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ABSENCE OF SHOCK-ELICITED AGGRESSION IN PIGEONS[1]

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Two pigeons that attacked a taxidermically prepared target pigeon during a schedule of positive reinforcement for key pecking, and two that did not, were shocked through implanted electrodes in the presence of the target. Shock intensities of 2 and 4 mA, durations of 0.1 and 1.3 sec, and frequencies of 2, 6, 20, and 35 per minute were delivered across 16 sessions with 180 shocks per session. No pigeon attacked the target; one pecked the shockplug on its back. The two pigeons that had not attacked during the positive reinforcement schedules were conditioned to peck the target for food reinforcement before another 16 sessions of shock. No attack was observed in these shock sessions. During subsequent positive reinforcement of key pecking, the target was attacked by the two pigeons that had originally attacked and by one that had not. Absence of shock-elicited attack in these pigeons may be related to the parameters of the experiment or may be yet another instance of the absence of shock-elicited attack in the class *Aves*. At least under the present conditions, it was not possible to predict the level of attack during electric shock from the level of attack during schedules of positive reinforcement for key pecking.

Attack produced by electric shock ("shock-elicited aggression") has apparently not been studied in the pigeon (Azrin, 1967; Meyer, 1971; Ulrich, 1967), an organism that has been the most frequent subject in studies of attack as a byproduct of reinforcement schedules ("schedule-induced aggression"; *e.g.*, Azrin, Hutchinson, and Hake, 1966; Flory, 1969; Gentry, 1968). The present experiment was undertaken to provide information about shock-elicited aggression in pigeons whose history of schedule-induced aggression was known from previous experiments.

Four pigeons were drawn from experiments on schedule-induced aggression in which key pecking was intermittently reinforced in the presence of a taxidermically stuffed target pigeon. Two of them ("attackers") had previously attacked the target during an extended number of sessions, whereas the other two ("non-attackers") had attacked infrequently. Failures in attack against a stuffed pigeon during schedules of food reinforcement are not uncommon (e.g., Azrin *et al.*, 1966) and "attackers" and "non-attackers" were shocked in the present experiment to determine whether these pigeons would show similar differences in attack during shock.

METHOD

Subjects

Four male White Carneaux pigeons, obtained from the Palmetto Pigeon Plant, Sumter, S. C., were housed in individual cages in a large colony room that was constantly illuminated. Water was freely available and the pigeons were maintained at 80% free-feeding body weight in all phases of this experiment and in the previous experiments on schedule-induced attack, which are described below. These pigeons were selected for the present experiment on the twin bases of their availability and their prior attack behavior.

Apparatus

The experimental compartment was a conventional two-key pigeon box, (36 by 30 by 36 cm), with a shielded viewing window in a side wall and a ventilation fan that provided a masking noise. Two translucent response keys, a solenoid-operated hopper for food reinforce-

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ment, and a 7-W houselight were mounted on the front wall in the standard configuration. The hopper was illuminated by a white light while the solenoid was activated.

In all but one portion of the experiment, a taxidermically prepared White Carneaux pigeon in a natural standing position was present in a rectangular opening, (21 by 25 cm), centered in the wall opposite the response keys. The stuffed pigeon was 30 cm from the response keys and was mounted on a balanced platform above a snap-action switch in such a way that a force of 100 g (1.0 N), measured directly above the switch, resulted in a switch closure. Late in the experiment, a live White Carneaux pigeon, restrained in a tilt-box (see Azrin *et al.,* 1966, for details), replaced the stuffed pigeon for several sessions. The force required to activate the switch on the tilt-box was similar to that required when the stuffed pigeon was used. Switch closures from the stuffed- and restrained-pigeon devices provided a quantitative measure of attack that was augmented by direct observation through the viewing window.

In the shock phases of this experiment, 60-Hz ac current was delivered through a 10 K-ohm series resistor to 30 guage stainless steel wires implanted around the pubis bones of the pigeon (Azrin, 1959*a*). For shock sessions, the plug on the back of each pigeon was connected to a flexible telephone cable attached to a commutator in the center of the chamber's ceiling. The cable did not restrict the pigeons' movements noticeably.

Events in the chamber were scheduled by relay equipment in another room and data were recorded on digital counters.

Procedure

The experiment involved four major phases, which occurred in sequence. Each phase is described below and in Tables 1 and 2.

Phase A. Identification of attackers and non-attackers. The pigeons were identified as "attackers" and "non-attackers" during previous experiments in which key pecking was reinforced with food. These experiments employed a two-key pigeon box and stuffed target similar to that used in the present experiment. The two pigeons showing sustained attack were drawn from different experiments. Pigeon 2175 was identified as an attacker in an experiment by Dove (1971, Experiment 2) that employed concurrent chain schedules in which variable-interval (VI) 3-min schedules were arranged concurrently on both keys during the first links of the chains and five fixed-ratio (FR) 50 schedules of food reinforcement were arranged in each of the second links. The target was available in only one of the second links and sessions were terminated after 50 reinforcers were obtained. Pigeon 2175 was trained for 47 sessions on this schedule before the present experiment. Pigeon 8 was identified as an attacker in an experiment by Dove, Rashotte, and Katz (*in press*) in which key pecking was reinforced with food on increasingly long VI schedules and sessions were terminated after 64 reinforcers. This pigeon had been trained for approximately 220 sessions on schedules ranging from VI 0.25-min to VI 10-min. Immediately before this experiment, Pigeon 8 was trained on VI 3-min for seven sessions in an attempt to recover levels of attack observed at that schedule earlier in the experiment. Since little attack occurred, Pigeon 8's attack rate on the preceding schedule (VI 10-min) is presented below as evidence that this pigeon had attacked the target.

Pigeons 56 and 2691 were identified as non-attackers in an unpublished experiment in which the target was continuously available and key pecking was reinforced with food on increasingly long FR schedules. These sessions terminated after 60 reinforcers. Other pigeons attacked under identical conditions in that experiment. The FR schedules employed and the number of sessions under each FR schedule is shown for these pigeons in Table 1.

Phase B. Shock procedures. After a layoff of approximately one week for Pigeons 56 and 2691, and 10 weeks for Pigeons 2175 and 8, all pigeons were implanted with electrodes (Azrin, 1959*a*). On 16 successive shock sessions, each pigeon was placed in the darkened experimental chamber and plugged into the shock cable. While the session was in progress, the houselight was illuminated, the keys remained dark, the stuffed pigeon was constantly available, and the hopper was never presented. The frequency, intensity, and duration of shocks were constant throughout a given session. Shock frequencies of 2, 6, 20, and 35 per minute were assigned in an irregular order to sessions in successive four-session blocks. Sessions were always terminated after 180 shocks had been delivered. Shock intensity

Table 1

The event scheduled, the schedule of the event, the response upon which the event was contingent, the number of sessions at each schedule, and the median attacks per minute on the target are shown for all phases for the two pigeons classified as non-attackers. Except when otherwise noted, medians are taken over all sessions. The range is shown in brackets beneath each median. A stuffed pigeon was employed as a target in all but Condition 2 of Phase D when a live pigeon was used.

		Pigeon 56					*Pigeon 2691*				
Phase	*Condition*	*Event*	*Schedule*	*Response*	*Sessions*	*Attacks/Min*	*Event*	*Schedule*	*Response*	*Sessions*	*Attacks/Min*
A	1	4-sec grain	FR 50	Key peck	79	0.0 (–)	4-sec grain	FR 50	Key peck	63	0.0 (0.0-0.8)
	2	”	FR 100	”	15	0.0 (–)	”	FR 75	”	24	0.0 (0.0-0.15)
	3	”	FR 150	”	12	0.0 (–)	”	FR 100	”	4	0.0 (–)
B		20 V, 0.1-sec electric shock	35/min	–	1	0.0	Same as Pigeon 56				
		”	20/min	–	1	0.0					
		”	6/min	–	1	0.0					
		”	2/min	–	1	0.0					
		”	2/min	–	1	0.0					
		”	6/min	–	1	0.0					
		”	20/min	–	1	0.0					
		”	35/min	–	1	0.0					
		20 V, 1.3-sec electric shock	6/min	–	1	0.0					
		”	35/min	–	1	0.0					
		”	2/min	–	1	0.0					
		”	20/min	–	1	0.0					
		40 V, 1.3-sec electric shock	20/min	–	1	0.0					
		”	2/min	–	1	0.0					
		”	35/min	–	1	0.0					
		”	6/min	–	1	0.0					
C	1	3-sec grain	FR 25	target peck	15	126.0* (120.0-132.0)	3-sec grain	FR 25	target peck	14	102.0* (96.0-108.0)
	2	–	EXT	”	7	0.0* (0.0-6.0)	–	EXT	”	8	0.0* (0.0-0.6)
	3	Shock: Same as in Phase B				No attack	Same as Pigeon 56				
D	1	3-sec grain	FR 100	Key peck	10	0.0 (–)	3-sec grain	FR 100	Key peck	11	0.1 (0.0-0.3)
	2 (live target)	”	”	”	5	0.0 (0.0-0.1)	”	FR 80	”	7	0.2 (0.1-0.4)
	3	”	FR 1/EXT	”	10	0.07 (0.0-10.3)	”	FR 1/EXT	”	10	26.0 (11.0-52.0)

*Median based on last three sessions

Table 2

The event scheduled, the schedule of the event, the response upon which the event was contingent, the number of sessions at each schedule, and the median attacks per minute on the target are shown for all phases for the two pigeons classified as non-attackers. Except when otherwise noted, medians are taken over all sessions. The range is shown in brackets beneath each median. A stuffed pigeon was employed as a target in all but Condition 2 of Phase D when a live pigeon was used.

		Pigeon 2175					*Pigeon 8*				
Phase	*Condition*	*Event*	*Schedule*	*Response*	*Sessions*	*Attacks/Min*	*Event*	*Schedule*	*Response*	*Sessions*	*Attacks/Min*
A	1	3-sec grain	Conc chains VI 3-min FR 50	Key peck	47	6.0* (2.0-12.0)	3-sec grain	VI 600-sec	Key peck	79	0.3* (0.1-0.8)
B		20 V, 0.1-sec electric shock	35/min	—	1	0.0		Same as Pigeon 2175			
		"	20/min	—	1	0.0					
		"	6/min	—	1	0.0					
		"	2/min	—	1	0.0					
		"	2/min	—	1	0.0					
		"	6/min	—	1	0.0					
		"	20/min	—	1	0.0					
		"	35/min	—	1	0.0					
		20 V, 1.3-sec electric shock	6/min	—	1	0.0					
		"	35/min	—	1	0.0					
		"	2/min	—	1	0.0					
		"	20/min	—	1	0.0					
		40 V, 1.3-sec electric shock	20/min	—	1	0.0					
		"	2/min	—	1	0.0					
		"	35/min	—	1	0.0					
		"	6/min	—	1	0.0					
C		Not Run					Not Run				
D	1	3-sec grain	FR 100	Key peck	19	0.1 (0.0-0.2)	3-sec grain	FR 100	Key peck	13	0.2 (0.0-2.9)
	2 (live target)	"	"	"	5	0.8 (0.4-1.3)	"	"	"	7	1.3 (0.0-3.2)
	3	"	FR 1/EXT	"	10	9.0 (5.0-14.0)	"	FR 1/EXT	"	11	3.0 (1.0-11.0)

*Median based on last 19 sessions

was 20 V for the first 12 sessions and 40 V for the last four sessions. Shock duration was 0.1 sec for the first eight sessions and 1.3 sec during the final eight sessions. Since shocks were delivered through a 10-K ohm resistor in series with the pigeon, each 10 V produced approximately 1 mA of current flow. The tables show the shock parameters for each of the 16 sessions. Each pigeon was observed continuously during all but the longest sessions (two shocks per minute) of shock presentation during this phase.

The present parameters of shock differ from those found to be effective in some studies of punishment of key pecking in pigeons with implanted electrodes (*e.g.*, Azrin, Hake, Holz, and Hutchinson, 1965; Hake and Azrin, 1965). Specifically, in the present experiment the first shock duration was as brief as in most previous studies (0.1 sec) but was much longer (1.3 sec) in the final eight sessions; and, relatively low shock intensities (20 to 40 V) were employed. However, the present shock parameters are well within the range at which punishment effects were obtained by Azrin (1959*a*), *e.g.*, 10 to 110 V at 0.02- to 0.1-sec durations. The frequencies and intensity of shock in the initial eight sessions were chosen to approximate shock values in parametric studies with footshock in rats (*e.g.*, Ulrich and Azrin, 1962). Shock duration was increased to 1.3 sec after eight sessions because probability of fighting between rats receiving 2-mA footshock at about 20 shocks per minute is greater at shock durations of 1.5 sec than at durations of about 0.1 sec, particularly during the early part of each session (Azrin, Ulrich, Hutchinson, and Norman, 1964). Plans to study at least as wide a range of shock intensities as has been employed in experiments with rats were abandoned when tetanization occurred with 60-V 1.3-sec shock.

Phase C. Attack conditioning and shock retest. Target pecking was shaped with food reinforcement in the non-attackers (Pigeons 56 and 2691) to put "target contact" into these pigeons' response repertoires before another shock test. Shaping was accomplished by successive approximations, and no special topography of target pecking was set as a criterion behavior. When the pigeons reliably pecked the target with sufficient force to record on the counters, the schedule for target pecking was increased gradually across several sessions from FR 1 to FR 25. Target pecking was reinforced with 3-sec access to grain timed from an effective peck so that, unlike key-peck training in Phase A, the pigeon had to cross the chamber to obtain food after the hopper was presented. Sessions were terminated after 60 reinforcers. When visual inspection showed that target-pecking rates had stabilized for three sessions, an extinction procedure was instituted in which target pecks never produced grain. Extinction sessions were terminated after 15 min, approximately the average session length at FR 25, and continued until two successive sessions occurred without a target peck. The pigeons were connected to the shock cable throughout these sessions. Table 1 shows the number of sessions for each pigeon at FR 25 and extinction. In the final part of this phase, both pigeons were given 16 sessions with the shock procedures of Phase B.

Phase D. Re-test of the attacker/non-attacker categorization. In the final part of the experiment, pecking the right key was "re-shaped" for all pigeons with food reinforcement in the presence of the target. The response requirement was gradually increased to a maximum of FR 100 in sessions that terminated after 60 presentations of grain. Because attack rates were low for the attackers on this schedule, two other procedures were employed to investigate the reliability of the original attacker/non-attacker categorization. First, a live target was substituted for the stuffed target while FR 100, or the highest FR that could be maintained without undue pausing, was continued for several sessions. Second, the stuffed target was returned to the chamber for several sessions in which periods of 10 reinforced key pecks (FR 1) alternated with 5-min extinction (EXT) periods in the manner of Azrin *et al.* (1966). Each session began and ended with a FR 1 period, and was terminated after 60 reinforcers.

RESULTS

Medians and ranges of the rate of attack in all phases of the experiment are shown for the non-attackers in Table 1 and for the attackers in Table 2. These statistics accurately represent attack levels except where trends occurred, and these are noted below.

Table 1 shows that Pigeons 56 and 2691 were categorized as non-attackers on the basis of attack levels in FR schedules of Phase A: Pigeon 56 never contacted the target, and the median rate of attack for Pigeon 2691 was zero. The relatively large range for the latter pigeon on FR 50 is attributable to attack during the first 10 sessions. Few attacks occurred after the tenth session. Pigeon 2175 and Pigeon 8 had attacked the stuffed target for an extended number of sessions. Their attack rates under Phase A of Table 2 are based on the last 19 sessions on the reinforcement schedule and choice of this number of sessions was arbitrary (see Dove, 1971, for more complete data on Pigeon 2691; and Dove *et al., in press,* for data on Pigeon 8).

The tables show that no contacts with the target were recorded for any pigeon in the 16 shock sessions of Phase B. During these sessions, wing flapping accompanied the initial presentations of each new shock intensity in all pigeons, but, after a session or two, it occurred only with the first few shocks of each session. During most of these latter sessions Pigeons 56, 2175, and 8 stood motionless and the occurrence of a shock usually could be detected by a "flinch", in which the head and neck momentarily contracted and the body simultaneously lowered towards the floor. In contrast, Pigeon 2691 was more active and usually pecked the shock-delivering plug at the onset of shock and for a brief period afterward. The pigeons often faced the target or the wall with the viewing window during shock sessions.

At the outset of Phase C, four to seven sessions were required to shape target pecking in Pigeons 56 and 2691. This large number of shaping sessions was needed to overcome crouching and immobility in both pigeons, and possibly was related to delay of reinforcement due to the food hopper's location on the wall opposite the target. Target pecking increased from about 30 pecks per minute in the early sessions on FR 25 to median rates of 126 per minute and 102 per minute for Pigeons 56 and 2691, respectively, in the final three sessions. During the initial sessions on FR 25, Pigeon 2691 pecked the target in the upper breast and lower neck regions. In later sessions, pecks early in the ratios were often directed towards the upper neck and head, whereas once responding was underway, pecks occurred primarily on the mid-breast. Pigeon 56 pecked only in a relatively circumscribed area of the lower breast of the target. Target pecks were not accompanied by wing flapping, charging, burrowing into the neck and head areas, vocalizing, and other "emotional" accompaniments of attack in pigeons described in schedule-induced aggression experiments (*e.g.,* Azrin, *et al.,* 1966) and when pecking a live pigeon is reinforced with food (*e.g.,* Reynolds, Catania, and Skinner, 1963).

Table 1 shows that target-pecking rate fell to near zero for both pigeons by the third extinction session. Pecking decreased by a substantial amount in the first extinction session (by about 20 pecks per minute for Pigeon 56 and 30 pecks per minute for Pigeon 2691) and the topography of target pecking changed for both pigeons in the early part of extinction. On the first day, Pigeon 2691 pecked on a noticeably wider area of the target, with many pecks at the neck and head. Subsequently, this pigeon occasionally shook the target while grasping its feathers or beak, behavior not seen during FR 25 training. Over the first two or three sessions, Pigeon 56 increasingly pecked outside the lower breast region to which its pecks had previously been confined, and on occasion this pigeon pecked vigorously at the target's head for a brief period.

No target pecking was recorded in either pigeon during the 16 shock sessions that followed extinction of target pecking. The pigeons behaved much as in the shock sessions of Phase B: Pigeon 2691 was more active and pecked the plug on its back during and shortly after shocks, whereas Pigeon 56 stood motionless throughout most of the sessions.

The validity of the initial categorization of the pigeons as attackers and non-attackers in schedule-induced aggression procedures was first assessed in Phase D, when all pigeons key pecked on FR 100 in the presence of the stuffed target. Table 2 shows that, of the two attackers, Pigeon 8 attacked at about the same median rate as it did during VI 10-min, but Pigeon 2175 attacked very little. The statistics in the table do not indicate that Pigeon 8 first began to attack in the ninth session on this schedule and that attack ranged between 0.56 and 2.96 attacks per minute in Sessions 9 to 13. Table 1 shows that, of the two non-attackers, Pigeon 56 never attacked during the FR 100 sessions with the stuffed target, and Pigeon 2691 attacked little.

Replacement of the stuffed target with a restrained live pigeon resulted in increased attack for the two attackers and little change for the non-attackers. In these sessions, key pecking continued to be reinforced on FR 100 in all but Pigeon 2691, which had shown long pauses during FR 100.

When the pigeons received alternating periods of FR 1 and EXT, attack rates against the stuffed target increased for all pigeons. The highest median rate (per minute) was shown by Pigeon 2691, originally classified as a non-attacker. Attack reached 10.3 attacks per minute in one session for the other non-attacker, Pigeon 56, but in no other session was rate of attack greater than 0.5 per minute, and the median was 0.07 per minute, a marginal increase above the previous median. Pigeons 2175 and 8, originally categorized as attackers, attacked at median rates of 9.0 and 3.0 responses per minute respectively during this final condition of Phase D.

DISCUSSION

No pigeon attacked the target when given electric shocks. Only wing flapping and "flinches" accompanied shocks in three of the pigeons, while the fourth pecked at the shock-delivery plug. Consequently, classification of pigeons as attackers and non-attackers on the basis of differential attack levels during experiments on schedule-induced aggression did not predict attack levels during shock. Further, the non-attackers did not attack in shock sessions following training to peck on the target. In a check on the original classification of the pigeons as attackers and non-attackers in schedules of positive reinforcement, the highest rate of attack was shown by one of the non-attackers when periods of FR 1 and EXT alternated in the presence of a stuffed target. The latter finding indicates that the "attacker"/"non-attacker" categorization may be specific to the schedules employed, although exposure to a live target before the FR 1/EXT schedule may have contributed to the relatively high levels of attack during this schedule. The present procedure does not allow the influence of schedules to be separated from that of historical variables.

Absence of attack during shock sessions in all four pigeons may be due to a number of factors. One is the species-specific reaction of pigeons elicited by various intensities of electric shock. High-speed photography in a restricted chamber showed that the pigeon's unconditioned reaction to mild electric shocks (6.3 V ac, 0.08 sec duration) is incompatible with key pecking and, presumably, with attack: the pigeon moves its head towards or onto the breast during shock and extends its head upwards after shock (Smith, Gustafson, and Gregor, 1972). This reaction approximates the behavior described above as a flinch. At higher intensities (80 to 120 V ac, 0.05 sec duration), shock contingent upon key pecking produces "a violent lurching and fluttering of the wings" (Azrin, 1959*b*, p. 304). The latter is reminiscent of the wing flapping that occurred in the early part of the present shock sessions, particularly when a new shock intensity was introduced. If the pigeon's reaction to shock can be manipulated by adjustments in shock intensity, as these findings imply, it may be possible to demonstrate shock-elicited aggression when certain response topographies are elicited in a sufficiently confined space, as has been shown with rats (Meyer, 1971; Ulrich and Azrin, 1962). Since the findings with rats have typically been obtained when pairs of free-moving rats are shocked simultaneously, it may be necessary to employ a comparable procedure with pigeons and not use an inanimate target, as in the present experiment.

An experiment with rats (Roberts and Larson, 1967) suggests that the present failure to show shock-elicited attack may be a natural consequence of the experimental design employed. Because the pigeons were drawn from experiments on schedule-induced aggression, they had a relatively long history in the experimental chamber with the target before shock was introduced. Roberts and Larson (1967) found that exposure to an experimental chamber, either alone or in pairs, reduced the probability of fighting between rats when shock was introduced. The general nature of the present experiment could be preserved while eliminating this factor if the shock phase was run at the outset and tests of aggression during reinforcement schedules were conducted later.

Another factor contributing to the present failure may be the type of target employed. Ulrich and Azrin (1962) showed that shocked rats will not attack a dead rat unless it is moved about on a stick. The inanimate target employed here may not be optimal for shock-elicited attack in pigeons, even though it was adequate for attack during reinforcement schedules.

Exceptions to the rather wide species generality of shock-elicited aggression have been noted (*e.g.*, Azrin, 1967; Ulrich, 1967) and in view of the present data it is of some interest that several mostly unspecified members of the class *Aves* are among these exceptions (*e.g.*, "... chickens, hawks, (and several other species of birds)", Azrin, 1967, p. 29). The present failure to find shock-elicited aggression in pigeons may document another failure in *Aves*, but a more complete range of experimental parameters must be employed before pigeons can be confidently regarded as one of these exceptions. The absence of published research on shock-elicited aggression in pigeons is surprising, since effective techniques for delivering electric shock have been available for several years (Azrin, 1959*a*; Hoffman, 1960) and since an otherwise comprehensive study of factors influencing aggression in pigeons has been undertaken (*e.g.*, reproductive cycle: Fabricius and Jansson, 1963; hormonal level: Murton, Thearle, and Lofts, 1969; dominance relationship: Lumia, 1972; season: Murton and Isaacson, 1962; brain stimulation: Akerman, 1966; reinforcement schedule: Gentry, 1968; target characteristics: Rashotte, Griffin, and Katz, 1973).

Aggression during schedules of positive reinforcement and during shock presentations is sometimes attributed to aversiveness of prevailing experimental conditions (*e.g.*, Azrin, 1967; Richards and Rilling, 1972; Ulrich, 1967). In the present experiment, the within-subject comparison of reinforcement schedules and electric shock as conditions that produce aggression may at first appear to provide an experimental test of this view. However, major differences in the behaviors elicited by different primary aversive stimuli are well documented (*e.g.*, Meyer, 1971), so that the present failure to find attack during shock in pigeons that had attacked during food reinforcement need not be contradictory to the hypothesis that aversiveness underlies aggression in both cases.

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