Resistance to extinction as a function of constant delay of reinforcement\(^1,2\)

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Abstract

Two pairs of experiments are reported in which a constant 20-sec. delay of reinforcement produced markedly increased resistance to extinction. These results severely strain theoretical efforts to relate the delay-extinction phenomenon to the partial reinforcement effect and suggest the necessity of an independent interpretation.

Problem

The need for additional empirical evidence on the role of constant delay of reinforcement as a determinant of resistance to extinction has recently been emphasized by Renner (1964). As he points out, most of the experimental work on delay has involved a mixture of delayed and immediate reinforcement. This fact makes it simple to incorporate the increased resistance to extinction shown in such studies within the framework of the partial-reinforcement effect. On the other hand, if constant delay of reinforcement also increases resistance to extinction, then a different theoretical interpretation may be required.

Only a few studies have been reported bearing on this problem. Pubols (1958) found that constant delay of reinforcement impeded reversal learning and so, by extrapolation, resistance to extinction should also be increased. In a more direct test, Fehrer (1956) found some increment in resistance to extinction with constant delay in acquisition but used a very small number of test trials. Negative or inconclusive results have been reported in other studies (Logan et al, 1956; Logan, 1960; Renner, 1963, 1965).

This report presents data from two pairs of experiments providing a clear positive answer to this question. In each experiment resistance to extinction was markedly increased by a constant delay of reinforcement during acquisition. All the experiments were performed with young, naive albino rats on a standard 23-hr. food-deprivation schedule.

Experiments 1 and 2

The first two experiments used a simple straight runway with a 1-ft startbox, 8-ft stem and 4-ft goalbox. In the first experiment 9 rats were given 50 reinforced trials, over five days, with a constant 20-sec. delay of blinking-light cue and food reinforcement (Noyes .45-gm pellet delivered through a tube by a Gerbrands plate magazine). They were then given massed extinction trials. (The variable manipulated was temporal location of the blinking-light cue during extinction. Since this did not show any effect on trials to extinction it is not here treated.) Using a criterion of two successive failures to enter the goal box within 180 sec., only 2 of the 9 Ss extinguished in less than 250 trials; 4 did not extinguish in more than 300 massed trials. Although no immediate-reinforcement control condition was used, these data were—quite unexpectedly—suggestive of a remarkably potent influence of constant delay training on resistance to extinction. Previous experiments using this runway indicated that immediately reinforced animals typically extinguished in less than 120 trials.

This experiment was repeated, using spaced extinction (5 trials daily). Again a remarkably strong resistance to extinction was demonstrated. The range of trials to extinction was 119 to 800, with 4 of the 14 Ss failing to extinguish.

Experiments 3 and 4

The unusual number of pretraining reinforcements used in accommodating Ss to the 20-sec. response-reinforcement delay was considered to be a factor of possible importance in the first two experiments. By using paired Ss matched in number of pre-training reinforcements, the second pair of experiments controlled this variable in addition to providing immediately-reinforced controls.

The first experiment of this second pair utilized the runway apparatus. Again, a constant 20-sec. delay of food-pellet reinforcement was used in acquisition, but now all Ss were given the blinking-light cue immediately in extinction. (The implications of this treatment are not directly pertinent to the present purpose but will be discussed elsewhere when this pair of experiments is reported more fully. It should be noted, however, that for the present purpose it is necessary to assume that the change per se, from a 20-sec. delay of the cue in training to no delay in extinction, was not responsible for the obtained difference. This assumption gains some empirical support from the previous set of studies where the manipulation of the temporal location of the cue in extinction had little effect upon resistance to extinction.) Massed extinction trials were administered, to a criterion of three successive failures to enter the goalbox in 90 sec. A minimum of 50 and a maximum of 200 trials were set.

Figure 1 shows the clearly inferior acquisition and superior extinction performance of the constant-delay group in running speed. Over acquisition trial blocks 2 through 4, the delay group was reliably inferior (\(F = 17.23; \text{df} 1, 24; p < .01\)). The delay group ran faster throughout the required 50 extinction trials (\(F = 7.38; \text{df} 1, 8; p < .05\)) and, in addition, the delay group required
more trials to reach the extinction criterion (means of 77.0 and 34.4 trials, t = 4.42; df 8; p < .01). Generally similar results were obtained for starting and goalbox speeds.

The purpose of the final experiment was to replicate the results of the previous experiment using a modified operant-conditioning procedure. The 8 boxes used with retractable bars and discrete-trial programming are described in detail elsewhere (Marx, Tombaugh, Hatch, & Tombaugh, in press).

The 18 Ss were again divided into two groups of matched pairs, half given immediate and half delayed reinforcement during training. Reinforcements were .1 cc of 16% sucrose solution and the associated cue was the onset of the "house light" in the box. Because of difficulties encountered in pilot work where the full 20-sec. delay was instituted throughout pretraining, a graduated-delay procedure was employed whereby regular 4-sec. delay increments were administered for the experimental S over 15-trial daily sessions. Training under the immediate and the 20-sec. delay conditions was carried out for 11 days, until asymptotic performance was achieved in both groups. In extinction, the light cue was produced immediately upon bar press for all Ss.

Figure 2 shows the barpress latencies for the two groups over training and extinction, and clearly indicates that the results of the previous experiment were replicated. Again the retarded acquisition and facilitated extinction performance of the delayed Ss was quite reliable (F = 7.14; df 1,8; p < .05; F = 24.74; df 1,8; p < .01). Resistance to extinction in terms of trials

(to a criterion of 5 successive failures to barpress within the 30-sec. limit) was also reliably greater for the delayed Ss (123.1 trials against 43.8; t = 6.13; df 8; p < .01).

Conclusions

It is concluded that these data from two pairs of experiments provide substantial empirical support for the proposition that delay of reinforcement as here administered retards acquisition and facilitates extinction. They thus suggest that the delay-extinction phenomenon cannot simply be attributed to a partial-reinforcement effect and may well require a different kind of theoretical interpretation.

References

FEHRER, ELIZABETH. Effects of amount of reinforcement and of pre- and post-reinforcement delays on learning and extinction. J. exp. Psychol., 1956, 52, 167-176.


Notes

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