

An effect analogous to "frustration" on interval reinforcement schedules¹

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There are similarities between pigeons' behavior under interval reinforcement schedules and the behavior of rats in runways. A free-operant experiment analogous in certain respects to the double-runway procedure produced large "frustration effects" in pigeons, lending support to this comparison.

A previous experiment (Staddon, 1964) showed that exposure of pigeons to a reinforcement schedule in which the frequency of reinforcement varied cyclically as a function of time, induced a periodicity in their responding matching that of the schedule, but out of phase with it; i.e., the birds' maximum rate of responding coincided with reinforcement rate minima. This phase lag seems to be independent of absolute reinforcement rate, period of cycle and amplitude of cycle over a wide range.

There are similarities between this finding and the results of classical frustrative nonreward experiments (e.g., Amsel & Roussel, 1952; Bower, 1962). In the Amsel experiment rats ran to obtain food in a goal box at the end of a runway; after a fixed delay they were then allowed to run to a second goal box at the end of a second runway. When food was available in the second goal box on all trials, but in the first on only 50% of trials, running speed in the second runway was reliably higher following unrewarded trials in the first runway. This elevation in the response measure is the "frustration effect" (FE).

The parallel between cyclic schedules and the Amsel procedure is apparent if we consider the simplest cyclic situation, in which the schedule provides a short fixed-interval followed by a long fixed-interval followed by a short fixed-interval and so on in a repetitive sequence. Under these conditions the animal will respond most rapidly during the long fixed-intervals (i.e., when reinforcement rate is least) (cf., Skinner, 1938, p. 272). Ignoring for the moment the stimulus difference between the two runways, the two procedures may be compared thus: when reward is available in the first goal box, running in each runway corresponds to a short fixed-interval; when reward is only available in the second goal box, running in runway 1 followed by running in runway 2 corresponds to a long fixed-interval. Hence the elevation in running speed in runway 2 following nonreward is analogous to the higher response rates found in the longer of the two fixed-intervals in the cyclic procedure.

In an attempt to explore this analogy a free-operant experiment similar in certain respects to the Amsel & Roussel procedure has been conducted. Instead of run-

ways, two identical fixed-interval schedules were used, presented alternately and separated by a "time out" (TO). The TO in our procedure corresponds both to the detention time in the first goal box and to the inter-trial interval, in the Amsel & Roussel experiment.

Method

The Ss were four male, White Carneaux pigeons, previously used in a variety of experiments and kept at 80% of their free-feeding weights.

The experimental chamber was a two-key box for pigeons made by the Grason-Stadler Co., with one key permanently covered. Effective responses produced an audible "feedback" click. The magazine aperture was illuminated during the presentation of grain and the house and key lights were turned off.

For most of the experiment 40 trials per day were given. A trial consisted of a 2-min. fixed-interval (component 1), TO (3.2 sec. darkness), 2-min. fixed-interval (component 2), TO (3.2 sec. darkness); with reinforcement (access to grain) during the first 3 sec. of every TO following component 2 and either every (continuous) or 50% (partial) of TOs following component 1. Responses were recorded as totals in each component over the session and, for component 2 (C-2), as totals following reward (C-2R) and nonreward (C-2N) in component 1 (C-1). Trial-by-trial data were recorded on a cumulative recorder and a printing counter.

The four experimental conditions to be discussed followed 10 conditions in which the TO duration was 30 sec.; this interval proved to be too long to produce reliable "frustration effects" in all four pigeons. During the next four conditions, when the TO duration was reduced to 3.2 sec., the variables manipulated were: (a) reward conditions in component 1: continuous vs. partial; and (b) stimulus conditions in the two components: both components signalled by the same stimulus (white key-light) vs. each component signalled by a different stimulus (red vs. green key-light). These conditions are summarized in Table 1.

Table 1. Order and duration of experimental conditions

Condition	Component 1 Stim Reward		Component 2 Stim Reward		Sessions
1	WL	cont	WL	cont	6
2	WL	part	WL	cont	11
3	RL ¹	cont	GL	cont	3
4	RL	part	GL	cont	7

¹ RL and GL counterbalanced among the 4 pigeons

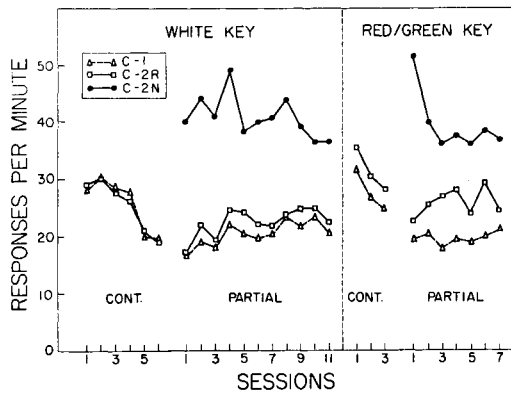


Fig. 1. Geometric means of the daily results for the four pigeons. Cont. and partial refer to the reward conditions in the first component.

Results and Discussion

Figure 1 shows the results of the four experimental conditions. In agreement both with Amsel and Roussel, and with the recent results of Davenport & Thompson (1965) in a similar situation, the major effect (shown by all four pigeons in both *partial* conditions) was a large elevation in response rate following nonreward. Cumulative records indicate that this effect is similar to the "running through" sometimes reported on both fixed-interval and fixed-ratio procedures; consequently, in terms of a "starting time" measure (e.g., latency to the first post-TO response), the magnitude of "FE" is even greater than the already large difference between C-2R and C-2N seen in Fig. 1.

A second effect, apparent in the mean curve and characteristic of three of the four birds, is that the FE in the second *partial* condition was highest on the first day and declined somewhat thereafter. These same three birds showed greater separation between C-1 and C-2R curves in the second than in the first *partial* condition; this difference is also reflected in the mean curves and is presumably the result of a discrimination between the *partial* and *continuous* components, made possible by the different stimuli associated with each in the last condition. The direction of this difference—higher response rate in the component associated with the higher reinforcement frequency—is in agreement with the results of Reynolds (1961) on multiple schedules. The first 10 conditions of this experiment, which showed a FE in only two of the four

birds, nevertheless demonstrated that the effects of both nonreward and discriminative stimuli are readily recoverable; it is possible, therefore, that the decline in FE following the first day of condition 4 is a reliable one, attributable to the stimulus difference between *continuous* and *partial* components.

The higher response rate in C-2R as compared to C-1 seen in condition 3 is largely attributable to a consistent green-preference shown by one of the pigeons throughout the experiment.

These results may be summarized as follows: (1) A comparison may be made between responding on cyclic interval schedules and behavior in a double-runway. (2) A fixed-interval procedure similar in certain respects to the double-runway situation produced large "frustration effects" in pigeons. (3) When the *continuous* and *partial* components of the procedure were signalled by different stimuli: (a) a discrimination developed between the two components; reflected in a higher response rate in C-2R than in C-1, in agreement with findings on multiple schedules; (b) the FE was highest on the first day of the *partial* condition and declined somewhat thereafter; this effect was probably also due to the development of a discrimination between the two components. (4) These results strengthen the comparison between cyclic schedule experiments and frustrative nonreward experiments; similarly, they imply a common behavioral mechanism between responding under interval schedules and behavior in runways.

References

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Note

1. Supported by National Research Council of Canada Grant APA-155 and Grant MH 11525 from the National Institute of Mental Health.