VR 2 interresponse times¹

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Rats with a short VR 2 reinforcement history bar press at a moderate but very steady rate. Individual interresponse time distributions are compact with 2 or 3 sec modes.

The analysis of interresponse times (IRTs) in operant conditioning is proving its value (cf., Morse, 1966), as well it should, since the IRTs comprise nearly all of the statistical information available from an operant session. A cumulative record, which is a serial display of IRTs, is often used. However, there are advantages in looking at IRTs in other than their serial order. The purpose of this study was to examine IRT distributions of rats performing on a variable ratio schedule.

The variable ratio schedule used was a VR 2 with equal representation of FR 1, FR 2, and FR 3 components. This is an interesting schedule for several reasons. First, it is the base variable ratio schedule, given symmetrical composition with at least three fixed ratio components (one can program a variable ratio with a mean less than 2 only by overrepresenting the FR 1 component). Second, it is much reward for little effort, a relatively "rich" schedule of reinforcement. Third, it is a 50% reward schedule, the counterpart of which has been frequently studied with running as the operant.

Method

The IRTs were taken from the third day of reward training of rats being prepared for punishment testing. The Ss were male hooded rats reduced to 80% ad lib weight. Their 80% weights were 275 ± 50 g, and their ages at the time of training varied from 90–150 days. On the first day of training they received 50 reinforcements (45 mg pellets) on FR 1 (including shaping), followed without delay by 50 reinforcements on VR 2. One hundred reinforcements were earned on VR 2 on each of the two succeeding days. The VR 2 involved equal representation of FR 1, FR 2, and FR 3 components. The cycle length was 30 steps, with each component occurring five times. The bar pressing was done in a single bar Grason-Stadler box located on a table in a soundproof enclosure. All recording and control equipment was outside except for the feeder. Water was not available. The IRTs were obtained from a printer which was pulsed and advanced each second. The analysis was based on all the mechanically perfect records available, of which there were 11 in all. Ten imperfect records were discarded, most of which had incorrect bar press totals. The IRTs were read in six sets of 30 starting with the 18th response of the session and ending with the last (198th) response. There were no notable trends over the six blocks of 30 IRTs so, for any S, 180 IRTs were pooled.

Results

Figure 1 shows the IRT distributions for individual Ss arranged in order of response rates as well as the pooled IRT distribution for all Ss combined. Response rate was calculated from the time taken to complete the 180 responses entering into the distribution. Response rates varied from 8.2 to 18.0 bar presses per min (BP/min). The median rate of 12.9 BP/min is about half again as high as we usually observe with FR 1 at a comparable stage of training. This is a reinforcement rate of six rewards per min.

The individual IRT distributions are rather compact. With one exception (Rat 11), modal IRTs were either 2 or 3 sec. As a rule the median was one unit higher than the mode. IRTs of 10 sec or longer were few in number, except for the three Ss with the lowest response rates. In the main, the longer IRTs were less than 20 sec and there were only nine IRTs of 60 sec or more, remarkably few in relation to the 1980 IRTs which figure in the pooled distribution.

Discussion

The IRTs of two rats which had been given extended training with a VR 15 schedule were analyzed in Kintsch's (1965) study. The IRTs decreased abruptly as S began the ratio and most IRTs were well under 1 sec. Since the first few IRTs are longer than the rest, the relative shortness of the IRTs observed by Kintsch is probably due more to the size of the ratio than to the length of exposure to the schedule. With a longer reinforcement history than that used in this study, it is reasonable to suppose that the high VR 2 reinforcement rate would limit the typical rat to 20 BP/min, a response rate half that displayed by Kintsch's slowest S.

A VR 2 schedule appears to be an economical way to train moderately fast, steady responding in the rat. Indeed, it would appear to be feasible to give VR 2 training for a session lasting only 10 min (timed from first bar press) with the rat's total take effectively limited to less than 100 reinforcements daily. This would be particularly useful for a study requiring a relatively large number of Ss. Other low variable ratios (e.g., VR 4) should have similar advantages.

References

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Fig. 1. Distributions showing per cent of IRTs falling in 1 sec intervals for each rat and all Ss combined. S's identification number and response rate is given with each individual distribution. The 0-sec interval includes IRTs of less than 1 sec; the 10-sec interval contains all IRTs of 10 sec or longer.