JOURNAL OF THE EXPERIMENTAL ANALYSIS OF BEHAVIOR 1979, 31, 91-101 NUMBER 1 (JANUARY)

ASSESSMENT OF ATTACK AND DRINKING IN WHITE KING PIGEONS ON RESPONSE-INDEPENDENT FOOD SCHEDULES[1]

Byron C. Yoburn and Perrin S. Cohen

NORTHEASTERN UNIVERSITY

Four White King pigeons in Experiment I were exposed to a fixed-time 90-second food schedule with successive access to water and a conspecific target. Drinking per session was sporadic and minimal, while attack per session occurred during most interfood intervals for all animals. Analysis of the temporal distribution of attack showed that the typical postreinforcement pattern of attack developed over the course of the experiment. In Experiment II, the same animals were exposed to a series of fixed-time schedules ranging from 30 to 360 seconds with successive access to water and target. Time engaged in drinking and the number of interfood intervals with drinking were less than that of attack. Food and no-food baselines, which have been typically used to assess schedule-induced drinking and attack, respectively, were used to evaluate the effect of the schedule on attack and water ingestion. Relative tó the no-food baseline, both attack and drinking were enhanced by the schedule in all birds. Relative to the food baseline, drinking was slightly suppressed in three birds and attack was enhanced in all. For all animals, the food baseline resulted in more attack and drinking than the no-food baseline.

Key words: attack, drinking, schedule-induced behavior, response-independent food schedules, White King pigeons

Schedule-induced attack in pigeons and schedule-induced polydipsia in rats have been shown to occur under similar conditions. Falk (1971) noted that the degree of both schedule-induced attack in pigeons and polydipsia in rats is dependent on the schedule of food delivery. Rats exposed to fixed-interval (FI) or fixed-time (FT) food schedules ranging from 1 to 480 sec drank more water per food pellet at the intermediate schedule values than at the extreme values (Falk, 1966; Flory, 1971; Wayner and Greenberg, 1973). This downward-concave function also describes the relationship between attacks per food delivery and interfood interval for some pigeons exposed to FT and FI schedules (Cherek, Thompson, and Heistad, 1973; Flory, 1969). Also, both schedule-induced attack and polydipsia are highly probable immediately following a food delivery, and decrease in probability as a function of time to the next food delivery (*e.g.*, Azrin, Hutchinson, and Hake, 1966; Falk, 1969; Killeen, 1975). In view of the similarity between these two behaviors, Falk (1971, 1977) suggested that they are members of a class of adjunctive behaviors that are generated by common variables and typically occur when reinforcement probability is low. Staddon (1977) also pointed out the similarities between schedule-induced attack in pigeons and polydipsia in rats. Although he has noted that they are differentially affected by reinforcement frequency, he includes them as typical interim activities that occur when a reinforcer is unlikely to be delivered.

In order to establish that two behaviors in one species are induced by common variables it is necessary to demonstrate that the food schedule exerts comparable effects on both behaviors. Since most of the comparisons between schedule-induced attack and polydipsia, to date, have been made between species, subjects, and experiments, it is still premature to assume that a reinforcement schedule that enhances drinking in one subject will also enhance attack in the same subject, or *vice versa*. Experiments by Knutson and Schrader (1975) and

---

[1] This research was supported in part by USPHS Grants RR07143 and R01 MH25514-01 to Northeastern University. Mary-Thomas Turnock and Rohe V. Pennington provided many helpful comments throughout this study. We thank Gary Hebner and Sharon Hogan for assistance in conducting the experiments. Some of these data were presented at the 1978 Annual Meeting of the Eastern Psychological Association in Washington, D.C. Reprints may be obtained from B. C. Yoburn, Department of Psychology, Northeastern University, 360 Huntington Avenue, Boston, Massachusetts 02115.

Hymowitz (1971), which made intra- and intersubject comparisons with rats, indicate that drinking is enhanced by food schedules, but attack is not. Similarly, across-experiment comparisons suggest that food schedules do not exert similar effects on attack and drinking in pigeons. While there are many reports of schedule-induced attack in pigeons, there is only one report of schedule-induced polydipsia (Shanab and Peterson, 1969), and that report has not been substantiated (Miller and Gollub, 1974; Whalen and Wilkie, 1977).

In light of possible species and individual subject differences, the present experiments assessed the effect of an intermittent food schedule on attack and drinking in the same subject. The first experiment investigated the development and maintenance of attack and drinking. The second experiment assessed the effect of the interfood interval on those behaviors and used two baseline procedures to evaluate the role of time and food intermittency.

EXPERIMENT I

This experiment examined attack and drinking in White King pigeons exposed to an intermittent food schedule that previously was shown to induce attack (Flory, 1969; Looney, Cohen, and Yoburn, 1976). Looney *et al.* (1976) showed that for one conspecific target, more pigeons engaged in schedule-induced attack when exposed to a food schedule before the target is introduced than when exposed to both the food schedule and the target on the first session. Although late introduction of a conspecific target was more effective in inducing attack than early introduction, this manipulation could interfere with the development of schedule-induced polydipsia in pigeons. Therefore, in the first experiment, animals either were given early or late introduction to water followed by access to a conspecific target and re-exposure to water.

METHOD

Subjects

Four, experimentally-naive male White King pigeons were maintained at 75% (±20 g) of their free-feeding weights. They had free access to water and grit in their home cage. Supplementary feedings of mixed grain were given following test sessions as required to maintain stable deprived body weights.

Apparatus

A 33.0-cm H by 35.9-cm W by 34.9-cm D black test chamber was placed inside a 63.5-cm H by 111.8-cm W by 101.6-cm D black enclosure. The walls of the enclosure were constructed of black wallboard and heavy black curtain. One wall had a 5.0-cm H by 5.5-cm W opening for video monitoring.

The door of the test chamber consisted of 2.5-cm grid mesh to allow video monitoring. Chamber illumination was provided by six 1.6-W houselights mounted on the roof of the chamber behind a ground-glass shield. An exhaust fan and white-noise generator partially masked extraneous noise.

Food was delivered by a hopper located behind a 5.1-cm H by 5.8-cm W hole centered on one 33.0-cm by 34.9-cm wall. A photocell was mounted in the hopper such that food deliveries could be timed precisely. Located directly opposite the food hopper was a modular wall that allowed presentation of either a target or water. The target was a color photograph of a conspecific (see target B; Looney, *et al.*, 1976) covered with a protective layer of Scotch Brand Magic Mending tape. The 15.3-cm H by 12.1-cm W target was mounted on a piece of Plexiglas, which was suspended from two frame-mounted Microswitches (Micro Switch, #311 SM 701T). The 22.1-cm H by 16.0-cm W frame was positioned on the modular wall such that the eye of the target was 20.5 cm above the floor and 9.4 cm from the mesh door. A force of approximately 0.1 N or greater applied to any point on the target closed one of the switches and was defined as one target response. Attack duration per session was defined as the cumulative duration of switch closures.

During sessions when subjects had access to water, the target was removed and a panel with a 6.8-cm H by 5.8-cm W opening was inserted in its place. This opening was centered at approximately the same location as the target. The center of the opening was positioned 14.9 cm above the grid floor and 7.0 cm from the mesh door. Behind the opening was a 3.9-cm H by 11.8-cm W by 6.7-cm D Plexiglas water cup with a shield to prevent spillage. The sides of the water cup were sandpapered to eliminate reflection, and the cup was completely enclosed by flat black walls. A 1.6-W light located above the water dish provided illumination. In order to record the frequency, duration, and temporal location of drinking, a photocell and light were mounted on opposite sides of the water dish. A drinking response was defined as a photobeam interruption, and duration of drinking per session was defined as the cumulative duration of interruptions.

During sessions when neither water nor target was available, the rear chamber wall was replaced with a smooth flat-black surface. Experimental recording and scheduling apparatus was located in an adjoining room.

Procedure

All birds were trained to eat mixed grain from the hopper before the first session. Beginning with Session 1 and continuing throughout Experiment I, all animals were exposed to an FT 90-sec schedule of food delivery in which 20, 3-sec food presentations were programmed independently of the birds' behavior at 90-sec intervals. Two birds (P9839, P8927) had access to water, but not the target, during the first 45 sessions of the FT schedule. The remaining two (P7824, P7492) were exposed to the FT schedule without water or target for 25 sessions, followed by 20 sessions with water available. Beginning with Session 46, the water was removed and all animals were given access to the conspecific target and the food schedule for 20 sessions. Finally, the target was removed and all animals were re-exposed to the water and FT schedule for an additional 10 sessions.

Throughout Experiments I and II, the amount of water ingested was measured immediately after a test session. Evaporation was measured and found to be negligible. In both experiments, a protective contingency delayed a scheduled food delivery until drinking or attack had not occurred for 10 sec.

RESULTS

Table 1 presents the mean and range of the behavior duration, interfood intervals with at least one response, water ingestion (ml) per session, and attacks per session over the last five sessions of exposure to water and target. Regardless of whether water was introduced on the first or twenty-sixth session, the amount of time engaged in drinking and the number of intervals with drinking was less than that with attack. Both P8927 and P7492 drank small amounts during both exposures to water. There was a small increase in all measures during the second exposure, although drinking during both exposures was infrequent and of short duration when compared with attack. Table 1 shows that P9839 and P7824 did not drink over the last five days of either water-

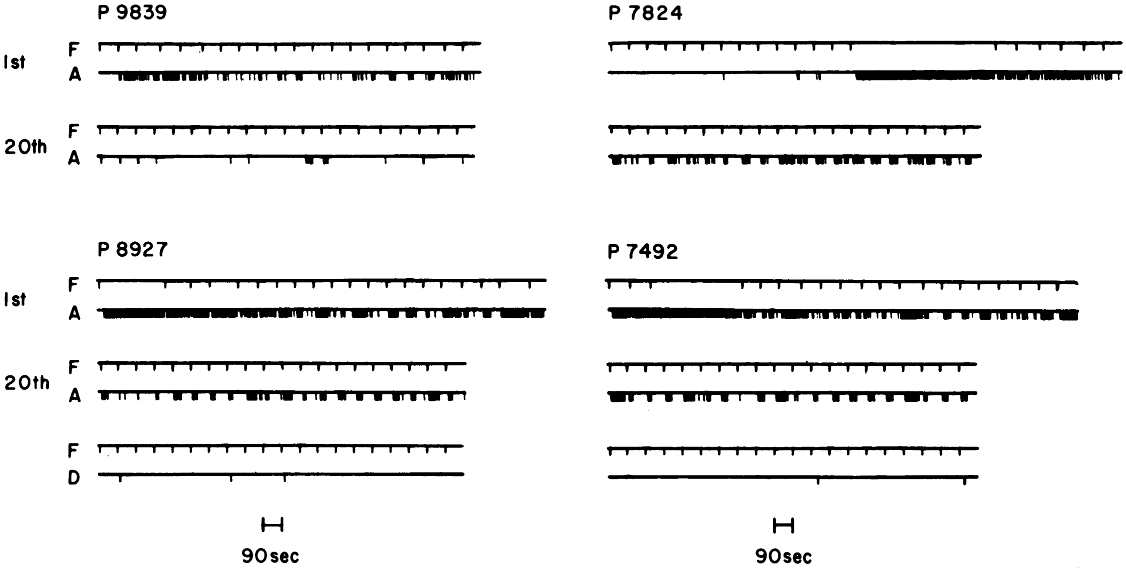

Fig. 1. Event records from the first and twentieth target-access sessions and representative records from sessions with drinking for P8927 (last session of first exposure to water) and P7492 (last session of second exposure to water). A downward mark on the F, A, and D lines corresponds to a food delivery, an attack response, and a drink response, respectively.

Table 1

Mean and range of behavior duration, interfood intervals with a response, water intake (ml) per session, and attacks per session over the last five sessions at each condition in Experiment I.

Animal	*Behavior Duration (sec)*			*Number of Intervals with a Response*			*Water Intake per Session (ml)*		*Attacks per Session*
	Water			*Water*					
	First Exposure	*Second Exposure*	*Target*	*First Exposure*	*Second Exposure*	*Target*	*First Exposure*	*Second Exposure*	
LATE									
9839	0.2 (0.0-1.1)	0.0	7.5 (3.2-12.8)	0.2 (0-1)	0.0	13.8 (10-16)	0.0	0.0	70.0 (42-101)
8927	1.4 (1.1-1.9)	1.9 (1.2-2.9)	57.1 (45.5-71.0)	2.2 (1-3)	2.4 (1-4)	19.8 (19-20)	3.7 (2.0-6.5)	5.1 (3.0-7.5)	484.4 (405-580)
EARLY									
7824	0.0	0.0	39.0 (25.8-61.7)	0.0	0.0	20.0	0.0	0.0	507.8 (427-589)
7492	1.8 (0.0-7.4)	2.3 (0.0-4.2)	36.8 (20.5-60.0)	1.0 (0-3)	1.4 (0-2)	20.0	0.5 (0.0-1.5)	2.0 (0.0-4.0)	363.2 (242-471)

access condition. P7824 sampled the water during five other sessions, but never ingested more than 1.0 ml per session. P9839 failed to ingest water during Experiment I, although this animal did insert its head into the water cup once during Session 43.

Figure 1 presents event records from the first and twentieth target-access sessions for all animals, and from representative water-access sessions for P8927 and P7492. Throughout Experiment I, drinking responses tended to be confined to the first third of the interfood interval and, as described above, were few in number and short in duration. In contrast, all animals attacked during each target-access session and, as can be seen in Figure 1, the attacks tended to be distributed throughout the interfood interval during the first session and, by the twentieth session, primarily occurred after a food delivery. Figure 2 presents the relative frequency of the last target response in an interfood interval as a function of time following a food delivery. The open circles represent the first five sessions, the closed circles, the last five. Due to the protective contingency, attacks occurring at the end of the interfood interval could delay the next scheduled food delivery and extend the interfood interval beyond 90 sec. For all birds, the distribution of occurrence of the last attack within an interfood interval shifted toward the postfood period. This shift was accompanied by a 51%, 14%, 31%, and 48% decrease in the mean number of attacks from the first five

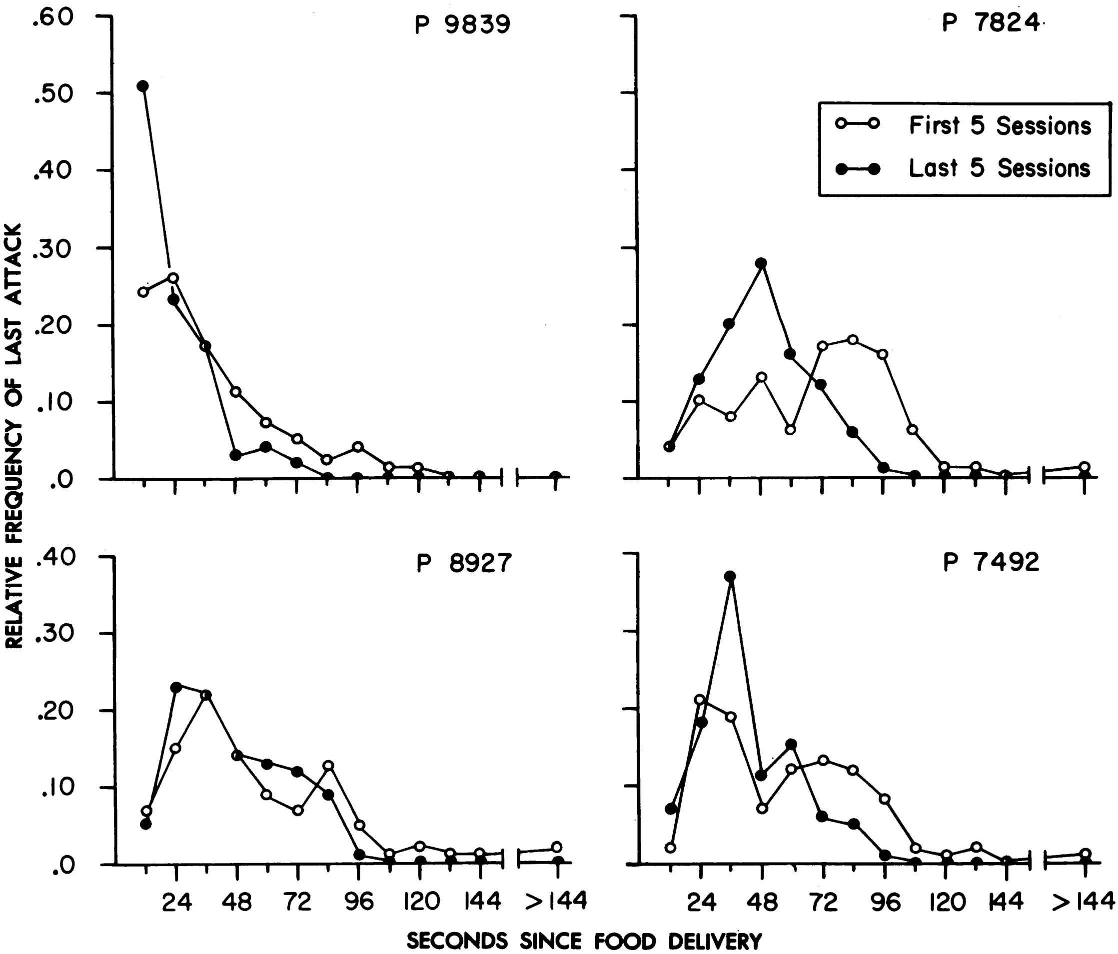

Fig. 2. Relative frequency of the last attack in an interfood interval as a function of time since a food delivery. The open circles correspond to the first five target-access sessions and the closed circles correspond to the last five target-access sessions in Experiment I.

to the last five sessions for P9839, P7824, P8927, and P7492, respectively. There was a similar decrease in attack duration for each bird. Due to the infrequent occurrence of drinking, comparable information on its temporal distribution was unavailable.

DISCUSSION

Pigeons exposed to an FT 90-sec schedule of food delivery exhibited a pattern of attack comparable to that reported in previous experiments (*e.g.*, Flory, 1969; Looney *et al.*, 1976), but showed little if any tendency to ingest water. This minimal drinking is consistent with previous experiments that have failed to find schedule-induced drinking in pigeons (Miller and Gollub, 1974; Whalen and Wilkie, 1977). This within-subject comparison of attack on a conspecific target and water ingestion demonstrates that an FT 90-sec food schedule does not generate comparable levels of attack and drinking.

The present data show that the typical postreinforcement pattern of attack that has been reported on FT food schedules (Cohen, Yoburn, and Looney, 1976; Flory, 1969; Killeen, 1975; Looney *et al.*, 1976) was not present during the first session but developed over the course of the experiment. Staddon (1977) suggested that the typical postreinforcement pattern of schedule-induced behavior is related to the reduced reinforcement rate following food delivery. However, if attack were solely a function of reduced reinforcement rate, its temporal location during the first target-access session should have been postreinforcement for birds with an extended history of exposure to an FT food schedule. That was not the case in Experiment I. It is possible that the extended attack bouts during the first session with the target may have been due to the pairing of the test chamber with the postreinforcement periods, such that the environmental stimuli present during the initial target sessions were conditioned stimuli. This possibility is supported by experiments that have shown that stimuli associated with attack-inducing food schedules acquire control over schedule-induced attack (Cohen and Looney, 1973; Cole and Litchfield, 1969). The novelty of the target also may have contributed to the extended attack bouts. The subsequent development of the postreinforcement pattern of attack may have been due to the waning of the novelty response and the control exerted by the schedule and the protective contingency.

EXPERIMENT II

Although Experiment I demonstrated that animals spend more time engaged in attack than drinking during an FT 90-sec schedule, it is possible that other interfood intervals are effective in inducing similar levels of drinking and attack, or perhaps greater levels of drinking than attack. Therefore, in the second experiment, birds were presented successively with access to water or a conspecific target at FT schedules ranging from 30 to 360 sec.

The role of the intermittency of food in inducing polydipsia in rats has been assessed by comparing water ingested during exposure to the intermittent food schedule with that which occurs during a baseline session when all the scheduled food is delivered at the beginning of an equal-duration session (Allen and Porter, 1977; Falk, 1966, 1969; Penny and Schull, 1977; Schaeffer, 1977; Yoburn and Flory, 1977). Drinking during baseline is usually less than that which occurs during intermittent food schedules. On the other hand, the baseline procedure that has been used in schedule-induced attack experiments with pigeons is designed to evaluate the level of attack in the absence of food during sessions of equal duration to scheduled food sessions (Azrin *et al.*, 1966; Cherek and Heistad, 1971; Cherek *et al.*, 1973; Gentry, 1968; Looney and Cohen, 1974; Looney *et al.*, 1976; Richards and Rilling, 1972). Typically, in these experiments, the amount of attack associated with the food schedules exceeds that during the no-food baseline procedures. Both baseline procedures have been used extensively and there are merits to each. Therefore, food and no-food baseline procedures were used in the second experiment, so that drinking and attack could be assessed adequately.

Subjects and Apparatus

Subjects and apparatus were the same as in Experiment I.

Procedure

Experiment II began immediately following Experiment I. P7824 and P9839 were exposed to the following series of FT schedules: 30, 120, 240, 360, 90 sec. The remaining two animals, P8927 and P7492, were exposed to the same FT schedules, but in the following order: 360, 240, 120, 30, 90 sec. As in Experiment I, all FT sessions consisted of 20, 3-sec food deliveries. At each schedule value each bird was first given 10 sessions with access to water. However, if drinking occurred during any of those 10 sessions, subjects were given a total of 15 sessions exposure. Following 10 or 15 sessions with access to water, animals were exposed to 10 sessions with the target. Subjects were then advanced to the next FT schedule.

When the series of FT schedules was completed, animals were exposed to no-food and food baseline procedures in a counterbalanced order (Table 2) with 15 sessions at each condition. Each baseline session was the same duration as an FT 360-sec session. The no-food baseline involved placing the animal in the chamber for 2 hr without food. The food baseline consisted of a total of 20, 3-sec food deliveries at the beginning of each session. No more than 1 sec elapsed between each food delivery. Following these 20 massed food deliveries, food was discontinued for the rest of the session.

Each baseline procedure was conducted with either access to water or target, for a total of four baseline conditions for each pigeon. After two baseline conditions, each animal was reexposed to the FT 90-sec schedule, with the target (10 sessions) followed by access to water (10 sessions). The remaining two baseline conditions were then completed for each animal.

Table 2

Order of baseline conditions for each animal in Experiment II.

Animal	*Baseline Condition*
9839	Food—Target Food—Water No Food—Water No Food—Target
8927	No Food—Target No Food—Water Food—Water Food—Target
7824	No Food—Water No Food—Target Food—Target Food—Water
7492	Food—Water Food—Target No Food—Target No Food—Water

RESULTS AND DISCUSSION

As in Experiment I, the amount of time engaged in attack was greater than time engaged in drinking. Over the last five sessions, the mean duration of attack was a minimum of 31, 7, 67, and 3 times greater than that of drinking at each FT schedule for P9839, P7824, P8927, and P7492, respectively. Figure 3 presents the mean number of interfood intervals with at least one attack or drink over the last five sessions at each FT condition. The mean number of intervals with at least one attack was equal to or greater than 19.4 of a maximum of 20 at each FT schedule for all animals. In contrast, the mean number of intervals with a drink was always less than the corresponding measure of attack, and increased as the interfood interval increased. Assuming that the momentary probability of drinking was constant within the interfood interval, this increase could reflect a corresponding increase in the opportunities to drink that accompanied the longer interfood interval. All animals attacked and drank during a similar number of intervals during re-exposure to the FT 90-sec schedule.

Figures 4 and 5 present the mean and range of water ingested per session and per minute, and attacks per session and per minute over the last five sessions of each condition. As shown in Figure 4, the mean quantity of water ingested during FT schedules was less than 13.1 ml per session (right ordinate) and 0.3 ml per minute (left ordinate) for all animals. All animals drank more water per session at the longer interfood intervals, whereas there was no systematic change in the rate of ingestion across FT schedules under which drinking occurred. The increase in water ingestion per session may reflect an increase in session duration, and not the longer interfood interval, *per se*.

A comparison between water intake per session during the food baseline and intake per session during the equal-duration FT 360-sec schedule indicated that the FT schedule enhanced water ingestion for P8927 and slightly suppressed ingestion for the remaining three birds. A similar comparison between rate of intake during the food baseline and the FT schedules indicated that the schedules either had no systematic effect or slightly suppressed rate of drinking for three birds. All schedules

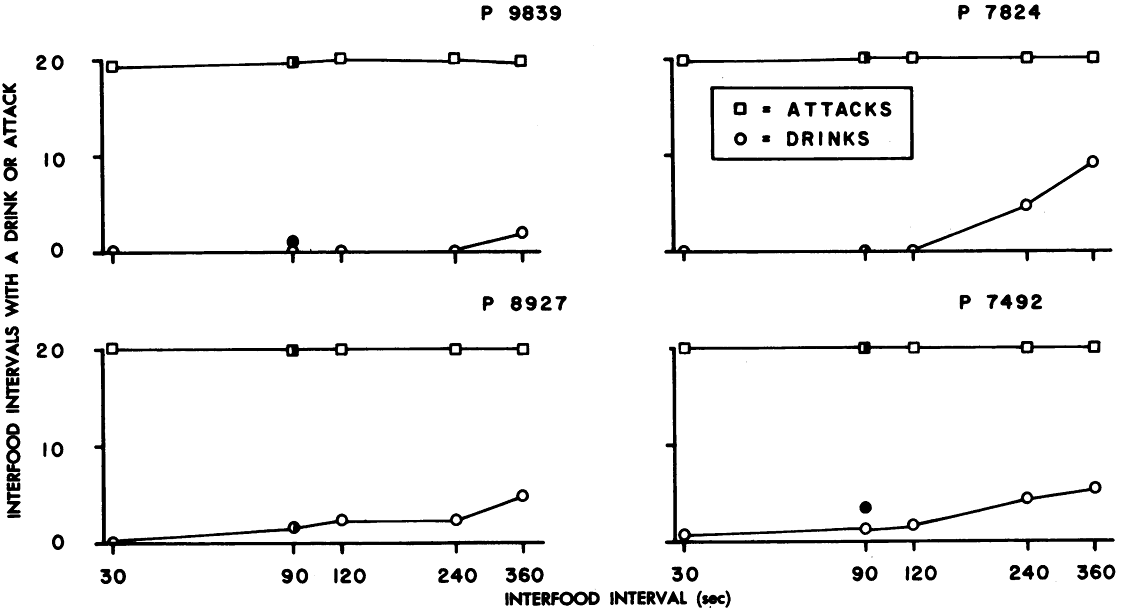

Fig. 3. Mean number of interfood intervals with an attack or drink as a function of interfood interval (logarithmic scale). Each data point was computed from the last five sessions at each FT schedule. Squares represent intervals with an attack, circles represent intervals with a drink. Open and closed symbols represent first and second exposure, respectively, to the FT 90-sec schedule in Experiment II.

other than FT 30-sec enhanced rate of drinking for P8927. In all cases, rate and frequency of drinking were less during the no-food baseline than during either the food baseline or the FT schedules that were accompanied by drinking.

Attacks per session (right ordinate of Figure 5) increased as the interfood interval increased for three of four birds and were unsystematically related to the interfood interval for P7492. Attacks per minute (left ordinate) remained constant across all FT schedules for P9839 and P8927, which suggests that the increase in attacks per session for these birds may be due to the increase in session duration. On the other hand, for P7824 and P7492, rate of attack was inversely related to interfood interval. The relationship between attack rate and interfood interval in this experiment is different from the results reported by Flory (1969). He found an inverted U-shaped relationship between attacks per minute on a stuffed target and FT schedule for two White Carneaux pigeons. It is possible that the type of target and strain of species may account for this discrepancy.

For all birds, mean attacks per session during the food and no-food baselines were less than that during the comparable duration FT 360-sec schedule, though there is substantial overlap in the ranges for P7492. Similarly, for all but P7492, mean attack rate during the food and no-food baselines was less than during all FT schedules. Furthermore, similar to the results for drinking, the food baseline enhanced attack rate and frequency relative to the no-food baseline.

GENERAL DISCUSSION

In summary, the data from Experiments I and II demonstrated that a wide range of response-independent food schedules did not induce comparable levels of attack and drinking in White King pigeons. For all birds, over 12 months of testing, the amount of time engaged in attack and the number of interfood intervals with an attack exceeded corresponding measures of drinking. This within-subject comparison of attack and drinking in pigeons is consistent with interexperiment comparisons that have demonstrated robust attack and little if any drinking. Perhaps these schedules might induce other behaviors, such as preening, wing-flapping, or bathing (Levi, 1974) during the interfood interval at levels similar to that of attack.

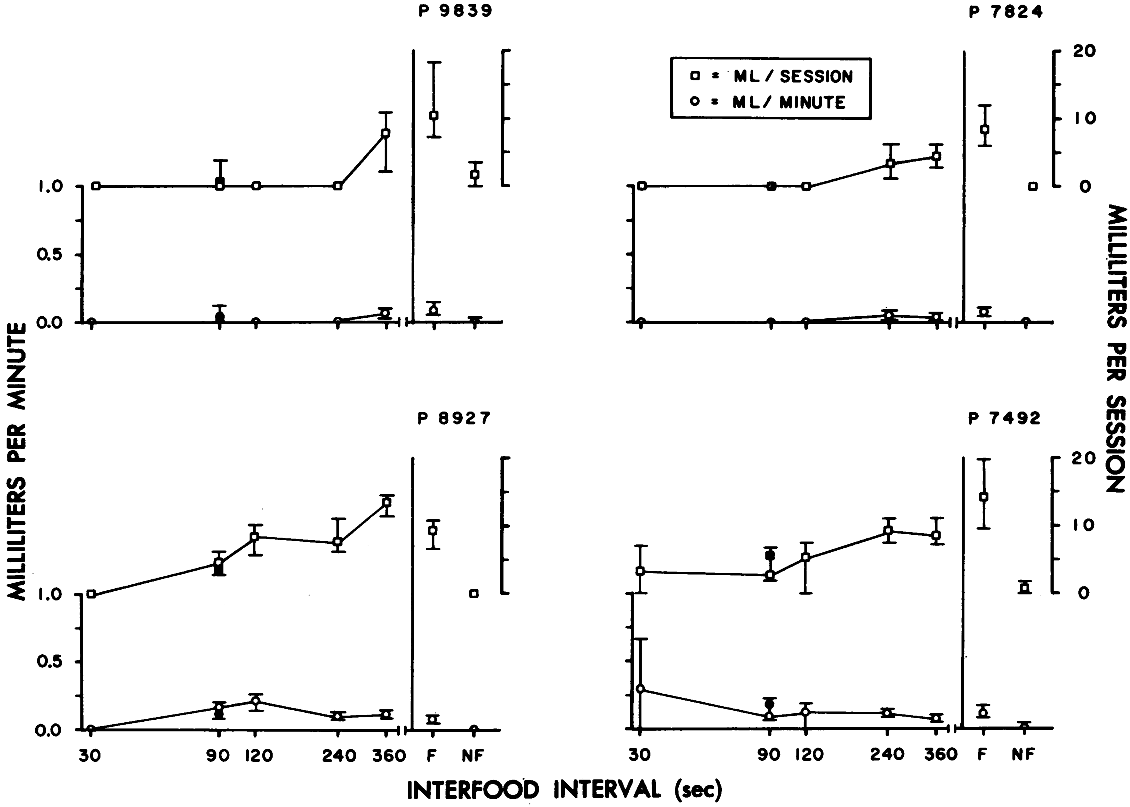

Fig. 4. Mean and range of water intake per session (left ordinate, circles) and per minute (right ordinate, squares) as a function of interfood interval (logarithmic scale) and food (F) and no-food (NF) baselines. Each data point was computed from the last five sessions at each condition. The open and closed symbols represent the first and second exposure, respectively, to the FT 90-sec schedule in Experiment II.

In Experiment II, the effect of the FT 360-sec schedule on attack and drinking was assessed relative to the equal duration no-food and food baselines. Relative to the no-food baseline criterion for assessing induced behavior (Azrin *et al.*, 1966; Gentry, 1968), the FT 360-sec schedule enhanced the rate and frequency measures of attack and drinking. However, relative to the food baseline (Falk, 1966), the intermittent delivery of food on the FT 360-sec schedule enhanced the rate and frequency measures of attack and drinking in one bird, and enhanced attack and slightly suppressed drinking in three. Thus, for three birds, the enhancement of attack by intermittent food deliveries was not accompanied by a corresponding increase in drinking. The enhancement of drinking for one of four birds in this study is consistent with the report of schedule-induced drinking in one pigeon (Shanab and Peterson, 1969) and subsequent failures to obtain that result in other studies (Miller and Gollub, 1974; Whalen and Wilkie, 1977).

As in the present study, Penny and Schull (1977) found that intermittent food schedules do not exert comparable effects on two behaviors, namely drinking and wheel running in rats. The rats in their experiment and the pigeons in the present study were differentially deprived in the home cage of access to one of the two behaviors measured in the test chamber. Although animals in both studies had continuous access to water in the home cage, oppotunities to attack or engage in wheel running were limited to the experimental chamber. This differential response deprivation may influence the effectiveness of a food schedule in establishing and maintaining schedule-induced behavior (Looney and Dove, 1978).

The occurrence of prandial drinking in many animals (Bolles, 1961; Cizek, 1959; Kissileff, 1969; Kutscher, 1969; McFarland, 1964, 1965) warrants the use of the food baseline,

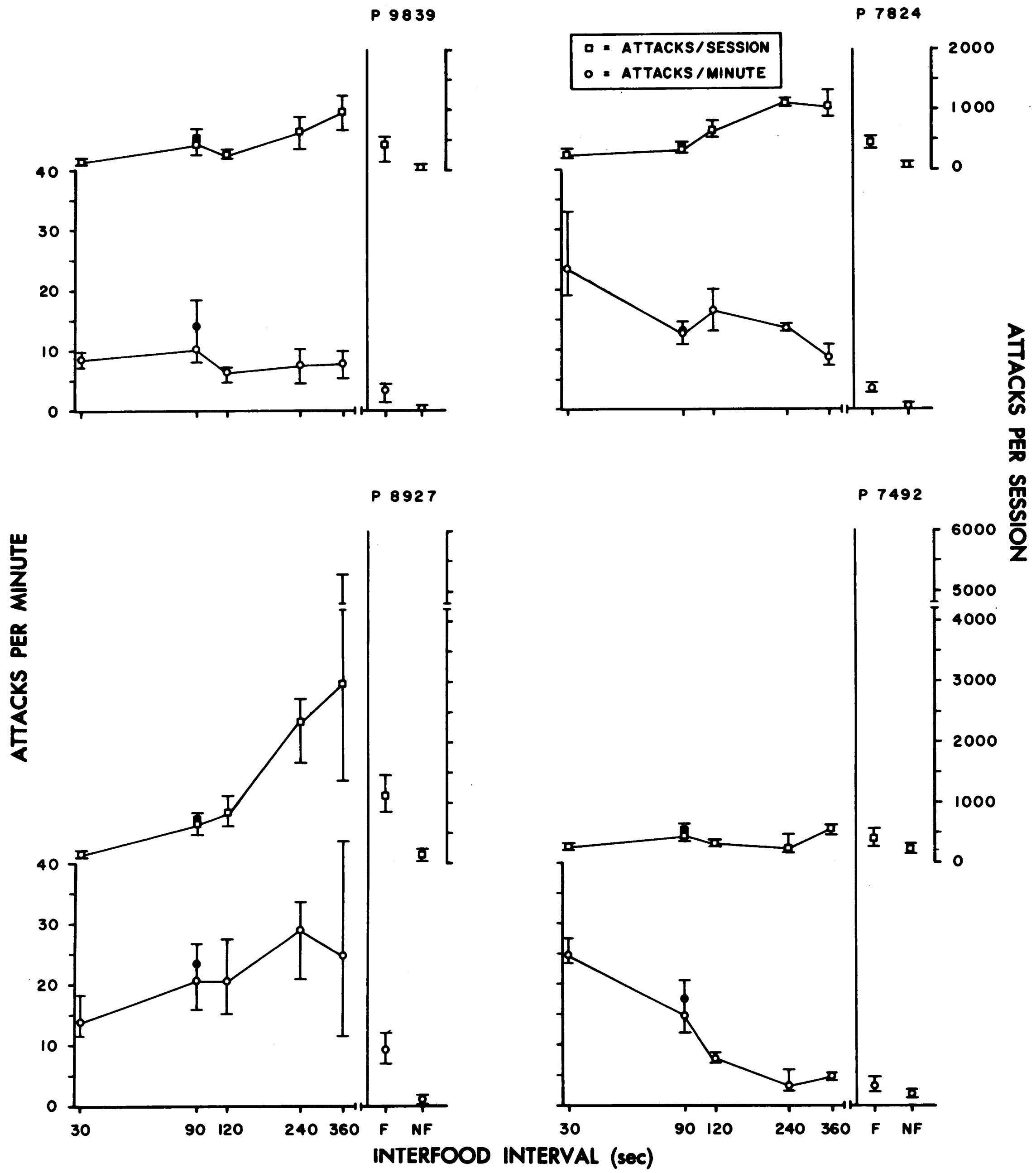

Fig. 5. Mean and range of attacks per session (left ordinate, circles) and per minute (right ordinate, squares) as a function of interfood interval (logarithmic scale) and food (F) and no-food (NF) baselines. Each data point was computed from the last five sessions at each condition. The open and closed symbols represent the first and second exposure, respectively, to the FT 90-sec schedule in Experiment II.

rather than the no-food baseline, to evaluate the effect of intermittent food deliveries on water intake. When the amount of water consumed during a food baseline is compared with that during an intermittent food schedule, it is possible to determine how much water intake is related to food intermittency and how much is prandial drinking. Similarly, the attack that followed massed food presentations in the Azrin *et al.* (1966) study, and the increase in rate and frequency of attack during the food baseline in the present experiment, may reflect eating-related, or prandial attack. This possibility is consistent with evidence that schedule-induced attack is directly related to deprivation level (Dove, 1976) and duration of food presentation (Azrin *et al.*, 1966). From this point of view, it is desirable to use a food baseline to assess the effect of intermittent food schedules on attack.

REFERENCES

Allen, J. D. and Porter, J. H. Sources of control over schedule-induced drinking produced by second-order schedules of reinforcement. *Physiology and Behavior*, 1977, **18**, 853-863.

Azrin, N. H., Hutchinson, R. R., and Hake, D. F. Extinction-induced aggression. *Journal of the Experimental Analysis of Behavior*, 1966, **9**, 191-204.

Bolles, R. C. The interaction of hunger and thirst in the rat. *Journal of Comparative and Physiological Psychology*, 1961, **54**, 580-584.

Cherek, D. R. and Heistad, G. T. Fixed-interval induced aggression. *Psychonomic Science*, 1971, **25**, 7-8.

Cherek, D. R., Thompson, T., and Heistad, G. T. Responding maintained by the opportunity to attack during an interval food reinforcement schedule. *Journal of the Experimental Analysis of Behavior*, 1973, **19**, 113-123.

Cizek, L. J. Long-term observations on the relationship between food and water ingestion in the dog. *American Journal of Physiology*, 1959, **197**, 242-246.

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.

Cohen, P. S., Yoburn, B. C., and Looney, T. A. An inexpensive random-access projector for rapid presentation of pictorial images. *Journal of the Experimental Analysis of Behavior*, 1976, **26**, 131-134.

Cole, J. M. and Litchfield, P. M. Stimulus control of schedule-induced aggression in the pigeon. *Psychonomic Science*, 1969, **17**, 152-153.

Dove, L. D. The relationship between level of food deprivation and the rate of schedule-induced aggression. *Journal of the Experimental Analysis of Behavior*, 1976, **25**, 63-68.

Falk, J. L. Schedule-induced polydipsia as a function of fixed-interval length. *Journal of the Experimental Analysis of Behavior*, 1966, **9**, 37-39.

Falk, J. L. Conditions producing psychogenic polydipsia in animals. *Annals of the New York Academy of Sciences*, 1969, **157**, 569-593.

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

Falk, J. L. The origins and functions of adjunctive behavior. *Animal Learning and Behavior*, 1977, **5**, 325-335.

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

Flory, R. K. The control of schedule-induced polydipsia: frequency and magnitude of reinforcement. *Learning and Motivation*, 1971, **2**, 215-227.

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

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

Killeen, P. On the temporal control of behavior. *Psychological Review*, 1975, **82**, 89-115.

Kissileff, H. R. Food-associated drinking in the rat. *Journal of Comparative and Physiological Psychology*, 1969, **67**, 284-300.

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

Kutscher, C. L. Species differences in the interaction of feeding and drinking. *Annals of the New York Academy of Sciences*, 1969, **157**, 539-552.

Levi, W. M. *The pigeon*. Sumter, South Carolina: Levi Publishing Co., 1974.

Looney, T. A. and Cohen, P. S. Pictorial target control 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., and Yoburn, B. C. Variables 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. and Dove, L. D. The effects of the presence of a home-chamber target on experimental session attack. *Physiology and Behavior*, 1978, **21**, 283-286.

McFarland, D. J. Interaction of hunger and thirst in the Barbary Dove. *Journal of Comparative and Physiological Psychology*, 1964, **58**, 174-179.

McFarland, D. J. The effect of hunger on thirst motivated behavior in the Barbary Dove. *Animal Behaviour*, 1965, **13**, 286-292.

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

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

Richards, R. W. and Rilling, M. Aversive aspects of a fixed-interval schedule of food reinforcement. *Journal of the Experimental Analysis of Behavior*, 1972, **71**, 405-411.

Schaeffer, R. W. The response of desalivate rats to a time-dependent food reinforcement schedule. *Physiology and Behavior*, 1977, **18**, 895-899.

Shanab, M. E. and Peterson, J. L. Polydipsia in the pigeon. *Psychonomic Science*, 1969, **15**, 51-52.

Staddon, J. E. R. Schedule-induced behavior. In W. K. Honig and J. E. R. Staddon (Eds), *Handbook of operant behavior*. Englewood Cliffs, New Jersey: Prentice-Hall, 1977. Pp. 125-152.

Wayner, M. J. and Greenberg, I. Schedule dependence of schedule-induced polydipsia and lever pressing. *Physiology and Behavior*, 1973, **10**, 965-966.

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

Yoburn, B. C. and Flory, R. K. Schedule-induced polydipsia and reinforcement magnitude. *Physiology and Behavior*, 1977, **18**, 787-791.

Received 6 December 1977.
(Final acceptance 6 July 1978.)