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ORIENTING RESPONSES AND UNDERWATER VISUAL DISCRIMINATION IN THE CALIFORNIA SEA LION

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In view of recent research activity on the visual and auditory perceptual abilities of the porpoise (Kellogg, 1961; Kellogg & Rice, 1964), it behooves the comparative psychologist to run parallel studies on other marine mammals having grossly different sensory and brain structures (McBride & Hebb, 1948). A start in this direction has recently been made by Schusterman et al. (1965), who report that the California sea lion has extremely good underwater visual discrimination.

In conditioning situations postural changes occur for orienting sense receptors within the range of the conditioned stimulus. Although orienting responses are not themselves directly instrumental in securing reward, an animal may learn orienting and fixating responses of the head and eyes in order to discriminate effectively between two stimuli (Riopelle, 1960). Further, there is evidence suggesting that conflict and the difficulty of a discrimination are important factors contributing to the production of orienting responses (Berlyne, 1960; Tolman, 1948). The underwater discriminative behavior of the sea lion offers a good opportunity for studying orienting responses because of the ease with which gross postural adjustments by a swimming sea lion may be observed.

The present paper describes two experiments concerned with orienting responses by the sea lion as a function of (a) visibility and (b) conflict.

METHOD

The experimental Ss were two wild-born California sea lions (Zalophus californianus). They were approximately 24-29 months old at the time these studies were undertaken. All testing was conducted in an oval tank constructed of redwood, painted white and measuring 15 feet x 30 feet and six feet deep. The testing conditions and apparatus have been previously described in detail (Schusterman et al., 1965). The Ss had been previously trained to remain rather motionless at a starting position 16 to 20 feet in front of a testing platform until they were signalled to approach by the sound of the stimulus display being lowered into the water (see Fig. 1). The S's task was to strike one of two target stimuli (differing in size) in order to obtain a small piece of herring. A perpendicular divider made of chicken wire projected four feet outward between the stimulus targets and all the way down to the floor of the tank, thus preventing Ss from swimming laterally from one target to another.

Two Es were always present throughout both experiments. One E presented the stimulus display and reinforced appropriate responses while the other E observed S from the testing platform, recording correct responses and the presence or absence of orienting responses. An orienting response was defined as postural changes of the head or body occurring within seven feet of the stimulus display. In most instances the response took the form of a lateral movement or change in swimming direction away from one stimulus and toward the other at a point one to three feet in front of the perpendicular divider. Occasionally two or three such reversals of head and body orientation occurred prior to the indicator response (striking the target). To provide an estimate of reliability, two Es independently scored the presence of orienting responses during 50 trials. Reliability expressed as percentage of agreement was 92.

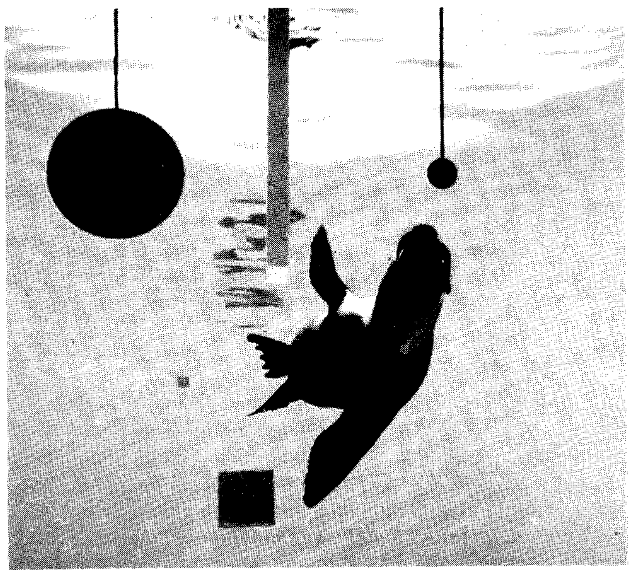

Figure 1. A sea lion approaching the underwater stimulus display. The stimulus divider is not the one used in the present experiments.

EXPERIMENT 1

Following a demonstration of perfect discrimination in clear water between a large black circular disk (736.1 cm.^{2} in area) and a small black circular disk (16.1 cm.^{2} in area) sea lion C (S_1) was confronted with the identical discrimination task in turbid water. A harmless vegetable dye, called Cloud, was poured into the water so that visibility was attenuated to a distance of approximately 110 inches, i.e., the maximum distance at which a skin diver was capable of perceiving the larger target. Presumably Ss were unable to perceive the stimulus display when they began their approach approximately 18 feet away. Following 150 training trials in turbid water S_1 and sea lion B (S_2) were tested alternately in clear and turbid water. Since S_2 had already received intensive discrimination training on moonless nights, it was impossible to obtain data on this S regarding the initial effect of poor visibility on a previously well-learned discrimination task.

Results

Figure 2 presents the effects of reduced underwater visibility on S_1's performance. Even though the discrimination had been perfected prior to making the water turbid, and despite the fact that visibility under water had not prohibited discriminability in advance of the choice point (approximately four to five feet), S averaged less than 60% correct responses during the first 75 trials. As the figure clearly shows, the acquisition curve for correct responses is closely paralleled by the acquisition curve for orienting responses.

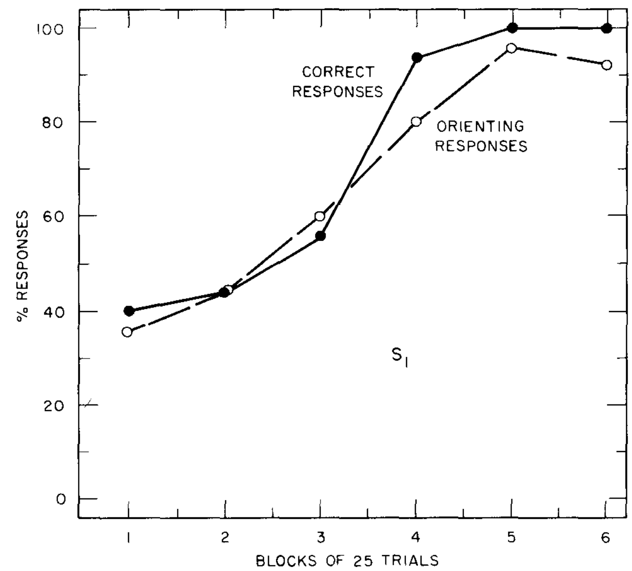

Figure 2. Acquisition of orienting and correct responses in turbid water.

During the second phase of the experiment, both Ss performed perfectly on the size-discrimination task regardless of visibility conditions. However, Fig. 3 shows that orienting responses are considerably more frequent ($p < .01$) for both Ss under the turbid-water condition than under the clear-water condition. It should be noted that S_1 emitted pulsed sounds during the initial stages of testing in both clear and turbid water. A description of these pulsed sounds will be reported elsewhere (Schusterman, in preparation).

A third sea lion was trained in turbid water on a slightly different task and its performance closely paralleled that of S_1 (see Fig. 2).

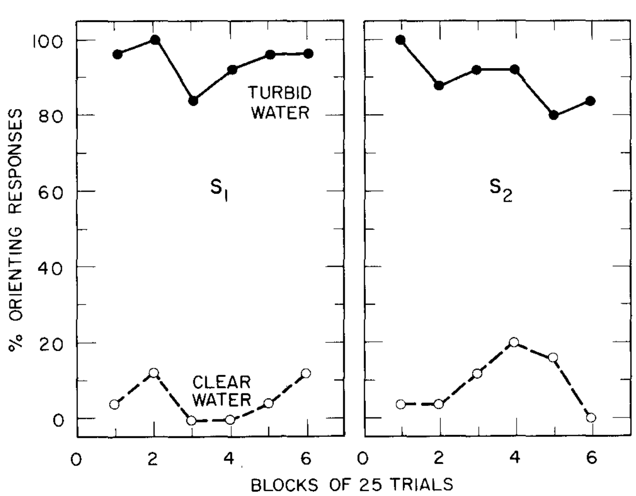

Figure 3. Orienting responses as a function of clear and turbid water.

EXPERIMENT 2

During this experiment all testing was conducted in clear water. A conflict situation was arranged by presenting Ss with a discrimination-reversal task Berlyne, 1960). After Ss showed a preference for the rewarded member of a pair of stimuli (differing in form) the reward values of the stimuli were reversed.

Results

Figure 4 shows that although both Ss exhibited little evidence of orienting behavior when conflict was not present, orienting responses became more numerous during the initial stages of conflict induction and diminished following conflict resolution.

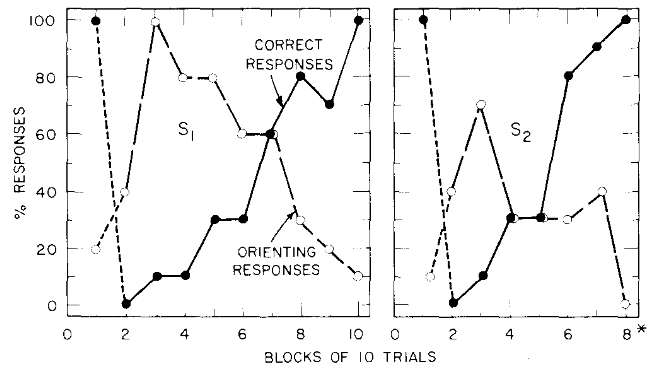

Figure 4. Acquisition of correct responses and adaptation of orienting responses on a discrimination-reversal task. * denotes a block of eight trials.

DISCUSSION

Orienting responses by sea lions are somewhat similar to the VTE responses of the porpoise (Kellogg & Rice, 1964); however, in the course of making these responses sea lions do not stop or reduce their speed noticeably as does the porpoise.

The present study has demonstrated the importance of measuring some aspects of the orienting behavior of sea lions during the course of discrimination learning. The topography of those orienting responses activated under a condition of impaired visual input is indistinguishable from those activated in a conflict situation. In the former case, however, orienting responses follow the same course of acquisition as do correct responses, whereas under a conflict condition orienting responses are acquired prior to criterional learning and subside when discrimination performance is perfected. These results suggest that the orienting responses of sea lions, as described in the present paper, may serve to mediate different kinds of discrimination-learning processes.

ACKNOWLEDGMENT

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