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THE EFFECT OF SMALL SEQUENTIAL CHANGES IN FIXED-RATIO SIZE UPON THE POST-REINFORCEMENT PAUSE[1]

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Duration of the post-reinforcement pause was measured for three pigeons on fixed-ratio schedules of reinforcement ranging from 10 to 160. Small sequential changes were made in the ratio values without disrupting stable performance. The post-reinforcement pause increased consistently for all birds within three sessions as the ratio requirement increased. A frequency analysis of the individual pauses at selected fixed ratios revealed an increase in dispersion for all animals as the ratio size increased. Response rate tended to decrease for two of the birds and remained relatively stable for the third; but there were many reversals in these data.

The data of Ferster and Skinner (1957) suggest that the post-reinforcement pause increases as the size of the fixed-ratio schedule of reinforcement (FR) is increased. A number of other studies (Kaplan, 1956; Premack, Schaeffer, and Hundt, 1964; Thompson, 1964; Winograd, 1965; Mintz, Mourer, and Gofseyeff, 1967; Felton and Lyon, 1966) have indicated a similar positive relationship, with the latter study offering the most extensive quantitative data. Felton and Lyon found in the pigeon consistent and stable increases in the post-reinforcement pause as the ratio size was increased from 50 to 150. Because of the size of the increases used (50, 75, 100, 150), the birds had to be extensively trained at each new FR value in order to achieve stable performance.

The present study was undertaken to determine the relationship between the post-reinforcement pause and fixed-ratio size, given small changes in the FR value. Small changes in FR size were used primarily in order to maintain stable responding so that no retraining would be required at different FR values. This would permit measurement of the animal's immediate sensitivity to changes in FR size, and also its sensitivity to relatively small changes in this requirement.

The post-reinforcement pause and response rate were analyzed in terms of the mean size at each fixed-ratio size. A frequency analysis of the individual pauses was performed at selected FR values.

METHOD

Subjects

Three White Carneaux pigeons were maintained within 10 g of 80% of their free-feeding weight. One (P42) was experimentally naive, the other two (P33, P44) had previous FR training. Water and grit were available at all times in the home cages.

Apparatus

A Lehigh Valley pigeon test chamber Model 1519C was employed. A grain mixture of 50% kafir, 40% vetch, and 10% hemp was used for reinforcement. A reinforcement time, which ranged from 2 to 3 sec, was empirically determined for each subject so that the animal's weight was maintained within the prescribed limits. During reinforcement the white key light was turned off.

The fixed-ratio reinforcement schedule was programmed by a Grason-Stadler ratio counter. The elapsed time from the end of the reinforcement period to the first response in the ratio run, *i.e.*, the post-reinforcement pause, was measured in fourths of a second. This was done by recording the pulses (4 pps) from a Foringer electronic timer which were initiated by the end of the grain hopper cycle and terminated by the animal's first response. These pulses were recorded cumulatively over each daily session on a digital counter; the

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number of pulses in each pause was recorded by a Grason-Stadler print-out counter. The data were also recorded by a Ralph Gerbrands cumulative recorder.

Procedure

All birds were trained at FR 10 until performance stabilized for three consecutive sessions. Then, ratio size was increased to FR 15, 20, 30, 40, 50, 60, 75, 90, 105, 120, 140, 160, and then decreased to FR 120, 90, 60, 40, 20, and 10. The birds were studied for three sessions at each ratio, so long as they maintained stable performance. Stable performance was defined as completion of at least 80% of the ratio runs in a session without discernible breaks in the cumulative record. Two birds (P42, P44) met this criterion over the full range of ratios employed. The third (P33) failed to meet this requirement when the FR was increased from 120 to 140. This bird was then switched to the next ratio in the descending order (FR 90) and performed successfully over the remainder of the experiment. Each experimental session ended after 40 post-reinforcement pauses.

RESULTS

The results were first analyzed in terms of the mean post-reinforcement pause in seconds for each session. The mean post-reinforcement pauses over the three sessions for each of the FR values are presented for each bird in Fig. 1.

Pause duration for each bird increased consistently as the ratio requirement increased, with only one significant reversal being evident. The curves for all animals appear to describe a positively accelerating function as ratio size is increased, with relatively little increase occurring up to FR 30. The descending curves appear to describe a similar function, with the exception of P44, whose curve is somewhat flatter.

The data indicate inter-subject reliability in the increases in pause duration. Pigeon 42 had the shortest mean pauses at all FR values studied; P44 displayed longer pauses than P33 at 14 of the 16 values to which they were both exposed.

Figure 2 shows the results of an analysis of the frequency distribution of individual

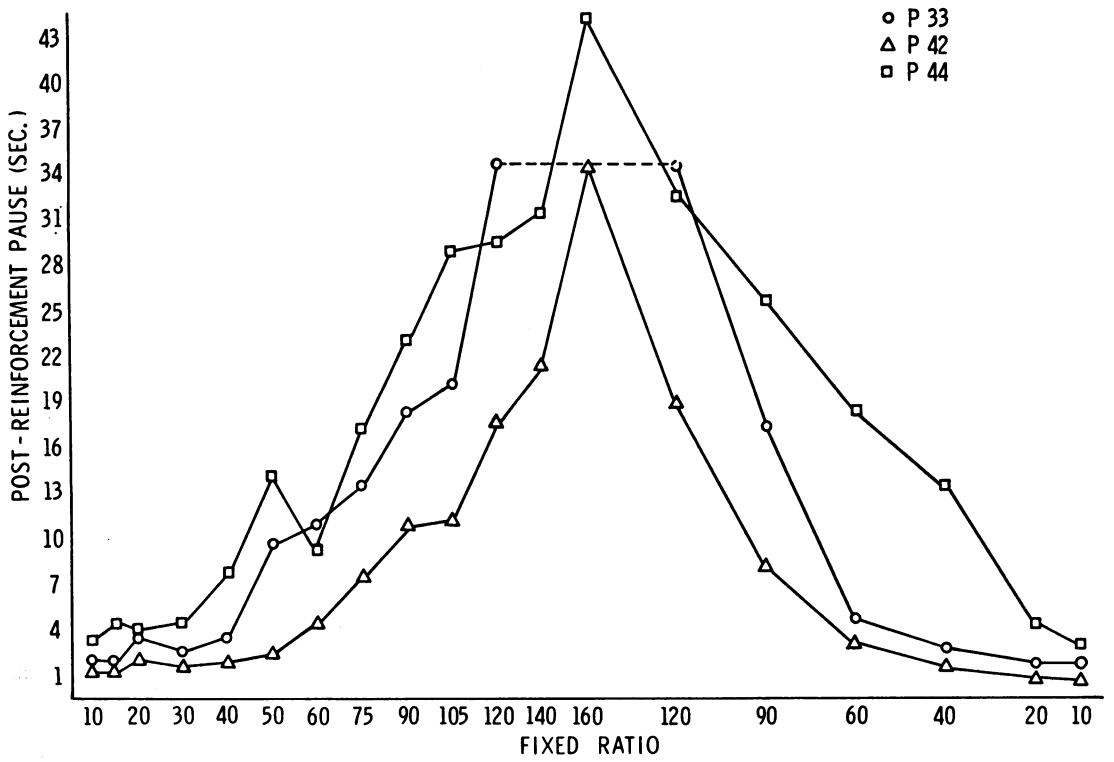

Fig. 1. The mean post-reinforcement pause in seconds for the three sessions at each fixed-ratio requirement.

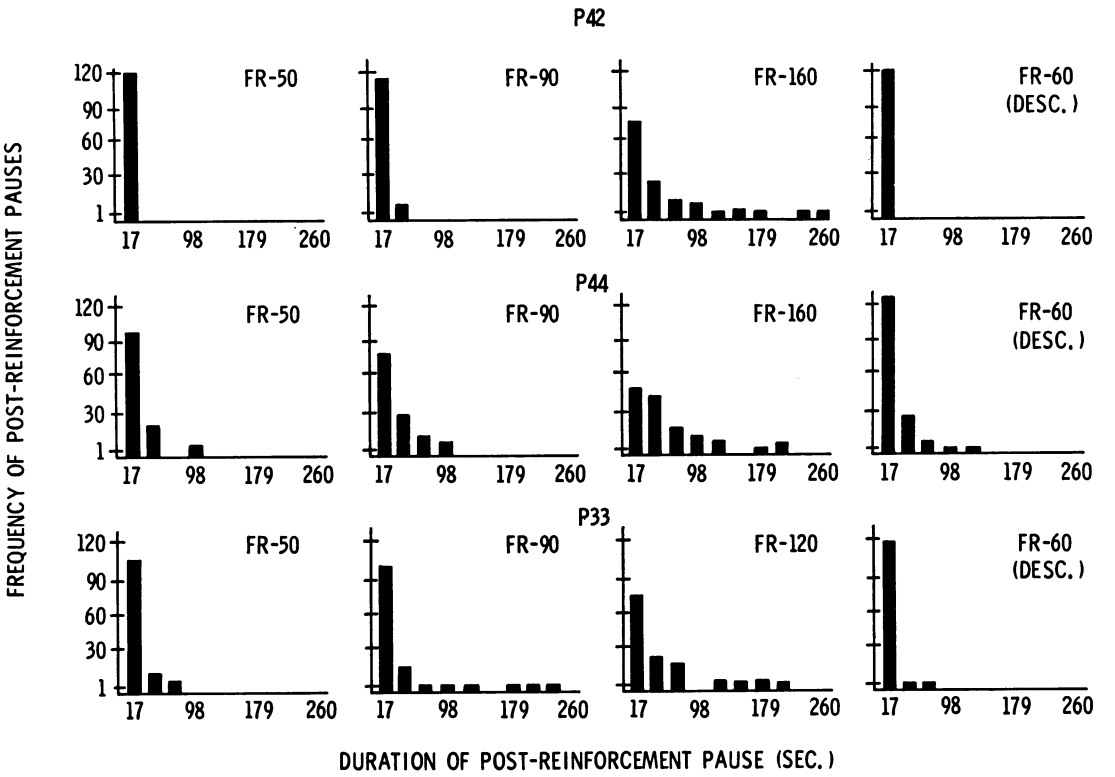

Fig. 2. The frequency distribution of individual post-reinforcement pauses over 10 equal class intervals is given for selected fixed-ratio requirements. The mean of the class intervals is presented in seconds. The data presented for each animal at FR 60 were determined during the descending series.

pauses at selected FR values for each pigeon.

Dispersion of the pauses tends to increase as the ratio size is increased. Each animal made a few extremely long pauses at each ratio requirement analyzed here. These extreme pauses exceed the mean by factors ranging from 5 to 15.

The mean response rate per second was determined by dividing the total number of responses per session by the total session time less the post-reinforcement pause less the reinforcement time. The mean response rates over the three sessions at each FR value are presented for each bird in Fig. 3. Two birds (P33, P44) show a generally decreasing rate as the ratio size increases; the third (P42) shows a relatively stable rate over the entire range of FR values. These data show little consistency, with many reversals being apparent.

Typical cumulative records for one bird (P42) are presented in Fig. 4. These data show the increase in post-reinforcement pause as the ratio increased. They also reveal several extremely long pauses.

DISCUSSION

Felton and Lyon (1966) gave quantitative support to earlier studies which suggested that the post-reinforcement pause increases as the fixed-ratio schedule is increased. The present results confirm this finding and extend it to include situations in which measurements of the pause are made immediately after the fixed ratio changes. Felton and Lyon employed a conventional baseline technique in which measurements of the behavior were made after extended training at each FR value. The present study used much smaller FR changes than those employed by Felton and Lyon, and stable performance was maintained without retraining the birds at each new value.

Response rate declined for two birds but remained relatively stable for the third. These data are not consistent, and contained many reversals, an inconsistency also reported by Felton and Lyon (1966).

A frequency analysis of the individual

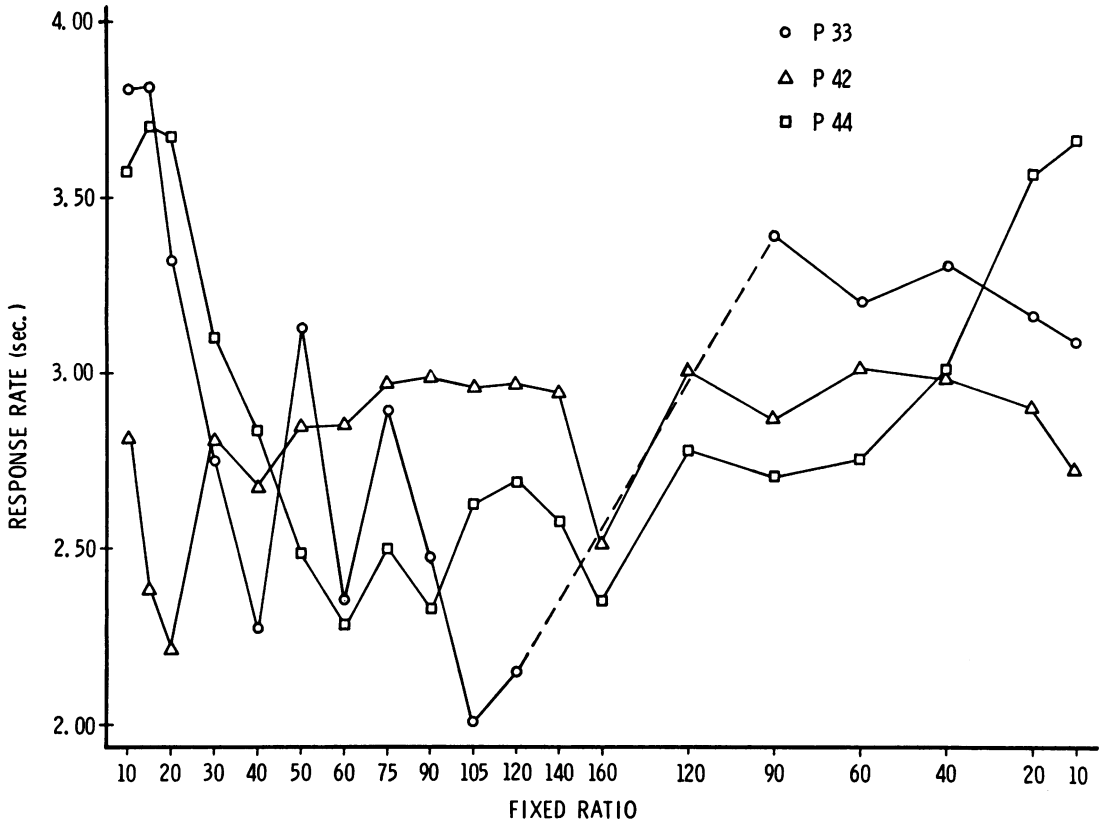

Fig. 3. The mean response rate per second over the three sessions at each fixed-ratio requirement.

pauses at selected FR requirements from 50 to 160 revealed that all birds made a small number of extremely long pauses. These long pauses occurred with an approximate frequency of 3 to 10%, and exceeded the mean of the particular distribution by factors ranging from 5 to 15.

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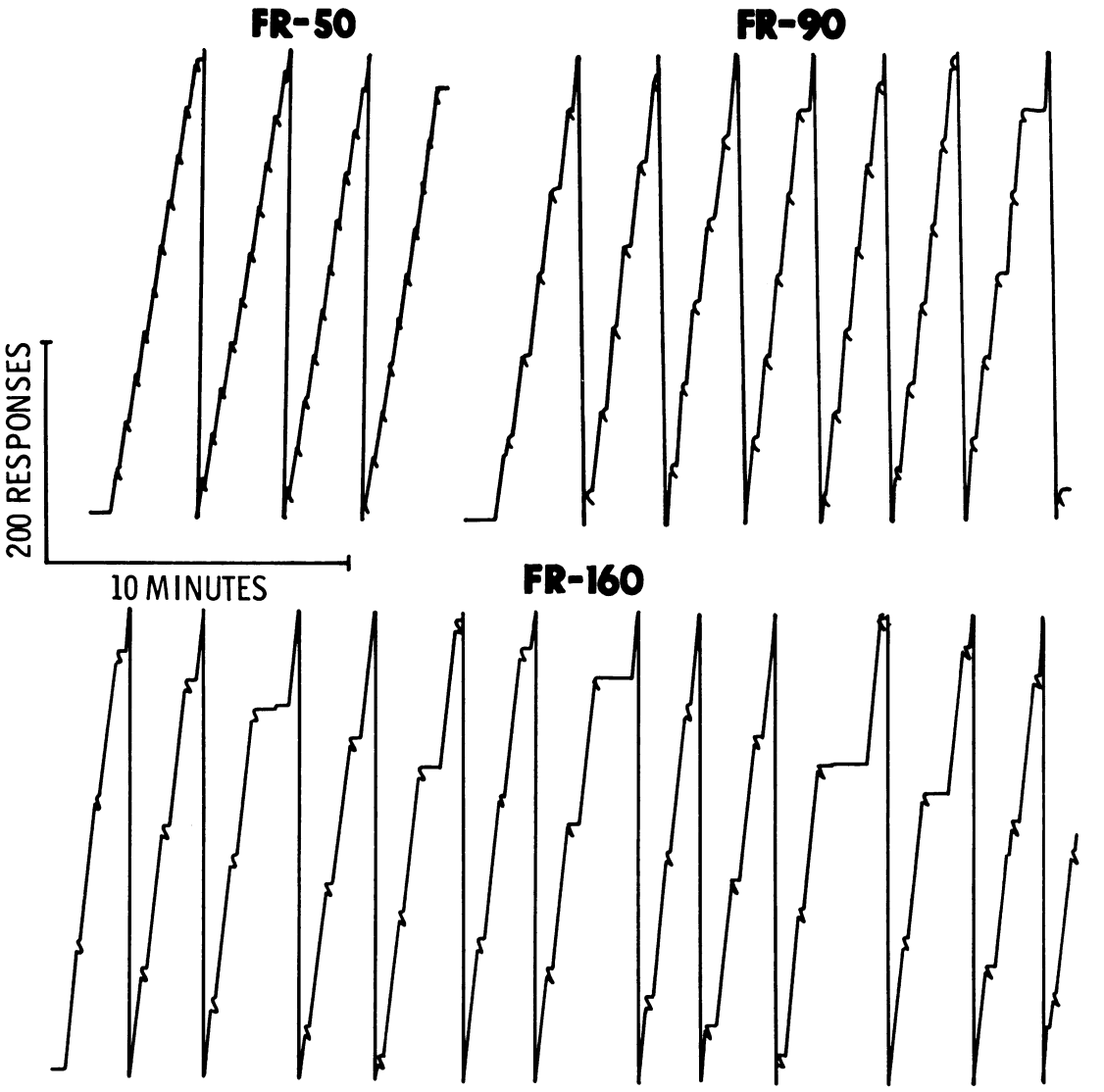

Fig. 4. Typical cumulative records for Pigeon 42.