BETWEEN DOLPHINS AND VOCAL EXCHANGES BETWEEN HUMAN AND DOLPHIN

FOLKWAYS RECORDS FX 6132

RECORDED AND EDITED BY JOHN C. LILLY, M.D.

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SIDE 1

Band 1: Introduction Band 2: Dolphins Communicate a) Strimp b) Dolphin whistles Band 3: Dolphins Isolated a) Normal speed b) Half speed Band 4: Male & Female Dolphins Band 5: Single Dolphin a) Normal speed b) Half speed c) Quarter speed d) Normal speed

SIDE 2 Band 1: Copying Male Human Sounds Band 2: Female Voice Stimulus Band 3: Female "Hello" & Other Sounds Band 4: Further Observation

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AND THE ULTRA-SOUNDS OF THE BOTTLE-NOSE DOLPHIN

SOUND COMMUNICATION BETWEEN DOLPHINS AND VOCAL EXCHANGES BETWEEN HUMAN AND DOLPHIN

RECORDED AND EDITED BY JOHN C. LILLY, M.D.

DESCRIPTIVE NOTES ARE INSIDE POCKET

COVER DESIGN BY RONALD CLYNE

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SOUNDS AND ULTRA-SOUNDS OF THE BOTTLE-NOSE DOLPHIN

Introduction to the Sounds and the Ultra-Sounds of the Bottle-Nose Dolphin John C. Lilly, M.D.

The story of this work was published in <u>Man and Dolphin</u> (Doubleday; Pyramid) and <u>The Mind of the Dolphin</u> (Doubleday; Avon). As recounted there, these recordings were obtained in my laboratory in the Virgin Islands and in Miami. In the second book, the details of the methods used for several of the recording conditions are presented; figures and photographs illustrate the findings. Please refer to <u>The Mind of the Dolphin</u> in order to understand the techniques used. One published paper supplements and expands the data (<u>Journal of the Acoustical Society of America</u>, Vol. 43, pp. 1412-1424, July, 1968). Please refer to this article for the analysis of the nonsensesyllable mimicry phenomenon.

In <u>The Center of the Cyclone</u> (Julian Press; New York), there is a presentation of the ethical dilemma which such work creates and its resolution by closing down the projects.

These recordings include those exchanges between Margaret and Peter Dolphin referred to in the footnote in their chapter in <u>The Mind of the</u> <u>Dolphin</u>. This recording makes these available for the first time.

Side One

BAND 1

This is a collection of high fidelity recordings of the sounds and ultra-sounds made by the dolphins both in wild and in the captive state. Excerpts from this collection are chosen to illustrate some of the complexities and some of the uses of these sounds. Scienti-

fic investigation shows that most of the sounds made by this particular species of dolphins are beyond the upper limits of human frequency discrimination and of human hearing. We have shown that the speed with which the dolphins emit complex sounds is also beyond that of the speed of human perception. The frequency range covered by the dolphins is approximately ten times as high as that covered by human speech. To satisfactorily present these sounds to the human listemer it is sometimes necessary to slow down the original tape recording so that one can satisfactorily follow the fast complexities and the high frequencies emitted by the dolphins.

In their natural state dolphins communicate with one another and can also detect various features of their environment. They detect the fish around them, the sharks and other preditors by means of sound. They have an ultrasonic echo ranging system commonly called sonar. The sonar operates in a frequency band for approximately 20 kilocycles per second to 160 kilocycles. Dolphins communicate with one another in a band of frequencies for approximately one kilocycle to forty kilocycles. This band overlaps the sonar band. It is also suspected that they can use the sonar band for communication as well as the lower frequency band. The characteristics of the sounds of the dolphin emitted in the wild is such that they can discriminate against the noise of waves and other sea noises including noise emitted by other biological organisms.

BAND

Our first example shows dolphins communicating with one another with slow clicking trains and with whistles. It is to be noticed that the clicking trains and whistles stand out against the background of snapping shrimp. In this recording the shrimp sound like frying bacon. First we hear the clickings against the shrimp background. In the next segment we hear whistles. Here we have slowed the tape to a half speed to bring the frequencies down to our hearing range.

BAND 3

To eliminate the noises of the snapping shrimp, laboratory tanks next to the sea are kept clear of these organisms. The dolphins are restrained in small bodies of water so that a record can be made of what they say to one another.

The next segment was recorded in our St. Thomas laboratory in a tank next to the sea. There are three dolphins in the tank who are being recorded. Notice the various clickings and whistlings going on and the complex interchanges between the dolphins. The first segment is played at normal speed to illustrate the very high frequencies of these exchanges. The second segment is at half speed to bring it closer to our hearing range.

BAND 4

Now throughout this recording we were not able to control the distance of the dolphins from the hydrophones. Some of the changes in the intensity of the signals were caused by the dolphins swimming and changing the distance from the hydrophone. Distance can be controlled in the following way:

Each of two animals is confined in opposite ends of a tank 15 feet long. Each animal is given a single hydrophone. Each dolphin's sounds are thus recorded separately on its own track of the tape. A connecting path through the water is left from one dolphin to another for the sound to move from one to the other. In this condition they do not use their sonar. There are two forms of communication in this sample: first the clickings and second the whistles.

This recording is slowed down by a factor of 8 to bring the whistles close to the human range. One can hear the male dolphin in one loudspeaker and the femal in the other loudspeaker.

BAND

In order to investigate how dolphins produce their sounds, a single dolphin was isolated in a shallow tank of water. Contact hydrophones were placed on the upper part of their head which was kept out of the water. One can hear the productions of two systems. One on the right side of the head on the right speaker and one on the left side of the head in the left speaker. Notice the stereo effects. The sounds appear to be moved from one side to the other. The following 18-second segment is played first at normal speed to give one an idea of the very high frequencies which are normally emitted.

The same segment is repeated at one-half speed, lowering the frequencies by a factor of two and prolonging the duration by the same factor.

We will now repeat the same segment at one-fourth speed increasing the durations by a factor of four and lowering the frequencies by the same factor. Notice the humanlike quality of the first prolonged sound and of the group of four sounds that follows.

Now back to normal dolphin real time and real frequency range.

Side Two

BAND 1

All of the sounds which have been presented so far are those which occur naturally between dolphins. They are all produced with the blowhole closed underwater within the head of the dolphin.

In the Institute we have been doing a series of researches on other types of sounds which the dolphins can be induced to emit. These sounds are produced with the open blowhole in air with the head above water. After the dolphin has been in captivity with humans who speak to him in air for a period of six or more weeks he begins to make airborne sounds. At first he makes the same sounds that he makes underwater in his native dolphinese way. Later with encouragement from the humans he attempts to bring his frequencies down lower to the human range and may begin to produce copies of human speech. At first his copies are extrememly poor as one might expect. Gradually with help from individual humans the sounds are "shaped up" as is said in psychology. The copies become better and better ones of the human voice. The voice of the dolphin in air has a much higher pitch and much higher frequencies of the formants than does that of the human. We might expect this to be the case since in their normal state (as we said above) they are operating at about ten times the frequencies of the noraml human voice. In the Institute we have trained six dolphins to earry on very exact performances and complex schedules of vocal interactions with human investigators. In the following segment a dolphin who had been trained for a period of three years shows his versatility in this area. The human investigator is reading from a list of randomly organized nonsense syllables varying in each presentation in number from one to ten. This experiment is designed to elicit copy only of the nonsense syllables given by the human voice. Here we are concentrating only on the number of sounds and how well they match the number given by the human. In this presentation count the number of sounds made by the human and the number of sounds to be compared by those emitted by the dolphin immediately thereafter.

BAND 2

In the previous presentation the male voice was used to stimulate the dolphin's responses. In the following segment the stimulus is a female voice. The female voice has an advantage in being higher pitched and somewhat higher in its formant frequencies than the male. To the dolphin this is an advantage in that his ears and his auditory apparatus function better at these higher frequencies. For the following recordings the material is natural English given by the girl to the dolphin. The aim in this particular case is to improve the enunciation of the dolphin's voice in air. These very short samples are taken from taped experiments done over a period of two years. The dolphin is given lessons for 15-minute periods approximately four times a day. These segments illustrate graphically Aristotle's ob ervation, "The voice of the dolphin in air is similar to that of the human voice in that he can pronounce vowels and combinations of vowels, but cannot pronounce the consonants."

BAND 3

The following segment will be repeated several times. One can hear the female human voice saying "hello." Immediately after hearing "hello" the dolphin comes back with a complex series of sounds. First listen with the idea that the dolphin is mimicking the girl's hello. He is drawing it out and using several vowels which may be present in short form in the girl's presentation.

BAND 4

Now listen to further samples of the same segment but this time imagine the dolphin is not mimicking the girl's "hello"; it is saying something else. What do you hear in the dolphin's presentation?

In reply to the girl's hello the dolphin instead of mimicking is saying "How are you?" leaving out the consonants and giving us only the vowels.

This example illustrates why we used nonsense syllables in the previous presentation of the man's voice. If one uses meaningful sentences, phrases and words, one can imagine what the dolphin may be saying in his very poor accent. However, one must have other evidence that the particular choice of meanings that the dolphins put out is the meaning intended by the dolphin. How can we do this? To securely know the answer requires other kinds of tests of the dolphins' ability to use meaningful words and phrases. In other words, one must investigate other kinds of behavior than the vocal behavior and tie the other behavior to specific vocal kinds of signals even as we do with our speech.

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