Behavior Research Methods & Instrumentation
1974, Vol. 6 (4), 409-410

Autoshaping in the goldfish*

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The target-striking response of the goldfish was classically conditioned to target-light color, the effectiveness of the pairing (of color and reinforcement) being demonstrated by appropriate controls.

Our purpose in this experiment was to determine whether target-striking in goldfish, like keypecking in pigeons (Brown & Jenkins, 1968; Gamzu & Williams, 1971) and leverpawing in rats (Peterson, Ackil, Frommer, & Hearst, 1972), could be established and maintained by a purely Pavlovian procedure. Some preliminary work by Squier (1969) on autoshaping in fishes provides no information on the effect of pairing target light and food, because the control procedure was inadequate. In the present experiment, two pseudoconditioning controls were employed. First, the performance of an experimental group was compared with that of an unpaired control group, and then both groups were differentially conditioned.

METHOD

Subjects

The Ss were 12 10-cm goldfish supplied by a local dealer. They were maintained in individual 15-liter tanks on a 24-h feeding schedule.

Apparatus

The 12 tanks, their two long sides and back ends painted flat black, were arranged on a turntable which could be rotated to bring each in turn into the training position. The training apparatus, mounted on a chassis of black Plexiglas, covered the top and the front end of the tank on which it rested, thus providing a visually isolated experimental enclosure which was illuminated by a dim houselight. The manipulandum was a circular target of diffusing Plexiglas presented at the front end of the tank. The target was mounted on a rod, the other end of which was inserted into the needle holder of a phonograph cartridge, and any contact of the animal with the target produced a voltage across the cartridge which was used to operate a response relay; the technique has been described elsewhere (Woodard & Bitterman, 1974). At the center of the target, which could be illuminated from behind by lamps of different color, was a small Plexiglas cup into which liquid reinforcement (Biorell and water thickened with tragacanth) could be delivered by a PetiPump (Harvard Apparatus Company). The training apparatus was cabled to programming equipment in an adjacent room. All events of the experiment were controlled automatically, and responses were recorded with a printing counter.

Procedure

The animals were pretrained to take food from the foodcup when the target was illuminated with white light. On each pretraining trial, which began after an intertrial interval in darkness averaging 180 sec, the target was illuminated and 50 microliters of food was supplied to the cup. The animal's first contact with the foodcup started a 10-sec interval, during which the white light remained on, giving the animal more than enough time in which to finish the food, but no further food was delivered. There were 10 such trials each day, and the pretraining continued until all animals were taking the food readily. Then the animals were divided into two groups of six each, matched for adjustment in pretraining.

In the first stage of the experiment proper, the experimental group was given 20 trials per day with a mean intertrial interval of 90 sec. Half the trials were conditioning trials–the target was illuminated with colored light (red for half the animals and green for the others) for a period of 20 sec (the CS-US interval), after which, independently of the animal's behavior, reinforcement was presented in the same way as in the pretraining (50 microliters of food delivered to the foodcup, the target light changed to white and remained on for 10 sec after the animal's first contact with the foodcup). The remaining trials of each day were blank trials–programmed as were the conditioning trials, but with no presentation of CS or US. On trials of both kinds, the number of contacts with the target during the CS-US interval was recorded with a printing counter. The training of the control group differed from that of the experimental group in two respects–the CS was not presented on what were conditioning trials for the experimental group, but it was presented on what were blank trials for the experimental group; that is, the CS and US were presented as often as for the experimental group, although they never were paired. The same measures of performance were used for the control animals as for the experimental–number of responses during 20-sec presentations of the CS and during 20-sec blank intervals.

In the second stage of the experiment, both groups were differentially conditioned. For the experimental group, the conditioning trials were the same as before, but unreinforced presentations of the color not used on conditioning trials were substituted for blank trials. For the control group, the procedure was exactly the same, the reinforced color being the one not used on unreinforced trials in this and in the preceding stage of training. The number of contacts with the target during each presentation of each stimulus was recorded.

RESULTS

The results are shown in Fig. 1, which is plotted in terms of mean probability of response on each trial, and in Fig. 2, which is plotted in terms of mean number of responses on each trial. The two measures provide very much the same picture, as do also the analyses of variance based upon them. In Stage 1, response of the experimental group to the stimulus paired with reinforcement (S+) was much greater ($p < .01$) than the response of the control group to the same stimulus, which for that group never was paired with

*This work was supported by Grant MH 23294 from the Public Health Service. Requests for reprints may be addressed to either author at the Laboratory of Sensory Sciences, University of Hawaii, 1993 East-West Road, Honolulu, Hawaii 96822.

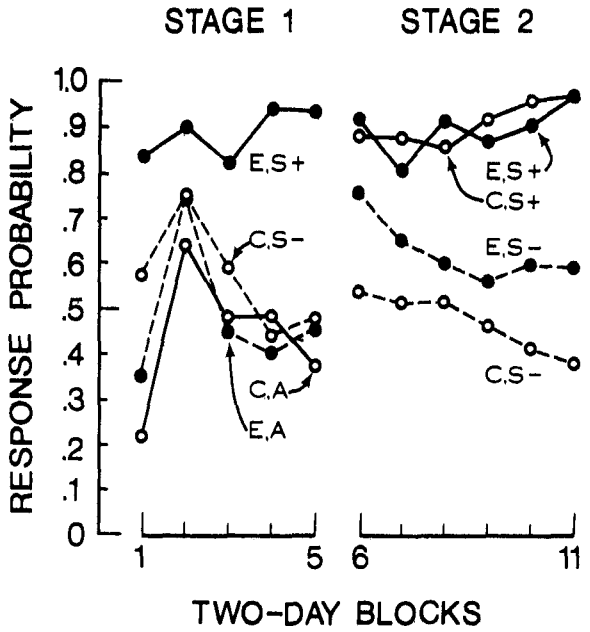

Fig. 1. The performance of experimental (E) and control (C) groups in each stage of training plotted in terms of mean probability of response on each 20-sec trial. S+, color paired with reinforcement; S–, color not paired with reinforcement; A, no stimulus.

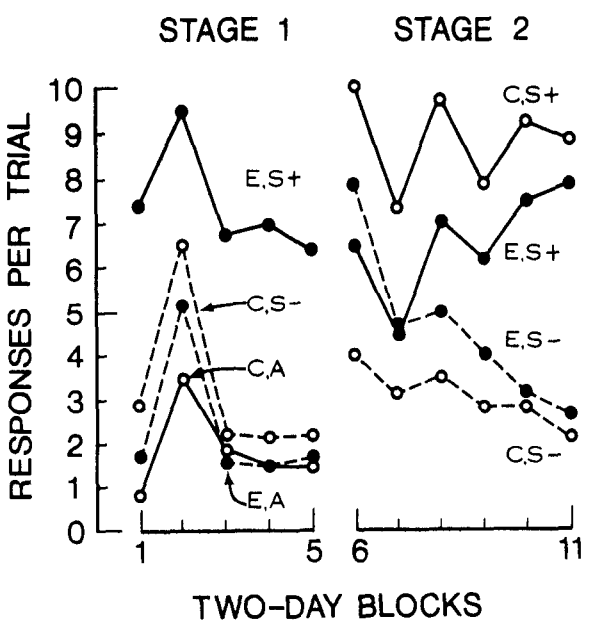

Fig. 2. The performance of experimental (E) and control (C) groups in each stage of the experiment plotted in terms of mean number of responses on each 20-sec trial. S+, reinforced color; S–, unreinforced color; A, no stimulus.

reinforcement (S–). Both groups responded on blank trials (A) at about the same level as the control group to S–. A significant interaction of groups with "stimuli" (S+ or S– vs A) also should be noted ($p < .01$); that is, the difference between response to S+ and A in the experimental group was greater than the difference between response to S– and A in the control group.

In Stage 2, response to S+ was significantly greater than response to S– ($p < .01$), and a significant interaction of Stimuli by Blocks of Days ($p < .01$) shows that the discrimination developed over days. A significant interaction (only for the frequency measure plotted in Fig. 2) of Groups by Stimuli by Blocks of Days ($p < .05$) suggests that pretraining with S– (control group) in Stage 1 contributed more to the discrimination than did pretraining with S+ (experimental group), due apparently to greater generalization of excitation than of inhibition. From the initial performance of the animals in each stage, it is clear that there was a good deal of generalized excitation from the white light which accompanied the food to the colored lights which served as discriminative stimuli, a finding which emphasizes the importance of proper control procedures in such experiments.

We conclude from these results that target-striking in goldfish can be classically conditioned, which is not to say, of course, that the behavior can be explained in terms of contiguity alone. As in all instances of classical conditioning with an appetitive unconditioned stimulus, the possibility must be considered that response to the conditioned stimulus is maintained by adventitious reinforcement (Hull, 1943).

REFERENCES

Brown, P. L., & Jenkins, H. M. Auto-shaping of the pigeon's key-peck. Journal of the Experimental Analysis of Behavior, 1968, 11, 1-8.

Gamzu, E., & Williams, D. R. Classical conditioning of a complex skeletal response. Science, 1971, 171, 923-925.

Hull, C. L. *Principles of behavior.* New York: Appleton-Century, 1943.

Peterson, G. B., Ackil, J. E., Frommer, G. P., & Hearst, E. S. Conditioned approach and contact behavior toward signals for food or brain stimulation. Science, 1972, 177, 1009-1011.

Squier, L. H. Autoshaping key responses with fish. Psychonomic Science, 1969, 17, 177-178.

Woodard, W. T., & Bitterman, M. E. Improved techniques for the measurement of consummatory behavior in fishes. Behavior Research Methods & Instrumentation, 1974, 6, 321324.

(Received for publication February 23, 1974; revision received March 26, 1974.)