JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1980, 34, 319-328 NUMBER 3 (NOVEMBER)

MIRROR PECKING AND TIMEOUT UNDER A MULTIPLE FIXED-RATIO SCHEDULE OF FOOD DELIVERY

NANCY A. ATOR

UNIVERSITY OF MARYLAND

Pigeons were trained to peck a key under a multiple fixed-ratio 25 fixed-ratio 175 schedule of food presentation. In the first condition, either a mirror or the opportunity to produce a 30-second timeout were available. In a second condition, mirror and timeout availability were reversed for the two groups. Following a return to the initial condition, mirror and timeout keys were presented together for all birds. Mirror and timeout responses occurred predominantly in the pause in the larger fixed-ratio component, regardless of whether the opportunities for the two responses were available singly or together. Mirror responding occurred in a greater proportion of the pauses than did timeouts. When the opportunities for both mirror pecking and timeout were available concurrently, they occurred with probabilities similar to those under the single conditions. Within the pause itself, mirror responses most frequently occurred immediately after reinforcement. Timeouts occurred most frequently toward the end of the pause, and some timeouts occurred in the early part of the run. Longer preratio pausing occurred in the larger fixed-ratio component in the conditions in which the mirror was present, whether or not any mirror pecks were recorded.

Key words: adjunctive behavior, schedule-induced aggression, schedule-induced escape, timeout from reinforcement, mirror attack, multiple schedules, fixed-ratio schedule, pausing, key peck, pigeons

Schedules of reinforcement exercise a pervasive influence not only upon the rates and patterns of responses which produce reinforcement, but also upon the likelihood of other concurrently measured behavior. The most extensively studied type of behavior is polydipsia in the rat; but attack, escape via timeout from the schedule of reinforcement, wheel-running, tube-biting, licking an air stream, and even pica have also been observed (Falk, 1971). These schedule-induced, or adjunctive, activities characteristically occur soon after reinforcement and their rates of occurrence typically change in similar ways with changes in interreinforcer interval. The many similarities in the relationship of these topographically disparate classes of behavior to the concomitant schedule of reinforcement have been discussed in a number of reviews (Falk, 1971, 1977; Segal, 1972; Staddon, 1977), and the possibility of the interchangeability of such classes has been suggested (Falk, 1971).

Although a number of studies have investigated single types of adjunctive behavior, only a few have examined the extent to which one type of behavior can be substituted for another, using the same subject under constant schedule conditions. In studies of polydipsia and running in rats, drinking typically occurs immediately after food delivery, whereas running is initiated later in the interreinforcement interval (Staddon, 1977). This relationship held when opportunities for both drinking and running were provided simultaneously (Levitsky & Collier, 1968; Penney & Schull, 1977; Smith & Clark, 1974) and also when opportunities for a third explicitly measured activity were introduced (Roper, 1978; Staddon & Ayres, 1975). Attack under a schedule of reinforcement has also been studied in conjunction with the simultaneous opportunity to drink. When both those activities were compared in individual pigeons, however, attack occurred immediately

This report is based on a master's thesis submitted to the Department of Psychology, University of Maryland, College Park. Portions of the data were presented at the meetings of the American Psychological Association in Washington, D.C., September, 1976. I am grateful to the members of the thesis committee, J. E. Barrett, R. M. McIntire, and D. M. Thompson, for their advice during the conduct of the experiment, to I. H. Iversen and E. L. P. Smith for helpful discussion of data presentation, and to J. E. Barrett and R. R. Griffiths for comments on the manuscript. Reprints may be obtained from Nancy A. Ator, Division of Behavioral Biology, Johns Hopkins University School of Medicine, 720 Rutland Avenue, Baltimore, Maryland 21205.

after reinforcement, but drinking failed to develop (Yoburn & Cohen, 1979). In a similar comparison with rats, drinking characteristically occurred after pellet delivery; but attack, when it was observed, occurred later, often after lever pressing had commenced (Knutson & Schrader, 1975). These results are consistent with the findings of others that schedule-induced polydipsia in pigeons (cf. Miller & Gollub, 1974; Whalen & Wilkie, 1977) and attack as studied in rats (Gentry & Schaeffer, 1969; Hymowitz, 1971) are not highly probable types of behavior for those species.

In other studies, attack and timeout production, have frequently been generated in pigeons. Pigeons attack live (Gentry, 1968), stuffed (Flory, 1969a,b), mirror (Cohen & Looney, 1973), and pictorial (Looney & Cohen, 1974) targets under schedules of intermittent grain delivery at rates greater than in the absence of the reinforcement schedule. Similarly, when provided with the opportunity to produce timeout from a schedule of reinforcement, pigeons have done so (Azrin, 1961; Brown & Flory, 1972; Thompson, 1965). Both attack and timeout characteristically occur in the period immediately following food delivery.

In the present study, these two activities were compared. Access to both a mirror target and a timeout key were provided to pigeons when keypecking was maintained under a multiple fixed-ratio fixed-ratio (*mult* FR FR) schedule of grain delivery. Of interest was whether the frequency and temporal locus of mirror attack and timeout between reinforcements would be the same for a given pigeon when the opportunity for one activity was substituted for that of the other, and whether one would occur to the exclusion of the other when both were available simultaneously. By counterbalancing the order of access to the mirror and the timeout key across birds, it was also possible to assess the contribution of a history of one type of behavior on the emergence of the other.

METHOD

Subjects

Six White Carneaux pigeons were caged individually in a vivarium with constant illumination. Five birds were maintained at 80% and one (P252) at 75% of ad lib weight by postsession feeding. Water and grit were continuously available in the home cages. The experimental histories of the birds are described below.

Apparatus

A BRS-Foringer Pigeon Intelligence Panel (Model 141-10-207) formed the front wall of the 35 by 34 by 43 cm experimental chamber. One side wall was formed by a Plexiglas door, lightly sanded to minimize reflection. The other side wall and the back wall were of wood, painted flat black. Only the right-hand key on the front wall (the food key) was uncovered; a force of .16N was required for a key peck to be recorded. The aperture for the food hopper was centered on the front wall. The mirror (13 by 31 cm) was suspended within a black wooden frame (16 by 36 by 5 cm) on the rear half of the left (wooden) side wall. Behind the mirror, four lever-type microswitches were mounted on the frame, one resting against each corner of the mirror. Only the bottom two microswitches recorded mirror pecks; the top switches maintained proper alignment of the mirror. A force of .5N was required for a peck to be counted. A second functional key, the timeout key, was installed on the front half of the same wall. It was mounted in a 5.5 by 13 by 6 cm black box which protruded into the chamber equally as far as the mirror surface (5.5 cm) and was at the same height above the wire mesh floor as the food key (27 cm). It could be transilluminated by a yellow 28-V dc light, and a force of .16N was required for a peck to be recorded. The distance between the right edge of the mirror surface and the center of the timeout key was 10 cm. Chamber illumination was provided by a 7-W white Christmas tree bulb mounted in the chamber ceiling and by the shielded 28-V dc light centered on the top of the intelligence panel. The chamber was housed in a larger, sound-attenuating enclosure equipped with a ventilation fan. A one-way miror permitted observation through the Plexiglas door. White noise was continuously present in the room. Experimental conditions were controlled and data recorded with electromechanical equipment in an adjacent room.

Procedure

Preliminary training. Prior to the present experiment, all six birds had been exposed to

the mirror in at least five 60-min sessions to determine levels of mirror pecking in the absence of a schedule of grain delivery. Five of the birds then were trained under FR schedules of food reinforcement, including a *mult* FR 25 FR x in which the value of x was manipulated. During those sessions, two birds (P243 and P250) had only the mirror available, two birds (P252 and P255) had only the timeout key available, and one (P24) had the mirror available first and then the timeout key. Those daily sessions were conducted over the 6 months preceding the present experiment, and the results are reported elsewhere (Ator, 1974). Prior to Condition I, described below, the schedule was *mult* FR 25 FR 150 for 8 to 12 sessions with only the mirror for P243 and P250 and only the timeout key for P24, P252, and P255. The sixth pigeon, PD2, was trained under the *mult* FR 25 FR x without either the mirror or the timeout key present in the month immediately preceding the present experiment and with no exposure to the mirror or timeout key other than the baseline sessions with the mirror mentioned above. The schedule was *mult* FR 25 FR 125 for 10 session prior to Condition I described below.

Experimental conditions. With the first session of Condition I, the mirror was uncovered for PD2 and the schedule of reinforcement was changed to *mult* FR 25 FR 175 for the other five birds. The schedule remained *mult* FR 25 FR 125 for PD2. These schedule values were in effect throughout the four experimental conditions to be described. The food key was green during the FR 25 component of the multiple schedule and red during the larger component. Reinforcement consisted of 4-sec access to mixed grain from the lighted food hopper. During reinforcement, the houselights and keylights were turned off. Components alternated after grain delivery.

In Condition I, half the birds (P243, PD2, and P250) had the mirror available, while the other half (P24, P252, and P255) had the timeout key available. In Condition II, the availability of the mirror and the timeout key was reversed for the two groups of birds. In Condition III, either the mirror or the timeout key was available as in Condition I. In Condition IV, both mirror and timeout key were available simultaneously for all birds. A peck on the timeout key, when available, darkened that key and the food key for 30 sec, during which responses on either key were counted but had no programmed consequence. The timeout key was covered with black tape in conditions in which it was not available; the mirror was covered with black cardboard when only the timeout key was available. A peck on either the mirror, the timeout key, or the dark food key (during timeout) had to be followed by at least 5 sec without a response before a peck on the food key produced reinforcement or counted toward completion of the ratio requirement. This contingency was included in an effort to minimize adventitious reinforcement of those responses with grain delivery. Sessions ended either when 90 min elapsed or after 60 reinforcements and were conducted six or seven days per week. Each condition remained in effect for 13 to 15 sessions.

Data analysis. The preratio pause (PRP, Griffiths & Thompson, 1973) was defined as time from the onset of the keylight to the fifth keypeck to minimize confounding by false starts on the food key (cf. Reynolds, 1961). Data were collected separately for the PRP and the time from the fifth keypeck until reinforcement (run time) in each component of the multiple schedule. Food key and mirror responses during timeout were recorded separately. In addition, the number of PRPs in which there was at least one mirror peck or one timeout were recorded.

RESULTS

Both mirror pecking and timeout occurred reliably over sessions in four birds (P243, PD2, P252, and P255). Those birds had also pecked the mirror during the baseline condition of mirror alone (see footnote in Table 1). Two birds (P24 and P250) failed to peck the mirror over five sessions of exposure during that original baseline condition and never exhibited sustained mirror pecking, nor sustained timeout key responding, under the subsequent conditions.

No timeouts and virtually no mirror responses occurred during the FR 25 component of the schedule. Rather, the four birds which did regularly produce mirror pecks and timeouts did so almost exclusively during the pause in the larger FR component. Once responding was initiated on the food key, mirror pecks and/or timeouts occurred infrequently; when

Table 1
Rates (responses/min) and local frequencies[a] of mirror and timeout key responding and durations (min) of the larger FR component of the *mult* FR FR schedule for the last five sessions of each condition.

Condition		Response Rate		Local Frequency		Component Duration	
		Mean	Range	Mean	Range	Mean	Range
				Bird P243			
I.	Mirror	1.17	.82-2.1	5.0	4.1- 6.9	4.9	3.3- 7.9
II.	Timeout	.035	.00- .04	1.0	—	2.7	1.6- 2.0
III.	Mirror	1.73	1.28-2.16	5.4	4.2- 6.2	3.3	2.6- 4.2
IV.	Mirror+	1.65	1.48-1.99	5.2	4.1- 6.0	3.4	2.5- 4.0
	Timeout	.01	.00- .01	1.0	—		
				Bird PD2			
I.	Mirror	.04	.00- .07	1.5	1.0- 2.0	8.3	3.3-12.4
II.	Timeout	.01	.00- .04	1.2	1.0- 1.5	4.8	3.5- 6.0
III.	Mirror	.92	.55-1.27	10.8	5.2-15.9	13.2	9.6-14.7
IV.	Mirror+	.68	.34-1.09	29.9	22.0-36.7	22.4	9.5-40.7
	Timeout	.01	.00- .05	4.0	—		
				Bird P252			
I.	Timeout	.01	.00- .01	1.0	—	3.9	3.2- 4.7
II.	Mirror	.14	.09- .17	2.7	1.6- 3.4	5.1	4.7- 6.0
III.	Timeout	.02	.00- .04	1.0	—	4.2	3.6- 5.8
IV.	Mirror+	.08	.00- .18	1.6	1.0- 3.5	6.4	4.7-10.8
	Timeout	.004	.00- .01	1.0	—		
				Bird P255			
I.	Timeout	.03	.00- .06	1.0	—	3.9	2.8- 4.6
II.	Mirror	.13	.07- .21	1.5	1.0- 2.5	3.4	2.0- 4.5
III.	Timeout	.01	.00- .02	1.0	—	3.9	2.3- 4.7
IV.	Mirror+	.49	.23- .69	2.3	.9- 4.3	3.3	2.7- 5.0
	Timeout	.11	.06- .15	2.1	1.4- 3.0		

[a]Local frequency = mean number of responses per pause, given that a response occurred, i.e., total responses in the PRP/number of PRPs with at least one such response.

Note: Means and ranges of rates of mirror pecking (r/min) over the five baseline sessions of mirror alone had been: P243, .7 (.5-.9); PD2, .3 (.0-.6); P252, .9 (.0-2.1); P255, .1 (.0-.6).

they did, however, timeouts generally occurred during the run more often than mirror pecks. Across all conditions, the mean percentage of total mirror pecks in the PRP versus the mean percentage of total timeouts in the PRP was: P243, 99% of mirror pecks versus 90% of timeouts; PD2, 94% versus 73%; and P252, 97% versus 64%. The exception was P255, 78% versus 87%.

Table 1 presents the means and ranges of rates of mirror pecking and timeout in the larger FR component over the last five sessions in each condition. The rates of mirror responding were much greater than of pecking the timeout key across all conditions. Comparison of the overall rates of mirror responding across conditions in which the mirror was available reveals that rates of mirror pecking did not change systematically when both mirror and timeout key were available concurrently as compared to conditions in which only the mirror was available. Mirror pecks generally occurred in bursts in the PRP, while only one timeout typically occurred per PRP. These data are summarized in the column labeled Local Frequency in Table 1, i.e., the mean number of mirror pecks, or timeouts, per PRP for those PRPs in which at least one such response occurred.

Since producing a timeout precluded the possibility of another for 30 sec, the probabilities of the two classes of behavior can most reasonably be compared using the proportions of total PRPs in a session in which at least one mirror peck or timeout occurred. Figure 1 presents these data for the larger FR component for each session of each condition. The proportions were obtained by dividing the number of PRPs containing at least one mirror peck (or the number of those

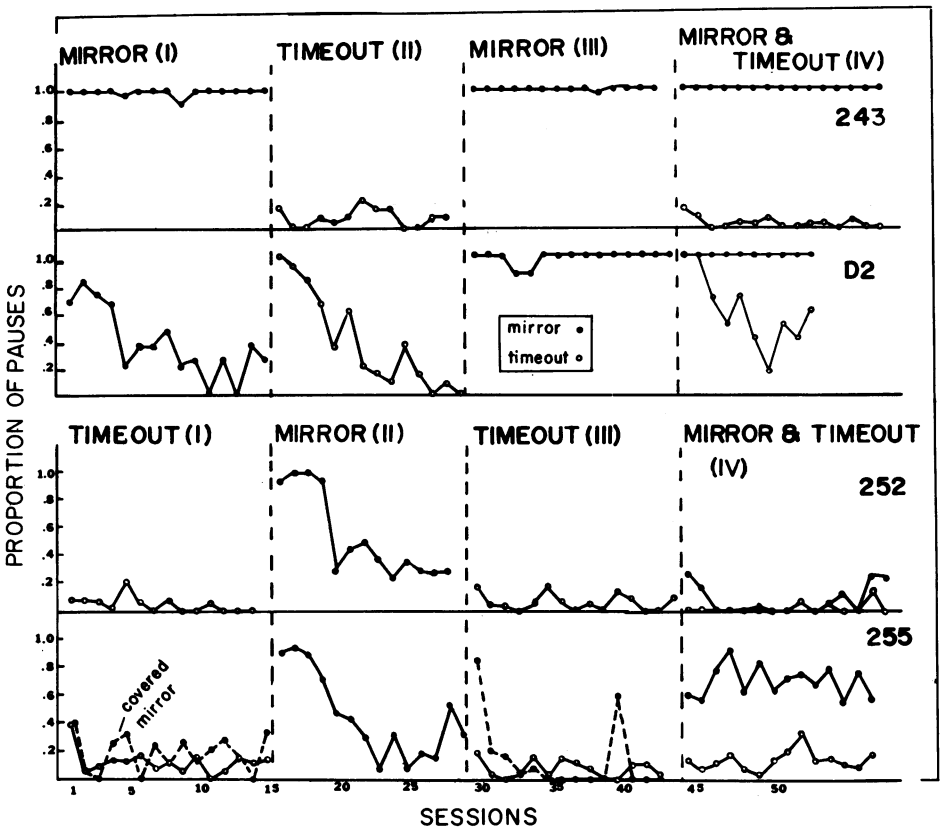

Fig. 1. Proportion of preratio pauses in the larger FR component in which at least one mirror peck or timeout occurred across conditions of availability. Note that the order of exposure to mirror and timeout key was counterbalanced across the four pigeons. The dashed lines for P252 indicate proportion of pauses in which wing flaps were recorded by contact with the covered mirror (see text).

PRPs containing at least one timeout) by the total number of PRPs in the session. Figure 1 shows that mirror pecks occurred in a greater proportion of the PRPs than did timeouts, regardless of order of exposure to the conditions. Although P243 pecked the mirror in virtually every pause, the same probability of responding on the timeout key did not develop when it was substituted in Condition II; yet, when mirror and timeout key both were available, mirror pecking did not occur to the exclusion of timeouts.

Uncovering the mirror for the first time generated high initial rates of mirror pecking in most birds, which are reflected in the proportion of pauses in which at least one mirror peck occurred (see Condition I for PD2 and Condition II for P252 and P255 in Figure 1). Mirror pecking tended to decrease in subsequent sessions, but PD2 ultimately developed a pattern of pecking the mirror in every pause (Condition III) and P255 pecked the mirror in more than two-thirds of them (Condition IV). When the mirror was uncovered in Condition II for P24 (not shown in Figure 1), at least one mirror peck occurred in 5 to 44% of the pauses in the first four sessions, but mirror pecking then decreased to zero and did not reoccur in Condition IV. Covering and uncovering the mirror did not induce mirror pecking in P250.

First exposure to the timeout key similarly resulted in a large number of pecks on it in the first session for PD2 (88 timeouts) and also for P243 (29 timeouts), disrupting performance on the food key. Food-key performance recovered by the second session, however, and timeouts decreased. For P250 (not shown in Figure 1), no timeouts occurred on first exposure to the timeout key (Condition II) until the second session when three were produced.

Five timeouts occurred in the third session and then zero or one occurred in the remaining ten sessions.

Pigeon P255 developed a stereotyped pattern of wing-flapping and bowing in the PRP of the FR 175 component during the first timeout condition (I). The pattern consisted of facing the front wall of the chamber, making quick bowing movements, and simultaneously flapping the wings. Some of the wing flaps contacted the covered mirror and were recorded as shown in Figure 1, with 85% of the total recorded wing flaps occurring in the PRP. This behavior persisted with a probability equal to or greater than timeout, although it declined in the second timeout condition (III). Observation during mirror conditions (II and IV) revealed that although some of the recorded mirror contacts were wing flaps, pecking predominated, becoming (in IV) a highly probable activity at the onset of each FR 175 component. During Condition IV, mirror contacts were recorded during timeout only for P255, with a mean of .3 to 5.9 contacts per timeout, but it is not known whether these were pecks or wing flaps. Staddon (1977, p. 137) also reported observations of induced wing flapping in pigeons under schedules of intermittent food delivery.

Cumulative records for P243 presented in Figure 2 exemplify the temporal patterning of responding typical of all birds. Responding on the food key under the multiple schedule was characterized by a pause followed by a run of responses at a high rate terminating with grain delivery. Pausing in the larger FR component was considerably longer than in the FR 25 component. Mirror pecking generally was initiated immediately or soon after grain delivery, while a response on the timeout key characteristically occurred in the latter half of the pause or interspersed with the first few pecks on the food key. Termination of a timeout frequently was followed immediately by the run of responses on the food key. When both mirror and timeout key were available

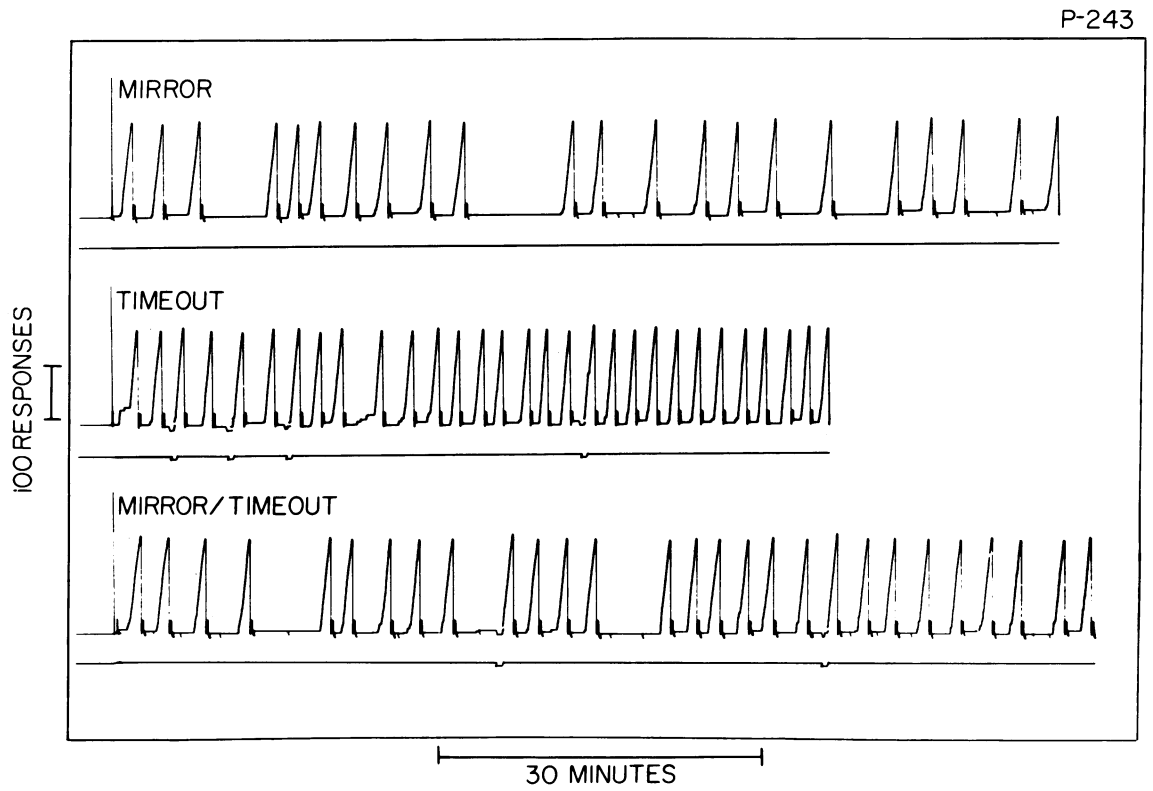

Fig. 2. Cumulative records for complete sessions with the mirror (Condition I, Session 15), timeout key (Condition II, Session 8), or both (Condition IV, Session 7) for P243 under a *mult* FR 25 FR 175 schedule of grain delivery. The upper pen stepped with pecks on the food key (including during timeout) and reset with grain delivery; it deflected with mirror pecks and during timeout. The lower pen deflected during timeout as well.

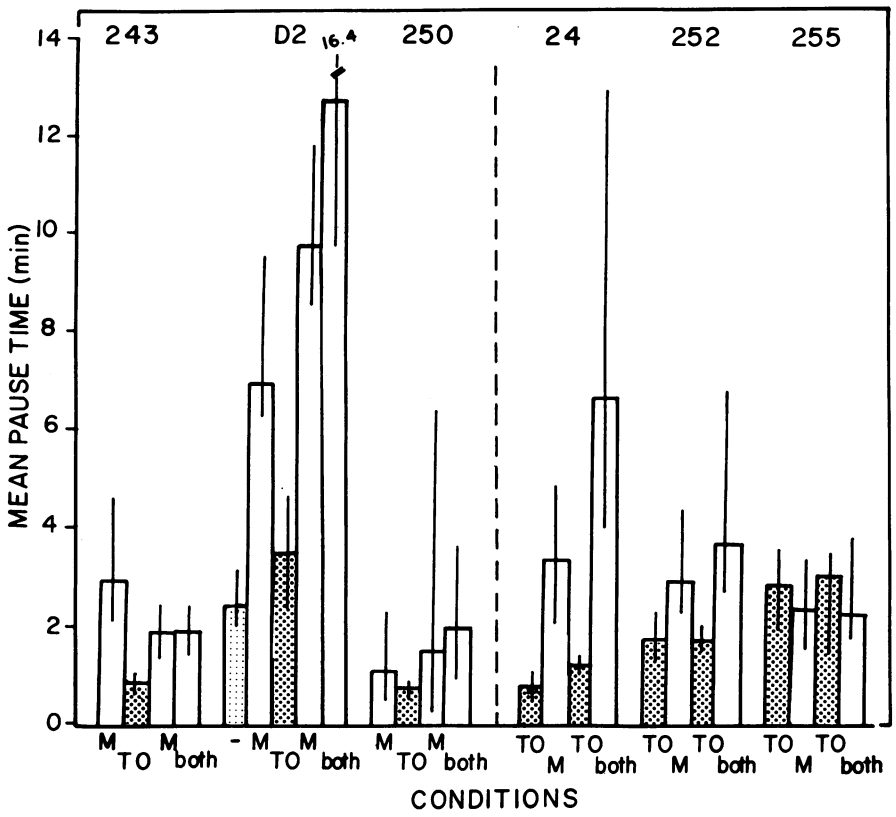

Fig. 3. Mean and range of preratio pause durations for the last five sessions in each condition of mirror or timeout key availability. The schedule of grain delivery was *mult* FR 25 FR 175 (except *mult* FR 25 FR 125 for PD2) throughout. The conditions of availability of the mirror alone (M) or timeout key alone (TO), or both are indicated on the horizontal axis; the differential shadings of the bars are redundant with the labels. The first condition shown for PD2 is for the last five sessions prior to Condition I, when neither mirror nor timeout key was available (–). The dashed line separates those birds for which the mirror condition preceded the timeout condition from those for which the reverse was true.

(Condition IV), the temporal loci characteristic of those responses when available singly generally were preserved for all birds (illustrated in Figure 2).

Durations of the larger FR component for individual birds are summarized in Table 1. It can be seen that this component was longer when the mirror was uncovered than when only the timeout key was available. As illustrated in Figure 2, this difference was attributable primarily to the difference in time spent pausing prior to initiation of responding on the food key. Figure 3 presents the means and ranges of pause durations (excluding time spent in timeout) in the last five sessions of each condition for all birds, including those which did not respond on the mirror or timeout key (P24, and P250). The unfilled bars indicate conditions in which the mirror was uncovered. The densely speckled bars indicate those in which only the timeout key was available. The lightly speckled bar for PD2 indicates pause duration for the last five sessions before Condition I, when neither mirror nor timeout key was available. All but Pigeon P255 showed a clear difference between those conditions in which the mirror was present and those in which it was not. The most striking aspect of this comparison is that the two birds for which mirror pecking failed to develop also paused longer when the mirror was available than when only the timeout key was available. Observation revealed that these birds stood facing, but not touching, the mirror during the PRP. Pausing in the FR 25 component was not consistently affected across

birds by mirror availability. Although pausing was appreciably longer when the mirror was present, systematic inspection of individual cumulative records revealed no relationship between the duration of single pauses and number of mirror pecks in that pause. Likewise, in the timeout condition, pauses which included a timeout were not longer than pauses which did not include timeout.

DISCUSSION

Both mirror and timeout key pecking were generated in the majority of birds in the present experiment. The two types of behavior were similar in that both were located almost exclusively in the larger FR component of the multiple schedule and predominantly in the pause preceding the ratio run in that component. These results are consistent with the findings of other studies which have examined attack (Cherek & Pickens, 1970; Cohen & Looney, 1973; Flory, 1969a,b; Looney, Cohen, & Yoburn, 1976) or timeout (Azrin, 1961; Thomas & Sherman, 1965; Thompson, 1965) in pigeons under single and multple FR schedules. Certain clear differences between mirror and timeout behavior emerged, however, in the present experiment. The probability of a peck on the mirror generally was greater than of a peck on the timeout key both within and across birds. This was true whether or not a stable and reliable pattern of mirror responding had been established prior to introduction of the timeout key. Also, mirror pecking generally was initiated immediately or very soon after onset of the keylight for the larger FR component, whereas timeouts typically were initiated later in the pause and, occasionally, after pecking on the food key had commenced. Examination of cumulative records from separate studies of attack (Cherek & Pickens, 1970; Cohen & Looney, 1973; Flory, 1969b) and timeout (Appel, 1963; Azrin, 1961; Thompson, 1975) in pigeons responding under ratio schedules of food delivery reveals patterning similar to that in the present study.

Only four of the six birds in the present experiment showed mirror responding. A number of variables have been reported to be influential or predictive in the development of attack against pictorial targets, including late exposure to the target (Looney et al., 1976), minimum level of attack during baseline (Looney et al., 1976), and extended exposure to the schedule of food delivery (Looney & Dove, 1978). For the two birds that did not peck the mirror in the present study, early exposure to the mirror at a low FR value prior to the present experiment (FR 25) was confounded with zero baseline rates of mirror responding in the absence of the schedule. Neither extended exposure to the mirror over the months prior to the present experiment nor time with the mirror covered (during the timeout condition) was sufficient to generate sustained mirror pecking.

That some behavior was generated by the presence of the mirror was indicated by the longer preratio pausing in the larger FR component for all birds, including the nonattackers. Cohen and Looney (1974) also found that longer preratio pausing was generated in the larger component of a *mult* FR FR schedule when the mirror was available compared to when the mirror was covered, even for birds which failed to register pecks upon the mirror. In addition, Cohen and Looney (1973), using a mirror, and Knutson (1970), using a stuffed pigeon, found that when the target was removed from the chamber, preratio pausing decreased and reinforcement frequency was higher. The present results extend this finding to a condition in which another explicitly measured behavior (timeout) was possible. Similarly, in studies of polydipsia, Iversen (1976) found that pause duration under FR schedules was generally longer when a water bottle was present than when it was not. Segal and Bandt (1966) reported that rate of responding in the initial (fixed interval) link of a chained schedule was lower when a water bottle was present than when it was not.

Although there were similarities between timeout and attack in the present study, there were also consistent differences between the two activities. The particular locus of attack and timeout within the pause was found to be idiosyncratic to that behavior under the conditions studied and, although most birds exhibited both types of behavior, mirror pecking clearly was the more probable. The two activities did not seem to be interchangeable, in a strict sense of the word, nor to be particularly affected either by a history of the other behavior or the simultaneous availability of the

other behavior. Having both timeout and mirror pecking available at the same time did not alter the likelihood of either activity. Rather, both occurred with probabilities similar to when the behavior was available singly, and each behavior retained its characteristic temporal locus.

Two reports have been made of one adjunctive behavior actually supplanting another. One is an anecdotal report that the opportunity for rats to shred and eat the excreta liner resulted in that activity (pica) supplanting drinking (Freed & Hymowitz, 1969). In the other report, Roper (1978) showed that as the interpellet interval was lengthened, running supplanted adjunctive drinking in rats. In future studies, manipulation of the interreinforcement interval when both attack and timeout are available would contribute to an understanding of the generality of the present findings and of the variables which are important in modulating the temporal patterning of these types of behavior.

REFERENCES

Appel, J. B. Aversive aspects of a schedule of positive reinforcement. *Journal of the Experimental Analysis of Behavior,* 1963, **6,** 423-428.

Ator, N. A. *The interchangeability of adjunctive mirror responding and adjunctive timeout production in pigeons.* Unpublished master's thesis. University of Maryland, 1974.

Azrin, N. H. Time-out from positive reinforcement. *Science,* 1961, **133,** 382-383.

Brown, T. G., & Flory, R. K. Schedule-induced escape from fixed-interval reinforcement. *Journal of the Experimental Analysis of Behavior,* 1972, **17,** 395-403.

Cherek, D. R., & Pickens, R. Schedule-induced aggression as a function of fixed-ratio value. *Journal of the Experimental Analysis of Behavior,* 1970, **14,** 309-311.

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

Cohen, P. S., & Looney, T. A. Mirror control of responding on fixed-ratio schedules in pigeons. *Bulletin of the Psychonomic Society,* 1974, **4,** 113-115.

Falk, J. L. The nature and determinants of adjunctive behavior. *Physiology and Behavior,* 1971, **6,** 577-588.

Falk, J. L. The origin and function of adjunctive behavior. *Animal Learning & Behavior,* 1977, **5,** 325-335.

Flory, R. Attack behavior as a function of minimum inter-food interval. *Journal of the Experimental Analysis of Behavior,* 1969, **12,** 825-828 (a).

Flory, R. Attack behavior in a multiple fixed-ratio schedule of reinforcement. *Psychonomic Science,* 1969, **16,** 156-157 (b).

Freed, F. X., & Hymowitz, N. A fortuitous observation regarding "psychogenic" polydipsia. *Psychological Reports,* 1969, 24, 224-226.

Gentry, W. D. Fixed-ratio schedule-induced aggression. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 813-817.

Gentry, W. D., & Schaeffer, R. W. The effect of FR response requirement on aggressive behavior in rats. *Psychonomic Science,* 1969, **14,** 236 & 238.

Griffiths, R. R., & Thompson, T. The post-reinforcement pause: A misnomer. *Psychological Record,* 1973, **23,** 229-235.

Hymowitz, N. Schedule-induced polydipsia and aggression in rats. *Psychonomic Science,* 1971, **23,** 226-228.

Iversen, I. H. Interactions between reinforced responses and collateral responses. *Psychological Record,* 1976, **26,** 399-413.

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.

Knutson, J. F., & Schrader, S. P. A concurrent assessment of schedule-induced aggression and schedule-induced polydipsia in the rat. *Animal Learning & Behavior,* 1975, **3,** 16-20.

Levitsky, D., & Collier, G. Schedule-induced wheel running. *Physiology and Behavior,* 1968, **3,** 571-573.

Looney, T. A., Cohen, P. S., & Yoburn, B. C. Variables of schedule-induced attack in White Carneaux pigeons. *Journal of the Experimental Analysis of Behavior,* 1974, **21,** 571-584.

Looney, T. A., & Cohen, P. S. Pictorial target control affecting establishment of schedule-induced attack on pictorial targets in White King pigeons. *Journal of the Experimental Analysis of Behavior,* 1976, **26,** 349-360.

Looney, T. A., & Dove, L. D. Schedule-induced attack as a function of length of exposure to a fixed-time 90-sec schedule. *Bulletin of the Psychonomic Society,* 1978, **12,** 320-322.

Miller, J. S., & Gollub, L. R. Adjunctive and operant bolt pecking in the pigeon. *Psychological Record,* 1974, **24,** 203-208.

Penney, J., & Schull, J. Functional differentiation of adjunctive drinking and wheel running in rats. *Animal Learning & Behavior,* 1977, **5,** 272-280.

Reynolds, G. S. Relativity of response rate and reinforcement frequency in a multiple schedule. *Journal of the Experimental Analysis of Behavior,* 1961, **4,** 179-184.

Roper, T. J. Diversity and substitutability of adjunctive activities under fixed-interval schedules of food reinforcement. *Journal of the Experimental Analysis of Behavior,* 1978, **30,** 83-96.

Segal, E. F. Induction and the provenance of operants. In R. M. Gilbert and J. R. Millenson (Eds.), *Reinforcement: Behavioral Analyses.* New York: Academic Press, 1972.

Segal, E. F., & Bandt, W. M. Influence of collateral water drinking on bar pressing under complex reinforcement contingencies. *Psychonomic Science,* 1966, **4,** 377-378.

Smith, J. B., & Clark, F. C. Intercurrent and reinforced

behavior under multiple spaced-responding schedules. *Journal of the Experimental Analysis of Behavior,* 1974, **21,** 445-454.

Staddon, J. E. R. Schedule-induced behavior. In W. K. Honig and J. E. R. Staddon (Eds.), *Handbook of Operant Behavior.* Englewood Cliffs, N.J.: Prentice-Hall, 1977.

Staddon, J. E. R., & Ayres, S. L. Sequential and temporal properties of behavior induced by a schedule of periodic food delivery. *Behaviour,* 1975, **54,** 26-49.

Thomas, J. R., & Sherman, J. A. Time out from a fixed ratio schedule. *Psychonomic Science,* 1965, **3,** 489-490.

Thompson, D. M. Time-out from fixed-ratio reinforcement: A systematic replication. *Psychonomic Science,* 1965, **2,** 109-110.

Whalen, T. E., & Wilkie, D. M. Failure to find schedule-induced polydipsia in the pigeon. *Bulletin of the Psychonomic Society,* 1977, **10,** 200-202.

Yoburn, B. C., & Cohen, P. S. Assessment of attack and drinking in White King pigeons on response-independent food schedules. *Journal of the Experimental Analysis of Behavior,* 1979, **31,** 91-101.

Received August 10, 1979
Final acceptance May 22, 1980