OBSERVATIONAL LEARNING IN THE CALIFORNIA SEA LION *(ZALOPHUS CALIFORNIANUS)*

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Summary

Three California sea lions were tested for evidence of observational learning on a problem requiring them to pull a rope into the center of their cage, after they had watched a fourth sea lion learn the task by a shaping method. Even though pulling a rope was a difficult task for the sea lions, the results confirmed that they were able to profit from observations. A retest after an interval of 37 days showed that, in the case of one of the sea lions, the problem solution was acquired during the observation period although the task was performed only after the delay.

Introduction

Observational learning probably plays a major role in social learning situations which lead to the acquisition of new behaviour patterns (Adler, 1977 ; Galef, 1976). It is likely that observational learning is an important mechanism of adaptation by providing a short-cut to trial and error learning. Bandura (1962, 1965) has stressed the importance of observational learning, or modeling, in human behaviour. Davis (1973) and Galef (1976) have recently reviewed the place and function of observational learning in nonhuman species. A varied range of terminology has been applied to this group of related phenomena, ranging from "imitation" and "allelomimetic" behaviour to "mimesis" and "matched-dependent" behaviour. For the purpose of the present study, observational learning is defined by the saving in time or trials of an observer given the same problem that a demonstrator had learned without the benefit of observation and the degree to which the observer's pattern of responses match those of the demonstrator's.

There has been a paucity of comparative data, due to the fact that only a few species of mammals have been studied in the laboratory, e.g. monkeys (Warden & Jackson, 1935; Warden, Fjeld & Koch, 1940; Darby & Riopelle, 1959; Hall, 1963), rats (Will, Pallaud, Soczka & Manikowski, 1974; Del Russo, 1975), cats (Adler, 1955; Tachiban, Yamaguchi & Haruki, 1974), dogs (Adler & Adler, 1977), and recently dolphins (Adler & Adler, 1978). Even less is known about observational learning under natural conditions, as exemplified by the studies on Japanese macaques (Kawai, 1965).

When the opportunity to study the behaviour of California sea lions *(Zalophus californianus)* was offered to us[1], we decided to investigate their ability to learn by observation. Even though the total number of animals available to us was small, we thought it best to test these four sea mammals, and perhaps replicate the experiment at a later date with other sea lions.

[1] The authors thank Mr. Stephen Spotte, Dr. J. Lawrence Dunn, and the staff of the Mystic Marinelife Aquarium, Mystic, Connecticut, for their cooperation and assistance.

Method

Four male California sea lions served as subjects. All were born in the wild. Salty weighed 138 kg and was 12 years old. Surfer, ten years old, weighed 91 kg. Skipper and Squirty were both five years old and weighed 50 kg and 48 kg respectively. The two older animals performed regularly in the hourly public aquarium shows. Skipper performed occasionally, while Squirty was still in training.

The living units, in which the sea lions were tested, were situated along the wall of a large room backstage. The two center units were occupied by Salty and Surfer, while Skipper and Squirty were housed in the end units. The dimensions of each compartment -except for Salty's, which was a double unit- were $1\frac{1}{2}$ m wide, 2 m long, and 2 m high. There were 91 cm of water in the bottom of the compartment, over which a platform protruded 91 cm from the front halfway into the cage. The wire mesh separating the units on each side also contained a door in the front, through which the animals left and re-entered their compartments. Above each door and to the right, 137 cm above the platform, there was a small opening (7 x 10 cm wide and high) through which the animals received their supplemental food rations, other than what they were fed during their public performances (see Fig. 1).

The subjects in the present experiment were used to being handfed. They moved their heads back, looked up, and opened their mouth, so that food could be dropped in by the trainer, either as reward during shows or as additional food after or between shows. In order to test observational learning, the response should be within an animal's potential repertory and should not be so difficult that the association between response and reward cannot be made. On the other hand, the task should not be so easy as to make the advantage gained by observation so small as to be insignificant.

The task the sea lions had to learn was to pull a 12 mm diameter thick yellow rope into the middle of their unit. Sea lions do not usually pull on ropes and no such skills had been included in their training, although feral animals have been observed occasionally manipulating strands of kelp.

This problem of pulling a rope was similar to the ribbon-pulling task that had been used to test observational learning in cats (Adler, 1955) and dogs (Adler and Adler, 1977), where a food cart had been attached to the ribbon, and dolphins (Adler and Adler, 1978) who pulled a rope with no food attached, but received food as their reward at the end of a successful completion of the rope-pulling task.

At the beginning of a trial the rope was inserted through the small opening above the platform so that it hung down approximately 15 cm on the inside of the cage and timing commenced. The rope started with a small loop, just big enough to hold a piece of mackerel, or occasionally herring, which was to be pulled out by the sea lion and thereby constituted the reward, as well as the end of the trial, which was signaled to the sea lions by a whistle. The other end of the rope was held by the experimenter, so that it could be retrieved quickly after each trial, stuffed with the reward and replaced through the opening in to the unit. This procedure differed from the studies previously mentioned in that the reward was located at the front end of the rope (Fig. 1).

The training started with the demonstrator, who had to learn the task by a shaping method, while the observers had the opportunity to watch through the wire mesh from their compartments nearby. This arrangement resembled the duplicate cage method to study observational learning, first used by Warden and associates (Warden & Jackson, 1935; Warden, Fjeld & Koch, 1940), and later employed by Adler (1955) and Adler and Adler (1977). Salty was selected as demonstrator out of necessity, rather

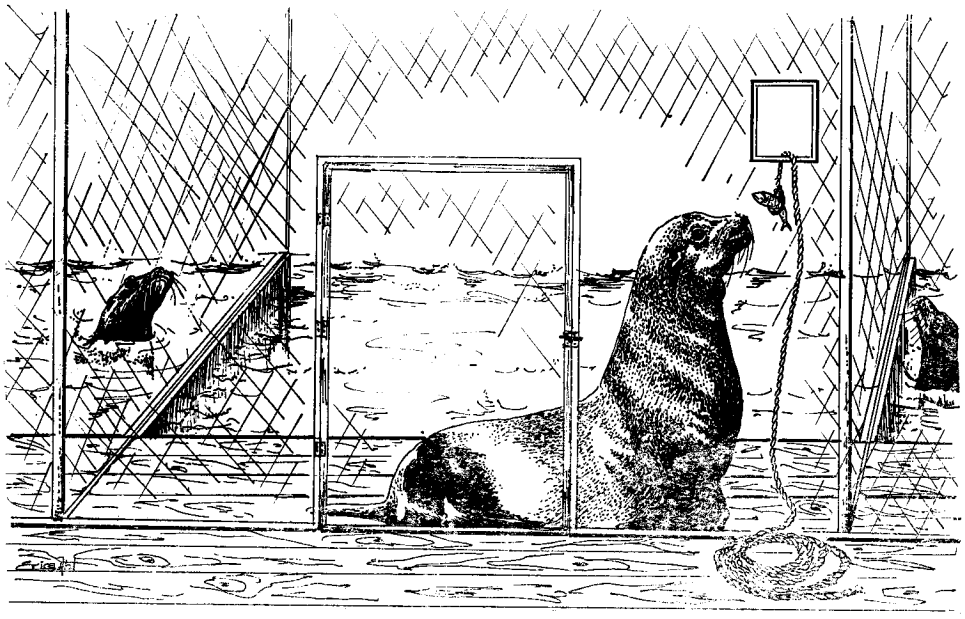

Figure 1. View of cage unit and sea lion at beginning of a trial. (Drawing by Erica Abt)

than either by chance or by choice. Surfer had actually been drawn by lot to be the demonstrator, but his trainer punished him on this day for poor performance during the Aquarium show and he was not allowed by the trainer to participate in our experiment. The use of Skipper in his place would have overtaxed this younger sea lion, since he had to work the performances. Squirty was in the outside unit, which would have made it diffioult for the sea lions at the other end of the bank of cages to observe his actions. Therefore Salty in the center compartment was the obvious solution.
The observers had the opportunity to watch Salty during three training phases: 1. A preliminary phase, during which the animal did not respond at all during four sessions, spread over two days. 2. Three sessions of approach training, when Salty by successive approximation learned to pull the rope and secure his reward for a total of 31 reinforcements. And 3. there were 55 trials forming the final phase, spread over a period of eight days, during which a spontaneous pattern of pulling the rope into the pool and removing the fish under water was demonstrated (Fig. 2).

Results

Salty's first successful trial occurred on the fourth day of the experiment and the 10th trial of the third shaping session. He took 160 sec to pull the rope into his cage and to jump with it into the water, where he consumed his fish. When Salty's performance was speedily and smoothly executed, the rope was made available to Surfer, who ignored both the rope and the attached fish[2]. First Skipper and then Squirty were then

[2] Previous to and during this period of time both Surfer and Squirty had been bothered by intestinal upsets and were on medication. Skipper was used for the public performances, since Surfer refused to cooperate.

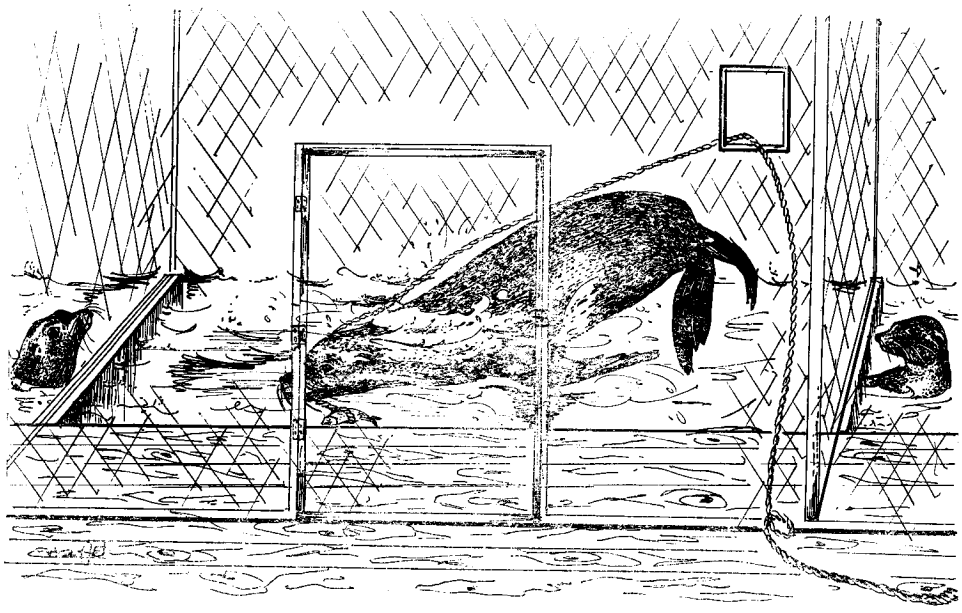

Figure 2. Sea lion pulling rope and attached fish into the water. (Drawing by Erica Abt)

tested. Their performances on the first 5 trials are presented in Table 1. It should be noted that their initial trials took only 43 and 23 sec respectively and were comparable to Salty's long practiced last performances. The observer's behaviour matched Salty's pattern of pulling the rope and attached fish into the water and consuming their bait under water.

TABLE 1

Duration of the first 5 trials by each observer

Date	Subject	Trial (sec)				
8/5/75	Skipper	43	251[a]	12	23	26
8/5/75	Squirty	23	22	12	32	11
9/13/75	Surfer	90	3	7	5	17

[a]Delay due to several unsuccessful attempts to remove the fish which was stuck tightly in the loop of the rope.

Each of the sea lions was tested again the following day. Salty, Skipper, and Squirty efficiently pulled the rope into their cage, but Surfer still refused all food. He acted excitedly, vocalized, and waved his flippers (which was part of his act). He jumped into his pool in a manner reminiscent of the performances he had observed in the other sea lions, but without pulling the rope, nor availing himself of the food reward. He appeared to simply go through the exact motions he had observed.

Delayed testing

Surfer was retested 37 days later, without the benefit of observations or any testing during the intervening period. He nuzzled the rope almost immediately, then jumped into the pool, as he had done before; but this time Surfer came to the platform again, took the loop with the fish gently into his mouth and gave it a tug to bring it halfway into the cage at 35 sec from the start. He continued to pull the rope with the fish attached until he was successful at 90 sec (see Table 1). Nine more trials followed in quick succession, showing complete mastery of the task. Surfer performed readily at this time, showing the effect of positive reinforcement on a well motivated and healthy organism. At the conclusion of Surfer's session, each of the other three sea lions received three trials. All pulled the rope smoothly and efficiently, giving evidence that they had retained the solution of the problem and the skill they had learned during the period of 37 days during which no experimentation of any kind had taken place[3].

Discussion

Pulling a rope, even when baited with a fish, appeared to be a difficult behaviour pattern for sea lions, which had to be shaped in the case of Salty, the demonstrator. The observers, Skipper and Squirty, responded quickly in their first trial. The saving in time and trials, compared to Salty's performance, and the similarity of their pattern of pulling the rope, showed that most likely they had learned this behaviour by observation. Also learned by observation, it seems, was the knowledge that the stimulus (the rope with the fish) was "safe" when the careful and cautious behaviour of the demonstrator was compared with that of the two quick responding observers. In the case of Surfer, it is possible to attribute his observational learning to vicarious reinforcement, similar to that reported by Bandura and Walters (1963). In the first test trials he did not avail himself of the award, but matched the demonstrator's behaviour, which he had seen reinforced. After a five-week interval, without further observation of the task, Surfer performed very well, demonstrating the effect of positive reinforcement on a well motivated and healthy organism, as well as the retention of a task that had previously been learned by observation. Bandura (1965) distinguished response acquisition, related to the cognitive and perceptual elements of vicarious learning, from the performance of the newly acquired response, which depended on motivational and reinforcefent related variables.

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[3] Retested almost two years later (7/21/77), Salty, Surfer, and Skipper performed their task immediately and smoothly when the rope was made available to them. Squirty was in an outdoor pool and not available for testing.

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