary islands, have shown that both species instigate a dialogue by vocalizing its own signature and the signature of its correspondent. Think of these two signature calls as that animal's own name for itself as well as the name individual receiving the message. It has been conjectured that this identification process allows members of a large pod of constantly vocalizing animals to carry on multiple dialogues at the same time.

Cachalotsare a special case because the species uses the same basic clicking rhythms for social intercourse as they do for echolocation. Echolocation, of course, contains visual and spatial information about the animal's environment. If similar echolocation clicks also comprise the basis of social communication, it suggests that sperm whales talk to one another by vocalizing a three-dimensional, X-

ray analog of recent events. We have lately been referring to this conjectured communication medium as holosonic projection.

Many speculative ideas have arisen to explain the mysterious potential of echolocation as the basisa of toothed whale language. One of our own correspondents, Finnish cultural anthropologist Jöns Carlson, speculates that belugas may not be talking to one another in a "language" (as humans define that term). They may use sound instead, to externalize and communalise their own emotional state as it relates to the group's stability. Carlson's idea reflects a common non-lingual use of human sound. Chanting and other forms of spiritual music likewise affects a group's experience of communal joy. It is even suggested that we human beings first started playing music, eons ago, so we might feel as good about life on Earth as the birds do.

Certainly, when we sing and dance together, we feel a part of a genuine community, even if temporary. Since community is the essence of every social animal's survival strategy, a communal emphasis to comprehending beluga sound production makes sense. Jöns Carlson takes it a poetic step further, declaring that it is impossible for a human to imagine the mental state that must accompany cetaceans dancing through life in three dimensions. He concludes that vocalizing belugas are like Chinese dancers who wave banners to accentuate their own vitality.

Buddhist Vipassana meditation teaches its aspirants to perceive thoughts and words as harmonic vibration. Aspirants learn to disregard their actual thoughts, and begin to perceive brain operations as waves triggered by electrical impulse. Foregoing content, they open to the possibility of tuning our minds to the rhythms of the body. Meditators promote this consciousness expansion as a basis of healing and enlightenment.

Since beluga whales vocalize in a sonic spectrum ten or twelve times as wide as a humans and with commensurately refined sensitivity, the opportunities for reflecting upon vibration as a source of healing and attunement may also be that much more advanced. Add in the perceptual realm of echolocation, and it becomes obvious that cetaceans are acutely sensitive to high frequency vibration in ways human beings can not even imagine.

Therapist Patricia Saint John conjectures that dolphin sound-making positively affects the introverted behavior of autistic children. Seeking an explanation for the phenomenon, she has hypothesized that the dolphins focus a beam of infrasonic sound (below the lowest note humans hear) which resonates a brain otherwise crippled to external stimulus. It's as if bottlenose dolphin's make a gift of the same alpha waves attained through Vipassana meditation.

What about Proof?

But let's be clear. There is no way, at least yet, to "prove" that beluga calls express mental health and/or

group harmony. The problem of proof, however, offers its own interesting corollary. At a time when pro-active scientific research remains radical and therefore non-existent, the only parameters of whale sound-making that traditional biologists seem willing to test are the parameters that human beings already understand abpout human communication. Otherwise, there can be no basis for measurement. And traditional biology operates by measuring. Or stated another way, any attempt to study cetacean communication insists that researchers open themselves to non-traditional ideas about "animals", some of which seem like fertile ground for science fiction. The philosphical implications clearly impede the science.

The Raucus Party

In my last book, The Charged Border: Where Whales and Humans Meet, I wrote:

> Belugas were called sea canaries by 19th century whalers for the way they chirp and chortle among their own kind. Many beluga calls are audible to a human ear. They are also among the few cetacean species to naturally vocalize in air. Listening to them vocalize to one another at Lancaster Sound in the Canadian High Arctic, the discourse reminded me of a raucous party heard through the walls of an apartment building. I intuited that the revelers were indeed talking coherently to one another, although individual words could not be discerned.

The implications of a whale language are profound. In a way, demonstrating that language is not a unique talent of the human intellect, is akin to Copernicus showing that the universe did not revolve around the Earth. How tragic that we have finally found ET, alive and well and living in the Arctic, and the only thing we know to do with this intelligent being is kill it for sport and dice a bit of its blubber into cubes for snacking. The government's SETI project spends millions of dollars searching space, while our project scrounges for used computer parts.

The Beluga Game

Game Theory seems one of the most promising methodologies to develop if we hope to engage wild whales in a way that encourages language research. Consider a computer game that relies on well-established ideas of audio sampling, digital signal processing and game theory. The game is based on the belugas' own calls, modulating them in some logical fashion, and then regenerating the altered calls back into the water in as close to real time as possible. Based on the whales vocalizations, the output is re-shaped with the primary objective of entertaining these same whales.

Being a game, the sounds must not only engage the whales curiosity, but offer clear hints just how their vocal and spatial input actually controls the output. Once they learn this, we plan to up the ante, and give the whales full control over the modulation process itself. Recent advances in audio software makes the

idea of this game not only plausible, but quite irresistible. Nonetheless, to succeed will take great patience and humility, and a willingness to listen closely to the responses of the Other.

Choosing the initial vocal attributes that control modulation lies at the heart of this process. All of us involved agree that setting the parameters best occurs while working directly with the whales. As the belugas respond or desist, we simply adapt the parameters to the situation. There are, however, a few things we can assume:

1. Since FFT grants the capability to recognize individual voices, we can focus the game's response on individuals rather than on calls made by the anonymous group.

2. It seems counterproductive to get too abstract or even artistic with our modulated output. As the output strays from its kernal of whale sound, it loses the potential for interactivity.

3. If we focus on whale sounds that demonstrate a clear beginning and end, the possibility arises that we may not only be devising a sound game, but a word game as well.

4. The specific rules of the game need be logically-based to facilitate a valid scientific analysis. For example, if a whale calls in middle C, then the machine might respond by shifting that call an octave higher.

Our modulation toolkit is adapted from filtering techniques used commonly by recording engineers, and includes slap-back echo, flanging, chorusing, and gating. The two related digital audio filters of shifting pitch without altering time, and time shift without altering pitch present an obvious combination easy to comprehend. I am especially interested in looping algorithms that rely on time and repetition.

A simple example might explain the game better than an abstract description. Beluga whales hear sound roughly from 10 hz up to 150 khz. The human ear functions between roughly 15 hz and 20 khz. What if we let the game respond to every high frequency call by transposing it down to 20 Khz before re-circulating it into the water? Concomitantly, low frequency calls are re-circulated at 60 Hz. The possibility arises that the whales may eventually comprehend that they are dealing with a species possessed of very limited hearing. Regard it as a lesson that naturally communicates other lessons.

Finding a Research Sponsor

I have expressed many ideas here, but not given a lot of answers. The more talent we involve in the discussion concerning the relationships between input and output, whale and human, the better chance we have not to miss some wild and crazy idea that could conceivably engender a breakthrough.

But the opposite also holds true. We must never lose sight that these animals are marine mammals, not

humans in whale suits. They appear to us joyous, exuberant, and exceedingly vulnerable to any alteration of habitat. If the sound we produce disturbs them, we are prepared to adapt or even stop it altogether. Unfortunately, the concept of technological hubris doesn't get enough emphasis in these times when every problem seems to have a digital solution ready to download next week.

On a personal note, Interspecies has failed dismally in its own fundraising efforts to test these ideas. The main problem seems to be that the foundation world views us as an arts organization, and this work is viewed as science. We don't agree with this assessment since the work is actually an extension of computer audio, and we at Interspecies are computer audio professionals. Nonetheless, our non-profit struggles to make ends meet in this down-economy, with the result that Interspecies.com does not possess the necessary budget to purchase the necessary recording equipment or to produce a cogent field project.

—Jim Nollman, April 2004

For more information about this project, or to suggest ideas about funding, please contact us by email.

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