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PICTORIAL TARGET CONTROL OF SCHEDULE-INDUCED ATTACK IN WHITE CARNEAUX PIGEONS[1]

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Three pigeons with a history of attacking a mirror target, and two of six pigeons with no prior exposure to targets, attacked a colored photograph of a conspecific during exposure to intermittent schedules of reinforcement for key pecking. Rate of attack on the photograph decreased when the reinforcement schedule was removed. The topography, temporal pattern, and locus of attack on the picture were comparable to schedule-induced attack on live, stuffed, and mirror targets. When silhouette, outline, and plain paper targets were used, schedule-induced attack was more sensitive to a change in target characteristics with a concurrent target-preference procedure than with an analogous successive-testing procedure. The combined results of the two testing procedures indicated that an "upright" white-on-black silhouette of a pigeon with or without an eye was more effective in controlling attack than was a comparable "inverted" silhouette, an outline of a pigeon, or a piece of colored paper.

CONTENTS

Cohen and Looney (1973) demonstrated that mirror-image stimulation is effective in establishing and maintaining high rates of schedule-induced pecking and charging at a mirror target during exposure to certain intermittent schedules of reinforcement. The fact that pigeons exhibited sustained rates of schedule-induced pecking and charging on a hard two-dimensional mirror raises the possibility of using other two-dimensional pictorial stimuli such as photographs, projected slides, movies, drawings, and similar stimuli for studying the target conditions needed to initiate and maintain attack behavior.

Previous research with taxidermically stuffed targets (*e.g.*, Azrin, Hutchinson, and Hake, 1966; Smith and Hoskings, 1955), wooden models (*e.g.*, Stout and Brass, 1969), and mirror targets (*e.g.*, Cohen and Looney, 1973) suggests that target characteristics play an important and perhaps similar role in con-

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trolling schedule-induced and reproductive (Hinde, 1952; Marler, 1956) attack in birds. This is demonstrated, in the schedule-induced attack situation, by the fact that *not* all experimentally naive pigeons attack taxidermically stuffed (Azrin, *et al.*, 1966) and mirror (Cohen and Looney, 1973) targets whereas, under the same conditions, all experimentally naive pigeons attacked a live, restrained, conspecific target. In the case of territorial attack in birds, it has been demonstrated that specific features of a conspecific intruder such as head size (*e.g.*, Huxley and Fisher, 1940; Lack, 1940; Smith and Hoskings, 1955) and head height (Stout and Brass, 1969) can differentially control attack.

The present studies evaluated the visual target characteristics that control schedule-induced attack in the White Carneaux pigeon (*Columba livia*) by first determining if pigeons that exhibit schedule-induced attack on a mirror target will also exhibit schedule-induced attack on a colored photograph of a conspecific. Secondly, given that pigeons attack a colored photograph of a conspecific, are all aspects of that colored photograph essential for maintaining attack? Finally, do pigeons without a history of schedule-induced attack on a mirror, or any other pigeon target, also exhibit schedule-induced attack on a colored photograph?

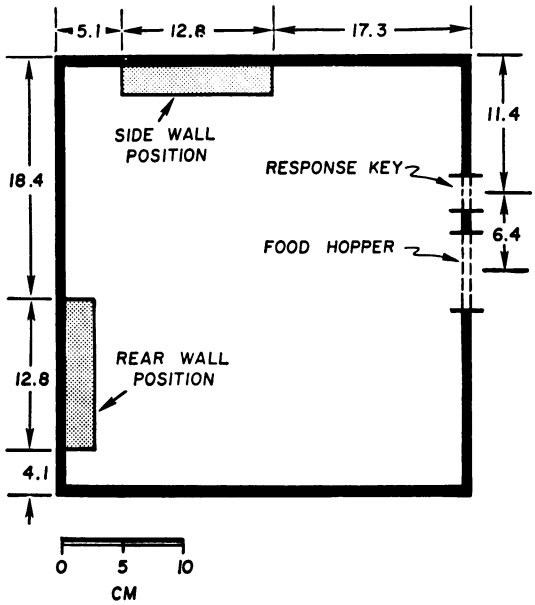

Fig. 1. Floor plan of experimental chamber indicating the spatial relationship among the pictorial targets, food hopper, and response key.

GENERAL METHOD

Apparatus

A 31.5 by 35.3 by 35.2-cm operant pigeon chamber (Figure 1) with a Lehigh Valley Electronics, two-key intelligence panel was used. Only the response key to the left of the grain hopper was operative. This key was transilluminated with either a green or white light and had a minimum force requirement for operation of 0.15N as measured by a Jonard dynamometer. Reinforcement was defined as 3-sec access to grain from the hopper. Pictorial targets (12.8 by 30.0 by 2.2 cm) enclosed in a 0.95-cm black frame were mounted on either or both the "side-wall" and "rear-wall" positions indicated in Figure 1. The shortest distance between the center of the grain hopper and the center of the "side-" and "rear-wall" targets was 27 and 32 cm, respectively. In addition to the pictorial target stimuli illustrated in Figure 2, white, brown, and black pieces of paper of identical size were also used. Regardless of the target stimulus, a force of 0.40 N or more applied to any point on a pictorial target was defined as one target response. Before each experimental session, all pictorial targets were covered by a piece of waxed paper (Cut-Rite) that eliminated reflections from it and allowed the locus of pecking to be recorded. The arrangement of pictorial targets, food hopper, and response key specified in Figure 1 prevented a pigeon from brushing into either target while responding on the key or eating from the hopper. Chamber illumination was provided by six, 1.6-W houselights mounted on the roof of the chamber behind a ground-glass shield. A wide-angle peephole was mounted on the chamber door and a blower provided ventilation and masking noise. Experimental dependencies and recordings were scheduled by relays, counters, and timers in an adjacent room.

Procedure

Throughout Experiments I, II, and III, each pigeon was exposed to a multiple fixed-ratio–fixed-ratio (*mult* FR FR) schedule of reinforcement. Key pecking was reinforced on an FR 25 schedule in the presence of a green or white keylight and on a higher FR schedule (100 to

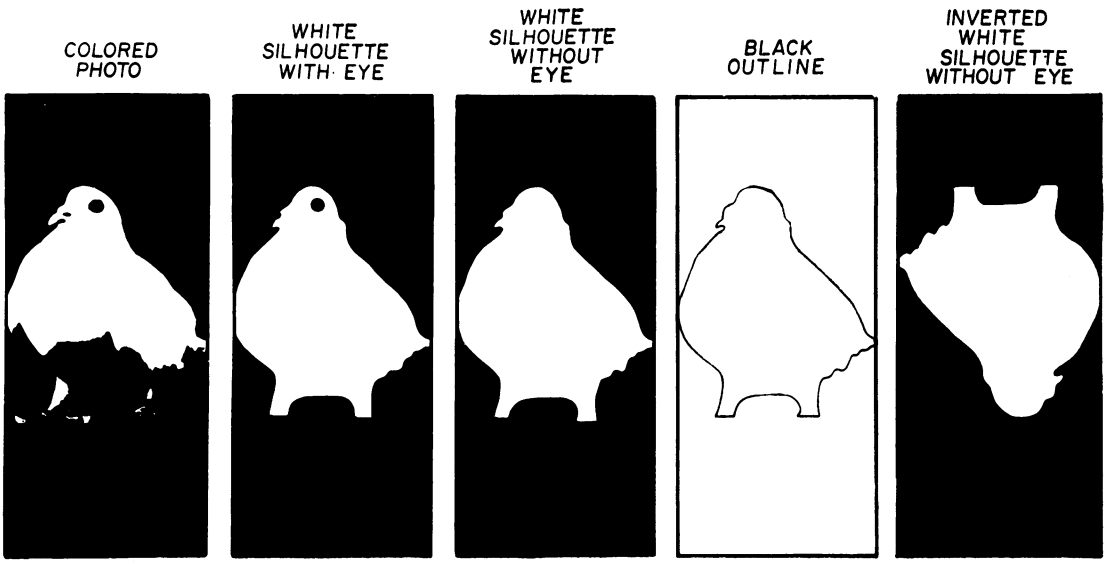

Fig. 2. Colored-photograph, silhouette, and outline targets used in Experiments I to IV.

150 depending on the bird) in the presence of the alternate keylight. During each experimental session, one food presentation in the presence of the green keylight alternated with one food presentation in the presence of the white light. A session was terminated after either 60 food presentations or 90 min, whichever occurred first.

EXPERIMENT I. RATE, TOPOGRAPHY, TEMPORAL PATTERN, AND LOCUS OF ATTACK ON A COLORED PHOTOGRAPH OF A PIGEON DURING A MULTIPLE SCHEDULE OF REINFORCEMENT

Subjects

Three White Carneaux pigeons from Palmetto Pigeon Plant, Sumter, S.C. were maintained at 80% (±15g) of their free-feeding body weights. Pigeons were approximately 2-yr old at the start of the study and were housed in individual home cages under constant illumination. Wing and tail feathers were kept short by periodic trimmings throughout the experiment to prevent brushing against the pictorial targets while pecking the response key. All three birds had experimental histories (Cohen and Looney, 1973) of attacking a mirror target during *mult* FR FR reinforcement schedules.

Procedure

Each pigeon was exposed to 20 daily sessions on a *mult* FR 25 FR X schedule of reinforcement in the presence of the colored photograph of a White Carneaux pigeon (Figure 2) mounted in the "side-wall" position (Figure 1). For Pigeons 8572 and 4964, the higher FR was FR 100 and for Pigeon 857, it was FR 125. For Pigeons 857 and 8572, the higher FR schedule was arranged in the presence of the white keylight, whereas it occurred during the green keylight for Pigeon 4964. The multiple schedule was discontinued for the next 15 sessions. During these sessions, a bird was placed in the operant chamber for 1 hr with the colored photograph target present but with neither food hopper nor discriminative stimuli presented (dark key). Finally, the multiple schedule was reintroduced for 15 sessions with the target present.

Results and Discussion

Figure 3 plots for each pigeon the overall rate of target responding on the colored photo-

graph (total response per minute) as a function of successive sessions. All three pigeons exhibited fairly stable rates of responding on the colored photograph when the multiple schedule was in effect. When the schedule was removed, target responding decreased for all three pigeons. Finally, when the schedule was reintroduced, rate of target responding returned to the previous level.

During the multiple schedule, approximately 95% (range for the three subjects: 90 to 98%) of target responses occurred after food was presented on the lower-valued FR schedule, *i.e.*, in the presence of the stimulus associated with the larger FR schedule. This relationship between key and target responding is comparable to that reported in other studies involving multiple schedules (*e.g.*, Cohen and Looney, 1973; Cole and Litchfield, 1969; Flory, 1969) in which live, taxidermically stuffed pigeons, or mirror targets were used. Informal observations of the pigeons, as well as the waxed paper recordings obtained during each daily session, indicated that the pigeons attacked the colored photograph by charging and pecking at it in the head region. Thus, the topography and locus of attack on the pictorial target were similar to that reported in previous studies of schedule-induced (Azrin, *et al.*, 1966; Cohen and Looney, 1973; Flory, 1969; Gentry, 1968) and territorial (Smith and Hoskings, 1955; Stout and Brass, 1969) attack using live, stuffed, and mirror targets.

EXPERIMENT IIa. A SUCCESSIVE TARGET-FADING PROCEDURE FOR EVALUATING TARGET CONTROL OF SCHEDULE-INDUCED ATTACK ON PICTORIAL TARGETS

The present study determined if all features of the pictorial target were essential for maintaining attack. The three pigeons that exhibited schedule-induced attack on a colored photograph of a conspecific in Experiment I were exposed to a procedure in which the colored photograph was faded out across successive blocks of sessions.

Subjects

The three White Carneaux pigeons employed in Experiment I were housed and maintained under the same conditions used in that study.

Procedure

The subjects were exposed to a series of 80 to 130 daily sessions on their respective *mult* FR FR reinforcement schedules specified in Experiment I. The colored photograph was faded out over successive blocks of 10 to 30 sessions using the following sequence of targets illustrated in Figure 2: white-on-black silhouette with eye, white-on-black silhouette without eye, black-on-white outline, white paper, brown paper, and black paper. When, at any point in the fading sequence, one of the

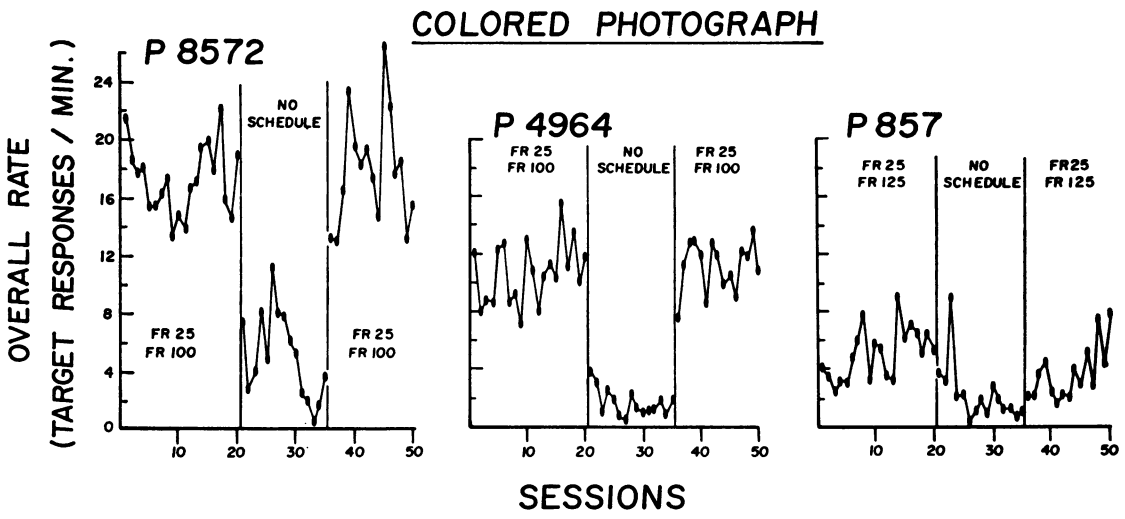

Fig. 3. Overall rate of target responding on the colored photograph (total responses per minute) as a function of successive sessions. The vertical lines correspond to changes in schedule conditions.

pictorial targets was ineffective in maintaining stable rates of target responding, the pigeon was re-exposed for 10 to 15 sessions to the previously effective target. Finally, each pigeon was re-exposed for 10 to 20 sessions to both ineffective and then effective targets.

Results and Discussion

The results of the target-fading procedure are summarized in Figure 4, which shows overall rates of responding on the pictorial target as a function of sessions. As indicated in the

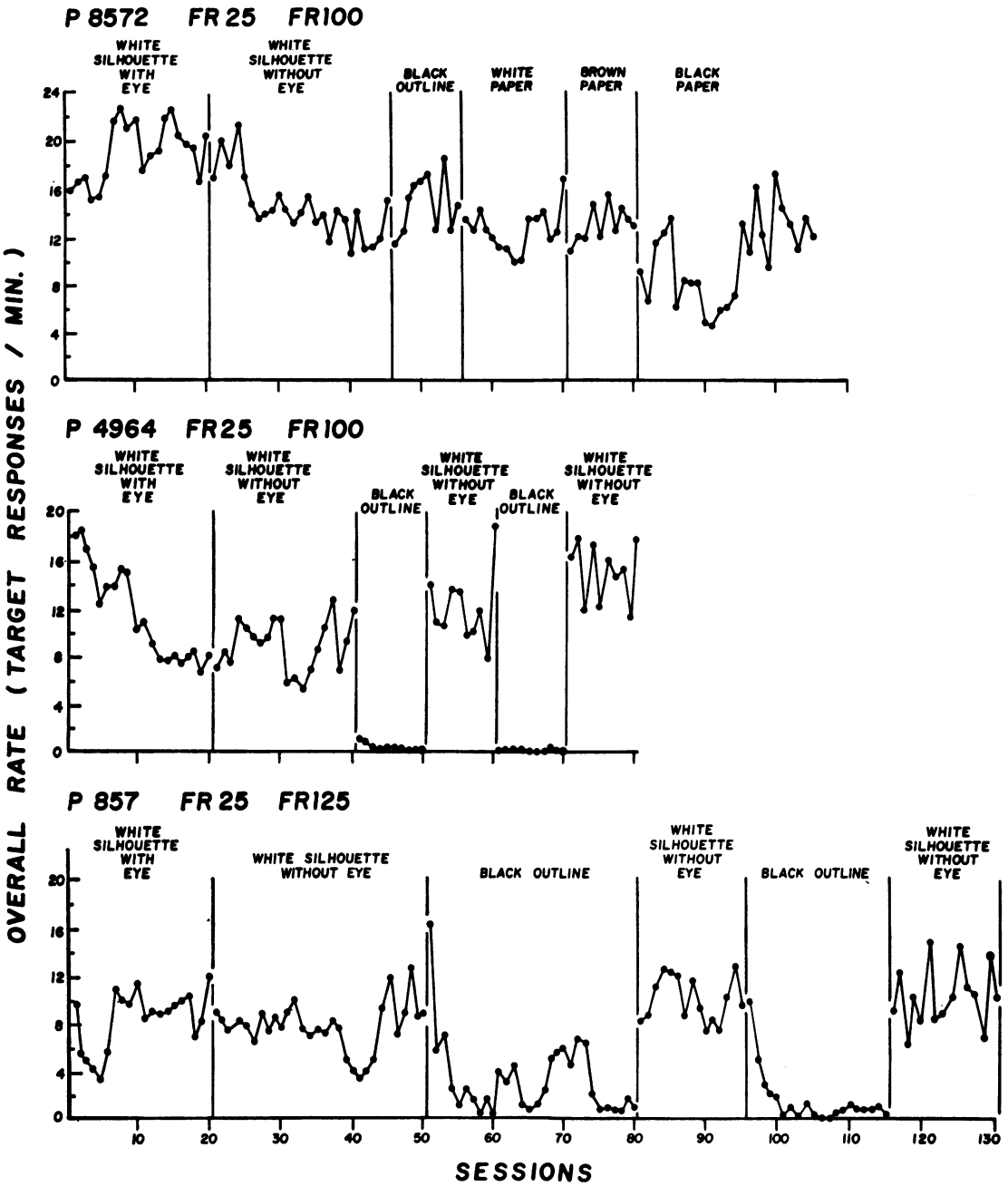

Fig. 4. Overall rate of responding (responses per minute) on pictorial targets. The vertical lines correspond to changes in target conditions.

left-hand panel of this figure, all three pigeons exhibited sustained rates of attack on the silhouette target with eye. The response topography and temporal pattern of attack on this silhouette target, as well as on all other targets used in this experiment (described below), was the same as that which occurred on the colored photograph in Experiment I. In addition, a comparison of Figures 3 and 4 indicates that overall rate of attack on the silhouette target with eye did not systematically differ from that which occurred on the colored photograph in Experiment I. Pigeon 4964 exhibited an increase and then a decrease in attack rate on the silhouette relative to attack rate on the photograph, whereas the change in target conditions from colored photograph to the silhouette with eye had relatively little effect for the other two pigeons.

Although removal of the eye from the silhouette target had relatively little effect upon attack rate (a small decrease for Pigeon 8572), a change to the outline target decreased attack rate for both Pigeons 4964 and 857 and had no systematic effect on attack rate for Pigeon 8572. When Pigeons 4964 and 857 were re-exposed to the silhouette and outline targets in an ABA sequence, attack rate was consistently higher on the silhouette than on the outline target. In fact, for Pigeon 857, the difference in rate of attack on the two targets increased with successive alternations of targets. On the other hand, Pigeon 8572 exhibited no systematic change in attack rate across target conditions when exposed to the white, brown, and black paper targets. This lack of target control over schedule-induced attack is particularly interesting, since in a previous study (Cohen and Looney, 1973), the same brown paper did not maintain schedule-induced attack in this pigeon. This perseveration of attack on the white, brown, and black targets suggests that historical variables, such as extended exposure to a schedule, or possibly the target-fading procedure itself, can influence rate of schedule-induced attack. It is, therefore, possible that target control of attack observed for Pigeons 4964 and 857 may be specific to the target-fading procedure used. If, for example, the colored-photograph target had been faded in across successive sessions rather than faded out, different target control may have occurred. Smith and Hoskings (1955) reported other examples of perseverative attack in field studies in which a bird will often "attack" the place in its territory where a stuffed target bird was previously located.

EXPERIMENT IIb. A CONCURRENT TARGET-PREFERENCE PROCEDURE FOR EVALUATING TARGET CONTROL OF SCHEDULE-INDUCED ATTACK ON PICTORIAL TARGETS

Although silhouette, outline, and colored-paper targets had no differential effect upon overall rate of schedule-induced attack for Pigeon 8572 in the preceding experiment, there may be other testing procedures in which attack rate would be more sensitive to changes in target characteristics. Since behavioral measures obtained with concurrent operant key pecking in pigeons (*e.g.,* Catania, 1963), concurrent licking in rats (*e.g.,* Benjamin, 1955), and concurrent egg retrieval in gulls (Baerends and Kruijt, 1973) are reported to be more sensitive to changes in an independent variable than comparable successive-testing procedures, Pigeon 8572 was exposed to a concurrent target-preference procedure. During exposure to the *mult* FR FR reinforcement schedule used in Experiments I and II, Pigeon 8572 was given a choice between the silhouette without eye and each of the following targets: (1) black paper target (2) black-on-white outline, and (3) silhouette with eye.

Subject

Pigeon 8572 used in Experiments I and IIa was maintained and housed under the same conditions used in those studies.

Apparatus

Pictorial targets were mounted in both the "side-wall" and "rear-wall" positions as indicated in Figure 1.

Procedure

Pigeon 8572 was again exposed to the same *mult* FR FR schedule used in Experiments I and IIa. Before introducing two pictorial targets concurrently, the black paper target used during the last phase of Experiment IIa was moved to the "rear-wall" position for 10 successive daily sessions. With the black paper target remaining in the "rear-wall" position, the white silhouette target without eye was then concurrently mounted in the "side-wall"

position for 10 daily sessions. The relative positions of the black paper target and silhouette target were then reversed three consecutive times with 10 to 15 daily sessions under each condition.

With the white-silhouette target without eye mounted on the "rear-wall", the black outline target was substituted for the black paper target on the "side wall" during the next 10 sessions. The relative positions of the black outline and silhouette targets were then reversed two times with 10 sessions under each condition. Finally, with the white silhouette target with eye mounted on the "rear wall", the white silhouette without eye was substituted for the black outline target for 12 sessions. The relative positions of the silhouette targets with and without eye were then reversed two times with 12 sessions under each condition.

Results and Discussion

Figure 5 plots overall rate of target responding as a function of successive sessions. The specific target on which responding occurred as well as the position of the targets are indicated in the legend on the figure. The vertical lines correspond to changes in experimental conditions. With the transfer of the black target to the "rear wall", rate of target responding decreased and stabilized at approximately half of that which occurred with the target

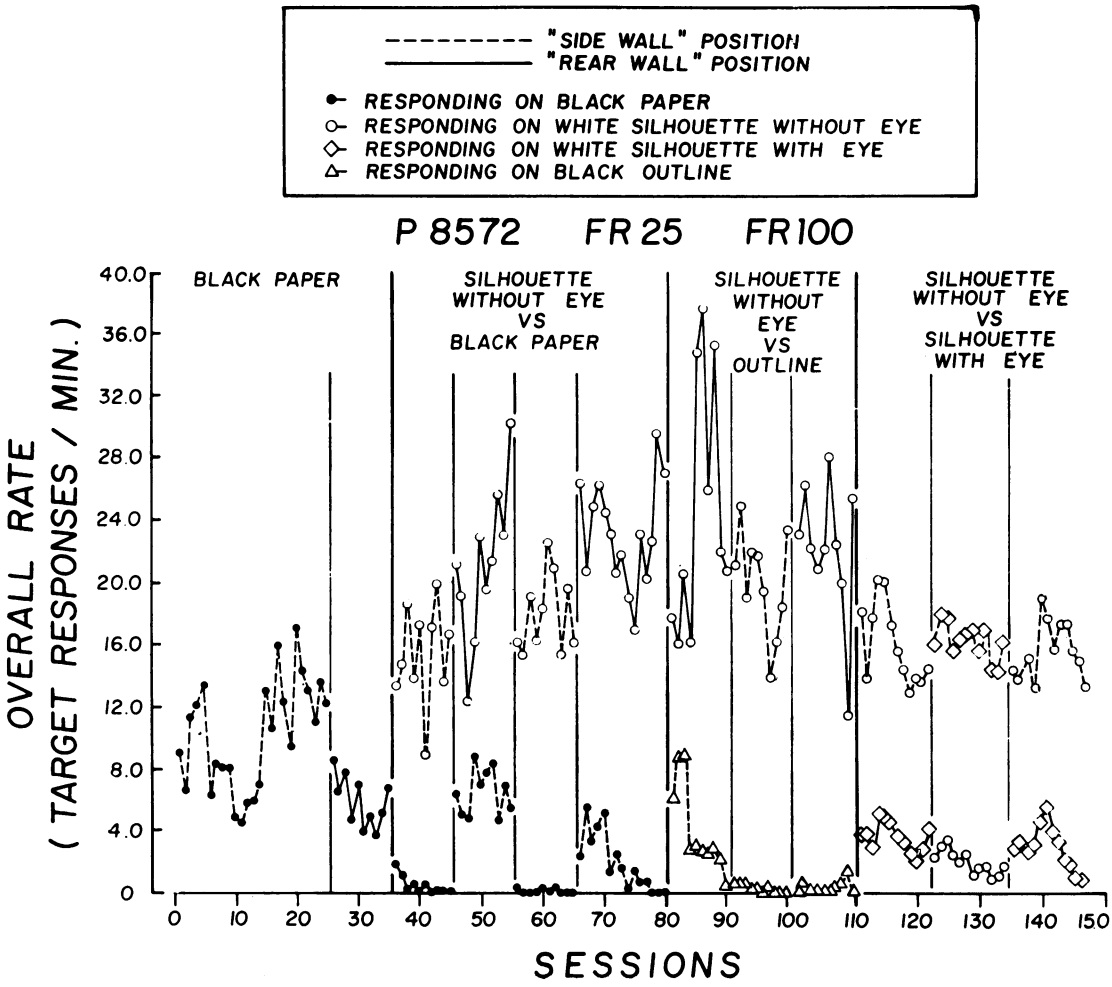

Fig. 5. Overall rate of target responding as a function of successive sessions for Pigeon 8572. The specific targets on which responding occurred and the position of the targets are indicated in the legend on the figure. The vertical lines correspond to changes in experimental conditions.

mounted on the "side wall". With the introduction of the silhouette without eye on the "side wall" (Session 36), rate of responding on the black target decreased to almost zero and rate of responding on the silhouette was comparable to that which occurred on that target in Experiment IIa (Figure 4). With the subsequent three reversals in the relative position of the silhouette and black paper targets (Sessions 46 to 80), rate of target responding was always higher on the silhouette than on the black target. Whereas differential responding on the two targets was initially influenced by the relative position of the targets (Sessions 46 to 55), the rate differential increased over successive reversals with the relative position of the targets having minimal effect upon attack preference during the last seven sessions of the final reversal. When the black outline was substituted for the black paper target on the "side wall" (Session 81), Pigeon 8572 continued to respond on the silhouette target as it did in the previous condition. While the presentation of the outline was initially followed by an increase in responding on the "side-wall" target, responding on the outline gradually decreased to nearly zero responses per minute. With the subsequent two reversals in the relative position of the silhouette and black outline, rate of target responding never went below 11.11 responses per minute on the silhouette and was approximately zero responses per minute on the outline.

When the black outline on the "rear wall" was replaced with a white silhouette with eye (Session 111), the pigeon continued to respond on the silhouette without eye mounted on the "side wall". With the subsequent two reversals in the relative positions of the silhouette with and without eye, most target responding persisted on the "side-wall" target closest to the food hopper and response key. In short, the silhouette target with eye did not differentially control target responding relative to a silhouette target without eye.

Whereas this pigeon had previously attacked the black paper, outline, and silhouettes at approximately the same rate in Experiment IIa, it consistently preferred to attack the silhouette without eye at a higher rate than either the black paper or outline target in this study. Thus, as with concurrent operant key peck (Catania, 1963), concurrent lick (Benjamin, 1955), and concurrent egg retrieval procedures (Baerends and Kruijt, 1973), the concurrent attack procedure was more sensitive to changes in an independent variable than was a successive-testing procedure.

The lack of differential control by the silhouette targets with and without eye might be due in part to the fact that the targets were not equidistant from the food hopper. Although a silhouette with an eye *versus* one without an eye might differentially control attack rate under other conditions, it is worth noting that removal of the eye from the silhouette target in Experiment IIa had little or no effect upon attack rate in pigeons whose attack rate was sensitive to changes in other target characteristics. Thus, the combined results of Experiments IIa and b tentatively suggest that the eye of a pictorial target has little if any control over the maintenance of schedule-induced attack.

EXPERIMENT IIIa. EFFECT OF PICTORIAL TARGET ORIENTATION ON SCHEDULE-INDUCED ATTACK USING THE SUCCESSIVE-TESTING PROCEDURE

The results of Experiment II indicated that a white-on-black silhouette of a pigeon (with or without an eye) is effective in controlling schedule-induced pecking and charging on that target, whereas a black outline of the same pigeon or colored paper targets are less effective. Since most of the attack on the silhouette target was directed at the upper half of the target (head and chest regions), the next experiment determined if the "upright" orientation of a silhouette is an important factor in controlling the schedule-induced attack.

Subjects

Two White Carneaux pigeons (4964 from Experiment IIa and 430), with comparable histories of schedule-induced attack on the colored photograph and silhouette targets employed in Experiment IIa, were maintained and housed under the same conditions used in the previous experiments.

Procedure

Throughout this study, Pigeon 4964 was exposed for 53 sessions to the *mult* FR 25 FR 100 schedule used in Experiments I and II, and Pigeon 430 was exposed for 160 sessions

to a *mult* FR 25 FR 150 schedule with the higher FR schedule arranged in the presence of the green keylight and the lower schedule in the presence of the white light. During each session, either an "upright" or "inverted" white-on-black silhouette (without eye) target was mounted in the "side-wall" position. Over successive blocks of 5 to 25 sessions, the orientation of the silhouette target alternated between the "upright" and "inverted" positions eight times for Pigeon 430 and four times for Pigeon 4964.

Results and Discussion

Figure 6 plots overall rate of target responding for both birds as a function of successive sessions with the vertical lines corresponding to changes in the orientation of the silhouette target. Pigeon 430 consistently responded at higher rates on the "upright" target than on the "inverted" one, with differential attack rates becoming more accentuated with successive reversals. This gradual development of target control over attack rate is similar to the development of differential target control by silhouette and outline targets observed in Experiment IIa for Pigeon 857. For Pigeon 4964, on the other hand, there was no evidence of differential attack on the "upright" and "inverted" targets over successive reversals in orientation. Waxed-paper records of pecking on the silhouette target indicated that when the pigeons pecked at the "inverted" target, they did so on the upper half of it and not on the "inverted" head and chest region. Thus, target orientation differentially controlled schedule-induced attack rate for one of the two pigeons, but, for both birds, failed to control differentially attack locus.

EXPERIMENT IIIb. EFFECT OF PICTORIAL TARGET ORIENTATION ON SCHEDULE-INDUCED ATTACK USING THE CONCURRENT TARGET-PREFERENCE PROCEDURE

The results obtained with a successive-testing procedure for the two pigeons in Experiment IIIa were not consistent, in that the orientation of the silhouette target differentially controlled schedule-induced attack rate for one pigeon and not for the other.

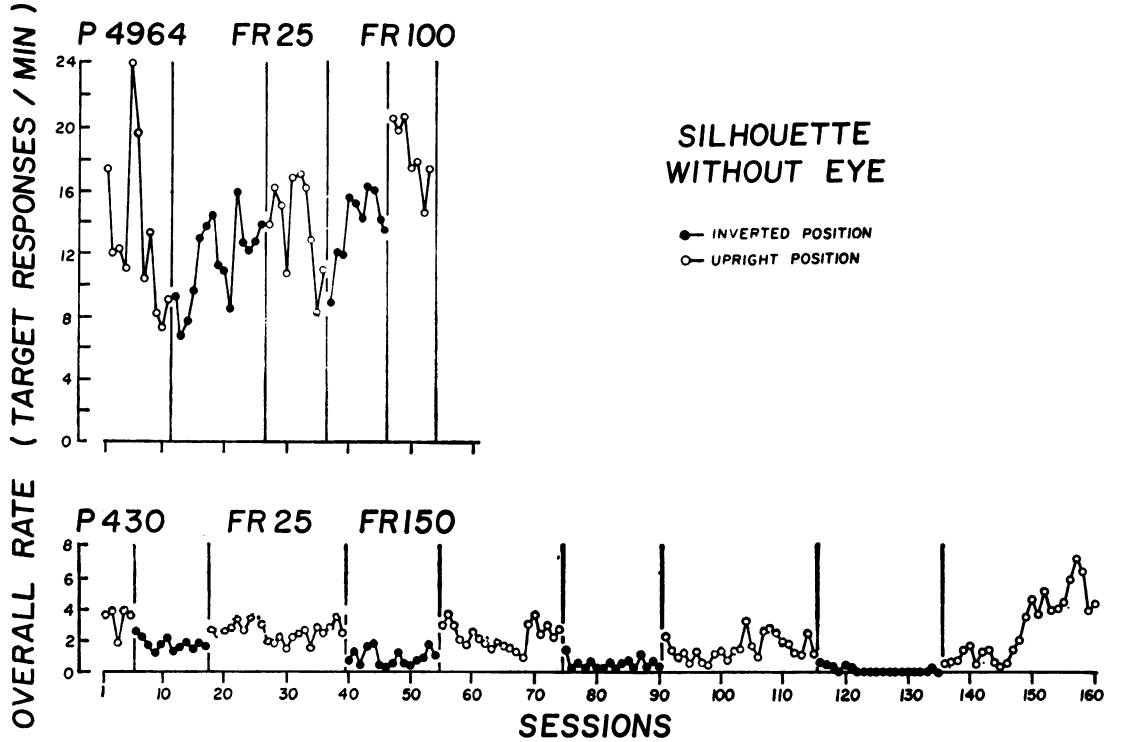

Fig. 6. Overall rate of target responding as a function of successive sessions. The vertical lines correspond to changes in target orientation.

Experiment IIb suggested that measures of schedule-induced attack obtained with a target-preference procedure are more sensitive to changes in target conditions than measures obtained with a successive-testing procedure. If this is correct, one might expect that if both pigeons from Experiment IIIa were exposed to a concurrent target-preference procedure, target orientation would have differential control of attack rate for both birds.

Subjects

The two White Carneaux pigeons employed in Experiment IIIa were maintained and housed under the same conditions used in that study.

Apparatus

As in Experiment IIb, one pictorial target was placed in the "side-wall" position and another one in the "rear-wall" position.

Procedure

Both birds were exposed to a series of 15 daily sessions on their respective *mult* FR FR schedules specified in Experiment IIIa. During the initial five sessions, the "upright" silhouette target was mounted in the "rear-wall" position and the "inverted" silhouette target was mounted in the "side-wall" position. The relative position of the "upright" and "inverted" targets was then reversed two times with five sessions under each condition.

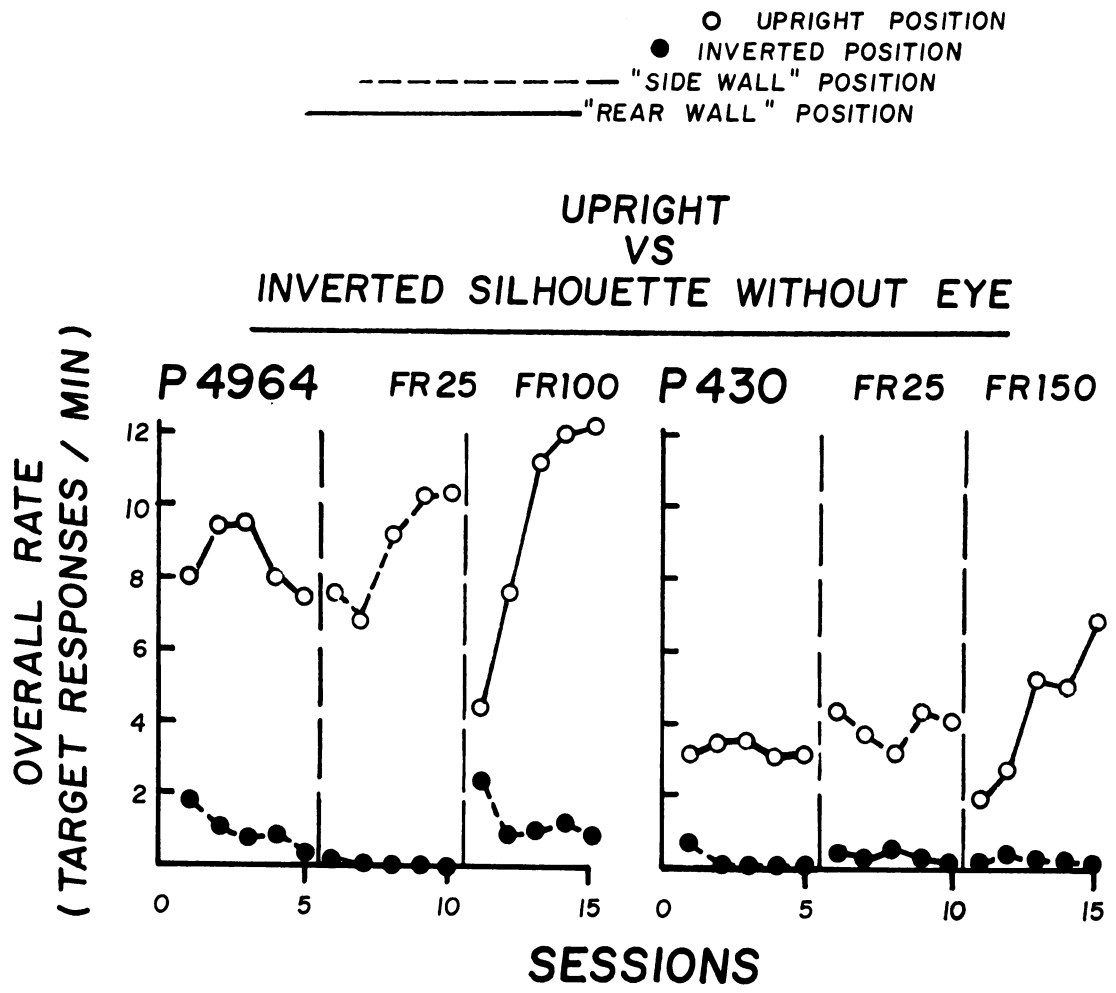

Fig. 7. Overall rate of target responding as a function of successive sessions. The specific targets on which responding occurred and the position of the targets are indicated in the legend on the figure. The vertical lines correspond to changes in experimental conditions.

Results and Discussion

Figure 7 plots overall rate of target responding as a function of successive sessions. The specific target on which responding occurred as well as the position of the targets are indicated in the legend on the figure. With the "upright" target on the "rear wall" and "inverted" target on the "side wall", rate of target responding on the "inverted" target decreased to almost zero for both pigeons and stable rates of target responding persisted on the "upright" target. With the subsequent two reversals in the relative positions of the "upright" and "inverted" targets, rate of responding was always higher on the "upright" target than on the "inverted" one for both pigeons. As was the case in Experiment IIIa, when the birds pecked at the "inverted" target, they did so on the upper half of it and not on the inverted head and chest region. The fact that target orientation differentially controlled rate of target responding for both birds in this study, but for only one of two birds with a successive-testing procedure in Experiment IIIa, is additional evidence that a concurrent target-preference procedure is a more sensitive method for evaluating target control of schedule-induced attack.

EXPERIMENT IV. ACQUISITION AND MAINTENANCE OF SCHEDULE-INDUCED ATTACK ON A COLORED PHOTOGRAPH OF A CONSPECIFIC IN PIGEONS THAT WERE PREVIOUSLY EXPOSED TO REINFORCEMENT SCHEDULES WITHOUT A PIGEON TARGET PRESENT

In the preceding experiments, pigeons that exhibited schedule-induced attack on a pictorial target had previously been exposed to a reinforcement schedule in the presence of a mirror target. Experiment IV was designed to determine if such a prior history is a necessary condition to establish and maintain schedule-induced attack on a colored photograph of a conspecific. Because of constaints on research time, a fixed-interval (FI) reinforcement schedule was used instead of the *mult* FR FR schedule used in the preceding experiments.

General Method

Subjects

Six White Carneaux pigeons obtained from Palmetto Pigeon Plant were maintained at 75% (±15g) of their free-feeding body weights and were housed under the same conditions used in Experiments I to III. Four of the pigeons had previously been exposed to a wide range of fixed-interval and fixed-ratio schedules of reinforcement for key pecking *without* a pigeon target available in the chamber, whereas the remaining two birds were experimentally naive.

Apparatus

The apparatus was the same as that used in Experiments I to III.

Procedure

Training without pictorial target. During this initial phase, neither a "side-wall" nor "rear-wall" target was in the chamber and the response key was transilluminated with white light. In the first experimental session, the two experimentally naive pigeons were hopper trained, and key pecking was hand-shaped and maintained on a continuous reinforcement schedule (CRF). After four to five sessions on the CRF schedule (60 reinforcements per session), both birds were exposed to an FI 30-sec schedule for 10 sessions and then to an FI 60-sec schedule for an additional five sessions. During this preliminary phase, the four pigeons with a history of key pecking on intermittent reinforcement schedules were exposed for five sessions to an FI 60-sec reinforcement schedule. As in Experiments I to III, reinforcement was defined as 3-sec access to grain from the hopper, and sessions were terminated after either 60 food presentations or 90 min.

Training with colored-photograph target. During this phase, the colored-photograph target was mounted in the "side-wall" position. After introduction of the colored photograph, all pigeons were given 10 additional sessions on the FI 60-sec schedule with the colored-photograph target present. If a bird failed to exhibit sustained rates of responding on the pictorial target over the block of 10 sessions, an FI 90-sec schedule was introduced for an additional 10 sessions. If sustained rates of pictorial responding again did not occur on the

FI 90-sec schedule, an FI 120-sec schedule was introduced for 10 sessions. If a bird did not exhibit target responding under this latter condition, the experiment was terminated for that pigeon.

If at any point in exposure to this ascending sequence of FI schedules, a pigeon did exhibit stable rates of target responding over a block of 10 sessions, it was not exposed to the higher FI schedules but rather to alternating blocks of 10 to 26 daily sessions with and without the FI schedule in effect. For those sessions in which the FI schedule was removed, the bird was placed in the operant chamber for 1 hr with the pictorial target but with neither food hopper nor discriminative stimuli presented (dark key).

Results and Discussion

Only two of the six pigeons (both of which had an extended history of key pecking on intermittent reinforcement schedules) exhibited sustained rates of schedule-induced attack on the colored photograph of the conspecific. The results for those two pigeons (5901 and 2759) are summarized in Figure 8, which plots overall rate of target responding as a function of sessions.

Pigeon 5901 had a median rate of 5.61 responses per minute on the colored photograph during exposure to the FI 60-sec schedule, whereas Pigeon 2759 did not respond on the pictorial target under the FI 60-sec schedule. During the subsequent exposure to the FI 90-sec schedule (Sessions 11 to 35), however, Pigeon 2759 exhibited highly variable session-to-session overall rates of responding on the pictorial target, ranging from 0.02 to 39.90 responses per minute. For both pigeons, the temporal pattern, response topography, and locus of attack on the colored photograph was comparable to that observed in Experiments I to III for pigeons with a history of schedule-induced attack on a mirror target.

During the last five sessions (6 to 10 for Pigeon 5901, 31 to 35 for Pigeon 2759) on their respective FI schedules, the median overall rates of target responding were 5.80 and 16.50 responses per minute for Pigeons 5901 and 2759, respectively. Following the removal of the FI schedules, rates of target responding initially increased for both pigeons and then decreased to medians over the last five sessions of 1.42 and 0.13 responses per minute for Pigeons 5901 and 2759, respectively. When re-exposed to the FI schedules, rates of target responding increased for both birds to levels higher than those that occurred during the preceding no-schedule condition. Since overall rates of target responding were again highly variable from session to session for Pigeon 2759 and tended to decrease across successive sessions, this pigeon was re-exposed to the no-schedule (Sessions 76 to 100) and schedule (Sessions 101 to 126) conditions. As in the previous exposure to the no-schedule condition, rate of target responding initially increased and then decreased to a median of 0.10 responses per minute over the last five sessions. When the FI schedule was reintroduced, overall rate of target responding increased relative to the no-schedule condition, but was again highly variable. Median rate of target responding over the last five sessions was 5.64 responses per minute.

In summary, two of the six pigeons that had never been exposed to any type of pigeon target in an operant-reinforcement schedule situation, exhibited schedule-induced pecking and charging at a colored photograph of a conspecific during a fixed-interval schedule of reinforcement. These results are comparable to those reported in previous studies in which not all experimentally naive pigeons attacked taxidermically stuffed (Azrin *et al.*, 1966) and mirror (Cohen and Looney, 1973) targets. In the present study, two of the four pigeons that had extended, prior operant training without a conspecific target in the test chamber subsequently attacked the colored pigeon photograph. On the other hand, neither of the two pigeons without this extended history of operant training attacked the colored photograph. It may, therefore, be the case that some aspect of that extended operant conditioning history (*e.g.*, deprivation, exposure to the test chamber, and/or reinforcement schedules) increased the probability of schedule-induced attack.

GENERAL DISCUSSION

In general, the data indicate that a pictorial target such as a colored photograph of a conspecific is an effective stimulus for maintaining, and in some cases, establishing schedule-induced attack. Pictorial targets provide an experimental preparation for systematically

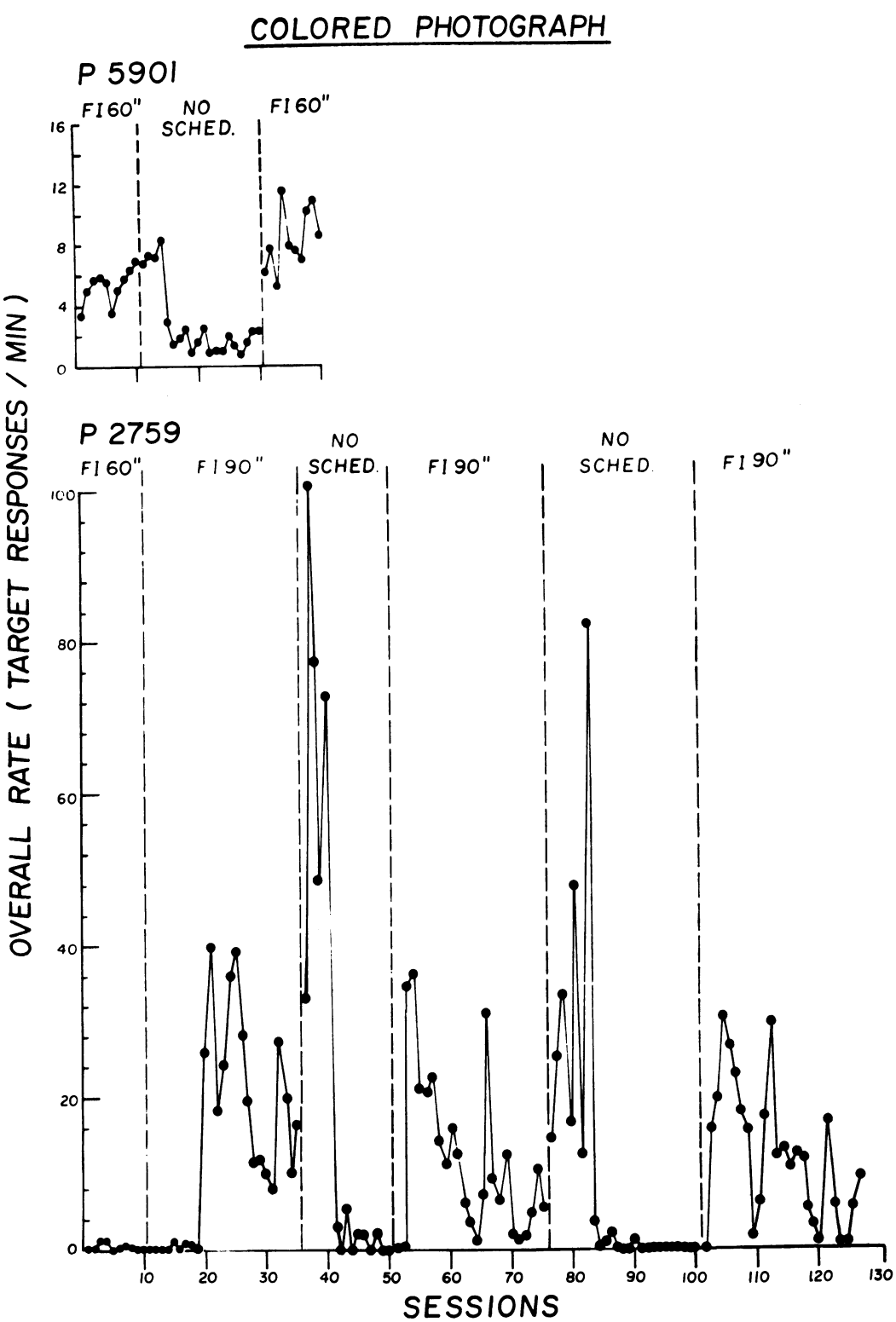

Fig. 8. Overall rate of target responding as a function of successive sessions for Pigeons 5901 and 2759. The vertical lines correspond to changes in reinforcement schedule conditions.

exploring the visual target features that control schedule-induced attack. The target-preference procedure used in Experiments II and III and by Stout and Brass (1969) for studying territorial attack in gulls and by Baerends and Kruijt (1973) for studying egg retrieval in gulls seems to be a particularly sensitive method of evaluating the role of visual target characteristics in controlling species-specific behavior.

Stout, Wilcox, and Creitz (1969) reported that with the Glaucus Winged Gull (*Larus glaucescens*), tape-recorded species-specific calls (*e.g.*, choking, trumpeting, mew) markedly influenced attack on a mirror target placed in its territory. Perhaps testing procedures similar to those employed in this study could also be used to evaluate how species-specific calls modulate schedule-induced attack.

The use of a pictorial target such as a photograph or line drawing has the advantage of providing a constant visual target stimulus throughout an experimental session. Other pictorial targets such as a one-way mirror or rear-view projection system have the additional advantage of allowing for more flexible manipulation of target stimuli within an experimental session. For example, this latter type of target would be particularly suitable for evaluating both positive (*cf.* Cherek, Thompson, and Heistad, 1973; Dove, 1971) and negative (*cf.* Dove, 1971) reinforcing properties of specific target characteristics such as coloration, orientation, size, and posture. Some preliminary data on pictorial target control of schedule-induced attack using the rear-view projection method have been reported recently by Flory and Ellis (1973) and Rashotte, Katz, and Griffin (1973). The future use of pictorial targets for systematically examining target control of schedule-induced attack might eventually allow one to relate target characteristics that control schedule-induced attack to those target features that control other types of attack, such as are associated with reproduction and food competition (Hinde, 1952; Marler, 1956).

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