

MARINE SKILL REPORT SUBMITTED TO THE
UNIVERSITY OF HAWAII MARINE OPTION PROGRAM

COMPREHENSION OF AN IMPOSED
LANGUAGE BY BOTTLE-NOSED DOLPHINS

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Comprehension of an imposed
language by Bottle-nosed dolphins

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TRAINING SITUATION

The objective at the Kewalo Basin Marine Mammal Laboratory is to determine whether dolphins are capable of learning a language and if they are able to prove their comprehension of this language by correct behavior to sentences containing actions, objects and modifiers. The relevance of this study is to determine if man is the only species able to use language; this characteristic of language is what has set man apart from other animals.

Language acquisition is not species specific and past research has already proven success with the use of sign language (Peng, 1978). How far apart are we really from other animals?

The Yerkes Primate Research Center in Georgia has taught a chimp named Lana to read symbols on a computer keyboard and type out her requests. Only grammatically correct sentences—that is, correct sequence of signs, are rewarded by the computer. Lana has learned not only to state her requests correctly but also to erase and correct ungrammatical sentences presented by the computer (Rumbaugh, Gill & Von Glaserfeld, 1973).

The Lana Project has given inspiration to the present studies with computer-based language. Lana's present aim is to develop a computer-based language training system for investigating the possibility that chimpanzees can acquire human type language (Rumbaugh, 1977).

Their past accomplishments challenge previous conceptions of the linguistic limitations of subhuman species. The extent to which they can communicate with human beings via a shared language system gives some hope that the ability to communicate with animals will someday be a reality.

The research is being conducted with two female bottle-nosed dolphins (Tursiops truncatus). This species of dolphin was chosen because of its ability to understand complex directions. These animals also possess a number of intellectual traits comparable with those of primates. These traits include a capacity to learn general rules for solving sets of related problems and a flexible modeling capability. This means the ability to initiate and learn quickly by observation. (Herman, 1979).

They also have a well developed memory system and have acquired the ability to represent or symbolize one thing by another; this is referred to as representational ability (Herman, 1979). Both dolphins are approximately five years of age and will reach sexual maturity between six and ten years of age. Their names are Akeakamai for "lover of wisdom" and Phoenix for "rebirth." They were collected from the wild in the Gulf of Mexico at approximately two years of age.

The research so far has stressed language comprehension rather than language production. Two types of "languages" are used. The first is an acoustic language which uses computer generated sounds via an underwater hydrophone for listening to the dolphins responses and an underwater speaker so that the instruction may be carried out (Hill, 1980).

The second language is a visual language which uses gestures of the arms and hands. The language training has been in progress approximately twenty months with equal success with both language types (Prafit, 1980).

Since I have been working with the dolphins, their vocabularies have increased by seven words each, bringing the total to twenty-seven words for each dolphin. Of the new seven words, adjectives such as right, left, surface and bottom have been introduced to a vocabulary exclusively of nouns and verbs.

Akeakamai participates in gestural as well as mimicry training. This mimicry training is to prepare her for language production. She has learned to mimic the acoustical representations, or sounds, for various objects which are normally used for training. This training began by showing her the object and at the same time naming the object via the computer-speaker system. She responded quickly and accurately to this type of training. Within a few months she was whistling the name of the object upon command, no cue or computer sound was given. Her interest in this type of training could be due to the added attention she receives by having her special place in the tank and both speaker and hydrophone near her.

Phoenix is trained acoustically via computer generated sounds. The head trainer operates a keyboard similar to that of a typewriter. Each key represents a word or sound that the dolphin associates with an action, object or modifier. The keyboard is connected to the computer room which receives the sounds from the operator. Thus, the keyboard operator can instruct the dolphin via a series of words or sounds. For Phoenix, objects are placed into the tank and a computer sentence, given by the keyboard operator, is directed to her. Upon a correct response a fish is given along with social reinforcement such as touching and talking aloud as her reward.

Each dolphin is assigned a name from the computer which greatly resembles her signature whistle. This signature whistle sounds like our definition of a high pitched whistle, similar to the different frequencies one may inadvertently pick up while changing a radio station. They respond to their names by placing their heads on their respective paddles. These paddles hang over the tank wall inside of the water. The dolphins have been trained to use these as their separate training stations, here they await further instruction.

A typical training session begins with the head trainer setting up the keyboard in a tower overlooking the dolphin tank. The dolphin's plastic paddles are placed alongside the tank wall, extending into the water. The objects which are used as nouns are placed accordingly next to the trainer, the reward system of fish is placed in view of the dolphin and the session is ready to begin.

Two and three word sentences continue to be the core of the training. This means sentences such as noun-verb (object-action) or noun-verb-noun (object-action-indirect object) are used. An example of the former would be ball-pec touch, this means to find the ball among the other objects (nouns) in the tank and touch it with her pectoral fin. The latter would be demonstrated by hoop-fetch-person. This indicates to find the hoop in the tank and bring it to the trainer. Phoenix is instructed in three word sentences while Akeakamai responds to two word sentences.

Three word sentences are valuable training tools because of the syntax (word order) capabilities of the dolphins. To illustrate the importance of syntax, pipe fetch ball is a very different sentence in meaning than ball fetch pipe. Syntax is an important part of human language and may help us to demonstrate this training capability in dolphins.

Of the new words introduced, Phoenix was trained to understand her new modifiers: surface and bottom. Two identical objects are placed in the tank, one sinks to the bottom and the other stays afloat. The sentence is given via the keyboard operator: Phoenix-surface-ball-pec touch. Up to three pairs of objects are placed in the tank at a time and she completes these sentences with ninety percent accuracy.

Akeakamai's new words consist of right and left. Two identical objects are placed a few feet away on either side of her. The hand signals are given via a blindfolded trainer in order not to cue her. The sentence is given: right-ball-tail touch. Akeakamai's success rate is eighty-five percent.

I became involved in this project after talking with the Marine Option Coordinator regarding my interests about marine mammals. I was informed at the time that a lecture was to be presented that evening on the University of Hawaii campus. The oral presentation was November 1979. This lecture informed the community of the research that has been conducted over the past three years on the "Comprehension of an imposed language by bottle-nosed dolphins." Upon hearing this presentation I felt that this was an excellent opportunity to pursue my interests regarding marine mammals. I obtained more information regarding their project and upon acceptance to the Marine Option Program I began working with their project as a trainer. I feel I have gained from this experience a better understanding of the relationship between man and marine mammals, especially the communication between species.

JOB DESCRIPTION

Working with the dolphins on a one-to-one basis was my main duty as a trainer. Here I was able to learn the "imposed language" of hand signals which the dolphins acknowledge. The skills I acquired as a trainer included first learning the language and more importantly, watching the dolphins' behavior. The first month I spent about eighty per cent of my time training, the remainder of my time was dispersed with recording the sessions data and entering the information into the dolphin's logs. This was an important duty of the trainer so that an accurate description of the session could be logged in their respective data books. The data books or logs, are used to record the dolphins' performance during the session. The information included the training method used, who was keyboard operator, recorder and trainer. This information in addition to the number of success and errors during the training period is organized by constructing a data table showing per cent of errors. I also worked as recorder and learned the techniques of the keyboard operator. The recorder's job is to write down the dolphin's successes and errors during the trials. The keyboard operator essentially runs the session and instructs the dolphins via computer generated sounds. This position also includes observing their behavior and responding accordingly in regards to what the next training trial should consist of, thus deciding whether trials of increasing difficulty should be pursued. After my first month as a trainer up to ninety-five percent of my time was spent as keyboard operator.

We are presently using a computer to log in the data. Learning to use the computer in place of making our own confusion matrices, which identify problem areas, has given me a broader understanding of the importance of the accumulated data. The functions and accuracy are greater and faster than could be achieved by hand tallying the information for graphs.

As a trainer the supervision was almost constant since I worked under the direction of the keyboard operator. While operating the keyboard, supervision dropped dramatically. Discussions with project leaders before and after the training sessions were helpful. This aided in my development at the keyboard. Once I started operating the computer I was essentially on my own unless specific problems arose.

I feel the experience I acquired while working at Kewalo Basin, and knowledge from courses at the University of Hawaii have given me a better insight as to what research is all about. I feel confident in choosing a research project which would be important enough to merit studying and in going through the necessary steps to get the right people together and submit a proposal for funding. I anticipate continuing with research in my post-graduate work and feel this experience will be helpful towards my future studies.

EVALUATION

My objectives upon entering this project were to learn more about the relationship between species and the scientific strategy used to train and evaluate results.

The continuation of this project depends upon the renewal of funds from the National Science Foundation. We are all very optimistic regarding the future goals of this project.

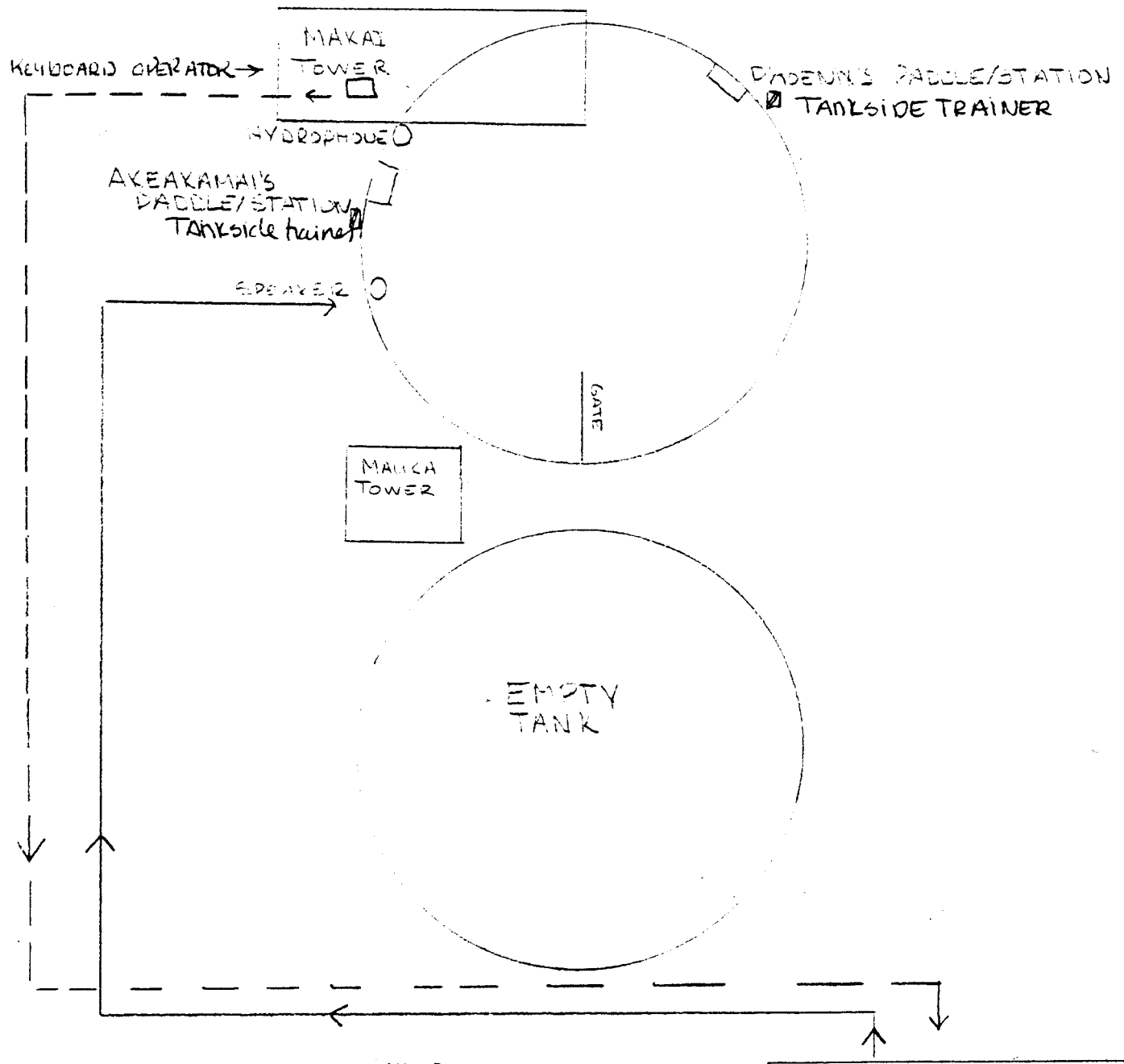
I am also very grateful to the Marine Option Program whose combined efforts with the Sea Grant office at the University of Hawaii at Manoa enabled me to experience this opportunity through a stipend I received during the Spring 1980 semester.

MAKAI
PORT

PUMP
ROOM

FISH FEEDING ROOM

STORAGE AREA



OFFICE

COMPUTER ROOM

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- 5) Dr. James Wolz, Associate Director of KBMML
- 6) Trainers:
 - Julia Atwood
 - Carolyn Borden
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 - Cindy Kleh
 - Mark Leidlemeyer
 - Lisa Lum
 - Bob Mitchell
 - Keith Oda
 - Beth Roden
 - Mark Sharp
 - Peter Sherman
 - Lisa Shigemura
 - Amy Suzuki
 - Pearl Yao
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