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THE NOT SO DUMB ANIMALS

"I think, therefore I am," cogito ergo sum, Cartesius said. Thinking was identified with being: with being human. Embodied and expressed in human language, thinking: the experience of the mind was what made humans human, what distinguished them, qualitatively, from the rest of the animal kingdom. Animals, on the other hand, were deemed to be machines: programmed computers, no matter how complex, bereft of the ability to think, to use symbols, to abstract, to form language, to fashion tools. Governed by built-in mechanisms and processes, the animal "mind" was thought to be incapable of forming intentions or even mental images, linking the immediate present to the past or the future.

How do we know?

"He dreams, therefore he thinks," one might propose, instead.

We know that animals dream.

My English setter is stretched out on the rug near the fire place. He is lying on his side, after a day of joyfully chasing birds, pursuing scents of squirrels and woodchucks. His nostrils are quivering in his sleep. His legs begin to twitch, to move forward and backward. He is running in his dream. Now he must have spotted something: He is barking, a peculiar sleep-barking that seems to come from the depth of his abdominal cavity, ventriloquially, without his opening his mouth. Now maybe the prey is escaping: for he is whining, in the same peculiar unmistakable dog-dream fashion.

It must have been a "mental image" that moved the dog. And a strong and vivid one at that. We do not know what it was, for he cannot tell us. ~~Or more exactly, perhaps we do not understand what he might be "telling" us. Perhaps we do~~

But if he can form "mental images" -- that is, "think" -- in his dream, it is more than likely that he can do it awake.

not even want to understand because, deep down, we feel a threat to our "human chauvinism," the gratifying conviction that we are the god-given overlords of this universe.

That unwillingness to give up this conviction has in fact slowed down research on animal intelligence is well known by now and frankly admitted. Donald Griffin tells us in his book, The Question of Animal Awareness: Evolutionary Continuity of Mental Experience, how his own research on the orientation capability of migrating birds was retarded by human chauvinism or anthropocentric conservatism. Though suspecting that they might orient themselves by the sun and the stars, he let himself be discouraged by such "realistic" objections as, "why, the poor birds would need to carry around a whole set of tables, a sort of almanac, to correct for the motions of the sun and the stars across the sky!" It took more than twenty years until it was actually discovered that birds are capable of making corrections for the motion of sun and stars across the sky and that they indeed practice time-compensated sun and star-orientation.

Similar delays, caused by the deep-seated reluctance to having to adjust to a basically different Weltanschauung slowed down Griffin's research on the echo-sounding capabilities of bats, which he discovered, and von Frisch's spectacular discovery of the language of the bees. "Ignoring the possible existence of mental experience and conscious intent in animals may have held back our scientific progress in this important field," Griffin notes. "This question leads to another," he concludes. "What are we now overlooking as a result of comparable restrictions imposed on the questions we ask, by our basic viewpoint about the nature of animal and human behavior?"

No matter how slow to come, the discoveries in the field of animal intelligence over the past quarter of a century have been amazing. One after the other, the basic, qualitative distinctions between man and beast have been demolished. Even the most exquisitely human attributes, art and religion, can now be traced back to some form of proto-art and proto-religion in the animal kingdom.

Some of the simplest animals use tools. Among insects, the wasp Ammophila uses a pebble as a "hammer" to beat down the soil around the opening of its burrow; the ants Polyrachis and Oecophylla fasten together leaves with silken threads produced by their own larvae whom the adult ants wield in their mandibles like tubes of glue.

Octopuses are known to jam mollusk shells with pebbles or other hard objects to prevent them from closing while they suck up the flesh.

Among "higher" animals, some finches of the Galapagos Islands have been observed to utilize cactus spines, which they hold in their beaks, to pry out insects from bark fissures. The bowerbirds of Australia make paints out of powdered charcoal, fruit pulp or chewed up grasses mixed with saliva. They also make paint-brushes -- wads of bark -- with which to apply the paint to the walls of their bowers.

The California sea otter uses stones to crack open the shells of molluscs on which it feeds. Elephants make themselves fly-swatters out of leafy branches, and chimps carefully prepare sticks to poke for ants and termites. Chimps also make "sponges" out of chewed-up leaves, with which they draw water from otherwise inaccessible scources.

These are facts, relatively easy to observe and quite irrefutable. Homo faber, man the tool-user, is a tool-user among many other tool-using species.

But more than using tools, animals have developed veritable technologies. By technology we mean more than tool using or even tool making. We mean the sum total of the transformations and utilizations of our environment according to our needs or desires. In this sense, we now know that there is such a thing as animal technology. Only that we still know very little about it.

For unwillingness to discover human-like phenomena in the animal kingdom goes together with inability: in general, we see only what we already know and are ready to see. We discover only what we have already invented in our minds or, at any rate, are ready to invent. This is why discoveries "fit into their time," are created by their time just as much as they create it.

We know so little about animal technology because our own technology is still so rudimentary. Step by step, as it evolves, our understanding of animal technology evolves with it.

Three types of animal technology which have been discovered over the past decades may serve as examples: the food-gathering technologies of the animals of the sea; the orientation and navigation technologies of fish, birds, and insects; and, related to these, the technologies of communication, leading up to the creation of language. For, in a sense, language, too, is technology, and vice versa, technology has been described, by the theologians of the Ecumenical Council Vatican II, as the "new universal language."

Fishes fish. And their fishing gear ranges from simple fishing nets to lines and hooks, spears and harpoons, sophisticated chemicals, and electronic gear and sonar for locating their catch.

Far back in the history of life, the first fishing net was operated by a tiny animal, an urochordate, the so-called larvacean. The animal is wormlike, with an enlarged head containing a simple nervous system. The larvacean builds itself a gelatinous house in which it deploys a system of large nets made of strong, fine threads. The house has three gates. Two of them serve as water inlet and outlet, maintaining a gentle flow of water through the nets. The third is the emergency exit. When the nets become clogged or otherwise malfunction, the larvacean slips out through the third door and builds itself a new house, with a new array of nets.

Fishing with rod and line was practiced, long before humans appeared on the scene, by the angler fish. Rod and line, called the illicium, protrude from just above the mouth. The illicium may be four times as long as the animal itself, and is equipped with a light at the end which can be switched on and off and is used as a bait.

Swordfish and narwhal are well armed spear fishers. Sea-slugs, anemonies, corals and many jellyfish have perfected the harpoon, and sharks, as well as many other fish, have developed a vibration-sensitive mechanism, the so-called lateralis system, that enables them to locate such disturbances as a ship sinking miles away. The shark can also use this mechanism to actively echo-locate objects by the time relation of reflected vibrations he emits himself.

The sperm whale possesses a highly developed long-range hunting sonar enabling him to precision-target squid or fish in the ocean depth from a distance of several miles; and the dolphin's echo-locating is so precise that he can identify not only the distance of an object and its precise shape but he can also distinguish its substance: whether metal or plastic, wood or rubber.

How eels or salmon, turtles or flocks of migrating birds orient their course during their globe-spanning migrations has long been a mystery. Animals have an *intelligence*, that is, a capacity to inter-relate (*inter-ligere*) data to which we humans fail to relate.

The olfactory sense in some fish is so highly developed that they can detect a scent even if diluted ~~millionfold~~ a hundred thousand fold. Salmon, it is assumed, orient themselves by scent -- at least to some extent. Currents are another navigational aid, for "senseless" beasts just as for human navigators. There are fishes, so-called electric fishes, who produce their own electricity. They orient themselves by sensing changes in the electric fields produced by their own electric organs. Birds not only understand the motion of sun and stars: there is recent evidence that they can sense, and orient by, the magnetic field of the earth! The same has been demonstrated for some insects and fish. Thus the compass was invented many millions of years before the Chinese reinvented it a mere thousand years ago.

What is peculiar about animal technology is that it is "built in." It may be built into the body structure, or it may be built into genetically determined behavior patterns. In either case the individual inherits it with its set of genes. Thus among animals the cost of education is low, technology is cheap, and there are no revolutions. To a very large extent, this seems to be so. On the other hand, there is evidence that at least some degree of learning occurs even among rather primitive animals. Some sort of nongenetic "transmission of culture" can be observed in many species, which leaves a certain margin of variability or freedom in the individual's response to differences in environment.

In human technology, on the other hand, the emphasis is on learning, on what is individually acquired, even thoug it is at present a wide open question how much is genetically or specifically determined. At any rate, there appears to be a wider margin of variability or freedom. The outcome is more rapid change, instability, "scientific revolution."

It is possible, however, that this is transitory in human evolution, of the duration of a few thousand years. It is quite possible that we are moving toward a new level of stability: that our technology will be "built in" again, in a way. Thus the physicist Werner Heisenberg predicted that "In the future many of our technical apparatuses will perhaps belong as inescapably to man as the snail's shell does to the snail or the spider web does to the spider. The apparatus would then be rather a part of the human organism." This may have to be taken with a grain of salt: metaphorically rather than literally. But the emphasis, again, is on "built in." Built into the "social genes," into the culture.

The same technologies that animals use to orient themselves in their environment, they also use to orient themselves vis-a-vis one another. In other words: they use visual, acoustic, olfactory, chemical or electric signals they produce, to build their systems of communication: systems that become more elaborate and complex in proportion to the complexity of social organization of a species.

We are just at the bare beginnings of learning to understand these systems. Many animals are indeed more successful in learning *our* language than we are in learning *theirs*!

We know that the great whales and their smaller cousins, the dolphins, have elaborate systems of communication. Reels of records have been taken. We know that whales dive to a certain submarine level where acoustic messages are carried for hundreds, even thousands of miles; that the range of social organization of whales is as large as the range of communication; that the whale community dies if the system of communication is disrupted. But what are the messages?

According to one theory the sound countours of objects might be used as "words." Another theory proposed that different whistle sounds play the role, in dolphin language, that syllables play in human language. They are the "phonemes", that can be combined into a great number of "morphemes," that is, significant messages. Eighteen different "phonemes" have been identified: which would give rise to a very large vocabulary of morphemes.

But all this was still guesswork. Then there was silence. The navies, both the U.S. and the Soviet navies, established, for all practical purposes, a monopoly on dolphin communication research, and the results were classified as top military secrets. A few facts, however, trickled down to those who wanted to know.

Dolphin intelligence, it appears, defies all traditional concepts of animal intelligence. Dolphins are able to learn the most complex tasks, and in the most unusual fashion. For instance, a dolphin learns to traverse, on command, hundreds of miles of open ocean (incidentally, the dolphin's behavior in the open ocean is totally different from that of his brother in captivity in a laboratory), to direct himself into the harbor of Havana, identify a certain determined Soviet warship, attach a package to the ship, leave the harbor, stay away for a determined period of days, return to the harbor, relocate the package on the ship, retrieve it and bring it back to his base. This task he learns, not by trial and error, not by "re-inforcement," that is the trainer's rewarding, step by step, the successful execution of a task -- the dolphin understands: "We think him through," the trainer says, meaning that the dolphin learns by telepathic communication, and he learns at the first trial.

This opens vast new vistas. Only that it is appalling to think that these vistas should open towards war and destruction rather than towards peace and understanding. The dolphins do not belong to any one nation. They belong to the oceans which, according to the emerging law of the sea, are common heritage and can be used for peaceful purposes only. The use of the dolphin as an instrument of war and destruction is a flagrant violation of this law. Apart from the fact that it exposes this unique animal to whole-sale extermination in case of international conflict: for dolphin-soldiers do not wear uniforms, and who can tell a trained or "enemy" dolphin from an untrained or "natural" one?

Far more is generally known about the decoding of the language of the bees by Professor Karl von Frisch, whose discoveries have been hailed by another great biologist, J.B.S. Haldane, as "a landmark in human achievement, comparable with Champollion's elucidation of hieroglyphics."

Thanks to the experiments von Frisch and his school conducted through decades with truly amazing patience, ingenuity, and intellectual elegance, we know today what the bees say to one another and how they say it. A scouting bee, returning to the hive, for example may say, "There is a large supply of nectar of a high sugar content on a flowering linden tree three and a half miles from here if you keep flying straight north-northeast. Let's all go there!" The nature of the food is communicated by the bee by disgorging a sample from her honey stomach for her fellow bees to taste. This is simple. The quantity of the discovered food supply is indicated by the degree of excitement accompanying the communication, and its duration. Distance and direction ofthe food site are indicated by a simple "circular dance" for very close sites, by a "wagging dance" for longer distances: tracing figure eights, the direction of the straight axix indicating the direction, the rhythm of the tail wagging specifying the distance. All this means that these ahimals have developed <u>symbols</u> to describe reality.

But bees do even more than use a "symbolic" language to communicate to one another rather complex concatenations of facts. They argue; they discuss; they deliberate. They vote and make joint decisions.

This has been observed -- and confirmed and recorded -- at the moment of "swarming," that is, when a young queen, followed by a part of the population, leaves the hive and sets out for a new abode. At that time scouts fly out in all directions to look for suitable sites for the new home. They return, and communicate to the others what they have found: distance, direction, smell, and degree of over-all desirability. Other bees follow their indications, fly out, come back, and advocate with various intensity -- with various conviction and convincingness, their findings. Some groups gain more adherents than others. Bees who initially advocated one site, get "converted" to another. This goes on, sometimes for hours, sometimes for days, until the whole throng expresses in a unanimous dance -- all figure eights in one direction, all wagging following one rhythm -- its unanimous acceptance of one determined site: whereupon the swarm takes wing and departs.

Until just recently people believed, scientists insisted, and philosophers desperately clung to the notion, that the great apes were incapable of language, theirs or ours. The pathetic failure of the simian vocal chords in pronouncing, after years of instruction, such simple words as "mamma" or "cup" was taken as a failure in language learning as such. This, it would appear, was based on an inadmissibly narrow and literal interpretation of the meaning of language, linking it inextricably, physically, to "tongue." If language, instead, is understood as a system of communication including the use of symbols and abstractions and their syntactic ordering, then language may indeed be all around us.

Recent work with the great apes has followed three different lines of approach. Each of them has given rather spectacular results apt to upset traditional notions of humanity and animality.

The simplest, most "natural" way of teaching apes language is to utilize their innate capacity to gesticulate by teaching them deaf-mute language or "Ameslan." This was first achieved by a couple of psychologists, the Gardners, at the University of Nevada at Reno, working with a young chimpanzee named Washoe. It has since been repeated with other chimps and, more recently, with a gorilla named Koko at Stanford.

After fifty-one months of training, the five-year old Washoe was able to use 132 Ameslan signs to express herself and could recognize hundreds more that were signed to her. Koko, now seven years old, uses a current working vocabulary of 375 signs actively although she too responds to many more. What is remarkable in both cases is the apes' ability to express their own feelings and comments (on seeing a horse with a bit in its mouth, Koko signed "horse sad." Questioned, "why sad?" she signed, "teeth."), to use abstract terms (Washoe's vocabulary includes "imagine," "understand," "curious," "idea," etc.), and to recombine what they have learned in novel and creative ways, like calling a water melon a "candy drink" or "drink fruit." Current journal and popular magazine literature is full of enchanting episodes of the linguistic learning career of these animals, which we need not repeat here.

The second approach, developed by David Premak at Santa Barbara and, later, at Indiana University, was to teach the apes the use of plastic tokens: word symbols that they could manipulate and order. This method had the advantage that it offered a visual representation of syntax: nouns, verbs, adjectives, pronouns and adverbs had different shapes, ~~and within each class of words, each one had its special~~ sizes, and colors. The chimps -- Sarah outstanding among them -- learned the order of words: subject, verb, object. They even learned the construction of questions and ~~negative~~ conditional sentences.

The third approachis to teach the animal the use of a typewriter or computer console. Letters may be marked on the keys, and each letter might stand for a different object or concept. Animals can also be taught to compose letters into words, although this makes matters unnecessarily complicated.

The typewriter or computer method has the advantage that it is readily adaptable to other animals: animals that do not have hands but can operate the keyboard by snout.

I myself trained a dog, Arlecchino, to operate a specially adapted electric typewriter, back in the early sixties. He could distinguish seventeen letters and form sequences or "words" under dictation. The words had no meaning for him, or so it would appear. Typing was a mechanical process, as it often is for human typists who, after long practice, have the sequences "in their fingers." There was, however, one exception: When I asked Arlecchino, "where do you want to go? Do you want to go into the...?", he infallibly typed c-a-r, car riding being his favored pastime. He got infact so excited by the prospect that he would, occasionally "stammer" on the typewriter. c-c-c-a-a-r, he might produce.

The keyboard also can be adapted to test other abilities and means of expression. Presently I am teaching my dogs music. One of them, Arlecchino's granddaughter Arlette, is truly musical, and her ability to learn rhythms and melodies (white keys only) is rather surprising. She had her public debut on CBS, where she played the opening bars of Tannhäuser.

Thus we are well on the way towards a revolution in communication with the not-so-dumb animals, and in the process a number of other facts have been discovered which only twenty or twenty-five years ago would have been relegated to the realm of fairytales.

Animals can count. Birds and squirrels probably cannot count beyond 5 or 7. We do not really know the limits of counting in elephants, dolphins or apes. Even birds and squirrels can "translate" "heard" numbers (number of gong- or drum-beats) into "seen" numbers (number of dots or other units on a screen), and they can be taught to play all sorts of games with numbers: a bit of set theory, a glimpse of new math. Animals can learn to distinguish abstract forms -- whether geometric figures or letters, and to recognize pictures. They can abstract concepts such as "triangleness," so that, once taught to identify a triangle, they will identify it no matter what its shape, size, or color. At Harvard, Richard Herrnstein trained pigeons to look at 35 mm. color slides and to "report" whether there were any human beings in the picture or not. The slides came from all parts of the world and presented all sorts of settings and backgrounds. The human beings were men, women, and children of all races. Sometimes they were visible in the far distance; sometimes they were almost totally covered up by intervening objects. The precision of these animals was simply amazing. "More than once we have found," writes Herrnstein, "that we had misclassified a picture ourselves, either failing to see a hidden person or seeing one where there was none, only to be corrected by our pigeons."

Herrnstein's conclusions are significant. "With this work we have shown that a pigeon, and presumably other animals, can be taught to employ a <u>concept</u> that is defined at a higher level of abstraction than simple geometrical form....This new work suggests a direction that might be characterized as <u>conceptual capacity</u>. One can think of human concepts as arranged in a hierarchy, going from those which are defined in terms of fixed physical properties, such as 'triangle,' to those whose definition we might well despair of ever staging, such as 'justice.' Our pigeons have established their claim to a level in the hierarchy somewhat above the base....How high in the hierarchy they or other animals can go has yet to be found."

The question, which species of animals is the most intelligent one, really is a wrong question to ask: for if we answer, "the ape," or "the elephant," or "the dolphin," we do so merely because we find their intelligence more closely relating to our own. Other animals -- birds, fish, and insects -- have intelligence which is basically different, but often vastly superior to our own. That is more difficult to grasp. Yet we must, if we want to proceed on the path of communicating with other species on our planet or, conceivably, at a later stage, on other planets: if we want to explore their minds and thereby gain a deeper understanding of our own.

That the new awareness of intelligence around us must profoundly alter our view of the world and of our own place in it, goes without saying.

The fearful and the conservative amongst us have argued that, assuming there were nonhuman intelligence, expressible in language -- then the whole structure of our human civilization would collapse. Neither human rights nor democracy, neither liberty nor justice, would survive. Quite apart from the relatively secondary fact that our economies would collapse: for if animals had minds we would have no right to kill them, let alone eat them.

To my mind all this seems somewhat exaggerated, and the sense of awe and love I have for other creatures leaves my faith in humanity untouched. Human cultural evolution with all it comprizes, continuing, accelerating, even if episodically perverting, natural evolution, stands. Obviously mind and language are basic to this evolution. But to admit that other creatures may have it in more or less closely related forms, does not, in any way, deny it to humanity.

Granted, it may become increasingly distasteful to eat our closest relatives, the mammals. The cattle slaughter economy with its rather horrid systems of mass production (or, rather, destruction) might as well go out of business. It may have to, anyway, considering economic cost and ecological scarceties. Idealism (the growing awareness of the animal mind) combined with realism (yielding to economic facts) may, over the next hundred years, drive us in the direction of greater reliance on vegetarianism. Young people, especially in the United States, may already be pointing the way. On the other hand, if other species in nature are carnivorous, wholly or partly, why should not mankind be so, at least occasionally?

There should be, somewhere alongside of the emerging environmental law, a body of interspecies law: outlawing genocide of animals; prohibiting the killing of whales, dolphins, apes, and elephants; proscribing the modification of the behavior of wild animals and their use in warfare, just as weather modification and its use for warfare is prohibited; severely limiting and controlling the use of laboratory animals and preventing unnecessary suffering.

Such a body of law -- already in the making in various bits and pieces -- would not detract from our humanity: on the contrary, it would enhance it greatly.