SCHEDULES OF CONDITIONED REINFORCEMENT DURING EXPERIMENTAL EXTINCTION

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If a stimulus is repeatedly presented in conjunction with a reinforcer, the stimulus becomes a conditioned reinforcer. One way to demonstrate this conditioned reinforcing effect is to allow the stimulus to alter the course of experimental extinction. This technique was used in an early experiment by Skinner (1938).

Whenever the sound of a food magazine occurred, food was delivered into a tray. The hungry rats in this experiment learned to approach the tray only at the sound of the food magazine. The rats were then trained to press a lever that operated the food magazine. After this chain of responses was thoroughly established, the food magazine was disconnected. Under this procedure, an extinction curve occurred in which response rates decreased to low values. Next, the food magazine was again connected, although food was still not delivered; that is, each response produced only the sound of the magazine. Response rates increased markedly, and a second extinction curve occurred (Skinner, 1938, p. 103). Skinner attributed the increased response rates to the conditioned reinforcing effect of the magazine sound.

Recent criticisms of this technique for demonstrating conditioned reinforcement have emphasized the importance of distinguishing between the effects of a stimulus as a conditioned reinforcer and the effects of a stimulus as a conditioned stimulus. Bugelski (1956) suggested that the sound of the food magazine is not a conditioned reinforcer but is instead a conditioned stimulus that *evokes* responding. Wyckoff, Sidowski, and Chambliss (1958) also suggested that the sound of the food magazine is not a conditioned reinforcer; however, they believe that the magazine sound is a discriminative stimulus controlling increased activity and consequently increasing the probability of responding.

The purpose of the present experiment was to elucidate the effects of the magazine sound during extinction by scheduling the presentation of the magazine sound just as the presentation of food is usually scheduled (Ferster & Skinner, 1957). The results demonstrate that the magazine sound can be used as a conditioned reinforcer.

SUBJECTS AND APPARATUS

The two subjects were male, White Carneaux pigeons maintained at 75% of their free-feeding weights. These birds had been trained to peck a Plexiglas key to obtain reinforcements. A reinforcement consisted of a 4-second access to a hopper of grain. The sound of a solenoid pulling the hopper into place produced a distinct magazine sound which preceded each reinforcement. The pigeons had about 50 hours of experience on a 5-minute, fixed-interval schedule (FI 5) just before the present experiment. The apparatus and recording equipment has been described generally (Ferster & Skinner, 1957).

PROCEDURE

During the experimental sessions described in this report, the hopper of grain was disconnected and the birds did not receive food; however, the magazine sound was produced according to a schedule. On one schedule, the magazine sound occurred whenever the bird paused for a specified period of time. I shall refer to this schedule as the differential re-

inforcement of pausing (DRP). On a second schedule, the magazine sound was produced by the first response occurring after 5 minutes had elapsed (FI 5). On a third schedule, the magazine sound was produced whenever the bird emitted a specified number of responses; that is, the magazine sound was produced on a fixed-ratio (FR) schedule. In the first two experimental extinction sessions, the DRP schedule and the FR schedule alternated. Food was not presented during these two sessions. Following the second session, the birds were returned to an FI 5 schedule of food reinforcement for 15 experimental sessions. Then, the food magazine was again disconnected, and both birds had a third experimental extinction session in which the magazine sound was produced on FI 5, FR, and DRP schedules.

RESULTS

Figure 1 presents the results with one bird during the first two experimental extinction sessions. In the first session (Frame A), the magazine sound initially occurred on a DRP of 10 seconds. Periods during which low response rates resulted in the frequent occurrence of the magazine sound are shown at *a* and *b*. During the 75 minutes in which the DRP schedule was in effect, the average response rate was 14.2 responses per minute.

Immediately after the pause at *b*, the next response produced the magazine sound (CRF). For the remainder of this first extinction session, responses produced the magazine sound on an FR schedule. The response requirement was increased from FR 5 to FR 25. The results are presented in the third and fourth cumulative-record segments in Fig. 1A. During the 28 minutes in which the FR schedule was in effect, the average response rate was 27.9 responses per minute.

On the following day (Frame B), the DRP schedule was again in effect at the start of the session. The results are presented in the first cumulative record in Fig. 1B. Again, low response rates at *c* resulted in frequent presentations of the magazine sound. During this exposure to the DRP schedule, the average response rate was 18.3 responses per minute. Immediately after *c*, the magazine sound was again presented on FR schedules of the values indicated. As shown in the second cumulative record of Fig. 1B, average response rates increased to 36.6 responses per minute. In the third cumulative record of Fig. 1B, the DRP was again introduced, and the average response rate decreased to 18.5 responses per minute. Low response rates at *d* resulted in frequent presentations of the magazine sound. In the fourth record of Fig. 1B, the FR procedure was again introduced, and the average response rates increased to 35 responses per minute.

The results for these first two sessions of experimental extinction demonstrate that the schedule of presentation of the magazine sound can be used to manipulate response rates even when food is not presented. The results with the DRP schedule indicate that the magazine sound may be followed by a low or zero response rate. However, even after a demonstration of this very low response rate following the magazine sound, high response rates can still be produced if the magazine sound is on an FR schedule.

After an additional 15 hours on the FI 5 schedule of food reinforcement, another session of experimental extinction was conducted. Cumulative-response records for one bird are presented in Fig. 2. In this session, all three schedules of presentation of the magazine sound were used. Changes from one schedule to another are designated.

As shown in the first two segments of Fig. 2, the magazine sound was produced on an FI 5 schedule, and the positively accelerated responding characteristic of FI schedules of

Figure 1. Cumulative-response records showing first (Frame A) and second (Frame B) sessions of experimental extinction. Performances on DRP 10 seconds and various FR values are presented. Pips indicate presentations of the magazine sound.

food reinforcement was maintained. Note that response rates were highest just before the magazine sound and lowest just after.

In subsequent segments, periods during which FR schedules were in effect alternated with periods in which either FI 5 or DRP 5 seconds was in effect. Response rates were usually high during the FR schedule. When the schedule of the magazine sound was shifted from FR to FI 5 (as at *a*, *c*, and *e*), the high response rates characteristic of the FR schedule occurred at the start of the FI 5 segment. In each case, further exposure to FI 5 (as at *b*) decreased these response rates following the magazine sound. Whenever the DRP 5 seconds was in effect, response rates were low; however, response rates increased rapidly whenever

Figure 2. Cumulative-response records showing third session of experimental extinction. Performances on FI 5, FR, and DRP 5-second schedules of presentation of the magazine sound are shown. The recording pen reset when the magazine sound was presented on the FI 5 schedule or when the type of schedule was changed. Pips indicate presentations of the magazine sound on the FR or DRP 5-second schedules.

the bird was shifted from DRP 5 seconds to FR. The results for the three experimental extinction sessions were confirmed with the second bird.

DISCUSSION

When the sound of the food magazine was used as a conditioned reinforcer, response rates and patterns of responding could be manipulated during experimental extinction. When the magazine sound was scheduled to occur only when the bird paused for a brief period of time (DRP), low response rates developed. Performance on this schedule demonstrated that the magazine sound, as a discriminative stimulus, could control a zero response rate in extinction. When the magazine sound could be produced on an FI 5 schedule, characteristic FI performances were developed; that is, the response rate was lowest following the magazine sound, and then increased as the interval elapsed. When the magazine sound could be produced on an FR schedule, high response rates prevailed.

The FR schedule produced high response rates even after low response rates had been produced on the DRP schedule. Abrupt shifts from the FR to the FI schedule caused transient disruption in the FI response pattern. That is, the birds responded at a very high rate following the magazine sound. The patterns of responding that occurred when the birds were shifted from the FR to the FI schedule are similar to those occurring on mixed FI FR schedules of food reinforcement (Ferster & Skinner, 1957).

Other investigations have suggested that the presentation of the magazine sound enhances resistance to experimental extinction only because the magazine sound is either a conditioned stimulus which elicits responding (Bugelski, 1956) or a discriminative stimulus which controls a high rate of responding (Wyckoff, Sidowski, & Chambliss, 1958). The present experiment demonstrates that the magazine sound can control either a high or a low rate during experimental extinction. In either case, the magazine sound is a conditioned reinforcer that can be used to maintain or develop characteristic patterns of responding in individual organisms during experimental extinction.

SUMMARY

Pigeons that had been trained on a 5-minute, fixed-interval schedule of food reinforcement received three sessions of experimental extinction. During the extinction sessions, the birds could produce the sound of the food magazine according to different schedules. Schedules of presentation of the magazine sound were effective in controlling response patterns and response rates during extinction. The magazine sound can be used as a conditioned reinforcer.

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