

NAVWEPS REPORT 8061

NOTS TP 3064

COPY 10

AD400270

NAVWEPS  
R-8061  
c. 10

AD-400270

ONE-WAY VOICE COMMUNICATION WITH PORPOISES

by

Willard G. Pumphrey  
Research Department

**ABSTRACT.** Child educational techniques were used as a new method of training porpoises. To test the effectiveness of this method, oral commands were given to porpoises to retrieve several objects, and their responses were noted. The results demonstrate the feasibility of this method of training: the porpoises' learning rate was very rapid and, taking into account their confined and unnatural environment, may have approached that of young children.

RETURN TO  
NAVY DEPT.  
WASHINGTON 25, D. C.



U. S. NAVAL ORDNANCE TEST STATION

China Lake, California

February 1963

# U. S. NAVAL ORDNANCE TEST STATION

AN ACTIVITY OF THE BUREAU OF NAVAL WEAPONS

C. BLENMAN, JR., CAPT., USN  
Commander

Wm. B. McLEAN, Ph.D.  
Technical Director

## FOREWORD

This report presents the results of two studies to develop one-way voice communication from a trainer to a porpoise. The first study took place in August 1961 and the second in November 1961.

This research project, funded by the Naval Ordnance Test Station (NOTS) Exploratory and Foundational Research Program, Weptask assignment number R360-FR-106/215-1/RO11-01-001, was conducted by Willard G. Pumphrey, who was hired by NOTS to determine whether or not standard educational techniques and voice communication techniques are effective as new approaches in porpoise training. Mr. Pumphrey, Principal of the Hooper Avenue Elementary School in Los Angeles, has had 15 years' teaching experience.

This report was reviewed for technical accuracy by R. Engel and T. Lang. It is issued for information only and may be subject to future modification.

Released by  
PIERRE SAINT-AMAND, Head,  
Earth & Planetary Sciences Div.  
1 January 1962

Under authority of  
T. E. PHIPPS, Head,  
Research Dept.

NOTS Technical Publication 3064  
NAVWEPS Report 8061

Published by ..... Publishing Division  
Technical Information Department  
Collation ..... Cover, 14 leaves, abstract cards  
First printing ..... 160 numbered copies  
Security classification ..... UNCLASSIFIED

## CONTENTS

|                                                      |    |
|------------------------------------------------------|----|
| Introduction .....                                   | 1  |
| Procedure .....                                      | 2  |
| Work Sessions .....                                  | 3  |
| Bob ... ..                                           | 3  |
| Lana .....                                           | 4  |
| Notty .....                                          | 5  |
| Second Study .....                                   | 7  |
| Training .....                                       | 7  |
| Treatment .....                                      | 8  |
| Conditions Contributing to Death .....               | 9  |
| Conclusions .....                                    | 10 |
| Recommendations for Future Studies .....             | 11 |
| Appendix:                                            |    |
| Results of the Two Voice Communication Studies ..... | 14 |

#### ACKNOWLEDGMENT

The author is indebted to T. G. Lang of NOTS for initiating the voice communication study, for helping plan the study, and for reviewing the report. The author also wishes to acknowledge the many helpful suggestions of R. Engel of NOTS in planning the study and in analyzing the results. The cooperation and aid of D. McBride and W. Ross of Pacific Ocean Park, and D. Brown and R. Penner of Marineland of the Pacific in training the porpoises is greatly appreciated. Special thanks are due H. A. Smith of NOTS for setting up and repairing the electronic instrumentation.

## INTRODUCTION

The purpose of the two studies dealt with in this report was to develop techniques of one-way communication with a porpoise by means of voice commands. The communication was centered around an object vocabulary. The responses to the commands were observed and recorded.

The following porpoises were used during the first study (August 1961). Technically dolphins, they will be referred to throughout this report as porpoises.

1. Bob (Delphinus delphis), about five years old, male, untrained, provided by Pacific Ocean Park, Santa Monica
2. Lana (Tursiops truncatus), about ten years old, bottlenose porpoise, female, trained show animal, provided by Pacific Ocean Park
3. Notty (Lagenorhynchus obliquidens), between seven and nine years old, Pacific Whitesided dolphin, female, trained only by NOTS, owned by NOTS, and located at Marineland of the Pacific, Palos Verdes

Because these porpoises were housed in commercial establishments and were therefore exposed to personnel not connected with the tests, complete control, such as measured amounts of food, was impossible.

The two studies herein described were conducted independently of previous porpoise studies and introduced a new training technique consisting of voice commands; an attempt was made to avoid hand signals altogether. The author, who had had no previous experience in porpoise training, relied upon his background in child education and standard educational techniques in training the porpoises. The porpoises' previous trainers were unavailable during most of the training, and consequently the author could not obtain all the details of the previous training methods.

These two studies, then, which introduced a new training technique and new training methods, were essentially conducted independently of previous experiments relying on standard practices.

Equipment used in the first study consisted of the following items:

Magnacord dual-channel tape recorder with amplifier  
Underwater sound communicat<sup>ion</sup> set AH/PQC-1

Hydrophone  
Underwater speaker (Universal Model MM-2FUW)  
Amplifier (Holman 210), modified  
Microphone

The following objects were used:

Ring (plastic hose)  
Hat (straw with styrofoam float)  
Ball (10-inch rubber)  
Stick (rubber hose)  
Pillow (12-inch-square boat cushion)  
Jacket (orange life jacket)

The equipment and objects listed were in continuous use during the training period, with the exception of the Navy underwater communication set, which frequently malfunctioned, leading to the early substitution of the underwater speaker.

#### PROCEDURE

The procedure used with each animal followed the pattern listed below. There was some variation in the type of object used and the time needed in the introduction of each new object, depending upon the animal and the learning situation.

1. Food intake was regulated as carefully as possible to ensure responsiveness in the porpoises. (A porpoise trained with food rewards will tend not to respond when satiated.)

2. The underwater speaker was used at all times.

3. Objects were introduced one at a time and placed 3 feet from the side of the tank and as far from the porpoise as possible. The wind and the waves created by the movement of the animal tended to change the position of the objects. This change of position varied with each trial. Records of the changes were not kept.

4. The object and its name were given in direct association. For example, the ball was placed on the animal's "nose" and the word ball repeated 8 to 12 times. A reward was normally given after four repetitions of the word.

5. The object was pushed or thrown from the side of the tank and the command "ball, get the ball" repeated until the animal brought it in for a reward.

6. After 15 successful trials with one object, another object was introduced in the same manner.

7. After two objects were introduced and placed in the water, the name of one was repeated until it was retrieved. (There is no evidence from this study of the exact number of sessions or repetitions needed to firmly fix the vocabulary and response. Each animal was so different in "readiness" for learning that only predictions can be made.)

8. Review periods consisted of six to eight repetitions for each object before starting any new trial.

9. The word come was used with Bob and Notty along with hand signals to come to the trainer. Neither voice nor hand signals were necessary with Lana who, because of her previous training, would come to the trainer unbeckoned.

#### WORK SESSIONS

Early morning or late afternoon were found to be the best times for work sessions. Records were kept of the porpoises' responses after two or more objects were introduced and commands were given to bring back a certain object. A plus (+) sign for a correct response and a minus (-) sign for a negative response were used for plotting the results. Table 1 (Appendix) presents a summary of all tests.

#### BOB

This porpoise was in a circular redwood tank, 2½ feet in diameter and 4 feet in depth, at Pacific Ocean Park. Bob had had no previous training. He had learned, however, to eat dead mackerel and to come to the trainer whenever the water was tapped. Bob was in poor physical condition because of injuries sustained during transportation from the East Coast. He was under medication, and there were several infected places on his body, including a large sore on his lower jaw. His movements were slow and cautious at all times. It is felt that his poor condition hindered the rate of learning.

His first response to the noise from the underwater speaker was that of fear. But gradually his fear completely disappeared.

Training periods lasted about 3 hours per day. Each training period was apportioned into 15- to 20-minute work sessions. The length of time of the work sessions was completely dependent upon the length of Bob's response time. When full or tired he would remain near the middle of the tank and appear to rest. There would be no response to any command.

At the end of 4 days Bob would put his nose through the ring and bring it a short distance. By the end of 10 days he would bring back a ring, ball, and hat.

Discrimination and understanding of commands by Bob were noted. During the seventh session he identified objects by going to them and brushing against them. Reliability was not established because of the small number of trials and Bob's poor health, the latter making it impossible to control his food intake without endangering his life. For this reason it was necessary to discontinue his training period.

Slow, listless, and apparently painful movements were noted throughout the entire training period. Bob was reluctant to touch any object even when he was hungry.

He appeared to learn very rapidly when he was feeling well. On the fifth day of training he was very lively and seemed playful, but this lasted only 1 day.

#### LANA

As it became apparent that Bob would be unable to continue in the training program, arrangements were made to work daily for a short period (30-45 minutes) with Lana. Lana's regular trainer, W. Ross, was most cooperative and greatly assisted in the work with her.

Because Lana was used four or five times each day for public shows, it was necessary for the author to limit her food intake and training time.

Procedures used to introduce the vocabulary in association with the objects were the same as mentioned previously. Each object introduced had been used by Lana in the shows.

It should be noted that the tank at Pacific Ocean Park was oval shaped and about 70 feet long, 50 feet wide, and 13 feet deep, and contained a total of three animals, including Lana.

The first training period indicated a very rapid rate of learning. Lana made five distinct changes of direction in response to voice command when heading for the wrong object. These changes were 90-degree turns. On three trials she passed a favorite (or easy) object to get the one called for. She seemed tempted to bring back the object easiest to transport.

During the second session Lana brought back a hat and a ring on command. Her response to the initial command took approximately 6 seconds. Some interference, caused by the presence of the other animals, was noted, but this was not a major hindrance.

Session number 3 lasted longer than the first two sessions. Thirty trials were made using three objects: ball, hat, and ring. Seventeen responses were correct. On three occasions she passed the other objects to get the correct one as commanded. There was evidence of impatience or anger in trials 16 and 28. This was due to her having previously made some incorrect responses.

Session number 4 had 15 trials using three objects. Six of the trials had a correct response. During this period there was interference by the other animals that resulted in seven of the nine incorrect responses. Three objects again were used. One of the other porpoises, Toro (Tursiops truncatus), a bottlenose, who was present when the vocabulary was given to Lana, retrieved the object that was called for. Lana refused to go near the object when Toro was near it. It is interesting to note that Toro had never tried to retrieve anything before--by any method.

Session number 5 had 18 trials and 12 correct responses. Toro again went to the object called. Lana was slower in response because Toro was near. As soon as he left the object, she would follow through on command.

The response from Lana, who was the fastest learner of the porpoises tested, gives good indication that many more objects could have been added and that she would have responded to the voice command. She is a very responsive, enthusiastic animal and wants to please. It is interesting to note that she emits frequent vocal noise.

It should also be noted that for all the trials, the various objects were placed in different locations each time, grouped close together and wide apart in various combinations.

#### NOTTY

The training of Notty, who was in a plastic and aluminum tank 22 feet in diameter and 4.5 feet in depth, did not begin until August 22, 1961. At the first session she evidenced great fear of the noise from the underwater speaker. By speaking in a soft voice and offering pieces of fish, the trainer got her to come close to the underwater speaker, and her fear lessened.

Objects were introduced in the same manner used with the other animals. Training sessions lasted from 1 to 3 hours.

In session number 2 Notty responded to the commands by going to the object called for, then switching to the object easiest to transport. This session consisted of 22 trials with 11 correct responses. The ball and hat were used.

Session number 3 consisted of 18 trials with eight correct responses. Trials 17 and 18 were for identification only. Notty did not bring the object back.

Session number 4 consisted of 17 trials using the t, ring, and ball. There were only six correct responses. Notty did not readily respond to the command, but merely swam around the tank. She seemed to have no need for food, possibly because of incipient illness (see pp. 7 ff.).

Session number 5 consisted of five trials during which two new objects were introduced; namely, a life jacket (jacket) and a boat cushion (pillow). She was reluctant to approach them. At one of the five trials she made a 90-degree turn from the incorrect to the correct object in response to a verbal command to get the jacket. It was felt at this time that she learned the names of the objects.

Following trial number 5, a strange pattern of behavior developed. She thrashed around the tank and pushed against its edge, giving the appearance of anger, frustration, or pain. On several occasions she tried to get out of the tank. Her body was one third out of the water and over the edge of the tank.

Upon inquiry of the trainers at Marineland, it was learned that this behavior had been observed in the past. It was due to long periods of isolation and the extensive experiments she had been exposed to. Following the aforementioned behavior pattern, no training session was attempted. Instead, several periods were used merely to play with Notty and develop a better relationship. A change of trainers, teaching procedure, and methods of training could have led to much frustration.

Session number 6 consisted of 21 trials with eight correct responses. For this session three objects were used. Notty seemed happier during this period, but not too anxious to work. It was not certain whether she was previously fed this day.

Session number 7 consisted of 10 trials with eight correct responses. Two objects were used in the first five trials, and an additional item was used during the last five. Three of the last five had correct responses.

During session number 8, on September 7, three and four objects were used in 16 trials with 15 correct responses. This remarkable performance was probably due to Notty's having rested for the 8 days that separated the seventh and eighth sessions.

An interesting observation is that no noises of any type were heard from Notty during the course of this study.

No records were kept from which a preference for certain objects might be inferred; but the author, observing that some objects (especially the ring and ball) were easier to transport than others, consciously strove to avoid favoring these objects in his commands.

## SECOND STUDY

This second study in the project to develop techniques in one-way voice communication with a porpoise was instituted during November 1961. The porpoise used for this study was Notty.

### TRAINING

Mr. Robert A. Karback, a high school biology teacher and swimming instructor, was assigned as an assistant to work with the writer to help operate the equipment, record data, and do other work as needed.

The following items were used for this study:

|                    |                                  |
|--------------------|----------------------------------|
| Microphone         | Ring (plastic hose)              |
| Amplifier          | Hat (straw with styrofoam float) |
| Hydrophone         | Ball (10-inch rubber)            |
| Underwater speaker | Stick (rubber hose)              |
| Tape recorder      | Float (10-inch styrofoam)        |

The experimental period was anticipated to extend through the month of November, with 40 hours to be devoted to the training sessions. The first session began on November 9, with a review period in which the various objects were introduced again. The data pertaining to each work session will be found in Tables 2 through 9 (Appendix). The comments in these tables serve to provide data for future evaluation; from them, taken in conjunction with data from previous and future studies, patterns of behavior, movement, or other items of significance might be established.

A total of eight sessions was conducted with Notty in her regular tank. During the first session it was observed that Notty remembered to get the object in response to the voice command but did not remember the name of the objects. Some progress was made during the first seven sessions. However, following the last session of November 18, Mr. David Brown, Curator of Mammals at Marineland, informed Dr. Engel at NOTS on November 22 that Notty was underweight and in very poor physical condition. Shortly thereafter, Notty was transferred to a community tank with four porpoises (Tursiops truncatus) and a trained whale named Squirt, who was recovering from an illness.

A conference was set up with Mr. Brown to determine the best methods of continuing training and at the same time of feeding Notty as much as possible. A feeding plan and chart to keep records of food and vitamin intake was established. On the average, 15 pounds of food was established as a minimum daily requirement.

During the period from December 4, 1961, until December 10, 1961, limited short-period attempts to train Notty were conducted. Close contact was maintained with Mr. Dave Brown at Marineland, so that no risk or undue stress was placed on Notty. Mr. Brown believed that this attention would help Notty to become more normal in her eating habits.

The sessions conducted during this period were more play sessions than work sessions. Notty was given all the food she would take. She appeared to want attention as evidenced by her effort to push Squirt, the trained whale, aside to maintain the attention of the writer. Table 10 (Appendix) shows Notty's food intake and the dates of these short-period training sessions.

#### TREATMENT

During the month of December, it can be seen that Notty developed a very poor pattern of eating. She was given extra vitamins to help improve her physical condition. On the days she was feeding, Notty was given super-B-complex vitamins, and during the last 15 days vitamins A and C were added.

On December 18, Mr. Brown gave Notty injections of vitamin C and antibiotics. Following these injections, her appetite was stimulated, but in 2 days she had stopped eating again.

Following the days of not eating, Mr. Brown again injected vitamin C to stimulate Notty's appetite. During the second injection of vitamin C on December 20, Notty's temperature was taken and found to be a normal 97.2°F. At this time a blood sample was taken. The results failed to indicate any infection.

Owing to the fact that there were three newly captured whales and the trained whale Squirt in the tank with Notty, it is possible that she ate additional food in the form of squid intended for these whales. This is one factor to be considered when analyzing the food intake.

The writer visited Notty nearly every day she was in the community tank. Usually she was very quick to respond and come to the edge of the tank, but not during the last 4 days of her life.

On the morning of December 25, 1961, at 10:30, the writer was observing her swimming pattern. At the time, it appeared that she was improving,

since her speed was moderate and she swam in a regular circle. This pattern is noted in newly captured whales.

Notty died some time that night. Looking back, it seems possible that this swim was the "death swim." It cannot be said for certain that this is true, but it is important to be aware of this swimming pattern in the future.

#### CONDITIONS CONTRIBUTING TO DEATH

It is necessary to go back at this point and determine the probable causes of death. There are many opinions that may be brought forth. Drawing from the writer's short experience and contact with Marineland personnel, from his chance meeting with Dr. John Lilly, leading authority in the field of porpoise research, and from books on cetaceans, it appears that death could be caused from one or more of the following factors:

1. Long periods of isolation
2. Long time in captivity
3. Stress of training
4. Inadequate or inconsistent feeding program, or both
5. Change of trainers and techniques
6. Foreign objects thrown into the water by unknown persons
7. Physical defects caused by stress, the unnatural environment, heredity, damage during capture or transport, falls, collision with objects or other animals, etc.

A brief discussion of each one of the seven points listed above may help in preventing future loss of animals.

1. Long periods of isolation could cause frustration and other psychological problems. Dr. John Lilly stated that one of his training procedures is to return animals to community tanks after 5 days of isolation. This appears to be an excellent procedure.

2. That the length of time in captivity is a cause of death is highly doubtful, but Dr. Lilly stated in his book "Man and Dolphin" that the Lagenorhynchus could not be kept in captivity in a shallow tank for as long a period as Notty had been kept. Although not entirely correct, this statement indicates that a short life-span might have been expected.

3. The stress of training must be counted as a possible cause of death. It is known that in teaching humans we may place a student under very heavy strain, causing many mental and physical problems. The area

of stress in a training situation should be more thoroughly studied. (The helicopter ride and numerous tank transfers add to stress.)

4. Inadequate and inconsistent feeding procedures must be considered. Notty was trained to eat cut fish. While in the community tank or in her own tank when no training was being undertaken, she was fed whole fish. It is also a possibility that with a number of personnel feeding her, she was not being given an adequate amount of food. The variable time of feeding each day may also have been a contributing factor.

5. A change of trainers and techniques could cause psychological problems that in turn could bring about physical problems. Learning and re-learning different techniques and then not reusing many of them can be a source of confusion and frustration.

6. Foreign objects entering the tank could be swallowed by Notty. Many people had access to the training area. This has been the cause of a number of cetacean deaths.

7. The existence of physical defects should be determined by experienced medical personnel. The result of such an investigation may be of great help in the future. (In June of 1960 Notty hit her head on an overhead railing at Convair when she jumped too high while going down the tank; around July of 1960 she rammed a hole into the aluminum tank with her nose; in September of 1961 she jumped out of the tank; and in December of 1961 there was possible damage caused by body contact with a wild whale that chased her in the community tank at Marineland.)

#### CONCLUSIONS

Although these studies were very brief and situations developed that made it necessary to change animals and locations, there were strong indications that it is possible to teach a porpoise to respond to voice commands.

While the records of these studies indicate that a porpoise in good mental and physical condition is able to learn and respond to voice commands, much more time is needed to establish the reliability of the animal's responses to the commands. In the case of Lana there was amazing evidence of response and rapid learning. Of the three porpoises, she was the most responsive to the training program.

The rate of learning of the healthy porpoises appears to be as fast or faster than that of young children, if consideration is given to the completely foreign environment in which the animal is located. The learning rate of Lana and Notty was particularly fast, probably because they had been in contact with humans for a long time.

In future studies it would be desirable to have much better control of the experimental situation. For example, the amount of food consumed by the animal, the kind and quantity of medication, and the number of persons coming in contact with the animal are serious points of consideration.

Association with other animals appears to be a very important factor in maintaining reliable responses. Provisions should be made to make possible the easy transfer from one tank or enclosure to another. This would enhance the learning situation.

The porpoises appear to vary in "personality." It is important to be very alert to any unique patterns of behavior that would aid in teaching. This would come after having experience with several porpoises.

#### RECOMMENDATIONS FOR FUTURE STUDIES

The two studies recorded in this report give rise to the following recommendations:

1. To maintain complete control over the animals and the environment, a Navy-owned and -operated establishment should be used, with full-time personnel in attendance.

2. To obtain a better evaluation of results, several animals should be tested concurrently.

3. A "logbook" for each animal, similar to the Cumulative Record Card and the Health Record Card (Fig. 1) used with students in California, should be established and used from the first day the animal is under NOTS control. In this log there should be maintained a record of every detail of the porpoise's history, such as

- a. Date of capture
- b. Food intake
- c. Training techniques and procedures
- d. Name of trainer
- e. Medical treatment or findings
- f. Weight and size
- g. Number of times the animal is moved and conditions of movement
- h. Room for additional data needed as more experience is gained

4. Larger tank facilities should be available once the initial training has been established.

5. Animals should have contact with one another, but provisions should be made to work with one animal, or any desired combination of animals, at a time.

6. There is a need for reliable methods to determine whether all electronic equipment is properly functioning.

7. Duplicate equipment is desirable so that quick changes can be made in case of equipment failure.

8. The following equipment needs should be met:

- a. Two portable tape recorders with on-off microphones and remote control switches--one for recording underwater sound and the other for recording experimental notes
- b. Two underwater speakers with frequency response to at least 10 kc
- c. One transducer receiver with frequency response to 200 kc
- d. Microphone and amplifier for underwater speaker

9. Systematic medical examination procedures should be established, such as weight, blood test, temperature, heart beat, and X-ray examinations. (Not having a medical background, it is not within the writer's domain to suggest additional examinations.)

10. An up-to-date library and file of all medical findings should be developed and maintained.

11. The trainer should consider spending much time in the water during the training sessions. (This procedure may assist in later teaching if it is found that a demonstration of the commands could speed the learning rate, as it often does with children.)

12. Administrative control over the animals should remain in the hands of the personnel directly concerned with conducting the experimental program. Outside groups should not be allowed to conduct experiments without the full consent and knowledge of these personnel.

V \_\_\_\_\_ DT \_\_\_\_\_ P \_\_\_\_\_

**LOS ANGELES CITY SCHOOL DISTRICTS  
HEALTH RECORD**

| Residence | Phone | School | Date Arr. | Birth Date        | Mo. | Day | Yr. |
|-----------|-------|--------|-----------|-------------------|-----|-----|-----|
|           |       |        |           | Birthplace        |     |     |     |
|           |       |        |           | Arrived in Calif. |     |     |     |
|           |       |        |           | Room Nos.         |     |     |     |
|           |       |        |           |                   |     |     |     |
|           |       |        |           |                   |     |     |     |
|           |       |        |           |                   |     |     |     |
|           |       |        |           |                   |     |     |     |

[illegible]

This card must be transferred with other record cards. Every child must have a health card or an "Excuse from Physical Examination."

| PERSONAL HISTORY |                |                   |               | Date          | Family Physician | Address        | Family Dentist | Address |
|------------------|----------------|-------------------|---------------|---------------|------------------|----------------|----------------|---------|
| Asthma           | Tbc Child      | Dental Decay      | Convulsions   | IMMUNIZATIONS | Years            | FAMILY S' ATUS |                |         |
| Hayfever         | Tbc Family     | Toothache         | Fainting      | S. pos        |                  | Father         |                |         |
| Eczema           | Chickenpox     | Freq Colds        | When?         | Diph.         |                  | Mother         |                |         |
| Diabetes         | Measles        | Freq Sore Throats | Nose Bleeds   | Wh. Cough     |                  | Bro's. Ages    |                |         |
| Heart Dis        | Ger. Measles   | Freq Coughs       | Growing Pains | Tetanus       |                  |                |                |         |
| Polio            | Wh Cough       | Freq. Headaches   | Operations    | Polio         |                  | Sis. Ages      |                |         |
| Pneumonia        | Mumps          | Wears Glasses     |               |               |                  |                |                |         |
| Rheum Fever      | Hernia         | Tires Easily      | Accidents     |               |                  |                |                |         |
| Scarlet Fever    | Eye Difficulty | Recent Bad Wtg    | Other Ser Ill |               |                  |                |                |         |
| Appetite         |                |                   |               | Milk Daily?   | Food Allergies?  |                |                |         |
| Breakfast        |                |                   |               |               | Bed Time         |                | Rising Time    |         |

[illegible]

**FIG. 1. Health Record Card.**

Appendix

RESULTS OF THE TWO VOICE COMMUNICATION STUDIES

Table 1 deals with the first study of this report. Tables 2-9, dealing with Notty's training sessions, and Table 10, dealing with Notty's food intake during the short-period training sessions, cover the data obtained from the second study.

The following information applies only to Tables 2-9:

The actual working time spent with Notty was 1 to 2 hours a session, with rest breaks about every 15 minutes or when Notty appeared to tire. The letter symbols, B, F, H, R, S, represent the objects Notty was commanded to retrieve: ball, float, hat, ring, stick. Response time signifies the time lapse between the issuance of the trainer's command and the porpoise's physical reaction to the command. It does not represent the time it took her to retrieve the object. The symbol NR indicates that no response was observed in Notty.

TABLE 1. Summary of Voice Communication Tests  
With Porpoises--First Study

| Lana ( <i>Tursiops truncatus</i> )          |                          |                   |          |           |       |                |
|---------------------------------------------|--------------------------|-------------------|----------|-----------|-------|----------------|
| Session                                     | Trial                    | No. of<br>objects | Response |           |       | Reliability, % |
|                                             |                          |                   | Correct  | Incorrect | Total |                |
| 1                                           | Preparatory <sup>1</sup> | ...               | ..       | ..        | ..    | ...            |
| 2                                           | 1-8                      | 2                 | 5        | 3         | 8     | 62.5           |
| 3                                           | 9-38                     | 2 & 3             | 17       | 13        | 30    | 56.7           |
| 4                                           | 39-53                    | 3                 | 6        | 9         | 15    | 40.0           |
| 5                                           | 54-71                    | 3 & 4             | 12       | 6         | 18    | 56.6           |
| Notty ( <i>Lagenorhynchus obliquidens</i> ) |                          |                   |          |           |       |                |
| 1                                           | Preparatory <sup>1</sup> | ...               | ..       | ..        | ..    | ...            |
| 2                                           | 1-22                     | 2                 | 11       | 11        | 22    | 50.0           |
| 3                                           | 23-40                    | 2                 | 8        | 10        | 18    | 44.5           |
| 4                                           | 41-57                    | 3                 | 6        | 11        | 17    | 35.0           |
| 5                                           | Training <sup>1</sup>    | ...               | ..       | ..        | ..    | ...            |
| 6                                           | 58-78                    | 3                 | 8        | 13        | 21    | 38.0           |
| 7                                           | 79-88                    | 2 & 3             | 8        | 2         | 10    | 80.0           |
| 8                                           | 89-104                   | 3 & 4             | 15       | 1         | 16    | 94.0           |

<sup>1</sup> No formal tests.

TABLE 2. Training Session No. 1, 9 November 1961

Food intake, 6 1/2 lb in p.m., unknown for a.m.; no medication.

| Trial no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                        |
|-----------|--------|---------|----------------------------------|-----------------------|-------------------------------------------------|
| 1         | RB     | R       | -                                | 20                    | Retrieved ball, slapped against ring            |
| 2         | HB     | H       | +                                | 5                     | .....                                           |
| 3         | B      | B       | +                                | 5                     | .....                                           |
| 4         | B      | B       | +                                | 5                     | .....                                           |
| 5         | R      | R       | +                                | 3                     | .....                                           |
| 6         | R      | R       | +                                | 3                     | .....                                           |
| 7         | H      | H       | +                                | 4                     | .....                                           |
| 8         | H      | H       | +                                | 3                     | .....                                           |
| 9         | BHR    | B       | -                                | NR                    | .....                                           |
| 10        | BHR    | B       | +                                | 3                     | Pushed against ball (playfully), retrieved ball |
| 11        | H      | H       | +                                | 4                     | .....                                           |
| 12        | RHB    | R       | -                                | NR                    | .....                                           |
| 13        | RHB    | R       | -                                | NR                    | .....                                           |
| 14        | R      | R       | +                                | 25                    | .....                                           |
| 15        | BHR    | B       | -                                | NR                    | .....                                           |
| 16        | BHR    | B       | -                                | NR                    | .....                                           |
| 17        | B      | B       | +                                | 3                     | Reintroduced ball                               |
| 18        | R      | R       | +                                | 3                     | Reintroduced ring                               |
| 19        | RB     | R       | +                                | 3                     | .....                                           |
| 20        | RB     | R       | +                                | 3                     | .....                                           |
| 21        | RB     | R       | -                                | NR                    | .....                                           |
| 22        | RB     | R       | +                                | 3                     | .....                                           |
| 23        | RB     | B       | +                                | 3                     | .....                                           |
| 24        | RB     | R       | +                                | 3                     | .....                                           |
| 25        | RBH    | R       | +                                | 3                     | .....                                           |
| 26        | HB     | H       | +                                | 3                     | .....                                           |
| 27        | B      | B       | +                                | 10                    | .....                                           |

<sup>a</sup> 20 correct responses, 7 incorrect. 75% reliability.

TABLE 3. Training Session No. 2, 11 November 1961

Food intake, 24 lb; medication, 2 multivitamins.

| Trial no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                        |
|-----------|--------|---------|----------------------------------|-----------------------|-------------------------------------------------|
| 1         | B      | B       | +                                | 2                     | Review with one object; objects thrown in water |
| 2         | B      | B       | +                                | 1                     | Do.                                             |
| 3         | H      | H       | +                                | 2                     | Do.                                             |
| 4         | H      | H       | +                                | 2                     | Do.                                             |
| 5         | R      | R       | +                                | 2                     | Do.                                             |
| 6         | R      | R       | +                                | 2                     | .....                                           |
| 7         | RHB    | R       | -                                | 30                    | .....                                           |
| 8         | RHB    | R       | +                                | 20                    | .....                                           |
| 9         | RHB    | B       | -                                | 5                     | Returned ball and ring                          |
| 10        | S      | S       | +                                | 5                     | Introduced stick, with a review                 |
| 11        | HS     | S       | -                                | NR                    | .....                                           |
| 12        | RBS    | R       | +                                | 40                    | Left ball to get ring                           |
| 13        | RPS    | R       | +                                | 40                    | .....                                           |
| 14        | RBS    | B       | +                                | 5                     | .....                                           |
| 15        | RH     | R       | -                                | 20                    | .....                                           |
| 16        | RBS    | S       | -                                | NR                    | .....                                           |
| 17        | RBS    | S       | -                                | 90                    | .....                                           |
| 18        | RBSH   | R       | -                                | 30                    | Four objects                                    |

<sup>a</sup> 11 correct responses, 7 incorrect. 61% reliability.

TABLE 4. Training Session No. 3, 13 November 1961

Food intake, 15 lb; medication, 2 multivitamins.

| Trial<br>no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                                                                                                                    |
|--------------|--------|---------|----------------------------------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1            | SH     | S       | -                                | 35                    | Before session a review was made of previous objects                                                                                        |
| 2            | SH     | S       | +                                | 10                    | .....                                                                                                                                       |
| 3            | SH     | S       | -                                | 35                    | .....                                                                                                                                       |
| 4            | SH     | S       | -                                | 20                    | Reviewed stick following this trial                                                                                                         |
| 5            | SH     | S       | -                                | 20                    | .....                                                                                                                                       |
| 6            | SH     | S       | -                                | 50                    | .....                                                                                                                                       |
| 7            | SH     | S       | +                                | 20                    | Headed for hat but changed to get stick                                                                                                     |
| 8            | SH     | S       | -                                | 10                    | Headed for stick but changed to hat                                                                                                         |
| 9            | SH     | H       | -                                | 50                    | .....                                                                                                                                       |
| 10           | SH     | H       | +                                | 10                    | .....                                                                                                                                       |
| 11           | SH     | S       | +                                | 10                    | Headed for hat but changed to stick                                                                                                         |
| 12           | SH     | S       | -                                | 40                    | .....                                                                                                                                       |
| 13           | SH     | S       | -                                | 30                    | Touched stick, brought back hat                                                                                                             |
| 14           | SHF    | F       | -                                | 40                    | Introduced float 5 times before this trial, to see if new object would stimulate more alertness; did not show much response; reason unknown |

<sup>a</sup> 4 correct responses, 10 incorrect. 29% reliability

TABLE 5. Training Session No. 4, 14 November 1961

Food intake, 15 1/2 lb; medication, 2 multivitamins.

| Trial no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                                                            |
|-----------|--------|---------|----------------------------------|-----------------------|-------------------------------------------------------------------------------------|
| 1         | HS     | S       | +                                | 5                     | General review of all objects before beginning session                              |
| 2         | HS     | H       | +                                | 7                     | Eliminated one spotlight used in previous session, to check light problem for Notty |
| 3         | HS     | S       | -                                | NR                    | .....                                                                               |
| 4         | HS     | S       | -                                | NR                    | .....                                                                               |
| 5         | HS     | S       | -                                | NR                    | Reviewed stick before this trial                                                    |
| 6         | HS     | S       | -                                | NR                    | Do.                                                                                 |
| 7         | HS     | S       | +                                | 3                     | .....                                                                               |
| 8         | HS     | S       | -                                | NR                    | Reviewed ball and float                                                             |
| 9         | FB     | B       | -                                | NR                    | .....                                                                               |
| 10        | FB     | B       | -                                | NR                    | .....                                                                               |
| 11        | FB     | F       | -                                | NR                    | .....                                                                               |
| 12        | FB     | B       | +                                | 3                     | .....                                                                               |
| 13        | FB     | B       | +                                | 5                     | 15-min break or rest following this trial                                           |
| 14        | FB     | F       | +                                | 3                     | .....                                                                               |
| 15        | FB     | F       | -                                | NR                    | .....                                                                               |
| 16        | FB     | F       | -                                | NR                    | .....                                                                               |
| 17        | FB     | F       | -                                | NR                    | .....                                                                               |
| 18        | FHB    | H       | -                                | 3                     | Returned hat 5 ft, dropped it, then brought float rest of way                       |
| 19        | FHB    | H       | -                                | NR                    | .....                                                                               |
| 20        | FHB    | H       | -                                | NR                    | .....                                                                               |

<sup>a</sup> 6 correct responses, 14 incorrect. 30% reliability

TABLE 6. Training Session No. 5, 16 November 1961

Food intake, 6 1/2 lb; medication, 2 multivitamins.

| Trial no. | Object | Command | Response, <sup>a</sup> |      | Response time, sec | Comments                                                                         |
|-----------|--------|---------|------------------------|------|--------------------|----------------------------------------------------------------------------------|
|           |        |         | +                      | or - |                    |                                                                                  |
| 1         | FB     | B       | -                      |      | NR                 | . . . . .                                                                        |
| 2         | FB     | B       | +                      |      | 3                  | . . . . .                                                                        |
| 3         | FB     | B       | -                      |      | 3                  | Returned both objects                                                            |
| 4         | FB     | B       | -                      |      | NR                 | . . . . .                                                                        |
| 5         | FB     | B       | +                      |      | 3                  | Reviewed ball at this point                                                      |
| 6         | FB     | B       | -                      |      | NR                 | . . . . .                                                                        |
| 7         | FS     | F       | -                      |      | NR                 | . . . . .                                                                        |
| 8         | FS     | F       | +                      |      | 3                  | . . . . .                                                                        |
| 9         | FS     | F       | -                      |      | NR                 | . . . . .                                                                        |
| 10        | FS     | F       | +                      |      | 3                  | . . . . .                                                                        |
| 11        | FS     | F       | +                      |      | 20                 | . . . . .                                                                        |
| 12        | FS     | F       | +                      |      | 4                  | . . . . .                                                                        |
| 13        | FS     | S       | +                      |      | 3                  | . . . . .                                                                        |
| 14        | FS     | S       | +                      |      | 4                  | . . . . .                                                                        |
| 15        | FS     | S       | +                      |      | 3                  | . . . . .                                                                        |
| 16        | FS     | F       | -                      |      | ?                  | Float very close to side of tank, wind pushed it to side after command was given |
| 17        | FS     | F       | +                      |      | 4                  | . . . . .                                                                        |
| 18        | FS     | S       | -                      |      | ?                  | Stick very near side                                                             |

<sup>a</sup> 10 correct responses, 8 incorrect. 56% reliability.

TABLE 7. Training Session No. 6, 17 November 1961

Food intake, 6 lb; medication, 2 multivitamins.

| Trial no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                                                           |
|-----------|--------|---------|----------------------------------|-----------------------|------------------------------------------------------------------------------------|
| 1         | FS     | F       | -                                | NR                    | Review period before this trial                                                    |
| 2         | FS     | S       | +                                | 4                     | Objects placed in water                                                            |
| 3         | FS     | S       | +                                | 4                     | Do.                                                                                |
| 4         | FS     | F       | -                                | NR                    | . . . . .                                                                          |
| 5         | FS     | F       | +                                | 4                     | . . . . .                                                                          |
| 6         | FS     | F       | +                                | 25                    | Response after water splashed by R. Korbach                                        |
| 7         | FS     | S       | -                                | NR                    | . . . . .                                                                          |
| 8         | FS     | S       | +                                | 5                     | . . . . .                                                                          |
| 9         | FS     | S       | -                                | NR                    | . . . . .                                                                          |
| 10        | FS     | F       | -                                | NR                    | . . . . .                                                                          |
| 11        | FS     | F       | +                                | 3                     | Objects thrown in water                                                            |
| 12        | FS     | F       | -                                | NR                    | Objects placed in water                                                            |
| 13        | FS     | S       | +                                | 60                    | . . . . .                                                                          |
| 14        | FS     | S       | -                                | ?                     | Hit against float and returned, then went to stick, hit stick, returned with float |
| 15        | FS     | F       | +                                | 45                    | Objects thrown                                                                     |
| 16        | FH     | H       | +                                | 2                     | Objects placed                                                                     |
| 17        | FH     | F       | -                                | NR                    | . . . . .                                                                          |
| 18        | HF     | F       | +                                | 60                    | . . . . .                                                                          |
| 19        | HFS    | S       | -                                | NR                    | . . . . .                                                                          |
| 20        | HFS    | F       | +                                | 20                    | . . . . .                                                                          |
| 21        | HS     | H       | +                                | 5                     | . . . . .                                                                          |
| 22        | HFS    | H       | -                                | ?                     | Returned stick                                                                     |
| 23        | HFS    | H       | -                                | ?                     | Returned float                                                                     |
| 24        | HFS    | H       | +                                | 7                     | . . . . .                                                                          |

<sup>a</sup> 13 correct responses, 11 incorrect. 54% reliability.

TABLE 8. Training Session No. 7, 18 November 1961

Food intake, 10 1/2 lb; medication, 2 multivitamins.

| Trial no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                                                                |
|-----------|--------|---------|----------------------------------|-----------------------|-----------------------------------------------------------------------------------------|
| 1         | HSF    | H       | +                                | 20                    | All objects placed in water following review period                                     |
| 2         | FS     | F       | -                                | NR                    | .....                                                                                   |
| 3         | HSF    | F       | -                                | NR                    | .....                                                                                   |
| 4         | HSF    | F       | -                                | NR                    | .....                                                                                   |
| 5         | HSF    | F       | +                                | 30                    | .....                                                                                   |
| 6         | HSF    | F       | -                                | NR                    | .....                                                                                   |
| 7         | HSF    | F       | -                                | NR                    | Reviewed float; Notty made negative responses, was weighed at this time. Weight: 180 lb |
| 8         | HRS    | R       | +                                | ?                     | Trainer stayed in water with Notty; gave commands from this position                    |
| 9         | HRS    | H       | +                                | ?                     | .....                                                                                   |
| 10        | HFS    | H       | +                                | ?                     | Very slow response                                                                      |
| 11        | HFS    | F       | -                                | NR                    | .....                                                                                   |
| 12        | HFS    | F       | -                                | NR                    | No microphone used                                                                      |
| 13        | HFS    | F       | -                                | NR                    | Microphone used                                                                         |
| 14        | HFS    | F       | -                                | NR                    | Played back tape from recorder; word float distorted                                    |

<sup>a</sup> 5 correct responses, 9 incorrect. 36% reliability.

TABLE 9. Training Session No. 8, 18 November 1961

Food intake, 9 lb; medication, 2 multivitamins.

| Trial no. | Object | Command | Response, <sup>a</sup><br>+ or - | Response time,<br>sec | Comments                                                                                                                                                                                                                                                                                                                                  |
|-----------|--------|---------|----------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1         | HFS    | F       | -                                | NR                    | Trainer in pool<br>Ended session playing with Notty;<br>fed her balance of fish, tape recorder used with hydrophone to listen for echo ranging on food; negative<br>Notty transferred to community tank on 23 or 24 Nov. 1961 at suggestion of Dave Brown, who felt that Notty was very thin and estimated that she was 40 lb underweight |
| 2         | HFS    | S       | +                                | 5                     |                                                                                                                                                                                                                                                                                                                                           |

<sup>a</sup> 1 correct response, 1 incorrect. 50% reliability.

TABLE 10. Notty's Food Intake During Short-Period Training Sessions

| Date,<br>Dec. | Total food<br>intake, lb | Marineland,<br>a.m., lb | Trainer,<br>p.m., lb |
|---------------|--------------------------|-------------------------|----------------------|
| 4             | 15                       | 7                       | 8                    |
| 5             | 15 1/2                   | 7                       | 8 1/2                |
| 6             | 17                       | 7                       | 10                   |
| 7             | 10                       | 10                      | 0                    |
| 8             | 7                        | 0                       | 7                    |
| 9             | 2                        | 0                       | 2                    |
| 10            | 0                        | 0                       | 0                    |

## INITIAL DISTRIBUTION

- 6 Chief, Bureau of Naval Weapons
  - DLI-31 (2)
  - R-12 (1)
  - R-5 (1)
  - RRRE (1)
  - RU (1)
- 3 Chief of Naval Operations
  - OP-07T21 (1)
  - OP-713 (1)
  - OP-716C (1)
- 2 Chief of Naval Research
  - Code 466
    - Dr. S. R. Galler (1)
    - Helen Hayes (1)
- 1 David W. Taylor Model Basin (Dr. Shoenherr)
- 1 Naval Academy, Annapolis (Librarian)
- 2 Naval Hospital, San Diego
  - Commanding Officer (1)
  - Executive Officer (1)
- 7 Naval Missile Center, Point Mugu
  - N00 (1)
  - N01 (1)
  - N020 (1)
  - N3 (1)
  - N33 (1)
  - N334 (1)
  - 6232 (1)
- 1 Naval Oceanographic Office (Code 3312)
- 1 Naval Postgraduate School, Monterey (Library, Technical Reports Section)
- 1 Naval Torpedo Station, Keyport (Quality Evaluation Laboratory, Technical Library)
- 1 Naval Underwater Ordnance Station, Newport
- 1 Naval War College, Newport (Institute of Naval Studies)
- 1 Naval Weapons Laboratory, Dahlgren
- 2 Naval Weapons Services Office
  - 1 Navy Electronics Laboratory, San Diego
  - 1 Navy Underwater Sound Laboratory, Fort Trumbull
  - 1 Navy Underwater Sound Reference Laboratory, Orlando
- 1 Office of Naval Research, London
- 1 Office of Naval Research Branch Office, Pasadena
- 1 USRO/DEF6, New York (U. S. Mission to NATO, Navy Section)
- 10 Armed Services Technical Information Agency (TIPCR)
- 1 Director of Defense (R & E) (Office of Fuels, Materials and Ordnance, Bayard Belyea)

NAVWEPS REPORT 8061

---

- 1 The Supreme Allied Commander Atlantic, ASW Research Center, La Spezia, Italy, via BuWeps (DSC), via SDMICC
- 2 Coast and Geodetic Survey
  - Head, Current and Tides Branch (1)
  - Head, Operations Branch (1)
- 1 Coast and Geodetic Survey, Los Angeles
- 1 Committee on Oceanography
- 1 Committee on Undersea Warfare
- 2 National Science Foundation
  - Director, Engineering Sciences Division (1)
- 1 U. S. Fish and Wildlife Service, Tiburon Marine Laboratory, Tiburon, Calif. (J. L. Squire, Jr.)
- 5 British Joint Services Mission (Navy Staff) via BuWeps (DSC)
- 2 Defence Research Member, Canadian Joint Staff (W) via BuWeps (DSC)
- 1 Applied Physics Laboratory, University of Washington, Seattle
- 1 British Museum of Natural History, London (Keeper of Zoology, F. C. Frazer) via BuWeps (DSC)
- 1 California State Fish and Game Commission, Sacramento (Director, W. Shannon)
- 1 Chesapeake Bay Institute, JHU, Baltimore
- 1 Communication Research Institute, Miami (Dr. J. Lilly)
- 1 Engineering Societies Library, New York City
- 1 Fisheries Research Board of Canada, Nanaimo, British Columbia, via BuWeps (DSC)
- 5 Hydrodynamics Laboratory, CIT, Pasadena
  - Dr. A. J. Acosta (1)
  - Dr. A. T. Ellis (1)
  - Dr. T. Y. Wu (1)
  - T. Kiceniuk (1)
  - Library (1)
- 1 Lockheed Aircraft Corporation, Burbank, Calif. (Dr. Archer)
- 1 Marine Physical Laboratory, University of California, San Diego
- 3 Marineland of the Pacific, Palos Verdes, Calif.
  - D. Brown (1)
  - J. Prescott (1)
  - R. Penner (1)
- 1 Ordnance Research Laboratory, Pennsylvania State University, University Park (Garfield Thomas Water Tunnel)
- 1 Oregon State College, Corvallis (Department of Oceanography)
- 1 Pacific Naval Laboratory, Esquimalt, British Columbia, via BuWeps (DSC)
- 1 Pacific Ocean Park, Santa Monica, Calif. (Walter Ross)
- 2 Scripps Institution of Oceanography, University of California, La Jolla
- 1 Southwest Research Institute, San Antonio (Oceanography and Meteorology Division)
- 1 Stanford University, Stanford, Calif. (Department of Civil Engineering, Prof. B. Perry)
- 2 The University of Southern California, Los Angeles
  - Allan Hancock Foundation (1)
  - Biology Department, Dr. John Mohr (1)

# ABSTRACT CARD

U. S. Naval Ordnance Test Station

One-Way Voice Communication With Porpoises, by Willard G. Pumphrey. China Lake, Calif., NOTS, February 1963. 26 pp. (NR 8061, NOTS TP 3064), UNCLASSIFIED.

ABSTRACT. Child educational techniques were used as a new method of training porpoises. To test the effectiveness of this method, oral commands were given to porpoises to retrieve several objects, and their responses were noted. The results demonstrate

(over)  
1 card, 4 copies

U. S. Naval Ordnance Test Station

One-Way Voice Communication With Porpoises, by Willard G. Pumphrey. China Lake, Calif., NOTS, February 1963. 26 pp. (NR 8061, NOTS TP 3064), UNCLASSIFIED.

ABSTRACT. Child educational techniques were used as a new method of training porpoises. To test the effectiveness of this method, oral commands were given to porpoises to retrieve several objects, and their responses were noted. The results demonstrate

(over)  
1 card, 4 copies

U. S. Naval Ordnance Test Station

One-Way Voice Communication With Porpoises, by Willard G. Pumphrey. China Lake, Calif., NOTS, February 1963. 26 pp. (NR 8061, NOTS TP 3064), UNCLASSIFIED.

ABSTRACT. Child educational techniques were used as a new method of training porpoises. To test the effectiveness of this method, oral commands were given to porpoises to retrieve several objects, and their responses were noted. The results demonstrate

(over)  
1 card, 4 copies

U. S. Naval Ordnance Test Station

One-Way Voice Communication With Porpoises, by Willard G. Pumphrey. China Lake, Calif., NOTS, February 1963. 26 pp. (NR 8061, NOTS TP 3064), UNCLASSIFIED.

ABSTRACT. Child educational techniques were used as a new method of training porpoises. To test the effectiveness of this method, oral commands were given to porpoises to retrieve several objects, and their responses were noted. The results demonstrate

(over)  
1 card, 4 copies

NAVWEPs Report 8061

the feasibility of this method of training: the porpoises' learning rate was very rapid and, taking into account their confined and unnatural environment, may have approached that of young children.

NAVWEPs Report 8061

the feasibility of this method of training: the porpoises' learning rate was very rapid and, taking into account their confined and unnatural environment, may have approached that of young children.

NAVWEPs Report 8061

the feasibility of this method of training: the porpoises' learning rate was very rapid and, taking into account their confined and unnatural environment, may have approached that of young children.

NAVWEPs Report 8061

the feasibility of this method of training: the porpoises' learning rate was very rapid and, taking into account their confined and unnatural environment, may have approached that of young children.

- 1 United Research, Inc., Cambridge, Mass.
- 1 University of Arizona, School of Engineering, Tucson (Howard A. Baldwin)
- 3 University of California at Los Angeles (Department of Zoology)
  - Dr. K. Norris (1)
  - Dr. T. John (1)
  - Dr. V. Walters (1)
- 2 University of California, Institute of Engineering Research, Berkeley
  - J. Herder (1)
- 1 University of Miami, Marine Laboratory, Miami
- 1 University of Washington, Seattle (Department of Oceanography)
- 2 Woods Hole Oceanographic Institution, Woods Hole, Mass.
  - R. H. Backus (1)