Sequential effects in fixed-ratio postreinforcement pause duration¹

DONALD E. MINTZ, DENNIS J. MOURER, AND MIRIAM GOFSEYEFF²
CITY COLLEGE OF THE CITY UNIVERSITY OF NEW YORK

Pigeons were run on fixed ratio schedules that alternated between pairs of long and pairs of short ratios. Length of ratio was differentially cued. The longest pause in response preceded the longer ratio. However, sequential effects were observed. These suggested a contrast effect rather than a direct relation between amount of responding preceding a pause and pause duration.

The postreinforcement pause (PRP) has frequently been shown to be the property of behavior controlled by fixed-ratio (FR) schedules—reinforcement of every *n*th response—most sensitive to experimental manipulation. FR length (Boren, 1961), response effort (Notterman & Mintz, 1965), drive level (Sldman & Stebbins, 1954), and number of reinforcements (Mintz, Mourer, & Weinberg, 1966a) are a few among the variety of variables shown systematically to affect pause duration.

Since both effort of individual response, and the number of responses in the FR exert great influence on pause duration, total energy expenditure in achieving reinforcement suggests itself as an important determinant of pausing. However, the regularity of the FR schedule, as opposed to, say, a variable ratio (VR) averaging equal length, is also important. Ferster & Skinner (1957) suggest a discriminative basis for the PRP. Response is least likely when its contingent reinforcement is least likely. Extensive training on FR establishes the reinforcement itself as the stimulus systematically preceding the lowest probability of subsequent reinforcement.

Further evidence for the importance of stimulus control in the FR performance has been shown in chained schedules or related procedures where different stimuli are regularly correlated with different component responses in the sequence leading to reinforcement (Ferster & Skinner, 1957; Thomas, 1964; Mintz, Mourer, & Weinberg, 1966b). In general, when the S is provided with exteroceptive stimuli correlated with the beginning of the FR sequence, control of the behavior is weaker than when cues that have been related to closer proximity to reinforcement are presented.

The present study is concerned with an analysis of PRP duration as it is influenced by FR length. The PRP occurs when one FR cycle has just been completed and a new one has begun. Our interest is to isolate the effects of the length of the preceding and the present FR on this pause.

Method

The Ss were two adult male White Carneaux pigeons. S24 was experimentally naive and S10 had a prior history of FR reinforcement on a white key. Both Ss were maintained at 80% of their ad lib feeding weights.

The apparatus was a standard Lehigh Valley two key operant chamber for pigeons; only the right hand key was used.

Both birds were run on two-component multiple FR schedules that followed a fixed pattern. Pairs of each ratio length were regularly alternated. For S10 the pattern was FR50-FR50-FR20-FR20 etc; S24 ran on FR40-FR40-FR20-FR20 etc. The longer FR was cued by a red key light, the shorter by a green key light for both Ss. During the 3.5 sec periods of reinforcement, the key light was off. It was illuminated with the color appropriate to the next schedule in the sequence immediately following reinforcement. A grain mixture of 50% kaffir, 40% vetch, and 10% hemp was used for reinforcement. Daily sessions were run for a total of 65 reinforcements for each bird. Training was conducted until an adequate sample of stable performance was obtained, 122 days for S10 and 103 days for S24.

Temporal data were recorded on a Presin Printing Counter pulsed at 10 cps by a Scientific Prototype Reed clock.

Results and Discussion

The regular pattern of the multiple schedule employed provided a nominal classification of four different interfaces at which pauses were measured. These interfaces were defined by the FR just completed and the one then in effect. Thus, short-short designates the pause at the beginning of an FR20 when FR20 has just been completed. Short-long identifies the PRP preceding the longer ratio following reinforcement on FR20. Each component schedule was regularly preceded by that same or the contrasting

Table 1
Median Postreinforcement Pause Duration
(seconds)

Preceding FR	Present FR			
	S 10		S 24	
	Short	Long	Short	Long
Short	1.9	19.4	1.7	8.8
Long	1.9	16.4	1.6	5.3

Table 2. Median Postreinforcement Pause Early in Training for S 10 (seconds)

Preceding FR	Present FR	
	Short	Long
Short	0.6	17.4
Long	0.9	10.4

schedule, providing the short-short, short-long, long-long, and long-short interfaces.

Medians of the postreinforcement pause distributions at four interfaces are shown in Table 1. Pauses were defined as the time from the termination of reinforcement to the time of the next response. The data analysis is based on the last 14 days' performance for S10 and the last 13 days for S24. Pausing preceding the longer FR is substantially greater than for the shorter FR. However, within the two longer FR conditions, pausing shows a contrast effect. With a long FR following a short FR (short-long), the pausing is longer than in the long-long condition. For both birds this effect was significant at the .01 level, using a Kolmogorov-Smirnov two-sample test. The slight difference within the two short FR conditions for S24 was not found to be significant based on this test.

Early in training, effects in the short FR conditions were noted for both birds and data for S10 were available for analysis. These are based on eight days during the initial 13 days of training and are shown in Table 2. The differences between PRPs in either the short or long FRs are significant at the .01 level and indicate that a change produced longer pausing than a repetition of either schedule. The data of Table 1 indicate that this effect within the shorter FRs disappears with extended training.

Interactions between components of multiple schedules have been noted by Reynolds (1961). However, in the present study, the immediate sequence appears of great importance. Interestingly, the effect is opposite

to what one might expect if concepts of fatigue or other response produced suppressive phenomena were invoked in the analysis of the PRP. These effects would presumably be greatest following the greater effort expenditure in the longer sequence of responses. However, just the opposite is true. A primary determination of pausing appears vested in the stimulus cueing the ratio in effect. The cue for a long ratio produces a long pause. The immediate antecedent completion of a short ratio makes this pause longer rather than shorter. Although energy expenditure in achieving reinforcement undoubtedly influences the PRP, it would appear that its influence is largely related to the long term development of stimulus control, with little or no short term effect.

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Notes

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