Effects of shock on mirror reinforced behavior of *betta splendens*¹

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Mirror-reinforced operant behavior of male Siamese Fighting Fish was suppressed when shocks were presented immediately following the response (concurrent with mirror onset). Operant response rate increased when shock was presented at mirror-offset (30 sec following the operant) or when shocks were presented on a VI 3 schedule noncontingent on the animal's behavior. It was suggested that shock with mirror-offset and noncontingent shock increase the effectiveness of mirror reinforcement and the opportunity to engage in aggressive display, while shock with mirror onset punishes the operant.

Electric shock presentation can elicit aggressive behavior in a variety of species directed towards other animals and inanimate objects (Ulrich & Azrin, 1962; Ulrich, Wolff, & Azrin, 1964; Ulrich & Azrin, 1965). Shock presentation can also set the occasion for an operant which provides the opportunity to engage in aggressive behavior (Azrin, Hutchinson, & Sallery, 1964). A mirror image elicits aggressive display behavior in the male Siamese Fighting Fish (*Betta splendens*) much as shock elicits aggressive behavior in rats and monkeys. Mirror presentation can also serve as an effective reinforcer for an operant response (Thompson, 1963). It has been suggested that the degree to which the mirror image of a male *B. splendens* is reinforcing depends on the degree to which it elicits aggressive behavior (Thompson, 1966;

Simpson, 1968). The purpose of the present experiment was to determine whether the presentation of shock would increase the disposition to display aggressively and thereby increase the effectiveness of mirror reinforcement.

SUBJECTS

Five domestic stock male *B. splendens* with extensive histories of working for mirror reinforcement were used as Ss. Two of the fish were blue, two were red, and one was orange.

APPARATUS

The Ss were maintained in 2-liter Pyrex aquaria, measuring 4.5 x 9 x 10 in., filled with conditioned tap water at 27 deg C. The test apparatus (Sturm, Grabowski, & Thompson, 1966) consisted of a ¾ x 1½ x 1½ in. transparent Lucite response channel suspended in the tank with photoelectric detectors on one side and a light source on the other, a 3 x 6 in. mirror presented alongside the tank, and one 2 x 7 in. stainless steel electrode plate at each end of the tank connected to a 6-V dc shock source. The duration of the mirror presentation was 30 sec. All stimulus presentations and recording were done by remote programming equipment and cumulative recorders.

PROCEDURE

The overhead lights were on 24 h per day and feeding occurred 1 h before sessions at the same time each day.

Experiment 1. Following baseline sessions in which each channel-swimming response produced a 30-sec mirror presentation, the first shock procedure was instituted. In this method a 0.5-sec shock was presented following each operant response, concurrent with mirror onset.

Experiment 2. The shock was programmed to occur with mirror offset, i.e., 30 sec after the operant. Sessions consisted of 1 h of contingent shock, 1 h of no shock, and reinstatement of the contingent shock condition in the third hour.

Fig. 1. The effects of three shock presentation contingencies on mirror-reinforced operant responding. A. Baseline (1) followed by two responses producing shock with mirror onset (2), followed by a 3-h pause (3) which was omitted, and a return to baseline (4). B. Shock with mirror offset, followed by a period of no-shock presentation, returning to the shock with mirror offset. C. Shocks presented on a VI 3-min schedule, not contingent on the S's behavior, followed by a no-shock conditioning, then returning to noncontingent shock.

Fig. 2. The number of responses during the last ½ h of noncontingent shock (closed circles), no-shock conditions, and noncontingent shock for Fish 1 and 5, over a 15-day period.

Experiment 3. Twenty noncontingent shocks were presented on a VI 3 schedule. The shocks were programmed independently of the status of responding or mirror condition. Sessions consisted of 1 h of noncontingent shock, 1 h of no shock, and then reinstatement of the noncontingent shock condition.

RESULTS

Figure 1A shows a cumulative record of responding by one fish for the first session. The segment at 1 indicates the baseline, while the segment at 2 shows the two responses which occurred when each response was immediately followed by shock and mirror onset, followed by the subsequent 1-h pause at 3 (omitted). One noncontingent mirror presentation reestablished responding (Segment 4). The cumulative record at B shows the third 3-h session for the same fish.

Figure 1C is a cumulative record of performance during one 3-h session for one fish, consisting of the noncontingent-shock, no-shock, noncontingent-shock conditions. The slopes of this record and the record during the contingent-shock are not comparable since the paper drive continued during reinforcement in Fig. 1A and B but did not in Fig. 1C. The event marker at the bottom of the Fig. 1C indicates the occurrence of shock.

The noncontingent shock data illustrated in Fig. 2 shows the last ½ h of each of the conditions for each of the 15 days for both fish. (Data for Day 3 for Fish 1 does not include the reinstatement of the noncontingent shock condition due to an apparatus malfunction). With the exception of Day 2 for Fish 5, each set of points indicates that more responses were emitted during the noncontingent shock conditions than during the intervening no-shock condition.

DISCUSSION

It is evident that the presentation of response-contingent shock with mirror onset produced a decrease in the frequency of the operant and thereby decreased the frequency of mirror presentation. Since the frequency of mirror presentation was diminished, the frequency of aggressive display was diminished as well. When shock was presented with mirror offset, the operant was well maintained and it is apparent that contingent shock with mirror offset resulted in a higher rate than the no-shock condition.

These data indicate that presenting shock immediately following the operant response suppresses the operant which precedes it. However, presenting the shock with mirror offset facilitates the operant performance, which might be interpreted as increasing the effectiveness of mirror reinforcement. Unfortunately, response-contingent shock with the mirror offset confounds the possibility of delay of

punishment, the reinforcing aspects of mirror offset, and simple facilitative effects of shock presentation.

The presentation of response-contingent shock led to permanent cessation of responding by three of the five fish. Consequently, the noncontingent shock study included two of the original animals. The findings of Simpson (1968) are of interest with regard to identification of the fish which ceased to respond. His data indicate that blue Siamese Fighting Fish display and attack more readily than Siamese Fighting Fish of other colors. In the present experiment, the two fish which continued to respond were blue.

Differences between the response rates under the noncontingent-shock and no-shock conditions are apparent. The rates during the no-shock condition which intervened between noncontingent-shock conditions were slightly higher than the rates of the no-shock condition which intervened between contingent-shock conditions. This difference is perhaps due to the more discriminable contingency involved in the latter. The extent of the difference under both the earlier contingent-shock condition and under the noncontingent-shock condition is of greater consequence in view of the fact that the usual pattern of responding during the last hour of 3-h sessions is a slight decrease in rate.

The data indicate that shock presentation superimposed on an operant baseline reinforced by mirror presentation can have a suppressing or facilitating effect on the operant, depending on the contingency relation. Shock immediately following the operant suppresses the operant. Shock 30 sec after the operant (i.e., with mirror offset) or noncontingent shock increases the operant rate. The noncontingent-shock facilitation provides clearer evidence since it is not confounded by the possible delay of punishment or the reinforcing properties of mirror offset. It is unlikely that in the case of shock with mirror offset, termination of the display behavior is providing more time to emit the operant since if this were the mechanism, the noncontingent-shock rates would not be expected to be high. It is possible that shock elicits further display thereby prolonging the reinforcing effect of the opportunity to display. A more plausible interpretation is that shock produces a state of the organism in which the opportunity to engage in aggressive behavior is more reinforcing. This interpretation seems most plausible and is consistent with Azrin, Ulrich and co-workers' data with squirrel monkeys.

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NOTE

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