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EFFECT OF REINFORCEMENT DURATION ON FIXED-INTERVAL RESPONDING[1]

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Five different reinforcement durations occurred randomly within each session on fixed interval 60-sec. Postreinforcement pause was directly related (and "running" rate inversely related) to the duration of reinforcement initiating each fixed interval.

Previous experiments (Staddon and Innis, 1966, 1969) have shown that the presentation of a brief blackout in lieu of reinforcement on fixed-interval schedules elevates responding over the following interval (omission effect). This effect has been interpreted in terms of a difference in the inhibitory after-effects (temporal inhibition) of reinforcement and the stimulus presented in lieu of reinforcement (*i.e.*, blackout). Reinforcement depresses responding after its offset more than a blackout of the same duration, hence reinforcement omission, with blackout presented in lieu of reinforcement, elevates subsequent responding.

In one experiment (Staddon and Innis, 1969), when blackouts of different durations were presented within the same experimental session, rate in the next interval was inversely related to blackout duration: the longer the blackout the lower the subsequent rate, until for the 32-sec blackout, rate and time-to-first-response were the same as after reinforcement. In the present experiment, reinforcement duration was varied, within sessions, in a similar fashion and a similar function was obtained. This result further emphasizes the similar functional properties of reinforcement and the stimulus presented in lieu of reinforcement on fixed-interval schedules.

METHOD

Subjects

Three White Carneaux pigeons, two naive (95, 96) and one with experience in a discrimination task (56), were maintained at 80% of their free-feeding weights.

Apparatus

An aluminum and Plexiglas chamber, enclosed in a larger sound-proofed box, was used. A Gerbrands clear pigeon key and grain magazine were mounted on one aluminum wall. Stimuli were projected on a screen immediately behind the pigeon key by a standard in-line projector (Industrial Electronic Engineers). The box was illuminated by a 6-w houselight that remained on throughout each experimental session. Reinforcement during the first six conditions involved 3.3-sec access to mixed grain. A click from a relay mounted on the roof of the box, above the key, accompanied each effective key peck. White noise and the noise from the ventilating fan helped mask extraneous noises. Scheduling was by means of an eight-channel paper tape reader and associated switching and timing circuitry located in another room. Data were recorded on digital and printout counters and a cumulative recorder.

Procedure

The two naive pigeons (95 and 96) were magazine and key trained in the presence of a white response key. House and keylights remained on throughout reinforcement. Both birds received about 35 reinforcements on FR 1 before exposure to the experiment proper.

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The training schedule was fixed-interval 61.7-sec (nominal FI 60-sec) in the presence of a white response key. The birds received 48 sessions under this procedure. Three vertical lines appeared on the key during reinforcement, which was 3.3-sec access to mixed grain during this phase. For nine sessions during the latter part of the 48, the procedure was modified slightly so that the first peck after 61.7 sec produced the three vertical lines on the key, with the reinforcement occurring after a further 3.3. sec independently of the animals' responding. Three generalization tests were also given during the 48-session training period. These manipulations have no bearing on the present experiment and will be reported elsewhere. After the 48-session pretraining period, the three birds were given 12 sessions of a variable reinforcement-duration procedure. Reinforcement duration at the end of each 61.7-sec interval was selected from one of five possibilities, presented in randomized blocks of five. The five durations, recorded via a food-magazine-operated switch were: 1.3, 2.4, 3.5, 5.7, and 9.0 sec. Sessions consisted of 40 intervals.

RESULTS

The top panel of Fig. 1 shows response rate as a function of the duration of the preceding reinforcement. With the exception of one discrepant point (Bird 95 after the 2.4-sec duration) all three pigeons showed a lower rate following longer reinforcements. The bottom panel shows the same pattern: postreinforcement pause was an increasing function of reinforcement duration for all birds. Figure 2 shows the average data, plotted in semi-logarithmic coordinates. It indicates that reinforcement duration exerted an effect not only on pause and thus overall rate during the following interval, but also on response rate after the

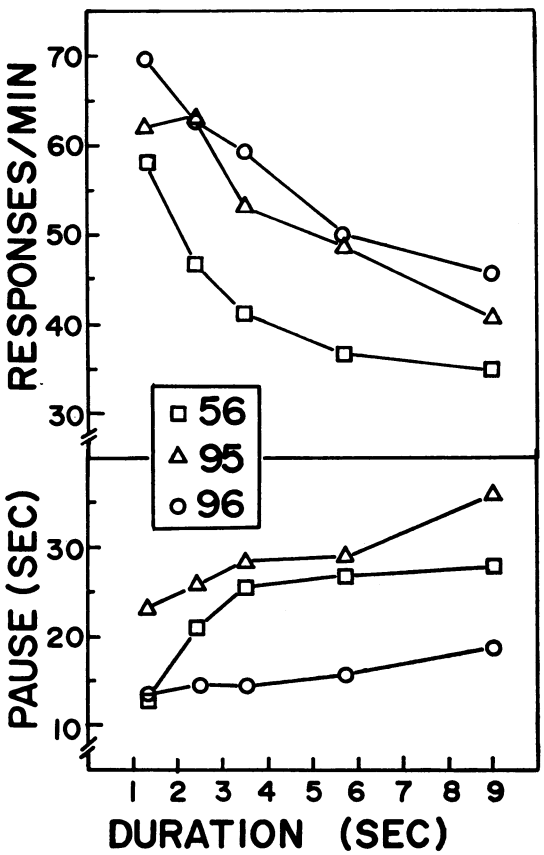

Fig. 1. Response rate over the following interval (top panel) and postreinforcement pause (bottom panel) following the five reinforcement durations, averaged across the last five days for the three birds.

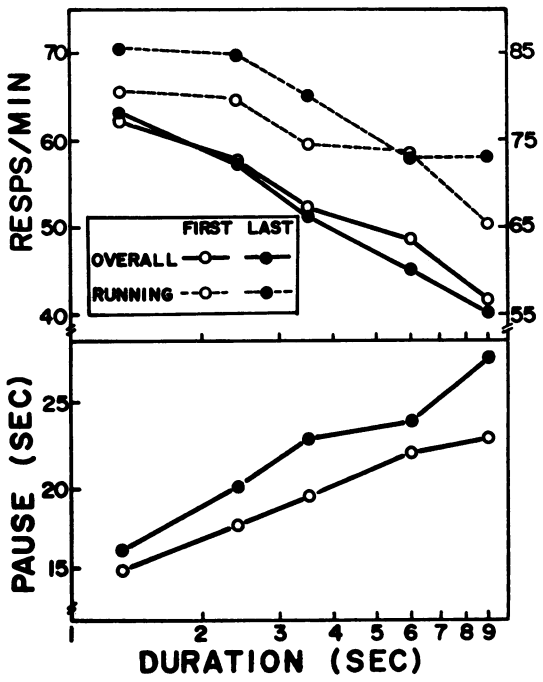

Fig. 2. Top panel: Response rates (continuous lines, left-hand ordinate) and "running" rates (dashed lines, right-hand ordinate) over the intervals following the five reinforcement durations, averaged over the last five days (filled circles) or the first five (open circles) across the three birds. Bottom panel: Postreinforcement pause averaged over the last five days (filled circles) or the first five (open circles) across the three birds.

first response of an interval ("running" rate). The plot shows data from the first and last five days of the 12-day period. The mean overall rate data, particularly, showed negligible change over this period, suggesting an effect of reinforcement duration relatively independent of experience with various durations. Examination of data for the first five days indicated little change over that period. Data for individual pigeons showed some change in the relationship between rate and reinforcement duration between first and last five days, but they were small and differed in direction from bird to bird.

DISCUSSION

These data clearly demonstrate that the temporal inhibitory effect of reinforcement on FI increases with reinforcement duration. The similarity between this result and our previous finding of an inverse relationship between blackout duration and rate over the following interval, further emphasizes the functional similarity between reinforcement and stimuli presented in lieu of reinforcement on FI (*cf.* Neuringer and Chung, 1967). A difference between this and our previous result is that blackout duration acted almost entirely to increase post-blackout pause and had a negligible effect on "running" rate, whereas reinforcement duration was effective in terms of both pause and "running" rate here. However, the previous experiment involved FI 2-min, as opposed to FI 1-min here, and sequential effects were directly controlled in the previous experiment (each blackout was preceded by an interval beginning with reinforcement) but not in this experiment. Either or both these factors may account for this difference, although on the basis of unpublished observations, the first is probably more important.

A second outcome of this experiment is that the function relating response rate to duration of the preceding reinforcement appears to be relatively independent of experience with the various durations: the function showed little change across a 12-day period for the group of three birds. However, the mean of the five durations used here was close (4.4 sec) to the fixed reinforcement duration (3.3 sec) throughout the previous 48 sessions. Therefore, this constant relationship is consistent with an effect of either absolute or relative (to the mean, "expected" duration) reinforcement duration on subsequent pause and rate. On the other hand, McHose and Ludvigson (1965), using rats in a runway situation, reported a fixed relationship between running speed and preceding reward magnitude that is independent of preshift reward magnitude. Their data suggest that the present results probably reflect an effect of absolute rather than relative reinforcement duration.

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