Delay of reward as a secondary reinforcer¹

EDWARD L. WIKE, CAROLE A. COUR, AND SARA S. SHELDON
THE UNIVERSITY OF KANSAS

Thirty rats were trained and extinguished in an alley of a Grice apparatus to determine whether or not delay of reward had secondary reward value. Half of Ss had delay associated with reward (DR) and nondelay associated with nonreward; half (DNR) had the opposite. In extinction half of each group had delay box confinement, half did not. An alternating reward and nonreward pattern was used in training and Ss in both groups showed clear evidence of patterned running. Group DNR ran significantly faster in training and extinction, but the expected secondary reinforcement effects were not found.

The purpose of this study was to learn whether or not delay box confinement could acquire secondary reward value by being associated in training with reward (DR group) or nonreward (DNR group). Following runway training, the two groups were given extinction tests in which half of the rats from each group had delay box confinement (D) on all trials and half had no delay box confinement (ND). By using an alternating pattern of rewarded and nonrewarded trials in training, the predicted order of results should be opposite in extinction for the two training groups. In Group DR, delay should acquire positive secondary reward value by its pairing with primary reinforcement, and nondelay should become a negative secondary reinforcer. The DR Ss with delay box confinement should display better resistance to extinction than the DR Ss without confinement (ND). On the other hand, delay should be a negative secondary reinforcer and nondelay a positive secondary reinforcer for Group DNR, and Ss in this group should extinguish faster with delay box confinement than without confinement. Accordingly, an interaction of delay conditions in training and confinement conditions during extinction would be anticipated in the analysis of the extinction data.

Method

Thirty naive male Sprague-Dawley rats, about 70 days old, were trained in a single alley of a Grice discrimination apparatus. It had an 11 in. long start box, a 7 in. long connecting section, a 25 in. long alley, a 12 in. long delay box, and a 3 in. long goal section. The first two sections were unpainted, the alley and goal sections were gray, and the delay box was painted black. Two Plexiglas drop doors kept Ss confined to the delay box. The response measure was the running time between a light beam located 1 in. inside the start of the alley and a second beam 3 in. inside the delay box. Breaking the beams served to activate a Hunter Klockounter through a Hunter photorelay. In the 13 day pretraining period, Ss were

gentled, adapted to the maze in groups of two to five for two 10 min. periods, and accustomed to 1 h daily feedings. On Days 12 and 13, Ss had two immediately rewarded (two 45 mg Noyes pellets) trials daily.

Training consisted of six trials daily, which were rotated among 10 Ss, for 39 days. For all Ss the odd numbered trials were nonrewarded (NR) and the even numbered trials were rewarded (R). The 15 Ss in Group DR were delayed for 20 sec on the rewarded trials, but were not confined on the nonrewarded trials. The 15 Ss in Group DNR were delayed on the nonrewarded trials, but were not delayed on the rewarded trials.

Extinction consisted of six rotated trials daily for eight days. The Ss in each training group were divided, half being extinguished with 20 sec delay box confinement on all trials (D), and half without confinement (ND). On the NR trials in training and on all extinction trials Ss were exposed to the empty goal section for 10 sec after the appropriate delay period had expired. In both phases of the experiment a 60 sec running time criterion was enforced; if S failed to enter the delay box within that period, it was put in the delay box by E.

Results

The daily medians were obtained for the three R and for the three NR trials for each S. The medians of these medians for three day periods were transformed into reciprocals. The resulting mean speed scores for the two groups on the rewarded and nonrewarded trials are displayed in the left panel of Fig. 1. It should be noted that there was no significant difference ($p > .05$) between the two groups during pretraining. Group DNR ran significantly ($p < .01$) faster in training, on the average, than DR. From the fifth block of trials until the end of training, Ss ran faster ($p < .01$) on the R than on the NR trials on every block. Within each group consistent discrimination ($p < .01$) was observed from the ninth block on.

The extinction data from two Ss, randomly selected, was discarded in order to equalize the Ns in the four treatments. Each S's daily median running times were converted to reciprocals. The resulting speed scores are shown in the right panel of Fig. 1. An analysis of variance of these extinction data yielded three highly significant ($p < .001$) effects: training conditions ($F = 20.60$, $df = 1/24$); trials ($F = 49.04$, $df = 7/168$); and training conditions by trials ($F = 12.95$, $df = 7/168$). As is clear from Fig. 1, the overall mean of Group DNR was larger than that of Group DR. Moreover, the significant interaction

Fig. 1. Mean running speeds on the rewarded and nonrewarded trials in training for the delay reward group and delay nonreward groups (left panel). Mean running speeds in extinction as function of acquisition delay and delay box confinement during extinction (right panel).

would appear to have resulted from the convergence of Groups DNR and DR as extinction progressed.

Discussion

There was clear evidence (Fig. 1) that Ss discriminated the alternating pattern of reward and nonreward in training. The slower running in training on the part of Group DR may be due to the fact that the Ss were delayed whether they ran fast or slow, while in Group DNR faster running produced quicker reinforcement. The expected interaction between training conditions and confinement conditions, indicative of secondary reinforcement, was not found. The failure to observe the expected secondary reinforcement effects in extinction documents again the importance of determining the precise training conditions that are necessary for the development of secondary reinforcement (Wike, 1966).

The extinction performance would appear to be the result of: (a) the carry-over of a higher level

of performance from training for Group DNR; and (b) the influence of confinement during extinction. We have already indicated a possible reason for the higher level of performance for Group DNR. Although confinement in extinction hastened extinction, the difference between D and ND was not significant. The direction of this result, however, is in full accord with the recent work of Tombaugh (1966), who found that increases in delay from training to extinction produced faster extinction, while decreases produced slower extinction.

References

- TOMBAUGH, T. N. Resistance to extinction as a function of the interaction between training and extinction delays. *Psychol. Rep.*, 1966, 19, 791-798.
- WIKE, E. L. *Secondary reinforcement: Selected Experiments*. New York: Harper & Row, 1966.

Note

1. This research was supported by a Grant GB 4299 from the National Science Foundation to the first author.