THE INTERACTING EFFECTS OF DEPRIVATION AND REINFORCEMENT SCHEDULE

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The effect with which this report is concerned is illustrated by the cumulative records shown in Fig. 1. The upper record is from an extensively trained rat working for water reinforcements on a multiple fixed-ratio (of 20), continuous-reinforcement (CRF) schedule. The periods of CRF are noted by the offset portions of the records (labeled by A's), and reinforcements on FR are marked by the diagonal pips. The animal had received 1 hour of free access to water 65 hours before the session shown in the upper record; the middle record was taken 22 hours after a 1-hour period of free access to water, and the lower one, 4 hours after such a period.

When the schedule was FR, the effect of decreasing the time since watering was a breakdown of performance, characterized by increasing pauses that in-

variably followed reinforcements on the FR schedule or periods of CRF. However, when the animal responded, responses were emitted at their usual rate. The increment in the postreinforcement pausing on FR, with maintenance of the local rate, has been described and discussed elsewhere (Ferster & Skinner, 1957; Sidman & Stebbins, 1957).

A comparison of the CRF and FR performances revealed instances in which the animal did not respond when switched to FR after a period of responding on CRF, and, further, in which CRF responses were emitted at their usual rate following periods of no responding on FR. These data essentially replicate those of an earlier study (Carlton, 1958).

The major portion of this report describes the effects of variations in time since watering on two other multiple schedules. In the first of these, performance under a variable-interval schedule with a 2-minute average interval (VI 2) was compared with performance under CRF; in the second, CRF performance was compared with that generated by a fixed-interval schedule of 2 minutes (FI 2).

METHOD

The subjects were four adult, male albino rats. During the experimental sessions, each animal was confined in a metal, soundproof response chamber containing two response levers. A small stimulus lamp was mounted directly above each lever. Depression of either of the levers activated the programming and recording equipment and could, under the contingencies to be described, operate a motor-driven dipper which delivered a small amount of water. The response chambers were housed in a room in which the continual operation of a random-noise generator masked external sounds; the programming and recording devices were located in a separate room.

Before the experiment, two of the animals had had extensive exposure to VI 2, scheduled on one of the response levers (Lever B); the other two had been similarly exposed to FI 2. Neither of the stimulus lamps was on during this period.

Continuous reinforcement was then made available for responses to Lever A only when the stimulus light over that lever was on and the light over Lever B was off. Reinforcements for responses to Lever B were available on the interval schedules only when the B light was on and the A light off. In each of these multiple-schedule sessions, the B light was on for the initial 18 minutes; it was then turned off, and the A light was on for 2 minutes. This cycle was then re-

Fig. 1. Mult FR 20 CRF performance 65, 22, and 4 hours after a 1-hour period of free access to water. The periods of CRF are shown in the offset portions of the record (labeled A). The coordinates of the records are shown at the upper right.

peated. Each session thus provided 36 minutes on one of the interval schedules and 4 minutes on CRF. The interval-timing tapes were stopped during the periods of CRF.

Two animals were trained on mult VI 2 CRF (Rats A1 and C3) and two on mult FI 2 CRF (Rats C1 and D10) until their performances were reasonably stable (about 12 sessions). All sessions were begun 22 hours after the animals had had free access to water for 1 hour; they had free access to Purina Lab Chow except during experimental sessions.

After the animals' performances had stabilized, these variations in procedure were introduced:

- Day 1: the session for all animals was begun 22 hours after 1 hour of free access to water; *i.e.*, deprivation time (DT) = 22 hours.
- Day 2: DT = 4 hours for Rats C1 and A1, and 0 for Rats C3 and D10.
- Day 3: DT = 0 for Rats C1 and A1; DT = 4 for Rats C3 and D10.
- Day 4: DT = 65 for all animals. (No sessions were run during the 65-hour period.)

Following these variations in DT, one of the animals (D10) was given extensive training on mult DRL 21 CRF (about 80 hours). On this schedule, a response to one lever (when its stimulus light was on) was reinforced only if that response was emitted at least 21 seconds after the preceding response (DRL 21), whereas each response on the other lever was reinforced when its light was on.

RESULTS AND DISCUSSION

The data of major interest have been entered in Table 1. In each case, the decline of CRF responding with decreasing DT was less than the decline on the opposite member of the schedule.

TABLE 1 RESPONSES ON CRF AND FI (OR VI) AT EACH DT								
RAT	C1		D10		A1		C3	
DT	CRF	FI	CRF	FI	CRF	VI	CRF	VI
65	30	452	37	400	32	445	31	321
22	32	369	33	269	29	348	31	214
4	31	149	31	70	26	183	24	85
0	31	63	29	46	11	50	23	46

Further, there was little basis for distinguishing the FI decline with decreasing DT from the decline under

Fig. 2. Responses emitted at each DT under VI 2 and under FI 2 as a percentage of the number emitted at DT = 22 hours.

VI. In order to facilitate this comparison, the FI and VI values, as a percentage of the values at DT = 22, have been plotted for all animals in Fig. 3. The curve in the figure, fitted by approximation, appears to describe all the data with reasonable accuracy regardless of schedule.

An incidental finding was that the two schedules appeared to be differentiated with respect to the CRF performance at DT's of 0 and 4. At these values, the animals tended to emit more responses when the opposite component was FI 2 than when it was VI 2. As Table 1 shows, the FI CRF animals emitted totals of 62 and 60 CRF responses, whereas the CRF totals on VI CRF were 37 and 47. The numbers of reinforcements on the FI (or VI) schedule did not show a comparable ordering. The total reinforcements (for DT's of 0 and 4) on FI were 26 and 23; the VI totals were 29 and 25.

The major effect with which this report is concerned, however, is that decreasing DT leads to a greater decline in response output when reinforcements are relatively infrequent (as in FR, FI, and VI) than it does when each response is reinforced (CRF). Figure 3 shows this differential effect when the low-frequency schedule was DRL.

The animal had had 1 hour of free access to water before the session (*i.e.*, DT = 0). At the first reset in the record, the animal had not responded for 6 minutes; in the preceding session, the longest time between responses was 45 seconds. After it had been shifted to CRF, Rat D10 began responding and had emitted 62 responses before the DRL 21 component was again introduced (the second reset). When the second 6-minute period of no responding on DRL had

Fig. 3. Cumulative record of performance on mult DRL 21 CRF immediately after a 1-hour period of watering.

elapsed, the schedule was shifted to CRF again. The animal emitted 33 responses during this period.

of continuous reinforcement than under the schedule in which reinforcement frequency was low.

SUMMARY

The effects of deprivation time on the behavior of rats working under four multiple schedules were studied. Each multiple schedule provided a comparison of the behavior controlled by a schedule in which the frequency of reinforcement was relatively low (FR, VI, FI, and DRL) with that controlled by continuous reinforcement. In every instance, the decline in performance that was correlated with decreasing deprivation time was less under conditions

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