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Productive and Creative Research with Man and Dolphin

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In this series of lectures dedicated to the memory of Albert D. Lasker, my distinguished predecessors have established such a high order of interest and eminence in their presentations that I am going to be hard put to match their performance alone without outside aid. In considering in detail what I should present to you I was tempted to go it alone and not appeal to the friendly bottlenose dolphin. However, it looks as though this might be unfair to those who invited me to speak here. I am sure that the inviters selected me as an agent for our dolphin friends, rather than for myself alone. If I once in a while attempt to establish my own individuality independently of the dolphins, I am sure that you will forgive me.

I would like to approach this subject from a slightly different viewpoint than that which I took in the book, *Man and Dolphin*.¹ In that book my point of view was historical and

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narrative, externally personal and impersonal, to present a broad view of the relationship between us and them. Here I will be internally personal and pursue an egoistical (or even egotistical) line of thinking. In a round-about way I will try to answer a question which many persons ask and which heretofore I have hesitated to answer fully. The question is, how does one go about finding such unexpected unlikely and improbable facts as that of our discovery of the ability of a whale to copy human speech? Let me veer off the direct answer, and bring it into your attention by a peripheral approach—somewhat the way one sees a dim star by looking to one side of its true position.

I wish to stress a very peculiar effect which we have noticed in the laboratory working with the bottlenose dolphin (*Tursiops truncatus*). I wish to bring the effect to your attention as an example of the peculiarities of a creative process which occurs in this particular kind of scientific research but which may have a wider occurrence than just here. I wish first to state it in a short, terse, and condensed fashion: if one works with a bottlenose dolphin day in and day out for many hours, days, and weeks, one is struck with the fact that one's current basic assumptions and even one's current expectations determine, within certain limits, the results attained with a particular animal at that particular time. (This effect, of course, is quite commonly found with one's peers in the human species.²)

This effect was first noticed in our work in 1955, 1957, and 1958. As my own convictions of the undoubted neuroanatomical size and complexity of this animal's brain became more and more secured and more and more accurate, I noticed a subtle change in my own attitude in regard to possible performances on the parts of these animals. To one trained in neurology, neurophysiology, and in some of the human sciences such as psychoanalysis, a large complex brain implies large complex capabilities and great mental sensitivity. Such capabilities and sensitivities can exist of course in as yet unrealized forms.

This working hypothesis of an advanced capability raised our index of suspicion and in turn sensitized our minds and methods to new sources of information. It was this subtle preparation of the mental climate which allowed us in 1957 to listen to some rather queer noises that the dolphin was producing in the laboratory and to review them very carefully on the tapes. Because the possibility of a very large brain capacity and because of musings about the possible areas of achievement already realized in this species, but as yet undiscovered by us, our minds began to open.

This opening of our minds was a subtle and yet a painful process. We began to have feelings which I believe are best described by the word "weirdness." The feeling was that we were up against the edge of a vast uncharted region in which we were about to embark with a good deal of mistrust in the appropriateness of our own equipment. The feeling of weirdness came on us as the sounds of this small whale seemed more and more to be forming words in our own language. We felt we were in the presence of Something, or Someone who was on the other side of a transparent barrier which up to this point we hadn't even seen. The dim outlines of a Someone began to appear. We began to look at this whale's body with newly opened eyes and began to think in terms of its possible "mental processes," rather than in terms of the classical view of a conditionable, instinctually functioning "animal." We began to apologize to one another for slips of the

tongue in which we would call dolphins "persons" and in which we began to use their names as if they *were* persons. This seemed to be as much of a way of grasping at straws of security in a rough sea of the unknown, as of committing the sin of Science of anthropomorphizing. If these "animals" have "higher mental processes," then they in turn must be thinking of us as very peculiar (even stupid) beings indeed.

About this time we began to be exposed to what I would call the dedicated, opposed skepticism of some scientific workers. These people were for several years in close contact with fishes and with dolphins in the oceanaria and did not and do not share our views of the possibilities resident in this huge and complex brain. Their view is not incomprehensible to those of us who are in the new area we have opened up. This group of scientists has denied publicly that mimicry of human speech was possible for these animals ("No vocal cords," is typical). When we demonstrated that mimicry exists, they changed their tack and now say, "Mimicry, so what? Parrots do it, Mynah birds do it." If anyone had said to me in 1947 that a whale could mimic human words, I would not have believed him. But in 1957 I was forced to believe—through the experience of hearing a whale (dolphin) do it. The "mimicry, so what" group must have lost their sense of wonder and surprise; we have not.

However, I do not wish to discuss opposing points of view, nor to dwell too long on the effect of such vociferous opposition on one's thinking. As to the latter, all I can say is that at one time they slowed us down a bit, but the dolphins continue to renew our confidence and make us eager to push on.

The mimicry effect was first obtained by the use of electrodes implanted deep in brain structures in these animals in rewarding sites within their brain.³ These results, therefore, may have been caused by the peculiar way that the brain was being stimulated. Possibly the animals did not have this ability when stimulated naturally through their normal inputs and outputs.

In the Fall of 1961 we were able to set up a new set of experiments as a control on the 1957 experiments. Here I wish to show you something of these scientific results but also something of the history and of our mental processes.

In 1961, Miss Alice Miller (who had participated in the 1957 experiments) and I once again closely examined the 1957 results. We decided to pay close attention to the tapes of the previous year (1960-1961) and look at them from the viewpoint that there may be evidence of a complex mental activity going on in our resident dolphins.

Lizzie, in March, 1960, had produced a sequence of humanoid noises underwater. This was the first and last time that Lizzie or Baby, the 2 dolphins of that period, produced any sounds of this type. Together in the pool in St. Thomas they had produced whistles and clicks practically exclusively. The language they were using was strictly "delphinese." However, the night before she died, Lizzie (freshly isolated from Baby) said something underwater which sounded suspiciously like, "It's six o'clock," which I had just shouted to her over the water of the tank.¹ Miss Miller and I reviewed that tape many times and each time the uncanny feeling of 1957 was evoked.

After the Lizzie episode and after we had moved our operation temporarily to Miami while the new laboratory was under construction in St. Thomas, on July 5, 1960, we obtained an animal which we named Elvar. Incidentally, he is currently (1962) with us and functioning very vigorously.

During his first year's residence Elvar had begun to develop a new series of voices over and above his "delphinese" one. These new emissions covered such a vast range of vocalization capabilities that we were hard put to analyze it all. His whistles and clicks were interpolated among a series of barks, wails, moans, buzzings, trumpeting, banjo-like sounds, quacking, etc. All of these sounds first occurred under water, but later more and more of them were emitted in air from his now opened blowhole. Some of his "quacking" noises had become similar but not

identical with those of human speech. In reviewing these records, Miss Miller and I saw some changes from the native delphinese, to noises which we felt were beginning to bridge the vast gap between delphinese and human sounds. We gradually became convinced that this was evidence of beginning primitive mimicry, not quite as advanced as we had found in 1957, but far enough along to be disturbing and exciting.

During this phase of our scientific development we were moving from one set of laboratory quarters to another; Elvar moved with us. We established the present laboratory in Miami in January, 1961; finally we had a more stable environment in which to observe Elvar. We began to obtain higher quality recordings of his emissions. In September, 1961, we were convinced that it was time to attempt to elicit straightforward and direct production of human speech sounds by Elvar by dedicated efforts without the use of brain electrodes or even of food reward.

Our reasoning was as follows: It was already known that by means of food reward these animals could be trained to do all sorts of circus tricks in a very precise and well-timed fashion. It was also known that such training could be obtained from other kinds of animals with food reward. We decided to test the hypothesis that possibly these animals were rewarded by participating in activities directly with the human, especially vocal activities. At that time we suspected that a human must also be willing to establish a close contact with the given animal and that the animal must also be kept separated from its own species.

Elvar was isolated in a shallow small tank. Alice started an intensive effort to induce him to vocalize in response to her vocalizations and activities. Within a few hours of the time that she started this activity, Elvar responded by beginning to mimic her voice. The unearthly feeling was once again evoked. Why?

Here is an animal who from the viewpoint of evolutionary theory is in a group of mammals who have developed for the last 30,000,000 years in the sea, completely separated from the evolution of the primates which gave

rise to *Homo sapiens*. His anatomy and physiology, though strictly mammalian, are of a strange and different form from ours, including his vocalization apparatus. Despite our careful mental preparations, it was literally a shock and a surprise to hear him say so soon after Alice, "more, Elvar."

The repeatedly painful and humbling part of this experience is that we, as human beings, had felt that man is at the top; we are alone; yet here is an "animal" which was entering into that which is peculiarly human, i.e., human speech. At no matter how primitive a level, he was entering into it. He was taking step Number 1. To convey to you our sense of wonder and yet the sense of the uncomfortable necessity of continuously reorganizing our basic assumptions is difficult. We gambled on Elvar's taking the first step, and he did. (We haven't done as well with his delphinese language.) He impressed us with the fact that he took the first step to repair a gap of at least 30,000,000 years in a few weeks. He may be skipping some of the belabored efforts of the human race for the last 40,000 years to achieve our present degree of articulate speech among ourselves. Maybe he is not skipping. Maybe he is just beginning what *Homo sapiens* went through 40,000 years ago. *And he first did it when and only when we believed he could do it and somehow demonstrated our belief to him.*

We are taking a very close look at his processes of acquisition of these words. We are impressed with his amazing ability to analyze our sounds and emit the products of his analysis. He does not reproduce a word in a "tape-recorder" fashion or in the fashion of a talking bird. In one's presence he literally analyzed the acoustic components of our words and reproduced various aspects in sequence and separately.

One of our clearest examples is when he started saying "more, Elvar." In one session he started out with, "more, Var," slowing down his natural pace and lowering his natural frequency well into the human range. He then took Alice's whole transmission, "more, Elvar," speeded it up, took it back into his natural frequency region around 4 to 12 kcps

and repeated it. He then slowed it down, and lowered his frequencies down near those that Alice was producing, and reproduced, "more, Elvar" on the human scale and in the human frequency region.

In another session in which I was working on the word "squirt" with him, he took the word, reproduced it at a high frequency and in very short abrupt fashion. It was so high-pitched and so fast that one cannot recognize it at all unless it is slowed down several times in playback. Next he went through at least 5 different variations of the word, each variation which he produced in response to my repeating the word "squirt." His productions sounded like "irt," "squir," "ir," to something which sounded like "squeeirte," and then finally something that sounded very close to "squirt" in a Donald-Duck-like voice. The latest studied voice that he uses resembles that of a very small child; it is very high-pitched and thin in quality, and yet can be of such an intensity in air that it is sometimes painful to listen to when one is closer than 3 or 4 feet from his blowhole.

When one is doing such vocalizations experiments with Elvar, one sometimes has the feeling that he is very impatient with our slow and laborious methods. He acts as if he wishes we would hurry up and understand him. He apparently is pushing points we as yet cannot imagine. For example, he sometimes inserts long passages of delphinese alternating with our words as if to translate for us.

This peculiar feeling of "as if a person or a personality or a being" who somehow reaches out towards us, who comes as far as we believe he can come at a particular time, and who seems to be waiting to proceed to the next as yet unknown step are some of the elements in the feeling that I above called "weirdness."

I do not wish to give the impression that every new thing we try with Elvar works. We have done several new things with him which turned out to be inappropriate. For example, we expected that when he was sick he would come and volunteer for an antibiotic shot with a hypodermic needle. (We

had seen another dolphin do this in the hands of Adolph Frohn.) Elvar would have none of it. He singled me out as a consequence of several such injections as the villain of the piece and expressed great dissatisfaction with my presence for literally weeks.

At first I found this inconvenient, but it led to another episode in which we learned something. Dolphins not only discipline their young somewhat the way humans do, but the young ones learn proper manners very rapidly. Elvar was expressing his dissatisfaction with me and his injections in the presence of Chee-Chee, an older female. I was attempting to induce him to approach me at the side of his shallow tank. He had been avoiding me assiduously by swimming to the far side. Suddenly, he whirled about in the water, opened his mouth and barked (underwater) as he charged towards my arm in the pool. Chee-Chee intercepted him at right angles to his course and slammed the bottom of her beak down on the top of his head so hard that I could feel the resulting jar at the side of the tank. She did this just before his jaws reached my arm. Since that episode Elvar has not attempted to charge me. (In general, our dolphins now tend to express their dissatisfaction with someone who is putting an arm or a leg, or their whole body into the pool by pushing him gently out again by a series of rapid bumpings with their closed jaws against the arm or leg.)

In such maneuverings, and in such non-vocal signals to us, they are amazingly silent in the humanoid sphere. They emit whistles, clicks, and their sonar, ultrasonic creakings as if signalling to one another. However, I doubt that this silence will continue. There are times when they make valiant attempts during their maneuverings with us to use humanoid sounds, apparently in (to them) an appropriate fashion. They apparently become discouraged by our inappropriate responses. The semantics of their language and their thinking is probably so different from ours that we sometimes become enamored of the differences and fail to see

simple similarities right in front of our noses.

Since September, 1961, we have been working every day with Elvar's enunciation and his vocabulary. We are now eliciting words with food rewards. He has been working in a tank immediately adjacent to that of Chee-Chee. In general they tend to communicate from one tank to the other underwater in natural delphinese clicks and whistles. During weekends they are allowed to be together for courtship and sexual play. Elvar apparently has been practicing his humanoid sounds when we are not there. We had not attempted to elicit these sounds from Chee-Chee until about 2 weeks ago. She was not giving them to us, free of charge, as it were, nor volunteering very many of them, except at peculiarly odd intervals. Every so often, however, we would detect a humanoid exchange going on in air between Chee-Chee and Elvar. We knew that she was getting some practice, however, privately.

About 2 weeks ago it was decided that Miss Nadell (a psychologist working with Elvar) would attempt to elicit similar sounds and a similar vocabulary from Chee-Chee. Chee-Chee shifted from delphinese (clicks and whistles) in air to fully formed humanoid word-like sounds on the first try. She held a fish up and said, "speak" to Chee-Chee. Chee-Chee came back and said something that sounded like "speak" and was given the fish. Miss Nadell then said, "louder," and Chee-Chee came back with something that was like, "louder," plus a lot of other completely nonunderstood emissions. And yet up to the time of this experience, no demands whatsoever had been put upon Chee-Chee in the vocal sphere.

One gets the impression during such experiences that the dolphin has been waiting for the day when he or she would be treated in the same way that the other dolphin has been treated. When the day comes, if the "proper" gesture and language are used with that particular animal he responds in the way that the previous one did.

A third animal, Sissy, has been kept in isolation from Elvar and Chee-Chee on another floor of the same building. Sissy is a much younger animal than either Elvar or Chee-Chee and is relatively undisciplined in comparison to the others. Sissy, about a week ago, was asked to vocalize for a food reward. In the first session she replied and demanded the food reward with a very peculiar delphinese emission in air: with the vocalization apparatus on the right side (inside her blowhole) she whistled in air and on the left side simultaneously she clicked in air.⁴⁻⁷ One could see the right side opening fairly widely and steadily and the exit pulsing only with the modulations of the whistles; on the left side it was vibrating with each of the very loud "clapping-like" clicks that were emitted into the air. After a week's experience with these noises she suddenly began a series of humanoid noises mixed with the clicks and the whistles. However, the clicks and the whistles are predominant. It is almost as if she is an uneducated dolphin who barely had enough time to get a toe hold on her own language and has had no opportunity yet to get a good toe hold on ours. (Various reports are coming in from the staff that she has been hitting their hands rather abruptly and suddenly with her beak and opening her mouth at them. It is possible that she needs the teaching and the discipline of an older animal to teach her proper manners at this point.)

These experiences illustrate the thesis that one can protect one's self by maintaining one's ignorance by belittling disturbing experiences, or one can newly recapture sensitivity and be open-minded (even painfully so) and *discover* new facts. Discovery, in my experience, requires disillusionment first, as well as later. One must be shaken in one's basic beliefs before the discovery can penetrate one's mind sufficiently above threshold to be detected. A certain willingness to face censure, to be a maverick, to question one's beliefs, to revise them, are obviously neces-

sary. But what is not obvious is how to prepare one's own mind to receive the transmissions from the far side of the protective transparent wall separating each of us from the dark gulf of the unknown. Maybe we must realize that we are still babies in the universe, taking steps never before taken. Sometimes we reach out from our aloneness for someone else who may or may not exist. But at least we reach out, and it is gratifying to see our dolphins reach also, however primitively. They reach toward those of us who are willing to reach toward them. It may be that some day not too far distant we both can draw to an end the "long loneliness," as Loren Eiseley called it.⁸

REFERENCES

1. Lilly, J. C.: *Man and Dolphin*, New York, Doubleday & Company, Inc., 1961.
2. Lilly, J. C., and Shurley, J. T.: Experiments in Solitude in Maximum Achievable Physical Isolation with Water Suspension of Intact Healthy Persons, Symposium, USAF Aerospace Medical Center, San Antonio, Texas, May 26-27, 1960, in *Psychophysiological Aspects of Space Flight*, New York, Columbia University Press, 1960.
3. Lilly, J. C.: Some Considerations Regarding Basic Mechanisms of Positive and Negative Types of Motivations, *Amer. J. Psychiat.* 115:498-504, 1958.
4. Lilly, J. C., and Miller, A. M.: Sounds Emitted by the Bottlenose Dolphin: The Audible Emissions Underwater or in Air of Captive Dolphins are Remarkably Complex and Varied, *Science*, 133: 1689-1693, 1961.
5. Lilly, J. C., and Miller, A. M.: Vocal Exchanges Between Dolphins: Bottlenose Dolphins "Talk" to Each Other with Whistles, Clicks, and a Variety of Other Noises, *Science* 134:1873-1876, 1961.
6. Lilly, J. C.: Vocal Behavior of the Bottlenose Dolphin: Annual Meeting of American Philosophical Society, Philadelphia, April 27, 1962, *Proc. Amer. Philos. Soc.* 106:(6) 1962.
7. Lilly, J. C.: *Man and Dolphin: A Developing Relationship*, London, England, Victor Gollancz, 1962.
8. Eiseley, L.: The Long Loneliness, *Amer. Schol.* 30:57-64, 1960-1961.