

# Rat memory: Have we anthropomorphized?

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The present study sought to ascertain the extent of memory utilization by the rat in a simple reinforcement schedule of four events. The results indicated that even under conditions that should have maximized memory (i.e., within-subject trial administration, odor-reduced conditions, short intertrial interval) the rat appears to be incapable of learning such a schedule. Attention is directed toward a consideration of the functional role of events that precede or follow reward.

The mediation of many instrumental responses such as T mazes, alleys, etc. has traditionally been attributed to memory. It is becoming more evident that some of these behaviors are controlled more by the cue properties of odor than by memory. For example, it has been well established (see Davis, Prytula, Harper, Tucker, Lewis, & Flood, 1974; Ludvigson, 1969; Ludvigson & Sytsma, 1967; Seago, Ludvigson, & Remley, 1970) that double-alternation responding is controlled more by odor than memory. However, an important question arises as to the controlling influence of odor in other schedules. Specifically, under odor-minimized conditions can the *rat* learn and retain a simple schedule of four events?

## METHOD

### Subjects

Twelve male albino rats, 90 days old at the beginning of pretraining were purchased from the Holtzman Company, Madison, Wisconsin and served as subjects. Two weeks prior to the start of the experiment, subjects were placed on food deprivation and maintained at 85% ad-lib body weight. All subjects were caged individually with water continuously available in the home cage.

### Apparatus

The apparatus was a straight runway (11.43 cm wide x 12.70 cm high). A 28.10-cm gray startbox was separated from a 91.44-cm black run section by a masonite guillotine door. A second masonite door separated the run section from a 30.48-cm black goalbox. Lifting the start door activated a Standard Electric timer, and interrupting a photobeam 15.24 cm beyond the start door stopped the first timer (start time) and activated a second timer. Interrupting a second photobeam 76.20 cm beyond the first photobeam stopped the second timer and

started a third timer. Interrupting a third photobeam located 5.08 cm in front of a recessed goal cup stopped the third timer (goal time). The entire apparatus was covered with ¼-in. hardware cloth and was floored with wood.

### Procedure

Four days prior to the beginning of the experiment proper, each subject received 2 days of exploration (5 min/day) in the unbaited apparatus. All subjects received daily pellet habituation to the 45-mg Noyes pellets in the home cage during pretraining.

The experiment proper consisted of two phases. During Phase I, each subject received four trials, two reward (R) and two nonreward (N), a day for 16 days according to the following schedule: RRNN. On R trials, each subject received 12 45-mg pellets and was removed from the goalbox upon consumption of the pellets. On N trials, each subject was confined to the goalbox for a 30-sec period. During all phases, each subject followed itself, with no *other subjects* intervening between trial administrations; that is, each subject received all four trials before the next subject was run. The intertrial interval for all subjects was 1 min and the order of running subjects was randomized daily.

Following the initial 16-day period, Phase II was initiated. During this 8-day period, the schedule was shifted to the following sequence: NNRR. All other conditions were unchanged.<sup>1</sup>

## RESULTS

Start, run, and goal times were transformed to reciprocals and, when multiplied by the appropriate constant, yielded speed scores in meters per second. The mean speeds for Phases I and II are presented in Figure 1. The transformed scores for Phases I and II were subjected to a Treatment (R-N) by Treatment (Days) by Subjects analysis of variance. Tukey's (a) procedure was employed for all significant contrasts.

### Phase I: RRNN

Analyses were performed over the last 5 days (the point at which asymptote appeared to have been

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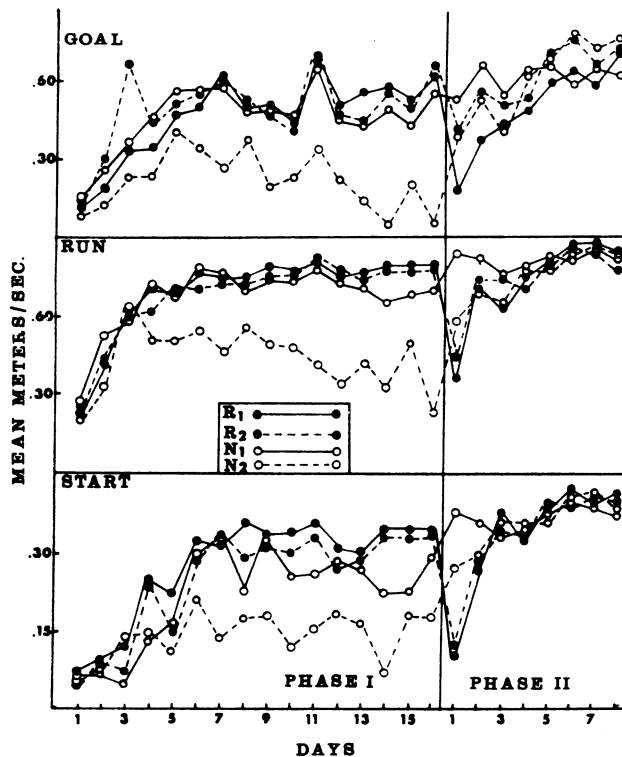


Fig. 1. Mean speeds (meters/sec.) during Phases I and II.

reached) and yielded significant R vs. N effects in all measures [start,  $F(1,99) = 7.23$ ,  $p < .01$ ; run,  $F(1,99) = 8.64$ ,  $p < .01$ , and goal,  $F(1,99) = 9.02$ ,  $p < .01$ ]. Further analyses indicated that the fourth trial differed significantly ( $p < .01$ ) from the other trials. Thus, the statistical analyses are supportive of the graphical impression (see Figure 1) that the subjects responded nondifferentially in all three segments on the first three trials but were significantly slower on the last N trial.

#### Phase II: NNRR

Phase II analyses yielded significant R-N by Days interactions in all three measures [start,  $F(7,165) = 3.14$ ,  $p < .01$ ; run,  $F(7,165) = 2.88$ ,  $p < .01$ ; and goal,  $F(7,165) = 2.35$ ,  $p < .05$ ]. Further analyses indicated that significant ( $p < .05$ ) R vs. N differences existed only on the first day of Phase II. When shifted to an NNRR schedule, the subjects maintained for a 1-day period the behavior from the preceding schedule. On the second and following days, (see Figure 1), the subjects responded nondifferentially on all trials.

#### DISCUSSION

The results of Phase I showed that when rats are given two rewarded trials preceding two nonrewarded trials, the subjects ran significantly slower on the last N trial. The first N trial did not differ from the rewarded trials. Theoretically, the rats should

have run slow on both N trials. Capaldi (1970) has stated that when rats are given R-N transitions, the subject learns to run slowly in the presence of cues on the nonrewarded trials. This slow running on N trials is due to a postreinforcement inhibition that generalizes from the reward trials to the following nonreward trials. Thus, for Capaldi (1970), the memory of R and N events mediates the instrumental response. An alternative explanation for the slow speed on the last N trial is that this trial acts as a *time-out* signal from the apparatus and hence reinforcement (see Leitenberg, 1965).

When rats are shifted to the NNRR schedule (Phase II), they immediately (within four trials) adjust their behavior to this new schedule, i.e., the subjects now run fast on all trials. It appeared that the previous 64 trials and consequent memory had very little effect upon the Phase II schedule, or that the memory of the rat is very labile and can be changed within a few trials. When nonrewards precede rewards, Capaldi (1970) maintains that the rat is trained to run fast in the presence of N cues with the memory of those events governing responding.

It must be remembered that in the present study memory should have been maximized since subjects were run under odor-reduced conditions, i.e., top of apparatus open, no subject intervened between trial administrations for any one subject, and a 1-min intertrial interval. It appears that the memory of R-N events is not very persistent.

Rather than positing events such as inhibition, etc., a more parsimonious approach would be: events that precede reward, N trials, etc., act as a discriminative cue signaling the eventual reward; whereas events, N trials, etc., that follow reward signal the nonavailability of reward. Therefore, events and behavior that precede reward are essentially strengthened while events and behavior that follow reward are essentially weakened and/or aversive.

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#### NOTE

1. It should be noted that the tops of the apparatus were uncovered so as to allow odor cues to dissipate; see Pitt, Davis, and Brown, 1974.

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