Effects of time out and S+ postponement training procedures on free operant discrimination acquisition[1]

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Rat Ss received free operant discrimination training in which: (1) imposing a time out before each S+ period and (2) an S+ postponement contingency for responding late in S– periods were used to ascertain effects of adventitious reinforcement of S– responding by the appearance of S+ (a conditioned reinforcer). Postponement training was more effective than time-out training. The effectiveness of S+ postponement training appeared to be due to a massing of extinction resulting from prolonged S– periods early in training. There was no evidence that S+ conditioned reinforcement interfered with discrimination acquisition.

A factor that may help maintain S– responding in a successive discrimination is its adventitious reinforcement by the appearance of S+ (a conditioned reinforcer). Several authors (see Sidman, 1960; Herrnstein, 1966) have referred to such an effect and suggested procedures that presumably guard against it. However, until recently, there was little experimental evidence bearing on this question.

Two procedures presumed to guard against adventitious S+ reinforcement are time out (TO) and S+ postponement training (PT). TO training consists of imposing a TO period between the end of S– periods and the start of S+ periods. During PT the termination of S– is contingent upon the cessation of responding for a specified time. During either training condition S+ reinforcement would have to be delayed following the last response in S–, the delay equaling the PT or TO duration. To ascertain the effectiveness of PT and TO training in eliminating adventitious S+ reinforcement the following controls have been used: (1) TO is compared with Ss who received extinction training (ET) in which there are fixed-duration S– periods with instantaneous stimulus change regardless of S's responding, and (2) a comparison of PT Ss with yoked controls (PT-Y) who receive identical S– durations as their experimental counterparts but without the PT contingency. The yoked design permits differentiation between effects of adventitious S+ reinforcements and prolonged S– periods.

Kamil & Davenport (1968), using a PT-Y procedure, found that PT training enhanced discrimination acquisition. However, each S+ period consisted of a *discrete* trial in which the first response not only produced reinforcement, but also terminated the period. Therefore, due to the contiguity between S+ onset and reinforcement, the effectiveness of PT training could have been due to the elimination of S+ reinforcement or the delay of primary reinforcement or both.

Snow & Uhl (1968) investigated the PT and TO procedures while using variable interval reinforcement in S+ with rat Ss. They did not find evidence for an adventitious S+ reinforcement effect and concluded that PT is effective because of prolonged S– periods early in training producing a massing of extinction effect. The authors did report that omission training (reinforcement of not responding during S–) appeared to be the most effective training procedure used to eliminate S– responding.

The purpose of the present study was to replicate, in part, Snow & Uhl's (1968) study while maximizing the probability of S+ reinforcement and measuring responding by PT-Y Ss near the end of S– periods. In the previous study such responding was not measured and S+ and S– periods did not alternate (opportunities for S+ reinforcement were not maximized).

METHOD

The Ss were 32 male albino rats maintained at 80% of base weight. Two Skinner boxes equipped with a retracting lever, a liquid dipper, white noise, a house light, and a stimulus light were used. When the house light was on, approximately .5 ft-c were measured at the floor of the box, and when the stimulus light was also on, approximately 4 ft-c were measured.

Each S was pretrained to lever press on CRF, FR 2 and FR 4 on 3 successive days and on a VI 15-sec schedule for the following 4 days. Reinforcement was 3-sec access to .04 ml of a 30% sucrose solution. Daily sessions consisted of 40 reinforcements for the first 3 days and 30-min duration for the last 4 days. The stimulus light was on during alternating minutes throughout pretraining.

Following pretraining Ss were assigned to one of four groups (PT, PT-Y, TO, or ET) so that group mean response rates for the last 2 days of VI training were approximately equal. All Ss started discrimination training in which S+ responding was reinforced on a VI 15-sec schedule and S– responding was never reinforced. Twenty S+ and 20 S– 1-min stimulus periods alternated. Half the Ss in each group were run in each box. Light on was S+ for half of Ss in each group and was S– for the other half of Ss. For Group TO, a 20-sec TO, during which lights were turned off and bar retracted, was imposed between the end of S– and the start of S+ periods. For Group ET, the control for Group TO, stimulus changes were instantaneous. For Group PT, a 20-sec PT contingency was in effect during the last 20 sec of S– periods. That is, each response during the last 20 sec of an S– period reset a 20-sec clock whose timing out-ended the period. Each PT S had a PT-Y control S who did not have a postponement contingency but whose S– durations were controlled by his PT counterpart.

Discrimination criterion was 90% correct responding in the last half of two consecutive daily sessions. Since PT and PT-Y Ss did not reach discrimination criterion on the same day, PT-Y Ss received fixed 1-min stimulus periods if their experimental counterparts reached criterion first.

RESULTS AND DISCUSSION

An analysis of variance was used to ascertain differences among groups in days to reach the discrimination criterion. The variance attributable to groups was significant [$F(3,28) = 4.91$, $p < .01$]. A Duncan Multiple Range Test, shown in Table 1, indicated the effect was due to Groups PT and PT-Y taking fewer days to reach criterion than Groups TO and ET. However, Groups PT and PT-Y did not differ from each other nor did Group TO differ from Group ET.

An analysis of variance of total S– time needed to reach criterion between groups was not significant [$F(3,28) = 1.63$, $p > .05$]. The means for Groups PT, PT-Y, TO, and ET were 154, 149, 212, and 195 min, respectively, parallel to the mean

Table 1
Summary of Duncan Multiple Range Test of Group Means of Days to Discrimination Criterion*

Groups	PT	PT-Y	ET	TO
Means	5.00	5.13	9.12	10.62

** Means not underscored by the same line are significantly different ($p < .05$).*

(Continued on page 220)

similar. During training, the effects of trial block ($F = 11.92$, $df = 11/524$, $p < .001$) and Trial Block by Recovery interval ($F = 2.48$, $df = 33/524$, $p < .001$) were significant. Although the Trial Block by Recovery Interval interaction was significant, an analysis of the scores on the final five training trials failed to show a difference between Ss later assigned to the separate groups ($F < 1.00$).

During extinction, the following effects were found to be significant: Experimenter by Recovery interval ($F = 2.49$, $df = 6/48$, $p < .05$); trial block ($F = 16.86$, $df = 5/236$, $p < .001$); and Trial Block by Experimenter ($F = 2.88$, $df = 10/236$, $p < .01$). Again, an analysis of the scores on the final five extinction trials failed to show a difference between Ss later assigned to the separate groups ($F < 1.00$). Thus, it seems reasonable to conclude that by the ends of training and extinction, the Ss assigned to the separate groups were all responding at similar levels.

Performance on the SR test is presented in Fig. 2. This figure shows mean per cent SR as a function of recovery interval with SR for each S calculated using the formula E-SR (100)/E. Here, E = median response latency on the final five extinction trials and SR = median response on the five SR test trials. This figure shows the expected negatively accelerated monotonic function with only a slight difference between intervals of 1 and 24 h. An analysis of variance carried out on these data showed the effect of recovery interval to be highly significant ($F = 7.10$, $df = 3/48$, $p < .001$).

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(Continued from page 218)

days to criterion for the respective groups. The major consequence of the PT procedure was prolonged S– periods in the early stages of discrimination training. The mean length of S– periods on the first 3 days of training was 48, 32, and 23 min, respectively.

The present results do not provide evidence of an adventitious S+ reinforcement effect in discrimination learning, confirming the earlier findings of Snow and Uhl (1968). If the change from S– to S+ adventitiously reinforced responding in S– just prior to the stimulus change, Groups PT-Y and ET, for whom there was no programmed delay between responses in S– and the change to S+, should have taken longer to attain the discrimination criterion than Groups PT and TO, respectively. PT-Y Ss averaged 6.3, 3.5, and 2.8 responses in the last 20 sec of each S– period on Days 1, 2, and 3, respectively, of discrimination training. Such responding in S– should have been strengthened by its contiguity with the change to S+ according to the adventitious reinforcement hypothesis, and consequently attainment of the discrimination criterion should have been delayed by the perseveration of responding in S–. A more parsimonious account of the effectiveness of PT, suggested previously by Snow & Uhl (1968), is that the longer S– periods experienced by both PT and PT-Y Ss provided for more complete extinction of S– responding as compared to Groups TO and ET—a massing of extinction in the early stages of discrimination training.

If adventitious conditioned reinforcement due to a change from S– to S+ is a factor retarding discrimination learning, it is a weak and elusive factor. The present results and those of Snow & Uhl (1968) suggest that Kamil & Davenport's (1968) demonstration of an adventitious S+ reinforcement effect may be restricted to the case of a discrete trial discrimination in which primary reinforcement is coincident with the change to S+.

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