Partial reinforcement and the CER¹

C. J. BRIMER AND F. J. DOCKRILL²

DALHOUSIE UNIVERSITY

Hooded rats were employed in two experiments to investigate the effects of partial versus continuous reinforcement of the CER. The experimental Ss who were trained with either a 25% or 50% partial schedule showed more resistance to extinction than did two continuously reinforced control groups. The control animals who received four daily training trials acquired conditioned suppression more slowly than did the Ss who received either one or two trials a day.

Although there have been many attempts to demonstrate the partial reinforcement effect (PRE) in classical conditioning situations, the results have tended to be equivocal. Slivka & Bitterman (1966) have recently noted that even in those few studies in which a PR effect is reported, this usually takes the form, not of a Groups effect, but of a Groups by Days or Groups by Trials interaction. It is possible, however, that this failure to find a marked PRE in classical conditioning may simply reflect the lack of a suitable experimental preparation. Geller (1964), for example, has referred to two unpublished experiments where the PRE is demonstrated with rats in a CER situation. The present study represents an attempt to document these observations.

EXPERIMENT 1

Method

The Ss were 18 experimentally naive male hooded rats maintained at 75% of ad lib weight throughout the experiment. The apparatus consisted of three standard Grason-Stadler operant conditioning units with relays, timers, and counters providing for automatic programming and recording. The CS was a 2 min. 70 db white noise. The US was a .5 sec. electric shock produced by a Grason-Stadler Model E1064GS shock generator set at an intensity level of 1 ma.

Preliminary training concluded after 10 hr. (five daily 2-hr. sessions) of bar pressing under a 2.5 min. VI food reinforcement schedule. The last day of preliminary training consisted of a pretest (Day P) during which the CS was presented alone for four 2-min. periods commencing 29, 54, 94, and 114 min. after the start of the session.

The Ss were randomly assigned to three independent groups of six animals. On each CER acquisition day, animals in the experimental group (E-50%) received four CS presentations (scheduled similarly to Day P) two of which terminated with shock reinforcement. The pattern of reinforced and nonreinforced CS presentations was varied between animals and between days according to a fixed irregular schedule. Two control groups trained under a 100% reinforcement schedule received either two (C-2) or four (C-4) CS-US presentations during each daily two-hr. bar pressing session. Each S in the C-2

condition was matched to an E-50% S in terms of the temporal scheduling of reinforced trials. Throughout acquisition and extinction the 2.5 min. VI food reinforcement schedule remained in effect.

Following the method employed by Annau & Kamin (1961), the CER was indexed by the suppression ratio $B/A+B$, where "B" represents the number of bar presses occurring during the CS, and "A" the number of responses in the immediately preceding 2 min. interval. A value of .50 indicates no effect of the CS on response rate while .00 indicates complete suppression. A daily suppression ratio was calculated for each S by summing the responses made during the appropriate intervals. Each S was run to an acquisition criterion of two consecutive days with a suppression ratio of .05 or less. On the following day shock was discontinued and S run until an extinction criterion of two consecutive daily ratios of .45 or higher was met. Within each group, the same schedule of CS presentations was employed throughout acquisition and extinction.

Results

Figure 1 presents the median suppression ratios for the experimental and control groups over the course of acquisition and extinction. Due to the criterion contingency, Ss completed acquisition and extinction after varying numbers of trials. For purposes of graphical representation, therefore, Ss who completed acquisition were assigned a score of .00 for the remainder of that phase of training while those who had completed extinction were given a score of .50. The statistical analyses, however, were restricted to the trials-to-criterion measure.

The three groups differed significantly during acquisition ($H=13.66$, $p<.01$) with the C-2 group requiring fewer trials to meet criterion than either the E-50% ($U=0$, $p<.01$) or C-4 ($U=5$, $p<.05$) animals. The three

Fig. 1. Median suppression ratios for blocks of four trials as a function of stage of training.

groups also differed significantly in terms of the number of trials required to meet the extinction criterion ($H=8.45$, $p < .02$). The E-50% Ss displayed more resistance to extinction than either the C-2 ($U=3$, $p < .02$) or C-4 ($U=2$, $p < .01$) groups. Thus, Experiment I clearly demonstrates a PR effect following partial reinforcement of the CER. This is true even when the partial-continuous comparison involves control animals (C-4) who have received significantly more reinforced trials during acquisition than the experimental Ss ($U=0$, $p < .01$).

EXPERIMENT 2

Method

The Ss were 21 male hooded rats randomly assigned to three groups of seven Ss each. The experimental program was the same as in Experiment 1 with the following exceptions. The experimental group (E-25%) was trained with a 25% rather than a 50% partial CER. As a consequence of this, the equated reinforcement control group (C-1) received only one CS-US presentation on each CER training day. All animals received 12 rather than 10 hr. of preliminary VI training.

Results

The results appear in Fig. 2. Missing scores during acquisition and extinction were, as before, assigned a value of .00 and .50, respectively.

The three groups differed significantly in the number of acquisition trials ($H=14.31$, $p < .01$). Multiple Mann-Whitney U-tests revealed that each of the three groups differed from each other at least at a .02 two-tailed level of significance. The three groups also differed significantly in trials to extinction ($H=8.88$, $p < .02$). The experimental animals were significantly slower to extinguish than the C-1 ($U=5$, $p < .02$) or C-4 ($U=0$,

$p < .01$) control Ss. The large difference between the two control groups during extinction suggested by Fig. 2 was predominantly due to two animals in each group. In terms of the extinction criterion, the difference between the two control groups fails to achieve the conventional level for statistical reliability ($U=10$, $.07 < p < .08$).

DISCUSSION

Looking at the results for the two experiments it seems clear that the PRE may be demonstrated in classical CER conditioning with either a 25% or 50% schedule.³ Furthermore, the magnitude of this PR effect appears comparable to that which is obtained in widely spaced discrete-trial instrumental situations (Weinstock, 1954). At least the experimental animals who were trained with a sufficiently "lean" partial schedule (E-25%) were also slower to acquire conditioned suppression. The differences in acquisition displayed by the two control groups in the two experiments may be attributed to the beneficial effects of distributed training trials. On the other hand, it is possible that these differences between control groups reflect the "reinforcement cost" phenomenon observed by Stein, Sidman, & Brady (1958).

References

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Notes

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2. The authors wish to express their appreciation to C. Hayes, who assisted in the collection of the data for Experiment 1.
3. One is tempted to draw conclusions about the effect of different partial schedules by comparing the results of Experiments 1 and 2. Such a comparison is likely not warranted, however, in view of the fact that the C-4 Ss who were treated essentially the same in the two experiments still differed significantly in their extinction performance ($U=5$, $p < .05$). This discrepancy may have simply reflected sampling variability or it may have been due to one or more of the minor differences which distinguish the two experiments. For example, the animals in Experiment 2, in contrast to those in Experiment 1, were run at a different time of year, were heavier (and older), and received an extra preliminary VI training day.

Fig. 2. Median suppression ratios for blocks of four trials as a function of stage of training.