DEVELOPMENT OF KEY-PECKING, PAUSE, AND AMBULATION DURING EXTENDED EXPOSURE TO A FIXED-INTERVAL SCHEDULE OF REINFORCEMENT

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Six pigeons key-pecked under a fixed-interval (FI) 3-min schedule of food presentation. Each pigeon was studied for 200 daily sessions with 15 intervals per session (3,000 total food presentations). Analyses included the examination of latency to first peck (pause), mean rate of key pecking, and ambulation. Characterizations of stable performance were assessed across measures of behavior and evaluated using commonly employed stability criteria. Stability of response rate and pause was identified better by assessments that evaluated variability and trend, rather than just variability. Between-subject differences in rate of acquisition and terminal values of steady-state performance of pause were observed, and stable pause durations took longer to develop than did stable key-pecking rates. Relative variability in response rate and pause duration decreased as the means increased. A temporally organized pattern of key-pecking (the so-called FI scallop) developed within 50 sessions of exposure to the schedule. Overall ambulation decreased during the early sessions of exposure and further analyses showed greater rates of ambulation during the pause than after it for 4 of the 6 pigeons. Performance under the FI 3-min schedule developed relatively slowly, and key-pecking, pause, and ambulation developed at different rates.

Key words: fixed-interval schedule, pause, ambulation, stability, key peck, pigeons

A fixed-interval (FI) schedule of reinforcement consists of the presentation of reinforcement following the first response after a fixed period of time. Fixed-interval schedules typically produce an initial pause at the beginning of an interval, in which few or no responses occur, followed by a shift to a constant or slightly accelerated rate until reinforcement delivery (e.g., Branch & Gollub, 1974; Dews, 1978). This temporally organized pattern of responding is often described as either a break-and-run or a scalloped pattern. Various aspects of behavior engendered by FI schedules or variations of them have been investigated previously, including performance on long and short FIs (e.g., Ferster & Skinner, 1957), variability and effects of extinction (e.g., Cumming & Schoenfeld, 1960), varied

reinforcement percentages (e.g., Zeiler, 1972), history effects following prior exposure to other schedules (e.g., Baron & Leinenweber, 1995), and stimulus control (e.g., Zeiler, 1970). Fixed-interval schedules also are frequently used to investigate temporal control (e.g., Harzem, Lowe, & Spencer, 1978; Odum & Schaal, 2000; Zeiler & Powell, 1994), and there is an abundance of pharmacological research in which FI schedules have been used to study drug effects (e.g., Branch & Gollub, 1974; Dews, 1964; McAuley & Leslie, 1986; McMillan, 1969).

Many researchers have investigated measures of behavior (e.g., response rates, postreinforcement pause [PRP]) under FI schedules upon satisfaction of one or more criteria defining stable performance. In order to extend previous research, a more complete characterization of the development of performance across the FI exposure was of interest in the present study. That is, in addition to the development of more traditional measures of experimenter-reinforced activity (i.e., key pecking), the development of ambulation across the FI exposure was also investigated. Despite the extensive literature dedicated to FI performance, variations in relations among pecking, pausing, and ambulation have not been investigated over the course of extended exposure to an FI schedule.

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Quantifications of performance stability were also of interest in the present study. A supposition of behavioral stability assumes consistency and little fluctuation of behavior across time. Despite a plethora of previous research dedicated to FI performance, no standard experimental practice exists for assessing stability prior to the subsequent introduction of other independent variables (e.g., drug administration). Detecting stability can be difficult (cf. Perone, 1991), and the use of one common method may be helpful for recognition of stable performance. Common methods of assessing stability of response rate include visual inspection of the data for the absence of systematic increases or decreases in performance (e.g., Catania, Sagvolden, & Keller, 1988; Kendall, 1967; Staddon, 1967), analyses of final baseline sessions of the FI exposure (e.g., Schneider, 1969), consecutive-session-block means in which response rates remain within a percentage range from all the blocked sessions (e.g., Cole, 2001), or a combination of the above techniques, among others (see also Sidman, 1960, for a discussion of index of curvature as another assessment of FI performance). Despite the widespread use of these techniques to assess FI stability, direct comparisons of such methods have not yet been made (although see Killeen, 1978, for general suggestions for stability criteria). A comparison of common techniques could provide an indication of which stability criteria are most appropriate for detecting stable performance.

One goal of the present study, therefore, was to assess stability of performance using several commonly employed criteria. It is also unknown whether measures of response rate and temporal organization become stable at the same time under FI schedules. Depending on the measure of interest (e.g., response rates, PRP), different exposure times may be required before stability is reached. Moreover, various stability criteria may be more appropriate for assessing stability of one measure, relative to another. To summarize, the specific purposes of the present study were to assess the development of key pecking rate, PRP, temporal patterning of key pecking, and ambulation and to compare methods of stability quantification across measures of behavior under an FI 3-min schedule of reinforcement.

METHOD

Subjects

Six experimentally naïve male White Carneau pigeons (*Columba livia*) approximately 1 year old, were obtained from Double-T Farms, Glenwood, Iowa, and were maintained at approximately 85% of their free-feeding weights by postsession feeding as needed. The animals were housed in individual cages, in a temperature- and humidity-controlled colony room, with exposure to a 16:8-hr light/dark cycle. Water and grit were available continuously in the birds' home cages.

Apparatus

The experiment was conducted in a custom-built operant conditioning chamber. The ceiling and three of the walls were made of clear 0.86-cm Plexiglas™, and the inside dimensions of the chamber were 31 cm high, 35.5 cm long, and 34 cm deep. The fourth wall (the intelligence panel) was aluminum and incorporated a 28-V houselight near the top center of the panel, one circular response key (2.5 cm in diameter) that was centered 23 cm from the floor, and a 6-cm by 5-cm opening for access to a solenoid-operated hopper filled with mixed grain. The center of the opening was located 10 cm above the floor and centered below the key. The key could be transilluminated white. Pecks with a force of at least 0.20 N operated the switch on the key and were accompanied by a 30-ms feedback tone (2900 Hz) via the operation of a Mallory Sonalert™. The floor of the chamber consisted of six equal-area panels mounted on microswitches to detect ambulation. Specifically, six 20-gauge stainless-steel plates, 16.47 cm × 10.95 cm, were attached to an aluminum frame in two rows of three, hinged either at the base of the intelligence panel or at the base of the opposite wall. Dimensions of the panels were designed based on approximate pigeon body size and previous observations of pigeon movement within their home cages. A roller-activated microswitch (Micro-Switch, V-1131) was mounted near the center of the floor underneath each plate and required a force of at least 0.78 N to close. Each panel press was recorded at its onset as a discrete count, and panel presses were recorded separately, in the order in which they occurred. Additional technical details as well

as images of the ambulation-detecting floor can be found in Pinkston and Branch (2006). During sessions, the floor was covered by a nonreactive, medical-grade silicone sheet to catch excreta. The entire chamber was housed in a light- and sound-attenuating experimental enclosure (Med Associates, Inc.). To mask extraneous sounds, white noise at 95 dB was present in the room in which sessions were conducted. Scheduling of experimental events and data collection were controlled via a dedicated computer system (Palya & Walter, 1993) operating with a resolution of 1 ms.

Procedure

Each pigeon first was trained to eat from the hopper and then trained to key-peck by shaping (see Catania, 1998) in the presence of a white response key. After the pigeon reliably pecked the key when it was transilluminated, a fixed-ratio 1 (FR1) schedule of reinforcement was implemented for two consecutive daily sessions. These two sessions were programmed such that each trial began with illumination of the houselight and the response key. A single peck to the key turned off the houselight, the key, and raised the food hopper, which was illuminated by a 28-V lamp for 3 s followed by a 10-s blackout period in which the chamber was dark. Each of the two sessions ended on completion of 50 food hopper deliveries.

Then each pigeon was directly exposed to an FI 3-min schedule of reinforcement for the remainder of the study. Although a 3-min interval is longer than those used in some previous studies (e.g., McAuley & Leslie, 1986; Shull & Brownstein, 1970; Zeiler & Powell, 1994), we chose an FI 3-min to ensure the development of a robust PRP, one hallmark of FI schedules. Following a 5-min blackout period for chamber acclimation, each daily session began with illumination of the houselight and the response key. The first response to the key after 3 min had elapsed resulted in food presentation. Each session consisted of 15 intervals.

In an attempt to capture dynamics of and between the development of response rate, PRP, and ambulation, each pigeon was studied for an extended number of sessions. To accomplish this, a fixed-time stability criterion (Perone, 1991; Sidman, 1960) was employed such that each pigeon was studied for 200 daily sessions with 15 intervals per session (3,000 total food presentations).

Data Analysis

Three dependent measures were analyzed to characterize overall performance and to assess development and stability: response rates, PRP, and ambulation counts. Response rates were recorded as the number of responses per minute during each session (minus blackout and hopper presentation time). The PRP values were calculated as the duration of time from the onset of the keylight after the presession or postfood-presentation blackout until the first peck within an interval. Ambulation counts were the number of panel presses within a session (location assessed by number of counts on each individual panel within a session), and rates of panel pressing were calculated as the number of panel presses per minute.

Analyses of Key-pecking, Postreinforcement Pause and Ambulation

The 10-session moving averages of response rates and session-median PRP durations are presented for visual inspection and comparison of development and stability of performance across the 200 sessions of exposure (see Tukey, 1977, for advantages of moving averages). This averaging method was chosen to smooth the functions and filter the day-to-day variability, simplifying the identification of trends upon visual inspection. A 10-session window was chosen in order to remain consistent with a number of the stability analyses conducted, in which 10-session block averages were analyzed.

Temporal patterning. Patterns of key-pecks and panel presses (not shown) were assessed in Sessions 1, 5, 50, 100 and 200 by dividing the FI 3-min schedule into 10 successive 18-s bins. This offered a means of viewing the organization of behavior throughout the interval. Quarter-life values (Gollub, 1964; Herrnstein & Morse, 1957), the mean percentage of the 3-min interval taken to emit 25% of the total responses based on bin totals, were also calculated.

To offer a more detailed account of the scalloped pattern within the bin analysis just described, frequency distributions of response totals within each bin were created using data from Sessions 50 and 200 for Pigeons 11, 63, and 884. Specifically, the number of key-pecks that occurred in each 18-s bin was tallied for each of the 15 food presentations per session.

The resulting frequency distribution for each bin contained 15 total key-peck values, with the exception of bins in which the first key-peck occurred (cf. Branch & Gollub, 1974). This analysis was conducted to assess the representativeness of the means generated by the aggregated-bin-total analyses.

A break-run analysis was also conducted for Sessions 50 and 200 for Pigeons 11, 63, and 884. Transitional periods in which the subject was shifting from pausing to pecking were identified by the frequency distribution analyses. Specifically, Bins 3-6 were evaluated for either a pause or run state. A pause state was defined as zero or one peck occurring within a bin and zero pecks occurring in the following bin, whereas a run state was defined as one or more pecks occurring in a bin and one or more pecks occurring in the following bin.

Postreinforcement pause. For a more detailed analysis of PRP durations across intervals, autocorrelation coefficients for successive PRP durations within a session were analyzed at initial, intermediate, and extended exposure to the schedule. The duration of each PRP was used to predict the PRP in the interval directly following (lag 1 autocorrelation). That is, the first PRP duration in a session was compared to the second PRP duration, the second to the third and so on, for 14 comparisons in total. The Pearson Product-Moment correlation value (r) was calculated for each session.

Ambulation. Floor-panel press rates were calculated as the number of presses per min before the first peck in an interval, and the number of presses per min after the first peck. To assess the location of ambulation across the FI exposure, panel presses before and after the first peck within an interval were counted separately on each of the six panels.

Stability Analyses

Stability of response rates and session-median PRP durations were assessed using four different stability criteria.

Criterion 1: Visual inspection. Visual inspection of 10-session moving averages was conducted. Stable performance was characterized by no increasing or decreasing trends and minimal variability.

Criterion 2: Variability of 10-session blocks. Performance was considered stable by this criterion when two consecutive 10-session means were each within $\pm 10\%$ of the 20-

session mean (Baron & Leinenweber, 1995; Cole, 2001).

Criterion 3: Variability and trend of seven-session blocks. Sessions were divided into three blocks of seven sessions beginning with Sessions 1-21. Performance was considered stable when a) the mean of all three blocks was within $\pm 10\%$ of the 21-session mean and b) no monotonic increase or decrease greater than 1 response per min or 1 s across the three 7-block means was detected.

Criterion 4: Variability and trend of three-session blocks. Same as Criterion 3 except that three blocks of three sessions were evaluated.

RESULTS

Analyses of Key-pecking, Pause and Ambulation

Temporal patterning. Figure 1 presents the mean number of pecks in successive 18-s segments (bins) of the FI 3-min schedule. Each graph shows data averaged over the 15 FIs from the 1st, 5th, 50th, 100th, and 200th sessions, and error bars represent the standard deviation of each averaged bin. Session 1 revealed a reverse scallop pattern in which there was a greater number of responses at the onset of the interval (i.e., Bins 1 and 2) for all pigeons. By Session 5, which began with the 61st interval, the initial elevation in pecking observed in the first few bins had diminished for each pigeon, and the numbers of responses in Bins 3-10 were roughly similar. By Session 50, the characteristic scalloped response pattern of the FI schedule was evident for each pigeon (especially so for 11, 63, and 884). The temporally organized pattern of responding noted in Session 50 further developed by Session 100, and a similar distribution remained for Session 200 for all pigeons.

To ascertain whether the mean scalloped patterns in Figure 1 were representative of interval-to-interval performance when the pattern was initially observed (i.e., Session 50), and after increased exposure (i.e., Session 200), frequency distributions of response totals within bins were evaluated for data from Sessions 50 and 200 for Pigeons 11, 63, and 884. In some cases the means were not representative. For example, the mean number of pecks for Pigeon 11 in the 5th bin of Session 50 was 4.7 (see Figure 1), yet frequency distribution data indicated that no pecks between the frequency of 1 and 7 occurred in

Fig. 1. Mean pecks per session in 10 successive 18-s segments (bins) of the FI 3-min schedule. Data are shown from Sessions 1, 5, 50, 100 and 200. Columns correspond to the session labeled at the top of the column. Error bars represent the standard deviations.

the 5th bin. In contrast, the data for the 5th bin for Pigeons 63 and 884 in Session 50 are more representative of the means shown in Figure 1. Similarly, the first and last few bins from Session 200 are reasonably characterized by the mean, yet the mean does not accurately capture performance of a number of transitional bins, replicating the findings of Branch and Gollub (1974). In other words, these means often represent averages from a bimodal distribution consisting of very low or zero rates and rates that are higher than the resulting session-average rates. Thus, an average scallop shows a more gradual increase in rate across the FI than actually occurs in many (or most) individual repetitions of the FI.

The frequency distributions were more variable in these transitional bins because during the same bins across different FI presentations, pigeons were either already pecking consistently or they were still pausing. A break-run analysis was conducted for Pigeons 11, 63, and 884 to assess further the variable patterns observed in a number of transitional bins of the frequency distributions. Specifically, transitional bins (Bins 3–6) of Sessions 50 and 200 were evaluated to determine when these pigeons were still in the pause (PRP) state and when they were in the pecking state. Summed across pigeons, Bin 3 yielded 18 pause states and 27 peck states in Session 50, and 25 pause states and 20 peck

Table 1
Mean and range of autocorrelation coefficients in 5-session blocks for successive PRP durations within a session.

Pigeon	Sessions				
	1-5	46-50	96-100	146-150	196-200
11	0.26 (-0.02, 0.32)	-0.08 (-0.49, 0.26)	-0.08 (-0.34, 0.24)	-0.23 (-0.94, 0.49)	-0.18 (-0.43, 0.09)
63	0.13 (-0.06, 0.50)	-0.01 (-0.40, 0.23)	-0.16 (-0.37, 0.14)	-0.28 (-0.52, -0.08)	-0.23 (-0.56, 0.14)
637	-0.10 (-0.28, 0.02)	-0.23 (-0.47, -0.04)	-0.25 (-0.44, 0.31)	-0.23 (-0.42, -0.07)	-0.22 (-0.53, 0.24)
750	0.03 (-0.44, 0.44)	-0.21 (-0.40, 0.03)	0.04 (-0.50, 0.49)	0.06 (-0.16, 0.29)	0.12 (-0.19, 0.46)
849	-0.15 (-0.45, 0.23)	-0.32 (-0.59, 0.16)	-0.03 (-0.43, 0.32)	-0.09 (-0.28, 0.03)	-0.09 (-0.50, 0.54)
884	0.18 (-0.04, 0.45)	-0.13 (-0.69, 0.35)	-0.33 (-0.41, 0.20)	-0.38 (-0.76, - 0.14)	-0.15 (-0.57, 0.45)

states in Session 200. For Bins 4–6, the number of pause states continually decreased across bins as the peck states increased. These patterns remained in Session 200.

As previously noted, quarter-life values are displayed in each panel in Figure 1 (Q). Similar to pausing, quarter-life values generally increased across sessions. Quarter-life values for 5 of 6 pigeons (except 637) indicated that a steady state of temporal patterning had developed by the end of the first 100 sessions. That is, values from Session 200 were similar to those of Session 100, and these values appeared to have reached a maximum by session 100.

Postreinforcement pause. Autocorrelation coefficients for successive PRP durations within a session were analyzed for Sessions 1–5, 46–50, 96–100, 146–150 and 196–200. The mean and range of these values are displayed in Table 1. When aggregated across pigeons, there were nearly equal numbers of positive and negative autocorrelation coefficients (16 positive out of 30) in Sessions 1–5; thus, the duration of the next PRP could not be predicted from the preceding one. In contrast, there were more negative coefficients (22/30, $p < .016$, binomial test) in Sessions 196–200. In these sessions, there was a tendency for PRPs to modestly alternate between long and short durations (see Shull, 1971), and this pattern was evident as early as Session 50. Binomial probability tests for the sign of the autocorrelation coefficient (magnitude of coefficient omitted from evaluation) were conducted for each pigeon using data from 20 sessions (46–50, 96–100, 146–150, and 196–200). For 4 of the 6 pigeons a significant negative correlation was detected, with 15 out of 20 negative values for Pigeons 63 and 849, and 18 out of 20 for Pigeons 637 and 884 ($p < .04$ in all cases).

Additionally, 9 of the 11 relatively stronger negative coefficients (those which exceeded $-.50$ in absolute value) occurred in later sessions (146–150 or 196–200). Although the negative autocorrelation coefficients were not exceptionally large and rarely exceeded $-.60$, 5 of the 6 pigeons showed an increased number of negative coefficients in the final five sessions of FI 3-min exposure relative to the first five sessions. The averages of coefficients across Sessions 1–5 and 196–200 were compared for all pigeons and the difference approached standard levels of statistical significance (Mann-Whitney U-Test; $p = .054$). This pattern was evident by Session 50 for all pigeons, and the magnitude of the negative coefficients continued to increase with extended exposure.

Ambulation. Table 2 presents the mean panel presses during the pause (DP) and after the first peck (AP) in 20-session blocks across the FI exposure. Although levels of ambulation varied among pigeons, by the end of training in 4 out of the 6 pigeons (11, 637, 849, and 884), higher rates of ambulation were observed during the PRP relative to after. The difference in rates, however, decreased across sessions for most pigeons as rate of ambulation (during and after PRP) decreased with increased exposure and differences were moderate or minimal in some cases (e.g., 11 and 849). In addition to rate, location of individual panel presses during and after the pause were analyzed in Sessions 1–5, 46–50, 96–100, 146–100, and 196–200, and the mean values are displayed in Table 3. All pigeons engaged in consistently more panel pressing on either of the two panels farthest from the chamber door, relative to the other panels, both during and after the PRP. Thus, the majority of panel presses did

Table 2

Mean and standard deviation of panel press rates during the pause (DP) and after the pause (AP) in 20-session blocks.

Pigeon	Sessions									
	1-20	21-40	41-60	61-80	81-100	101-120	121-140	141-160	161-180	181-200
11										
DP	9.1 (7.3)	7.8 (7.3)	5.5 (6.4)	9.1 (9.2)	2.8 (2.4)	1.2 (0.8)	3.0 (3.1)	4.0 (3.5)	3.9 (3.4)	6.8 (5.1)
AP	2.5 (1.6)	2.2 (1.1)	2.9 (2.7)	4.6 (3.0)	4.8 (2.7)	0.6 (0.3)	0.9 (0.7)	0.7 (0.9)	1.0 (0.7)	1.5 (0.9)
63										
DP	22.6 (14.0)	17.2 (6.5)	13.8 (4.9)	10.4 (3.1)	8.4 (3.6)	4.3 (2.2)	2.6 (1.6)	3.3 (2.5)	3.9 (1.9)	4.1 (2.3)
AP	35.8 (20.1)	25.4 (13.1)	15.7 (9.7)	8.4 (3.1)	5.8 (3.3)	3.0 (1.7)	1.6 (1.3)	3.2 (2.1)	4.0 (1.5)	7.2 (4.7)
637										
DP	16.9 (7.3)	14.1 (5.0)	16.2 (6.4)	16.0 (4.2)	10.2 (4.1)	9.1 (2.9)	10.2 (1.8)	10.7 (3.5)	12.6 (3.3)	9.9 (3.4)
AP	5.3 (6.5)	2.0 (0.9)	2.6 (1.3)	3.6 (1.2)	3.2 (1.0)	2.2 (0.8)	3.8 (1.5)	4.7 (1.9)	5.2 (2.6)	5.3 (2.8)
750										
DP	23.7 (13.5)	14.7 (5.9)	15.1 (7.6)	18.6 (9.4)	20.5 (11.1)	7.9 (7.2)	8.9 (8.5)	9.9 (6.4)	6.2 (5.2)	3.7 (2.6)
AP	12.8 (14.0)	4.8 (1.5)	4.2 (1.9)	4.6 (1.3)	5.8 (2.7)	4.9 (2.4)	9.2 (2.0)	13.7 (6.1)	13.8 (7.5)	9.6 (6.8)
849										
DP	5.6 (6.2)	3.6 (2.2)	2.5 (1.6)	2.3 (1.5)	1.0 (0.7)	0.7 (0.5)	1.1 (1.1)	0.9 (0.5)	1.3 (0.6)	1.3 (0.8)
AP	2.4 (1.6)	0.8 (0.6)	0.8 (0.5)	0.9 (0.8)	0.5 (0.3)	0.3 (0.3)	0.6 (0.4)	0.5 (0.3)	0.6 (0.4)	0.5 (0.4)
884										
DP	13.2 (10.6)	9.4 (3.7)	6.9 (3.7)	5.8 (2.4)	6.0 (3.4)	5.2 (1.5)	6.1 (1.9)	7.2 (2.3)	8.3 (2.3)	6.7 (1.9)
AP	2.3 (2.2)	1.6 (2.2)	0.8 (0.7)	0.6 (0.5)	0.8 (0.9)	0.2 (0.2)	0.4 (0.4)	0.3 (0.2)	0.4 (0.3)	0.3 (0.2)

not take place in front of the hopper, but rather in an area farthest from the door of the chamber, and pigeons did not necessarily shift the location of ambulation within the chamber after the first response in an interval occurred; instead they stayed to the left of the key (away from the chamber door).

Response-rate Stability Analyses

Criterion 1: Visual inspection. Figure 2 displays 10-session moving-averages of the rate of key-pecks (left column) and the session-median PRP durations (right column) across the 200 sessions of the experiment. For most pigeons, response rates initially increased across sessions and most pigeons reached a visually stable rate of key pecking by Session 100. For Pigeons 750, 849, and 884, the rate increase was complete within approximately 50 sessions (i.e., 750 intervals). Unconnected data points represent the 20-session mean values of response rates and PRPs across the 200 sessions of exposure, and follow the same general pattern of the 10-session moving averages. These 20-session means (e.g., Cumming & Shoenfeld, 1960) along with standard deviations are also presented in Table 4. In general, mean response rates increased over

the first 100 sessions (ranging from relatively small to large increases), and tended to stabilize with increased exposure in the second 100 sessions. Standard deviations did not systematically increase as response rate increased. Thus, coefficients of variation generally decreased across sessions, indicating a lessening of session-to-session relative variability with increased exposure.

Criterion 2: Variability of 10-session blocks. For comparison across stability criteria, Table 5 displays at what point during the FI exposure response rates met Criteria 2-4. All pigeons initially met Criterion 2 within 40 sessions and four (11, 63, 637, and 750) met the criterion by Session 20. For Pigeons 11, 63, and 637, Table 4 and Figure 2 suggest that response rates increased between Sessions 20 and 100. An extreme example is the difference in mean response rates from the first and last 20 sessions for Pigeon 63 (Table 4). By Criterion 2, this pigeon's response rate was stable from Sessions 20 to 100; whereas the 20-session averages shown in Table 4 reveal a steady increment across these sessions.

Although the majority of subsequent 10-session-block means fell within $\pm 10\%$ of 20-session means across all pigeons and sessions,

Table 3
Mean number of panel presses by location during the pause (DP) and after the pause (AP) for Sessions 1–5, 46–50, 96–100, 146–100, and 196–200.

Pigeon	Sessions									
	DP					AP				
	1–5	46–50	96–100	146–150	196–200	1–5	46–50	96–100	146–150	196–200
P11										
LB	5.8	0.8	0.2	22.6	23.2	18.0	0.4	1.0	0.2	3.4
RB	13.0	13.0	8.0	14.2	18.8	72.0	25.4	44.0	2.4	12.0
LC	12.0	1.8	0.4	3.0	11.0	50.8	4.8	0.6	0.2	2.8
RC	4.2	1.4	1.0	1.8	5.6	16.2	1.2	1.8	0.6	3.8
LF	3.0	0.2	0.2	2.8	36.2	15.2	5.6	1.2	0.0	9.4
RF	1.0	1.0	1.2	5.0	50.4	1.2	13.0	0.6	0.8	39.4
P63										
LB	7.0	9.8	16.8	7.2	12.6	164.4	185.6	13.2	4.2	5.4
RB	13.6	30.2	23.2	7.2	22.4	180.6	155.8	54.0	22.0	29.0
LC	12.4	15.2	2.8	1.0	0.2	95.4	144.0	13.2	7.2	7.2
RC	5.4	18.6	1.0	1.0	1.0	69.4	119.2	3.6	14.8	0.8
LF	5.8	5.4	5.2	5.6	10.8	6.4	15.6	24.2	26.8	92.2
RF	5.4	3.8	4.0	3.6	20.8	6.6	10.0	3.6	3.8	8.0
P637										
LB	13.2	1.0	14.0	21.0	19.0	142.2	1.0	1.0	1.6	0.0
RB	19.2	110.6	34.6	36.6	50.2	192.6	110.6	76.6	161.0	143.2
LC	12.8	2.8	1.6	10.4	10.2	132.6	2.8	1.4	5.8	16.2
RC	9.8	2.6	2.2	7.4	1.0	56.0	2.6	0.6	2.0	0.4
LF	2.4	0.6	2.2	2.4	11.6	8.0	0.6	0.6	0.2	0.0
RF	0.2	11.2	0.4	2.8	7.0	4.0	11.2	0.4	0.2	0.4
P750										
LB	20.8	42.4	75.2	12.4	15.6	517.4	11.6	12.2	3.6	2.2
RB	21.8	24.6	54.0	34.8	17.0	244.2	105.2	70.4	401.8	161.4
LC	15.8	42.0	21.8	8.0	7.8	257.4	11.0	25.0	2.6	4.8
RC	15.2	20.2	24.4	10.6	2.6	277.0	17.6	12.4	7.2	1.2
LF	2.6	2.8	0.6	0.8	7.0	2.2	0.8	0.6	0.2	0.0
RF	0.6	4.2	0.2	1.2	3.0	2.2	5.2	0.4	1.0	1.6
P849										
LB	4.2	5.0	4.2	3.8	5.8	32.4	2.2	2.2	2.2	3.4
RB	7.2	5.8	4.6	6.0	4.6	50.6	4.0	4.8	5.2	4.2
LC	5.6	6.4	1.2	3.8	1.0	43.0	6.4	0.4	1.8	0.6
RC	3.8	7.0	0.6	0.4	0.4	18.2	1.6	0.6	0.4	0.0
LF	0.6	2.8	3.4	3.4	2.6	2.4	0.6	1.0	0.4	1.0
RF	2.0	2.4	2.8	3.6	3.4	11.0	5.0	7.2	11.4	6.0
P884										
LB	7.4	8.8	11.6	35.0	20.0	42.0	0.6	0.6	1.4	0.6
RB	16.2	20.2	15.6	32.6	21.6	105.0	6.0	1.4	3.4	2.6
LC	13.2	25.4	2.6	5.0	2.0	56.0	3.6	0.0	0.2	0.2
RC	2.4	8.8	3.8	10.2	4.4	6.6	3.0	0.2	1.2	0.6
LF	1.8	5.0	12.8	10.0	25.6	7.0	0.2	0.8	0.0	1.0
RF	2.6	3.0	13.2	7.6	23.0	7.6	24.6	0.8	0.6	3.2

Note. LB, RB, LC, RC, LF and RF represent the left back, right back, left center, right center, left front and right front panels, respectively. Back refers to the panels farthest from the door of the chamber.

this criterion was not consistently met. For example, Pigeon 849 met this criterion in Sessions 61–80, 81–100, 101–120, 161–180, and 181–200, but failed to meet it in Sessions 121–140 and 141–160, indicating more extreme fluctuations in relative session-to-session response rates than in other analyzed sessions. In this particular case, the two 10-session means were relatively high then low, resulting in an intermediate 20-session mean that was not fully representative of either segmented 10-session performance.

Fig. 2. Ten-session moving-window average of responses per min (left column) and median pause (PRP) duration in seconds (right column). Unconnected data points represent the 20-session mean values of response rates and PRPs across the 200 sessions of exposure.

Criterion 3: Variability and trend of seven-session blocks. We also examined a trend criterion with three 7-consecutive-session blocks. Using this criterion, the response rates of Pigeons 63, 849, and 884 first stabilized no later than Session 42; Pigeons 11 and 750

stabilized at Sessions 84 and 63, respectively. Once Criterion 3 was initially met, however, response rates did not remain stable thereafter.

Criterion 4: Variability and trend of three-session blocks. Next, the same trend and percentage criteria as above were applied to

Table 4

Mean and standard deviation of response rates (Resp/min) and median pause(s) in 20-session blocks.

Pigeon	Sessions									
	1–20	21–40	41–60	61–80	81–100	101–120	121–140	141–160	161–180	181–200
11										
Resp/min	24 (6.4)	22 (4.8)	27 (4.9)	37 (4.3)	37 (2.9)	41 (3.7)	45 (6.9)	35 (8.0)	37 (2.9)	40 (5.6)
Pause	21 (11.9)	36 (12.6)	48 (16.2)	42 (12.0)	44 (12.5)	65 (10.3)	60 (15.3)	73 (18.9)	75 (9.7)	67 (11.5)
63										
Resp/min	23 (5.6)	30 (5.0)	38 (6.3)	51 (7.2)	62 (8.3)	59 (5.6)	57 (6.5)	58 (5.6)	56 (3.4)	67 (8.6)
Pause	25 (17.6)	26 (7.1)	29 (9.1)	37 (10.9)	39 (8.2)	41 (6.6)	41 (10.3)	42 (12.0)	52 (11.9)	58 (11.6)
637										
Resp/min	36 (10.4)	48 (8.1)	58 (6.7)	63 (6.4)	70 (10.8)	69 (7.3)	78 (9.4)	72 (8.3)	72 (8.0)	67 (6.3)
Pause	16 (5.5)	19 (4.5)	21 (5.8)	24 (6.0)	28 (4.7)	27 (5.9)	28 (5.0)	32 (6.1)	42 (7.3)	42 (7.2)
750										
Resp/min	29 (5.6)	48 (11.0)	52 (8.6)	46 (7.4)	44 (4.6)	55 (12.1)	55 (5.1)	56 (7.2)	58 (9.3)	54 (8.8)
Pause	18 (10.6)	25 (9.5)	33 (11.5)	40 (9.0)	45 (8.6)	40 (11.8)	40 (11.0)	48 (9.0)	44 (13.4)	50 (11.4)
849										
Resp/min	13 (8.7)	22 (7.2)	17 (17.3)	19 (4.1)	17 (3.6)	17 (6.8)	19 (5.9)	20 (5.6)	19 (4.1)	24 (5.6)
Pause	16 (11.9)	30 (12.8)	56 (23.1)	50 (13.4)	70 (15.2)	88 (23.3)	70 (24.2)	73 (16.1)	78 (21.7)	71 (17.8)
884										
Resp/min	42 (11.6)	55 (8.5)	51 (6.8)	59 (8.9)	54 (7.0)	52 (6.9)	62 (5.8)	54 (4.7)	52 (6.5)	50 (5.3)
Pause	14 (10.0)	28 (6.6)	41 (11.6)	54 (14.7)	59 (11.4)	67 (10.6)	67 (9.3)	63 (8.9)	69 (7.6)	73 (9.0)

Table 5

Whether each stability criterion was met (Yes/No) for response rates across specific blocks of sessions.

Response Rates	Pigeon	Yes/No (Session)									
Criterion 2:	P11	Y (20)	Y (40)	N (60)	Y (80)	Y (100)	Y (120)	N (140)	Y (160)	Y (180)	Y (200)
	P63	Y (20)	Y (40)	Y (60)	Y (80)	Y (100)	Y (120)	Y (140)	Y (160)	Y (180)	Y (200)
	P637	Y (20)	Y (40)	Y (60)	Y (80)	Y (100)	Y (120)	Y (140)	Y (160)	Y (180)	Y (200)
	P750	Y (20)	Y (40)	Y (60)	Y (80)	Y (100)	N (120)	Y (140)	Y (160)	Y (180)	Y (200)
	P849	N (20)	Y (40)	Y (60)	Y (80)	Y (100)	Y (120)	N (140)	N (160)	Y (180)	Y (200)
	P884	N (20)	Y (40)	Y (60)	Y (80)	Y (100)	Y (120)	Y (140)	Y (160)	Y (180)	Y (200)
Criterion 3:	P11	N (21)	N (42)	N (63)	Y (84)	Y (105)	Y (126)	N (147)	Y (168)	N (189)	
	P63	N (21)	Y (42)	N (63)	N (84)	N (105)	Y (126)	Y (147)	Y (168)	Y (189)	
	P637	N (21)	N (42)	N (63)	N (84)	Y (105)	Y (126)	N (147)	Y (168)	N (189)	
	P750	N (21)	N (42)	Y (63)	Y (84)	N (105)	N (126)	Y (147)	N (168)	N (189)	
	P849	N (21)	Y (42)	N (63)	N (84)	Y (105)	N (126)	N (147)	N (168)	N (189)	
	P884	N (21)	Y (42)	N (63)	Y (84)	N (105)	N (126)	N (147)	N (168)	Y (189)	
Criterion 4:	P11	N (9)	N (18)	N (27)	Y (36)	N (45)	N (54)	N (63)	Y (72)	Y (81)	N (90)
		N (108)	N (117)	N (126)	N (135)	N (144)	N (153)	N (162)	Y (171)	Y (180)	N (189)
	P63	N (9)	N (18)	N (27)	N (36)	Y (45)	Y (54)	Y (63)	Y (72)	Y (81)	N (90)
		N (108)	N (117)	Y (126)	N (135)	N (144)	Y (153)	Y (162)	Y (171)	Y (180)	Y (189)
	P637	N (9)	N (18)	N (27)	N (36)	Y (45)	Y (54)	N (63)	Y (72)	Y (81)	N (90)
		Y (108)	N (117)	N (126)	N (135)	N (144)	Y (153)	Y (162)	N (171)	N (180)	N (189)
	P750	Y (9)	N (18)	N (27)	N (36)	Y (45)	Y (54)	N (63)	Y (72)	N (81)	Y (90)
		N (108)	N (117)	Y (126)	Y (135)	Y (144)	N (153)	Y (162)	N (171)	Y (180)	Y (189)
	P849	N (9)	N (18)	N (27)	N (36)	N (45)	N (54)	Y (63)	Y (72)	N (81)	N (90)
		N (108)	N (117)	N (126)	N (135)	N (144)	Y (153)	Y (162)	Y (171)	Y (180)	N (189)
	P884	N (9)	N (18)	N (27)	Y (36)	N (45)	Y (54)	N (63)	Y (72)	N (81)	N (90)
		N (108)	Y (117)	Y (126)	Y (135)	Y (144)	N (153)	Y (162)	Y (171)	Y (180)	Y (189)

Note. Bold Y's represent the block of sessions in which the criterion was first met.

Table 6

Whether each stability criterion was met (Yes/No) for pause across the specific blocks of sessions.

Pause	Pigeon	Yes/No (Session)											
Criterion 2:	P11	Y (20)	Y (40)	Y (60)	Y (80)	Y (100)	Y (120)	Y (140)	Y (160)	Y (180)	Y (200)		
	P63	N (20)	Y (40)	N (60)	Y (80)	N (100)	Y (120)	N (140)	Y (160)	Y (180)	Y (200)		
	P637	N (20)	Y (40)	Y (60)	Y (80)	Y (100)	Y (120)	Y (140)	Y (160)	Y (180)	Y (200)		
	P750	N (20)	Y (40)	Y (60)	Y (80)	Y (100)	N (120)	N (140)	Y (160)	N (180)	Y (200)		
	P849	N (20)	N (40)	N (60)	N (80)	Y (100)	Y (120)	N (140)	Y (160)	Y (180)	Y (200)		
	P884	N (20)	Y (40)	N (60)	N (80)	Y (100)	Y (120)	Y (140)	Y (160)	Y (180)	Y (200)		
Criterion 3:	P11	N (21)	Y (42)	N (63)	N (84)	N (105)	Y (126)	N (147)	N (168)	N (189)			
	P63	N (21)	N (42)	N (63)	N (84)	N (105)	N (126)	N (147)	Y (168)	N (189)			
	P637	N (21)	Y (42)	N (63)	N (84)	Y (105)	Y (126)	Y (147)	N (168)	Y (189)			
	P750	N (21)	Y (42)	N (63)	Y (84)	N (105)	N (126)	N (147)	N (168)	N (189)			
	P849	N (21)	N (42)	N (63)	N (84)	N (105)	Y (126)	N (147)	N (168)	N (189)			
	P884	N (21)	Y (42)	N (63)	N (84)	N (105)	N (126)	Y (147)	Y (168)	N (189)			
Criterion 4:	P11	N (9)	N (18)	N (27)	N (36)	N (45)	N (54)	N (63)	N (72)	N (81)	N (90)	N (99)	
		N (108)	N (117)	N (126)	Y (135)	N (144)	Y (153)	N (162)	Y (171)	N (180)	N (189)	N (198)	
	P63	N (9)	N (18)	N (27)	N (36)	N (45)	N (54)	Y (63)	N (72)	N (81)	N (90)	N (99)	
		N (108)	Y (117)	N (126)	N (135)	N (144)	Y (153)	N (162)	N (171)	N (180)	N (189)	N (198)	
	P637	N (9)	N (18)	N (27)	N (36)	N (45)	N (54)	N (63)	N (72)	N (81)	N (90)	Y (99)	
		N (108)	Y (117)	N (126)	N (135)	Y (144)	Y (153)	N (162)	Y (171)	N (180)	Y (189)	Y (198)	
	P750	N (9)	N (18)	N (27)	N (36)	N (45)	N (54)	N (63)	N (72)	N (81)	Y (90)	N (99)	
		N (108)	N (117)	N (126)	N (135)	N (144)	Y (153)	N (162)	N (171)	N (180)	N (189)	Y (198)	
	P849	N (9)	N (18)	N (27)	N (36)	Y (45)	N (54)	N (63)	N (72)	Y (81)	N (90)	N (99)	
		N (108)	N (117)	N (126)	N (135)	N (144)	Y (153)	N (162)	N (171)	Y (180)	N (189)	N (198)	
	P884	N (9)	N (18)	N (27)	N (36)	N (45)	N (54)	N (63)	Y (72)	Y (81)	Y (90)	N (99)	
		N (108)	Y (117)	Y (126)	N (135)	N (144)	Y (153)	Y (162)	Y (171)	Y (180)	Y (189)	Y (198)	

Note. Bold Y's represent the session when the criterion was first met.

three blocks of three sessions and yielded similar results as those with three blocks of seven sessions. These criteria classified performance as stable prematurely when compared to visual inspection (e.g., 884 reached stability by Sessions 28–36), and response rates did not consistently meet the criteria throughout exposure. Thus, adding a trend criterion lessened the mischaracterization of steady-state performance (as compared to visual inspection), but did not eliminate the problem entirely, and after responding met the criteria it sometimes subsequently failed to in later blocks of sessions.

Postreinforcement Pause Stability Analyses

Criterion 1: Visual inspection. The moving averages of the session-median PRP values in Figure 2 and the 20-session means in Table 4 show increases in the duration of pausing for each of the pigeons across the 200 sessions. The functions are generally increasing and negatively accelerated, except for Pigeons 63 and 637, for which the increase is relatively linear. The minimum PRP values occurred in the first or

second sessions for all pigeons, whereas the maximum PRP values tended to occur in the range of Sessions 151–193 (Pigeons 11 and 849 being exceptions to this rule). Table 4 presents means of the session-median PRP durations in 20-session blocks across the experiment. The median-pause-duration means tended to increase for most pigeons across the entire 200-session exposure.

Criterion 2: Variability of 10-session blocks. For comparison across stability criteria, Table 6 displays at what point during the FI exposure PRPs met criteria 2–4. By Criterion 2, 5 of 6 pigeons (11, 63, 637, 750, and 884) reached stability no later than Session 40. Once the stability criterion was initially satisfied, the PRP durations of some pigeons (e.g., 11) remained consistently stable whereas those of others did not (e.g., 750).

Criterion 3: Variability and trend of seven-session blocks. Four of six pigeons (11, 637, 750, and 884) initially met stability Criterion 3 no later than Session 42 whereas 63 and 849 stabilized at sessions 168 and 126, respectively. Subsequent assessments of stability across the 200-session exposure yielded inconsistent outcomes.

Criterion 4: Variability and trend of three-session blocks. Comparable results were obtained using the same trend and variability criteria with three blocks of three sessions rather than three blocks of seven sessions. That is, meeting the variability and trend criteria across the 200-session exposure was largely inconsistent for most pigeons. There were a number of cases, however, in which PRP values met the maximum all-session-variability criterion, but not the trend criterion. Thus, the addition of the trend criterion provided better identification of gradual upward trends than did simple assessment of all-session variability.

DISCUSSION

Several notable results emerged from the present study, in which we investigated the development of response rate, PRP, and ambulation with extended exposure to an FI schedule of reinforcement. First, response rate stabilized before the PRP. Second, stability criteria that were adapted specifically to deal with slow trends better characterized stability across response-rates and PRP. Finally, ambulation varied widely within and across subjects, though pigeons generally ambulated more about the chamber towards the beginning of the 200-session exposure. Four of the 6 pigeons also engaged in higher rates of panel pressing during the pause than after the pause. Each of these findings will be discussed in turn.

Although fairly stable response rates were observed by 100 or fewer sessions for all pigeons, with the exception of Pigeon 849, PRP durations continued to increase after Session 100, indicating that temporal control was still developing. In some cases the increases in pausing were quite substantial in the second 100 sessions. For example, the average median PRP increased by about 50% between Sessions 81–100 and 181–200 for Pigeons 11, 63, and 637. Although the extended training was arranged to allow for all measures of behavior to reach stability, for some pigeons (e.g., 63), it is not apparent that pausing had stabilized by the end of 200 sessions of exposure. The import of the dissociation of stability of response rate and pause for future research will depend on the goals of that research. Fewer baseline sessions will be

needed if the focus is on response output than if it is on temporal control.

Another interesting feature of the data evident in Table 4 is that the absolute variation (standard deviation) in response rates and PRP tended to be constant across the study, at least when divided into 20-session means. That is especially intriguing in the case of pausing because the mean values often increased substantially, sometimes by a factor of almost 5 (see PRP data for 849). Often, especially when measures of temporal control are taken, there is a relatively fixed proportionality between the mean and variance of those measures (cf. Machado, 1997).

A second rationale for conducting this study was to evaluate different criteria for assessing stability. Criteria previously employed in the literature produced different characterizations of stable performance when applied to the data of the present study. Several of these stability methods assessed, specifically Criterion 1 (percentage variation), characterized performance as stable despite increasing or decreasing trends. In addition, measures taken from data obtained after the stability criteria had been met often revealed a lack of stability. This finding is interesting because, as illustrated in the findings in Table 4 indicating relative constant absolute (and therefore decreased relative) variability over the course of the study, the session-to-session relative variability was decreasing, making it easier to meet the variability of session-blocks criterion. Inclusion of a trend criterion (Criteria 3 and 4), along with a variability of session-blocks criterion, improved identification of stability. These methods, which involved 9 and 21 consecutive sessions (135 and 315 repetitions of the FI, respectively) worth of data, still failed, however, to be sensitive to relatively slow trends. If trends are not of central importance to an investigator (e.g., response rates are moving upward, yet a manipulation is expected to decrease responding), then the stability criteria used in the present study may be adequate. The present data, however, highlight the difficulty in developing stability criteria that actually identify stable performance.

A comparison across techniques of variability of session blocks alone (Criterion 2) plus the addition of trend assessments (Criteria 3 and 4) revealed that although changes in performance levels or extreme variability are

identified by Criterion 2, it misses potentially important gradual increases in rates and durations that are better identified by Criteria 3 and 4. More specifically, Criterion 2 generally characterized performance as stable within the first 20–40 sessions, despite clear trends. Our use of visual inspection (Criterion 1) and quantifiable Criteria 3 and 4 managed to identify these early sessions as unstable because of these trends. These results are likely attributable to Criterion 1 not being specifically adapted to account for slow trends. The gradual rise observed in PRP values across the FI exposure for some pigeons suggests that an addition of a trend criterion may be more valuable in identifying stability for PRP values than response rates. A comparison of the two criteria which contained trend requirements (Criteria 3 and 4) revealed no systematic differences (see Tables 5 & 6).

It should also be noted that for pigeons with lower response rates (e.g., 849) a session-variability criterion will be more difficult to satisfy. For example, the failure of Pigeon 849 to reach Criterion 2 consistently was at least partially due to relatively low response rates. Naturally, lower response rates result in a more stringent $\pm 10\%$ range, which may be difficult to attain (cf. Sidman, 1960). As mean response rates and standard deviations for Pigeon 849 in Table 4 demonstrate, however, no major shifts in performance or large deviations occurred after Session 100. Thus, Criterion 2 must be viewed with caution if overall rate is relatively low because normal increasing or decreasing drifts in response rates occurring within or between averaged blocks may result in an unmet criterion, despite extensive exposure and minimal day-to-day absolute variability.

It is also possible that behavior had equilibrated, and the failure of criteria to characterize behavior as stable was due to a detection issue rather than a lack of behavioral stability. That is, behavior may have stabilized to the extent probable by the end of the 200 sessions of exposure, and the stability criteria employed simply failed to detect such stability. In the case of the PRP, quarter-life values showed little change from Session 100 to 200, indicating stable performance, yet Table 4 and Figure 2 show steady increases in PRP. Thus, stability assessments also depend on the measure used. More specifically, such findings indicate that PRP and quarter-life are not

perfect substitutes for each other (cf. Gollub, 1964), and that pausing may be a more sensitive index of temporal control. Additionally, PRP durations towards the end of training ranged from 25% to 40% of the interval, which are slightly lower than several proportions previously reported (e.g., of 50% or more of the interval with FI values of 60- and 300-s; Shull, 1970).

The present findings suggest that if stable PRP durations are to be achieved, more exposure than we arranged (3,000 repetitions of the interval) may be needed. The future implications of this finding will depend on the duration of initial FI training and the duration of the experiment envisioned. In the present study, PRP durations increased primarily during the initial 750 to 1,500 reinforcers. Thus, studies that require asymptotic temporal discriminations as a baseline should be carefully monitored for PRP duration before the experimental parameters are manipulated. In studies of the effects of drugs on temporal discriminations under FI schedules, for example, the present findings suggest that it would be inappropriate to begin dosing for approximately 1,500 obtained reinforcers. After that, PRP durations are likely to increase gradually; an outcome that may impact the results of a long-duration experiment (e.g., repeated dosing at multiple doses). Researchers using these designs should be cognizant that some of the PRP variation will be due to continued learning. These gradual changes are less likely to affect the results of short-term experimentation (e.g., acute manipulations). It is possible that the time required to reach stability for different measures of behavior could vary with greater or fewer intervals presented per session (15 intervals per session were used in the present study). Another aspect of the present study that should be considered is that a single FI value was employed. The extent to which the results of varied exposure times needed for different measures to reach stability presented here generalize to other FI values is currently untested.

Initial exposure to the FI 3-min schedule engendered high levels of ambulation in the experimental chamber. Once temporal control of key-pecking began to develop, however, ambulation was unrelated to either response rate or PRP duration. Four of the pigeons showed higher rates of panel depressions during the PRP than during the period of responding, but it is important to note that 2

did not. Manipulation of the FI schedule value may reveal a more systematic relation between ambulation, PRP, and responding. Most ambulation occurred on the two panels farthest from the door, not farthest from the key. Perhaps handling of the pigeon which occurs near the door is aversive, rendering that part of the chamber relatively unfavorable.

In summary, the present study showed that the mean duration of the PRP under an FI 3-min schedule was still increasing in some pigeons after 3,000 repetitions of the interval, despite the fact that overall response output had reached stability about 1,500 repetitions earlier. These data highlight the difficulty in setting criteria that identify stable performance under FI schedules and that ambulation was unrelated to temporal aspects of the schedule or of key-pecking.

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