JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1976, 26, 415-423 NUMBER 3 (NOVEMBER)

FOOD DELIVERIES DURING THE PAUSE ON FIXED-INTERVAL SCHEDULES[1]

RICHARD L. SHULL AND MARILYN GUILKEY

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO

Pigeons were trained on fixed-interval schedules of food delivery. In Experiments I and II, the fixed interval was initiated by the previous fixed-interval reinforcer; in Experiment III, the fixed interval was initiated by the first key peck following the preceding fixed-interval reinforcer (a chain fixed-ratio one, fixed-interval schedule). During the postreinforcement pause, variable-time schedules delivered food independent of any specific response. Rate of food delivery during the pause had only small effects on pause duration in Experiments I and II. In Experiment III, however, pause duration increased systematically with the rate of food delivery during the pause. These data suggest that the momentary proximity to reinforcement delivered via the fixed-interval schedule exerts potent control over pause termination. Additional analysis revealed that pause termination was unaffected by the intermittent delivery of food during the pause. Such data suggest that the temporal control by fixed-interval schedules is highly resistant to interference.

Key words: fixed-interval schedule, response-initiated fixed-interval schedule, postreinforcement pause, temporal control, delay of reinforcement, changeovers, pigeons

On fixed-interval (FI) schedules, food delivery depends on a single response after an interval of time has elapsed. The most efficient response pattern—efficient in the sense of obtaining the highest rate of food delivery with the fewest responses—would be for the subject to pause exactly the FI duration and then make a single (reinforced) response. Instead, the average pauses of rats and pigeons are between one-third and two-thirds of the FI (Dukich and Lee, 1973; Schneider, 1969; Shull, 1971). Thus, one question to ask about pausing is, why are the pauses so short?

It seems reasonable that the conditions prevailing during the pause would contribute to pause duration. The more favorable the conditions are during the pause (relative to the scheduled terminal reinforcer) the longer the pause should be. This is simply an application of the relativity of reinforcement principle (*cf.* Baum, 1973; Herrnstein, 1970). By this reasoning, the pause is so short on FI schedules because the typical experimental chamber is so barren. It is somewhat surprising, then, that manipulations of food deprivation (Powell, 1972), amount of reinforcement (Hatten, 1974), physical restraint (Frank and Staddon, 1974), and the availability of objects controlling adjunctive behavior (Allen, Porter, and Arazie, 1975) only minimally affect the FI pause. One would expect these manipulations to alter the favorability (or value) of conditions during the pause relative to the scheduled terminal reinforcer.

The present experiments systematically varied the conditions prevailing during the pause by delivering food at different rates during the pause.

EXPERIMENT I

METHOD

Subjects

Three male pigeons were maintained at approximately 80% of their free-feeding weights. Pigeons 1 and 2 had previous training with variable-interval schedules. Pigeon 3 previously had autoshaping training and brief training with a small fixed-ratio schedule.

Apparatus

The experimental chamber was enclosed in a sound-attenuating box. White noise and a

[1]This research was supported by Grant #MH21368-01 from NIMH, Grant #BNS76-04317 from NSF, and by a UNC-G Research Council Grant. Reprints may be obtained from R. L. Shull, Department of Psychology, University of North Carolina at Greensboro, Greensboro, North Carolina 27412.

ventilating fan provided masking noise. On one wall of the chamber were three 2-cm diameter response keys, horizontally arranged, that could be transilluminated with different colored lights. Only the center key was used; the two side keys were covered with tape. When the key was transilluminated, a force to the key exceeding 0.2 N operated control and recording circuits. The key was disconnected from the circuits when darkened. Food deliveries were 4-sec access to mixed grain presented through a rectangular opening below the center key. During the feeder presentation, the key was darkened and the feeder illuminated. The feeder light and the keylight were the only sources of illumination in the chamber. A small wide-angle lens mounted through the roof of the chamber allowed the experimenter to observe the bird in the chamber.

Procedure

The basic schedule was similar to an FI schedule. After a fixed interval of time elapsed food became available for a key peck. The first interval in each session began with the onset of the keylight; the peck-produced food delivery initiated all subsequent intervals. The schedule differed from the usual FI because a different key color was associated with the pause and terminal periods. At the start of each interval, the key color was blue and a key peck changed the color to amber. The first peck in amber after the FI elapsed produced food. Since the key color-change depended only on the occurrence of the first key peck, it provided no information about elapsed time. The FI duration was either 120 sec or 240 sec.

During some conditions, food was delivered during the pause at variable times independently of any specific response—a variable-time (VT) schedule (Zeiler, 1968). When the bird pecked the key, changing the color from blue to amber, the variable timer stopped until the bird had collected the food scheduled by the FI and blue was re-imposed. Three different VT schedules were used to provide either 30, 60, or 120 food deliveries per hour during the pause. Each VT schedule was constructed so that the probability of food delivery was approximately constant at all times (Catania and Reynolds, 1968). The FI timer stopped during the actual delivery of food during the pause.

Table 1 lists the actual sequence of conditions and the number of sessions devoted to each. Daily sessions began and ended with the chamber darkened and contained 41 FI food presentations. Data were not recorded from the first interval in each session.

Table 1

The order of conditions in Experiment I and the number of sessions at each.

	Pigeons 1 and 2		*Pigeon 3*	
Condition	*Order*	*No. of Sessions*	*Order*	*No. of Sessions*
FI 120-sec				
0 pause food/hr	1	70	2	50
	3	15	4	15
	5	15		
	8	15		
60 pause food/hr	2	50	5	15
	4	15		
	6	15		
120 pause food/hr	7	15	1	50
	9	15	3	15
FI 240-sec				
0 pause food/hr	11	20		
	14	50		
30 pause food/hr	13	20		
	15	20		
60 pause food/hr	10	20		
	12	15		

Results

Figure 1 shows representative cumulative records. The basic FI 120-sec schedule generated the typical pattern of a pause followed by responding at a moderate rate until the food delivered by the FI. This pause-respond pattern persisted even when VT schedules delivered food during the pause.

Figure 2 shows that mean pause duration (*i.e.*, the mean time to the first key peck) often increased with the rate of food during the pause. However, these effects were quite small. In contrast, changes in the FI duration (Pigeons 1 and 2) produced corresponding changes in the pause duration. The variability across successive replications was generally small, with the exception of the basic FI 240-sec schedule for Pigeon 1. During one determination, occasional very long pauses developed; during another determination, a pattern developed consisting of a brief burst of pecking immediately after the FI food delivery and then a pause of the typical duration. Food presentations during the pause brought the perform-

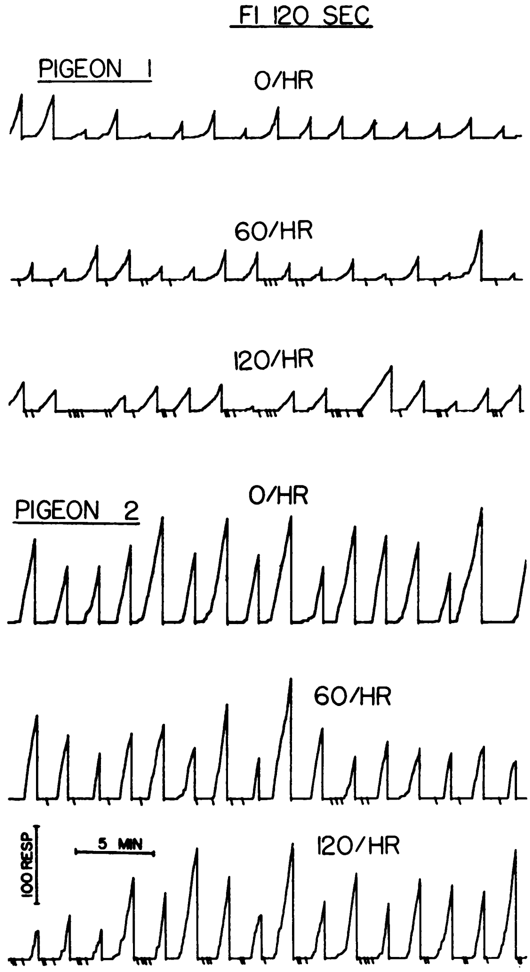

Fig. 1. Cumulative records for Pigeons 1 and 2 from one of the last five sessions of the condition indicated. The stepping pen reset to the baseline at the start of each FI. Slash marks indicate the delivery of food during the pause.

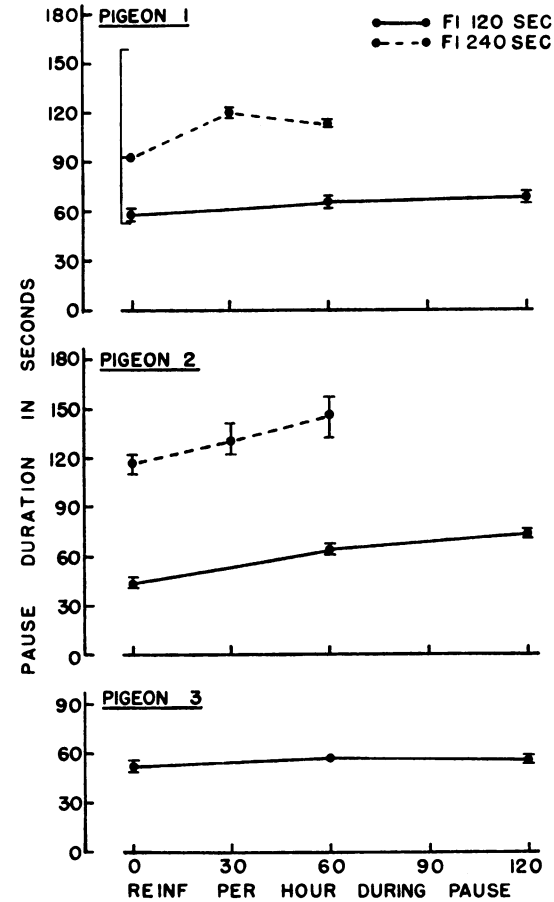

Fig. 2. Mean pause duration (time to the first key peck in the FI) plotted over the rate of food delivered during the pause by the VT schedules. Mean pause duration was derived from the last five sessions of a condition. Each plotted point is the mean of the five-session means. The horizontal lines above and below the points indicate the range of the five-session means.

ance of Pigeon 1 into conformity with that of the other birds.

Although the mean pause was not much affected, food deliveries during the pause might have affected pausing in other ways. For example, if pause termination depended on the time elapsed since food, each food delivery during the pause might have re-initiated the interval for the pigeon (*cf.* Logan and Ferraro, 1970). If so, the average time between a food delivery during the pause and termination of the pause would have been independent of when the food was delivered in the FI. If, however, elapsed time in the FI controlled pause termination regardless of intervening food deliveries, the time between food delivery and pause termination would have been shorter the later the food was delivered in the FI. Figure 3 shows mean food-to-pause-termination times plotted over the time of food delivery during the pause. Flat, or horizontal, functions would have indicated control by time since a food delivery during the pause, consistent with the re-initiation idea. However, since the functions decreased, pause termination seems to have been controlled mainly by time elapsed since the start of the FI.

To examine further the temporal control of pausing, the probability of pause termination was determined for different pause times. Individual pauses were arranged in a frequency

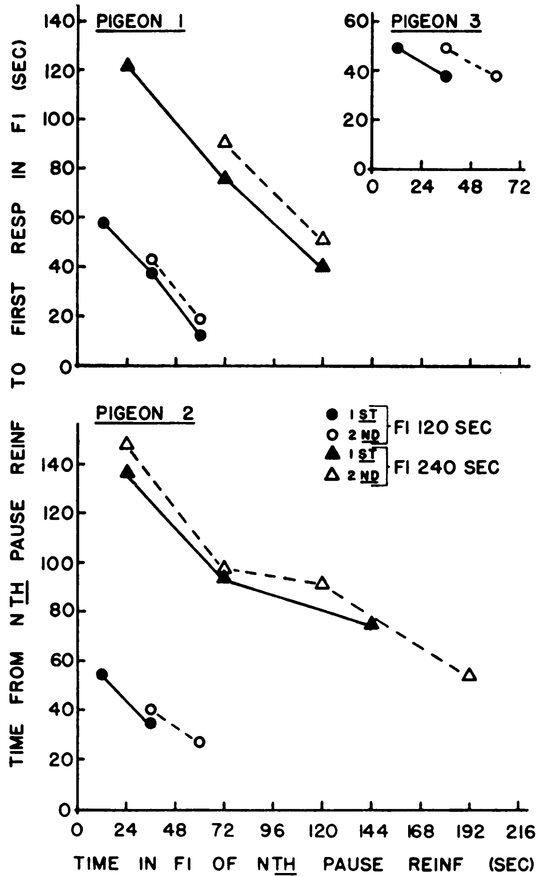

Fig. 3. The mean time from a food delivery during the pause to the termination of the pause (first key peck) plotted over the time in the FI that the food was delivered. Closed points indicate times from the first food delivered during the pause; open points indicate times from the second food delivered during the pause. The times of occurrence of the food deliveries were distributed to bins 24 sec wide for the FI 120-sec schedule and 48 sec wide for the FI 240-sec schedule. Points are plotted over the mid points of the bins. Points are not plotted for bins containing fewer than 10 entries. The values are derived from the last five sessions of the last determination of the conditions.

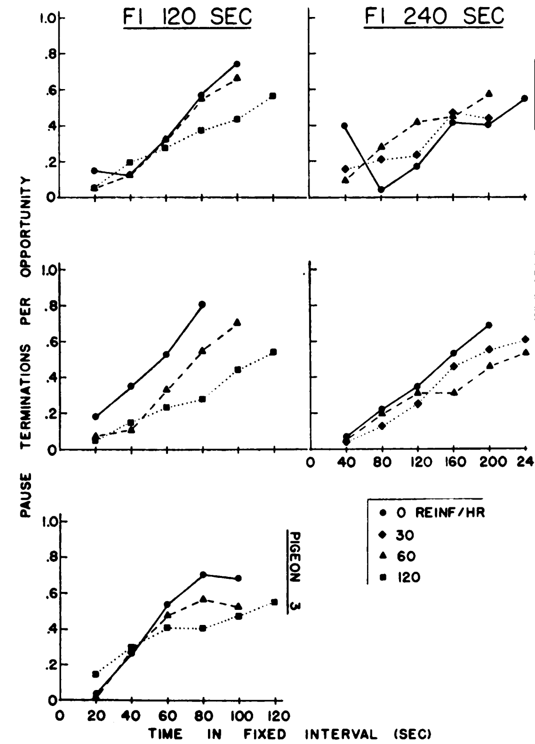

Fig. 4. Pause terminations per opportunity plotted over pause time for the FI durations and rates of food deliveries during the pause indicated. Bin size is one-sixth of the FI and points are plotted over the upper limit of the bin. Points were not plotted when the denominator (opportunities) fell below 0.1 of the total number of pauses in the distribution. Pause terminations per opportunity values were derived from pause frequency distributions based on the last five sessions of a condition. These frequency distributions were summed across replications.

distribution. Pause termination per opportunity values were calculated by dividing the number of pauses terminated during a particular bin by the number of pauses terminated in that and all later bins (Shull and Brownstein, 1975, after Anger, 1956). Figure 4 shows that the probability of a pause termination increased with elaped time in the FI. (The high value in the first bin for Pigeon 1 on the FI 240-sec schedule reflects the bursts that often occurred at the start of the interval.) Consistent with the average pause data in Figure 2, increasing rates of food during the pause sometimes decreased the slope of the termination per opportunity functions (see especially the FI 120-sec functions for Pigeon 2). But again, the effects were generally small and not always consistent (see the FI 240-sec functions).

Extensive visual observations revealed that the birds rarely failed to eat when grain was presented.

Discussion

Variations in the rate of food presentation during the pause had only small effects on the FI pause. Since time in the FI controlled pause termination similarly with and without the intermittent delivery of food during the pause (*cf.* Figures 3 and 4), the temporal control of pause termination must be highly resistant to interference and disruption. Similarly, positively accelerating response rates throughout the FI (the FI scallop) persist despite interruptions by concurrent reinforcement (Catania, 1962; Nevin, 1971) or by stimuli signalling nonreinforcement (Dews, 1962; 1970).

When food is not delivered during the pause on FI schedules, the rate of food delivery is independent of pause duration provided the pause does not exceed the FI. With the present procedure of delivering food during the pause, in contrast, the rate of food increases with pause duration until the pause equals the FI. The minimal effect on pausing suggests that the dependence of food rate on pausing was not a potent variable.

A more potent variable seems to be the momentary temporal proximity to food at the end of the FI. On FI schedules, the time remaining to the end of the FI decreases as pause time increases. Control by this increasing temporal proximity is suggested by the rising pause terminations per opportunity functions in Figure 4 (see also Shull and Brownstein, 1975). The relation between temporal proximity and pause duration might explain why food deliveries during the pause were so ineffective. The reason might be simply that the temporal proximity became so potent an inducer of responding at intermediate pause times that the schedule of food during the pause could not compete successfully.

The present data and interpretation are consistent with previous studies showing that close proximity to reinforcement (or short delays of reinforcement) induce responding even when that responding reduces the overall access to reinforcement (Ainslie, 1974; Rachlin and Green, 1972).

EXPERIMENT II

In Experiment I, the schedule of food during the pause operated only as long as the bird refrained from key pecking. Thus, a schedule requiring not-key-pecking (the schedule during the pause) was pitted against a schedule requiring key pecking (the FI schedule). Pecking is highly probable for hungry pigeons in the context of food delivery (*cf.* Hearst and Jenkins, 1974; Staddon and Simmelhag, 1971). Perhaps the schedule of food during the pause was so ineffective because the behavior it required (not-key-pecking) was incompatible with the dominant response of pecking. If so, the schedule of food during the pause might be more effective if that schedule required a key peck. Experiment II evaluated this possibility by requiring a peck on a second key to obtain the reinforcers during the pause on the FI key.

Method

Subjects and Apparatus

The subjects and apparatus were the same as in Experiment I except that the left key was uncovered. When that key was red, pecks exceeding 0.2 N operated control and recording circuits and darkened that key for 0.045 sec.

Procedure

The first condition was an FI schedule with food delivered by a VT schedule during the pause as described in Experiment I, except that the left key was red during the FI pause. Pecks on the left key were recorded but had no scheduled effect. For the next condition, the left key was covered, with the schedule otherwise unchanged, to provide a reference for determining whether the mere presence of the red key had any effect. For the third condition, the left key was uncovered. A peck on the red key was now required to obtain each food delivery assigned by the pause schedule; *i.e.*, the VT was changed to a variable-interval (VI) schedule on the red key. As before, the first peck on the FI key in each interval stopped the VI timer; but now it also darkened the red key. Several different FI and VI schedules were studied, with the sequence of conditions indicated in Figure 5. Sessions were conducted daily for Pigeon 3 and on alternate days for Pigeons 1 and 2. The fourth and sixth conditions shown in Figure 5 contained 21 food deliveries by the FI; all other conditions contained 41 food deliveries by the FI. The criterion for terminating the session was changed to reduce differences in the total number of food deliveries per session among conditions.

Results and Discussion

Figure 5 shows the daily mean pause. Also shown are the corresponding response rates to the red key (responses to the red key divided by the time that key was illuminated). Although some conditions were studied too briefly for stability, certain trends were clear. The red-key response rate was positively related to the rate of food deliveries provided by the VI schedule. In contrast, the FI pause was essentially independent of red-key responding and the rate of food delivery for pausing. Pause duration changed rapidly when the FI duration was changed.

These data support and extend the findings of Experiment I. Pausing was little affected by food during the pause, even at delivery rates higher than used in Experiment I. Thus, the minimal effects occurred whether or not key pecking was required for food delivery during the pause.

EXPERIMENT III

In Experiments I and II, the time remaining to the end of the FI decreased as pause time increased. If this feature of FI schedules caused the minimal effects on pausing, the effects might be larger if the time to the end of the FI were made independent of pause time. In Experiment III, the FI did not start until a key peck occurred (a chain FR 1 FI schedule) and so the absolute amount of time to the end of the FI did not change with pause time. Once

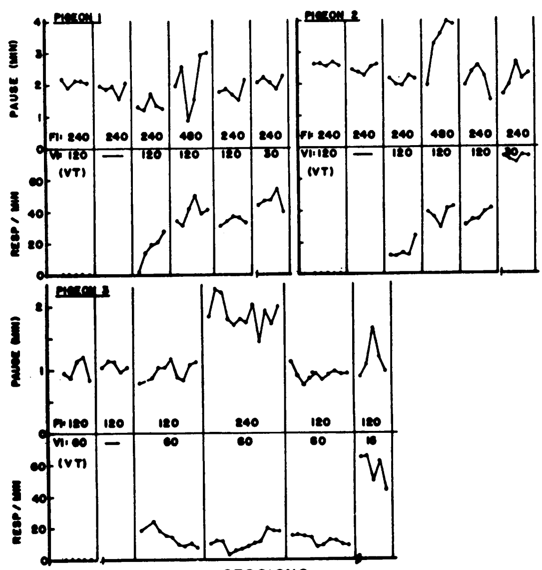

Fig. 5. Mean pause duration on the FI schedule and response rate on the key illuminated red during the FI pause (red-key responses per minute of FI pause time) for each session of Experiment II. The condition designations indicate the FI schedule and the VI schedule available during the pause. For the left-most panel for each bird the schedule during the pause was a VT schedule with the red keylight simply present during the pause.

again, food was delivered at different rates during the pause.

METHOD

Subjects and Apparatus

The same as in Experiment I.

Procedure

As in the previous experiments, the key was blue at the start of each cycle, the first key peck in each cycle changed the key color from blue to amber, and the first key peck in amber after the interval elapsed produced food. In this experiment, however, the FI began after the first key peck. This peck also changed the key color from blue to amber (a chain FR 1 FI schedule). Thus, the minimum time in amber was equal to the FI duration and was independent of pause (blue) time.

The FI duration in the chain schedule was either 60 or 30 sec. The 60-sec schedule was chosen because the average time in amber on the FI 120-sec schedules in Experiments I and II was about 60 sec. With both values of the chain FR 1 FI schedule, food was delivered during the pause at different rates by the VT schedules as in Experiment I. The actual sequence of conditions and the number of sessions at each are shown in Table 2. Unlike the case in Experiments I and II, food during the pause produced long pauses on the chain schedule. To ensure that these effects could not be attributed to satiation, the number of food deliveries per session was restricted: sessions

Table 2

The order of conditions in Experiment III and the number of sessions at each.

Condition	*Order*	*No. of Sessions*
Chain FR 1 FI 60-sec		
0 pause food/hr	1	25
15 pause food/hr	4	10
30 pause food/hr	3	15
	5	15
60 pause food/hr	2	15
	6	10
Chain FR 1 FI 30-sec		
0 pause food/hr	9	15
30 pause food/hr	8	10
60 pause food/hr	7	10
	10	10

terminated after 41 fixed intervals or 61 food deliveries regardless of source, whichever occurred first.

Results

Figure 6 shows representative cumulative records of several conditions for Pigeon 3. Increasing the rate of food delivery during the pause increased pause duration.

Figure 7 shows the mean pause duration for all three birds. With the exception of an inversion for Pigeon 1, pause duration increased with the rate of food delivery during the pause, with the slope of the curves being steeper for the chain FR 1 FI 60-sec schedule than for the chain FR 1 FI 30-sec schedule. Since median pause durations similarly increased, changes in mean values were not simply due to the occurrence of a few very long pauses.

GENERAL DISCUSSION

The pause was much more sensitive to food delivery under the chain FR 1 FI schedules (Experiment III) than under the FI schedules (Experiments I and II). This differential sensitivity is understandable if proximity to the end of the FI is a major determiner of pause termination. At every moment during the pause, the pigeon has the option of either continuing or terminating the pause. On FI schedules, the conditions become increasingly conducive to termination with increasing pause time because the food at the end of the FI gets closer in time. Conditions become so conducive before the end of the FI that conditions during the pause (*e.g.*, food deliveries) cannot maintain control. On chain FR 1 FI schedules, in contrast, the food at the end of the FI does not get closer in time with pausing and so the conditions do not become so strongly conducive to pause termination. As a result, the conditions

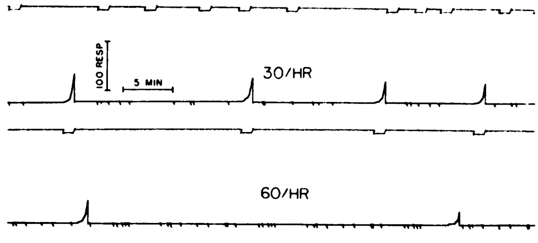

Fig. 6. Cumulative records for Pigeon 3 from one of the last five sessions of the condition indicated. The stepping pen reset to the baseline on delivery of the FI reinforcer. Slash marks indicate the delivery of food during the pause. The event line indicates the pause (up) and the FI (down) periods of the chain FR 1 FI 60-sec schedule.

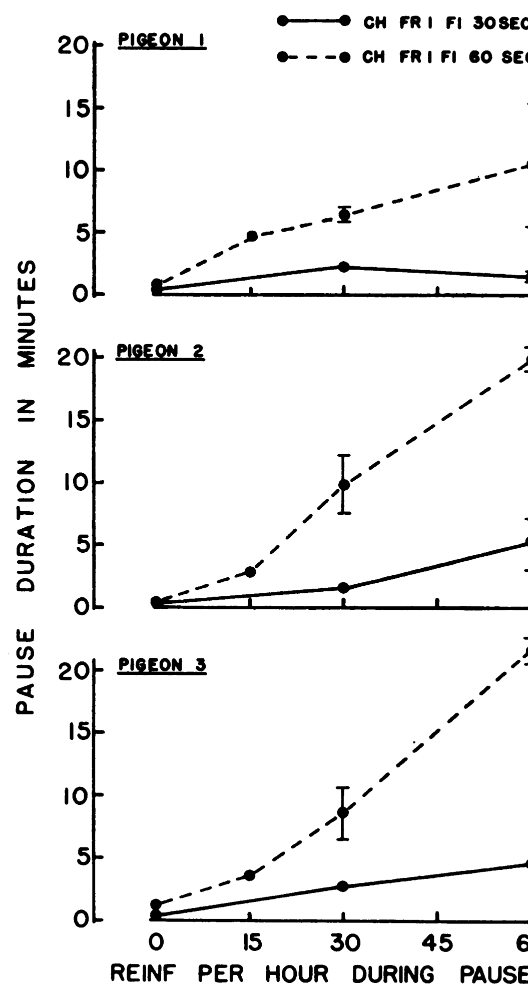

Fig. 7. Mean pause duration (mean time to the first key peck in the chain FR 1 FI schedule) plotted over the rate of food delivered during the pause by the VT schedules. Mean pause duration was derived from the last five sessions of a condition. When there was more than one determination, the mean of the five-session means was plotted and the range of five-session means indicated by the horizontal lines.

during the pause can exert a systematic effect. With increasing FI durations in the chain FR 1 FI schedule, the food at the end of the FI becomes increasingly remote from the pause termination. Conditions during the pause are more effective, therefore, with longer FI components because the schedule is less conducive to pause termination.

The temporal properties of fixed-ratio (FR) schedules are similar to those of the chain FR 1 FI schedules, in that the time to the terminal reinforcer is independent of pause time (*cf.* Morgan, 1972; Shull, 1970). The present results, and their interpretation, may help clarify the reasons for some differences between FI and FR schedules. Although direct comparisons are lacking, the pause appears more sensitive to various manipulations on FR than on FI schedules. First, shock punishment (Azrin, 1959), deprivation (Powell, 1969*a;* Sidman and Stebbins, 1954), reinforcer amount (Powell, 1969*b;* Winograd, 1965), and the availability of objects controlling adjunctive behavior (Cohen and Looney, 1973; Knutson, 1970) all appear to affect pause duration more on FR schedules than on FI schedules (Azrin and Holz, 1961; Allen *et al.*, 1975; Hatten, 1974; Powell, 1972). Also, reinforcer amount affects pause duration more on large than on small FR schedules (Morse, 1966), just as the effects of food during the pause depended on the duration of the FI in the chain FR 1 FI schedule. Since these manipulations can be construed as altering the favorability of conditions during the pause relative to conditions after the pause, these results parallel the present results. Secondly, attempts to change pause duration by requiring particular pause durations for the terminal reinforcer have been successful with FR schedules (DeCasper and Zeiler, *in press;* Kelleher, Fry, and Cook, 1964). Similar manipulations with FI schedules (Buchman and Zeiler, 1975) have not been successful. Such results are consistent with the present results because food delivered during the pause can be interpreted as providing differential reinforcement for increased pausing.

These data have implications for the generality of average pause values reported for FI, response-initiated FI, and FR schedules. The pause on FI schedules is most likely to be consistent among experiments because it is least affected by variables that probably differ among experiments.

REFERENCES

Ainslie, G. W. Impulse control in pigeons. *Journal of the Experimental Analysis of Behavior,* 1974, **21,** 485-489.

Allen, J. D., Porter, J. H., and Arazie, R. Schedule-induced drinking as a function of percentage reinforcement. *Journal of the Experimental Analysis of Behavior,* 1975, **23,** 223-232.

Anger, D. The dependence of interresponse times upon the relative reinforcement of different interresponse times. *Journal of Experimental Psychology,* 1956, **52,** 145-161.

Azrin, N. H. .Punishment and recovery during fixed-ratio performance. *Journal of the Experimental Analysis of Behavior,* 1959, **2,** 301-305.

Azrin, N. H. and Holz, W. C. Punishment during fixed interval schedules, *Journal of the Experimental Analysis of Behavior,* 1961, **4,** 343-347.

Baum, W. M. The correlation-based law of effect. *Journal of the Experimental Analysis of Behavior,* 1973, **20,** 137-153.

Buchman, I. B. and Zeiler, M. D. Stimulus properties of fixed-interval responses. *Journal of the Experimental Analysis of Behavior,* 1975, **24,** 369-375.

Catania, A. C. Independence of concurrent responding maintained by interval schedules of reinforcement. *Journal of the Experimental Analysis of Behavior,* 1962, **5,** 175-184.

Catania, A. C. and Reynolds, G. S. A quantitative analysis of the responding maintained by interval schedules of reinforcement. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 327-383.

Cohen, P. S. and Looney, T. A. Schedule-induced mirror responding in the pigeon. *Journal of the Experimental Analysis of Behavior,* 1973, **19,** 395-408.

DeCasper, A. J. and Zeiler, M. D. Time limits for completing fixed ratios. IV. Components of the ratio. *Journal of the Experimental Analysis of Behavior (in press).*

Dews, P. B. The effect of multiple S^{Δ} periods on responding on a fixed-interval schedule. *Journal of the Experimental Analysis of Behavior,* 1962, **5,** 369-374.

Dews, P. B. The theory of fixed-interval responding. In W. N. Schoenfeld (Ed.), *The theory of reinforcement schedules.* New York: Appleton-Century-Crofts, 1970. Pp. 43-61.

Dukich, T. D. and Lee, A. E. A comparison of measures of responding under fixed-interval schedules. *Journal of the Experimental Analysis of Behavior,* 1973, **20,** 281-290.

Frank, J. and Staddon, J. E. R. Effects of restraint on temporal discrimination behavior. *Psychological Record,* 1974, **24,** 123-130.

Hatten, J. L. *The effect of feeder duration on fixed-interval performance: context dependencies.* Master's thesis, University of North Carolina at Greensboro, 1974.

Hearst, E. and Jenkins, H. M. *Sign-tracking: the stimulus reinforcer relation and directed action.* Austin, Texas: The Psychonomic Society, 1974.

Herrnstein, R. J. On the law of effect. *Journal of the Experimental Analysis of Behavior,* 1970, **13,** 243-266.

Kelleher, R. T., Fry, W., and Cook, L. Adjusting fixed-ratio schedules in the squirrel monkey. *Journal of the Experimental Analysis of Behavior,* 1964, **7,** 69-77.

Knutson, J. F. Aggression during the fixed-ratio and extinction components of a multiple schedule of reinforcement. *Journal of the Experimental Analysis of Behavior,* 1970, **13,** 221-231.

Logan, F. A. and Ferraro, D. P. From free responding to discrete trials. In W. N. Schoenfeld (Ed.), *The theory of reinforcement schedules.* New York: Appleton-Century-Crofts, 1970. Pp. 111-138.

Morse, W. H. Intermittent reinforcement. In W. K. Honig (Ed.), *Operant behavior: areas of research and application.* New York: Appleton-Century-Crofts, 1966. Pp. 52-108.

Morgan, M. J. Fixed-ratio performance under conditions of delayed reinforcement. *Journal of the Experimental Analysis of Behavior,* 1972, **17,** 95-98.

Nevin, J. A. Rates and patterns of responding with concurrent fixed-interval and variable-interval reinforcement. *Journal of the Experimental Analysis of Behavior,* 1971, **16,** 241-247.

Powell, R. W. The effect of deprivation upon fixed ratio responding. *Psychonomic Science,* 1969, **16,** 17-18. (*a*)

Powell, R. W. The effect of reinforcement magnitude upon responding under fixed-ratio schedules. *Journal of the Experimental Analysis of Behavior,* 1969, **12,** 605-608. (*b*)

Powell, R. W. The effect of deprivation upon fixed-interval responding: a two-state analysis. *Psychonomic Science,* 1972, **26,** 31-34.

Rachlin, H. and Green, L. Commitment, choice and self-control. *Journal of the Experimental Analysis of Behavior,* 1972, **17,** 15-22.

Schneider, B. A. A two-state analysis of fixed-interval responding in the pigeon. *Journal of the Experimental Analysis of Behavior,* 1969, **12,** 677-687.

Shull, R. L. A response-initiated fixed-interval schedule of reinforcement. *Journal of the Experimental Analysis of Behavior,* 1970, **13,** 13-15.

Shull, R. L. Sequential patterns in post-reinforcement pauses on fixed-interval schedules of food. *Journal of the Experimental Analysis of Behavior,* 1971, **15,** 221-231.

Shull, R. L. and Brownstein, A. J. The relative proximity principle and the postreinforcement pause. *Bulletin of the Psychonomic Society,* 1975, **5,** 129-131.

Sidman, M. and Stebbins, W. C. Satiation effects under fixed-ratio schedules of reinforcement. *Journal of Comparative and Physiological Psychology,* 1954, **47,** 114-116.

Staddon, J. E. R. and Simmelhag, V. L. The "superstition" experiment: a reexamination of its implications for the principles of adaptive behavior. *Psychological Review,* 1971, **78,** 3-43.

Winograd, E. Escape behavior under different fixed ratios and shock intensities. *Journal of the Experimental Analysis of Behavior,* 1965, **8,** 117-124.

Zeiler, M. D. Fixed and variable schedules of response-independent reinforcement. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 405-414.

Received 2 March 1976.
(Final Acceptance 7 June 1976.)