

Rats classify qualitatively different reinforcers as either similar or different by enumerating them

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In a go/no-go situation in a runway, rats employed the memory of a single food reinforcement as an S+ cue and the memory of two consecutive reinforcements as an S- cue. To do this, however, one group had to classify two qualitatively different reinforcers as different (Group Different, Experiment 1), whereas another group had to classify the same two reinforcers as similar or alike (Group Same, Experiment 2).

It has long been known on the basis of a variety of evidence (e.g., taste aversion learning, reinforcement shift investigations) that rats are adept at discriminating among reinforcers differing in quality or magnitude. Surprisingly, perhaps, it has been shown only recently that rats given qualitatively different food reinforcers were able simultaneously to classify them as either similar or different (Capaldi & Miller, in press). Capaldi and Miller suggested that rats given two qualitatively different reinforcers, R and R', discriminate between them on the basis of the particular characteristics of each (e.g., one is sweeter than the other) while simultaneously seeing R and R' as exemplars of some general category such as food reinforcers. The modest purpose of the two experiments reported here was simply to supply additional evidence that rats can classify reinforcers flexibly. A go/no-go procedure was employed in which for most groups the memory of a single food reinforcer was an S+ cue and the memory of two prior reinforcers was an S- cue.

In each of two experiments, rats received runway trials terminating either in R, R', or N, where R and R' were qualitatively different food reinforcers and N was non-reinforcement. Each day rats received two series of trials in irregular order: one series of three trials and one series of four trials. The rationale for the two-series procedure was developed fully by Capaldi and Miller (in press). Trials of a series were separated by about a 15-sec interval; series were separated by about a 15- to 20-min interval. There were three groups in Experiment 1. Group Different received the series R'RRN and RRN. Group Identical received the series RRRN and RRN. Group N received the series NRRN and RRN. The single group of Experiment 2, Group Same, received the series RR'N, R'RN, NRR'N, and NR'RN. In Group Identical, the memory of two prior R events signaled both N (RRN se-

ries) and R (RRRN series) on a 50% irregular basis, and so should not have caused slow running on Trial 3 of the RRN series. This finding, in conjunction with the finding that all other groups were able to anticipate the terminal-N trials of both their series, would indicate that rats are able to categorize qualitatively different reinforcers as either similar or different.

METHOD

Subjects

The subjects of Experiments 1 and 2 were 6 and 4 naive male rats, respectively, purchased from the Holtzman Co., Madison, Wisconsin, about 115 days old at the start of the experiment.

Apparatus

The apparatus was a gray runway 197.1 cm long and 10.6 cm wide, enclosed by sides 13.85 cm high and covered by wire mesh on a hinged frame. The startbox and goalbox were 20.8 and 29.7 cm long, respectively, closed off by metal guillotine doors. Raising the startbox door started a completely silent 0.01-sec digital clock, which was stopped when a photobeam located 158.13 cm beyond the startbox door and 9.5 cm in front of the goal cup was broken. The goal cup was 4.0 cm in diameter and 1.5 cm deep. Upon interruption of the photobeam, an aluminum guillotine door was lowered, confining the rat to the goal area.

On arrival at the lab, all rats were caged individually and given ad lib food and water for about 35 days. They were then placed on deprivation consisting of 14 g of Wayne Rodent Blox each day, minus food eaten in the runway. On days 1-9 (Experiment 1) or 1-8 (Experiment 2), rats were handled for 1 min, and on Days 8-9 (or 7-8), each rat received 5 Kellogg's Corn Pops and 5 Kellogg's Honey Smacks, respectively, in the home cage. On Days 10-11 (or 9-10), each rat for 3 min explored the runway, which had Pops (Day 10 or 9) and Smacks (Day 11 or 12) scattered throughout.

In experimental training, reinforcement consisted of 15 sec access in the goalbox to about 0.5 Pop (P) or 1 Smack (S). In Experiment 1, 1 rat in Group N received the series NPPN and PPN, and the other rat the series NSSN and SSN. In Group Different, 1 rat was trained PSSN and SSN, and the other was trained SPPN and PPN. In Group Identical, 1 rat was trained PPPN and PPN, and the other was trained SSSN and SSN. The 4 rats of Experiment 2 received the series SPN, PSN, NSPN, and NPSN. In both experiments rats received each of their two series twice each day. In Experiments 1 and 2 there were six different orders of series presentation. Each rat received its first series before any other rat received its second series. This resulted in an interval of about 15 sec between items of a series and about 10-15 min between series.

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RESULTS

Running speed on each trial of the three-trial and four-trial series in blocks of 3 days is shown in Figure 1 for Group N (top panel), Group Identical (middle panel), and Group Different (bottom panel). Group Identical, which lacked a basis for determining whether Trial 3 would be R or N, ran slowly ultimately only on the terminal-N trial of its four-trial series. Group Different, however, like Group N, ultimately ran slowly on Trial 3 of its three-trial series as well as on Trial 4 of its four-trial series,

indicating that Group Different was able to discriminate between R' and R. An analysis applied to the data shown in Figure 1, which excluded Trial 1 of the four-trial series, indicated that significant differences ($p < .05$ or better) were associated with trials [$F(2,3) = 105.10$], series [$F(1,3) = 28.95$], and the groups \times trials \times series \times blocks interaction [$F(52,78) = 2.01$].

Subsequent Newman-Keuls tests indicated that on each of the last two blocks of training, Groups N and Different ran more slowly on the terminal-N trials of each of the two series than on any other trial; no other difference

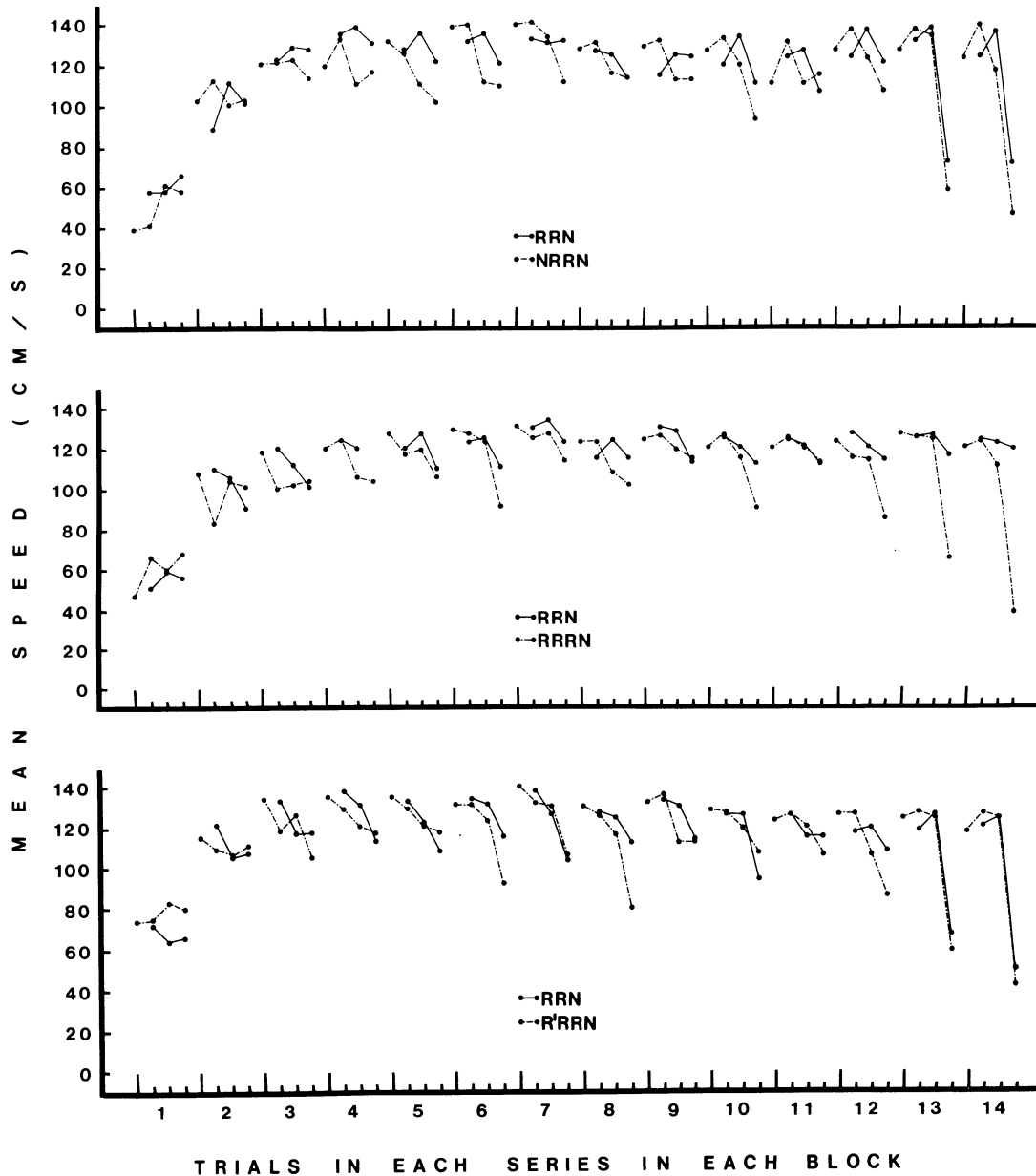


Figure 1. Running speed in Experiment 1 on each trial of the three-trial and the four-trial series for each group in blocks of 3 days. The top panel shows Group N, the middle panel Group Same, the bottom panel Group Different.

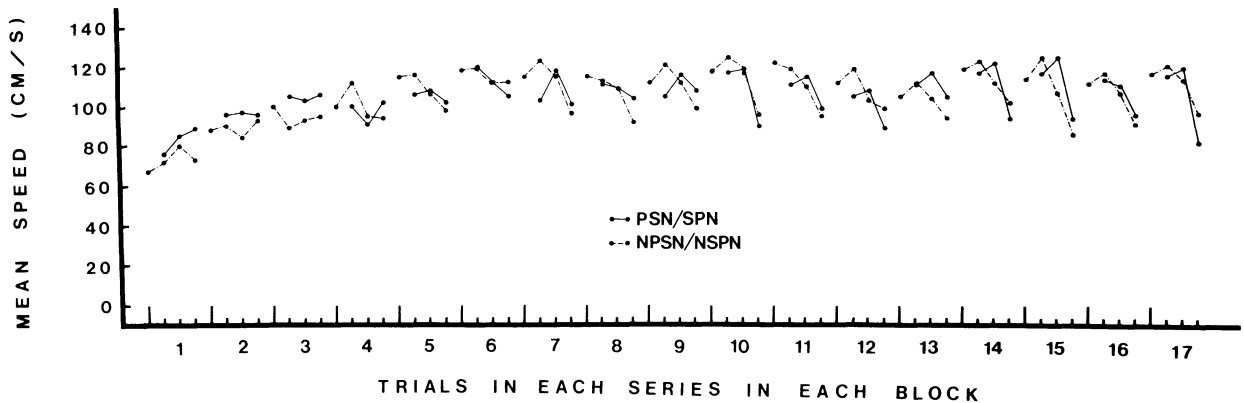


Figure 2. Running speed in Experiment 2 on each trial of the three-trial series (SPN and PSN) and on each trial of the four-trial series (NSPN and NPSN) in blocks of 2 days

was significant. Group Different, however, ran slowly only on the N trial of its four-trial series; no other difference was significant. In Experiment 2, as may be seen in Figure 2, Group Same ultimately anticipated the terminal-N trial of both its series. An analysis similar to that employed in Experiment 1 revealed that differences due to trials [$F(2,4) = 14.72$] and the trials \times blocks interaction [$F(32,64) = 2.28$] were significant; no difference associated with order (SP vs. PS) even approached significance. Subsequent Newman-Keuls tests indicated that on each of Blocks 10–17, with the exception of Block 13, averaged over series, running was slower on the terminal-N trials than on the S and P trials that failed to differ.

DISCUSSION

In all groups, except Group Identical, two prior reinforcements was a reliable signal for the terminal-N trial of both series, provided R and R' could be classified by rats either as similar or different. If rats in Group Different, trained R'RRN and RRN, were unable to classify R and R' as different, they would have, like rats in Group Identical, trained RRRN and RRN and run rapidly on Trial 3 of its RRN series. On the

other hand, if rats in Group Same, trained RR'N, R'RN, NRR'N, and NR'RN, were unable to classify R and R' as similar, they would not have run slowly on the terminal-N trial of each series. This is because R and R' considered individually received 50% irregular partial reinforcement, as examination of the series shows.

Capaldi and Miller (in press) suggested that rats trained, for example on the series R'RRN enumerate or count the reinforcing events by classifying them simultaneously either in particular terms, as one R' or two Rs, or in more general terms, as three food reinforcers, a category that embraces not only R and R', but novel food reinforcers as well. Consistent with this view, rats trained R'RRN and N showed immediate correct anticipation of all terminal-N trials when shifted to either RRN and NRRN or RRRN and NRRRN. Similar rapid transfer was shown by rats initially trained R'RRN and RRN and then shifted to RR'R'N and R'R'N and also by rats initially trained R'RRN, RRN, RR'R'N, and R'R'N and then shifted to novel food reinforcers r'rrn, rrn, r'r'n, and r'r'n.

REFERENCE

CAPALDI, E. J., & MILLER, D. J. (in press). Counting in rats: Its functional significance and the independent cognitive processes which comprise it. *Journal of Experimental Psychology: Animal Behavior Processes*.

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