

# Between- and within-subjects PRE with sucrose incentives

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This experiment was designed to test the generality of the between- and within-subjects partial reinforcement effect (PRE) with sucrose solutions as the reinforcer and female hooded rats as subjects in a free-operant leverpress situation. Twenty subjects were given 10 sessions of acquisition training with (1) CRF only, (2) PRF only, or (3) MULT CRF-PRF. Comparisons of responding during 3 days of extinction between subjects receiving only one schedule resulted in a conventional PRE with significant differences between the two groups on Day 1 of extinction, whereas the within-subjects comparison yielded a reversed PRE with significant differences between responses to the signal associated with CRF and PRF on Day 1 and Day 2 of extinction.

The partial reinforcement effect (PRE) refers to the finding that subjects trained on a partial reinforcement (PRF) schedule make more responses in extinction when compared to subjects trained on a continuous reinforcement (CRF) schedule. Most experiments demonstrating the PRE have used a between-groups design in which one group receives PRF only and another, separate, group receives CRF. It has been reported that subjects exposed to a multiple schedule in which one stimulus is associated with a CRF schedule and a second stimulus with a variable-ratio 3 (VR 3) PRF schedule in a free-operant leverpressing situation emit more responses in extinction to the stimulus associated with CRF than to the stimulus associated with PRF (Pavlik & Carlton, 1965; Pavlik, Carlton, & Lehr, 1967). This has been called a "reversed partial reinforcement effect."

Using discrete-trial leverpressing situations, two studies involved the manipulation of other variables on a within-subjects basis. One study (Pavlik & Collier, 1977) simultaneously varied the reinforcer magnitude and schedule of reinforcement and obtained results showing resistance to extinction was greater with CRF than with PRE (i.e., a reversed PRE) and was greater with a large reward than with a small reward. In the other study (Collier, Steil, & Pavlik, 1978), four experiments were conducted to access predictions from Capaldi's (1967) sequential theory that the outcomes of within-subjects PRF experiments depends on the loci of N-R transitions. The four experiments differed mainly in amount of acquisition training given, which ranged from 24 to 192 total acquisition trials. Again, greater resistance to extinction was associated with CRF than with PRF in all groups in all experiments, contrary to sequential theory predictions.

In general, the within-subject reversed PRE has been shown to be a large, robust phenomenon in discrete-trial and free-operant leverpressing situations. However, these studies have used food pellets as reinforcers and

male rats as subjects. In a simultaneous negative contrast study using two different sucrose concentrations and two different amounts of pellets as reinforcers, Ison and Glass (1969) found no negative contrast effect when the stimuli signaled differing sucrose concentrations, but reliable contrast effects when different amounts of pellets were signaled. Given the differing results with different reinforcers, the present study was undertaken to determine the generality of the within-subjects reversed PRE to another type of reinforcer (sucrose solutions) with female rats as subjects, in a free-operant leverpress situation.

## METHOD

### Subjects

Twenty female hooded rats from the departmental colony served as subjects. They were approximately 90 days old at the start of the experiment and were maintained at 80% of their free-feeding weights.

### Apparatus

Two standard Lehigh Valley Electronics (LVE) test chambers and associated electromechanical programming equipment were used. The test chambers were equipped with two levers; however, only the right-hand lever was available in this experiment. Each chamber was also equipped with two sets of three cue lights, one set mounted above each lever. The reinforcer was one drop (.10 ml) of a 20% (by weight) sucrose solution. The houselight was on during the entire session, providing dim illumination throughout the test chamber.

### Procedure

Nine days of pretraining were given, at the end of which all subjects were reliably responding on a CRF schedule with no cue lights present. Following pretraining, subjects were randomly assigned to one of three groups, with six subjects each in Groups 1 and 2 and eight subjects in Group 3. Group 1 subjects were reinforced on a CRF schedule. Group 2 subjects were on a VR 3 PRF schedule. These two groups provided the traditional between-groups comparisons of the effects of schedules. Both groups were given 10 acquisition sessions, each 10 min in length. The cue lights mounted over the levers alternated every 30 sec;

however, cue-light position was not correlated with schedule in these groups.

Group 3 subjects were exposed to the multiple CRF/VR 3 schedule for the within-subjects comparison. For this group, one set of cue lights was associated with the CRF schedule and the other set of cue lights with the PRF schedule; position of cue lights and associated schedule were counterbalanced across subjects. The cue lights and schedules were alternated every 30 sec. Ten acquisition sessions for Group 3 were given, each 20 min in length. Thus each subject was exposed to 10 min of each schedule in every session, allowing for direct comparisons with Groups 1 and 2. After acquisition, three extinction sessions were given on 3 successive days. These were identical to the acquisition sessions, with the exception that no reinforcers were delivered.

## RESULTS

The following results are from the 3 days of extinction. Figure 1 gives the mean responses for each group on each day of extinction. The between-groups comparison showed a clear PRE on Day 1 of extinction, but this difference disappeared as the response rates for the groups converged on Day 2 and Day 3. Analysis of these data yielded a significant effect of group for Day 1 [ $F(1,20) = 51.04, p < .001$ ], but no significant differences on Day 2 or Day 3.

The within-subjects comparison revealed a reversed PRE with a higher response rate to the stimulus associated with CRF as compared to the PRF stimulus. The within-subjects data yielded a significant difference on Day 1 of extinction [ $F(1,14) = 21.64, p < .001$ ] and on Day 2 [ $F(1,14) = 8.26, p < .025$ ]. By the 3rd day however, the differences were not significant.

Since it could be argued that the differences in responding on the 1st day of extinction could have been due simply to different levels of responding in acquisition, nonparametric tests were performed on the response rates during the first 30-sec interval of the 1st day of extinction. There were no significant differences in response rates for the first 30 sec between the different groups when subjected to Mann-Whitney or Wilcoxon tests.

## DISCUSSION

These results clearly indicate that the within-subjects reversed PRE is replicable in experiments in which a different type of reinforcer and different sex of subjects were used. The present results, together with the results of five previous within-subjects experiments, indicate that the reversed PRE is a large and robust phenomenon in rats. The effect has consistently appeared in

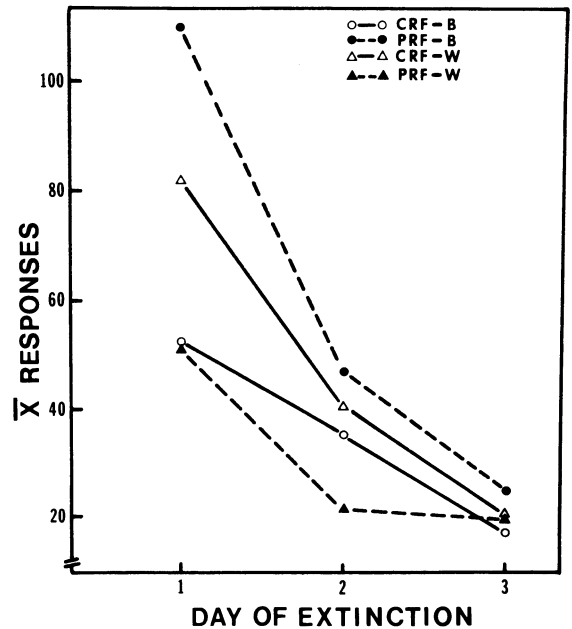


Figure 1. Mean responses for between (B) and within (W) groups as a function of day of extinction.

over 100 subjects given discrete-trial and free-operant leverpress training, different types of reinforcers, at least three different reward magnitudes, different types of N-R transitions, different sets of cues for the schedules, and over several different levels of acquisition training.

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