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RELATION BETWEEN LEVEL OF FOOD DEPRIVATION AND RATE OF SCHEDULE-INDUCED ATTACK[1]

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The relation between food deprivation and schedule-induced attack was investigated in four White Carneaux pigeons. Attack toward a mirror target was induced by a schedule of reinforcement in which 3-sec food presentations occurred at alternate intervals of 15 and 120 sec (multiple fixed-time 15-sec fixed-time 120-sec schedule). A continuous tone was presented during the 15-sec periods; it was absent during the 120-sec periods. Each pigeon was tested at 65, 80, and 95% of its free-feeding weight in ascending, descending, and ascending orders, respectively. Two relations were apparent; an inverse relation between body weight and rate of attack, and a tendency for rate of attack to increase during the experiment. Reduction or elimination of attack when the mirror was covered with brown paper for some sessions indicated that the results were due neither to changes in activity that might covary with weight nor to habituation to the experimental situation.

Key words: attack, deprivation, schedule induced, mirror pecking, pigeon

Pain-elicited attack occurs when a noxious stimulus, such as an electric shock or a physical blow (*e.g.* Azrin, Hake, and Hutchinson, 1965; Ulrich and Azrin, 1962) is presented. Schedule-induced attack occurs during certain schedules of food presentation when an appropriate target is present (*e.g.* Azrin, Hutchinson, and Hake, 1966; Gentry, 1968). Both types of attack have been described in terms of physical contacts, such as biting by rats (Ulrich and Azrin, 1962) and monkeys (Azrin, Hutchinson, and Sallery, 1964; Hutchinson, Azrin, and Hake, 1966), and charging, pecking, and feather pulling by pigeons (Azrin *et al.*, 1966; Cherek, Thompson, and Heistad, 1972; Dove, Rashotte, and Katz, 1974; Flory, 1969*a*, 1969*b*; Gentry, 1968). The effects of a number of variables on both of these phenomena have been investigated.

One elementary variable that has received relatively little attention is the deprivation state of the subject. Azrin *et al.* (1966) demonstrated that extinction-induced attack occurred less frequently in satiated pigeons than in pigeons maintained at 80% of their free-feeding weights. Other investigations have shown that food deprivation affects the level of attack when attack is elicited by electric shock. For example, the probability of attack following shock is higher in deprived as compared to nondeprived rats (Cahoon, Crosby, Dunn, Herrin, Hill, and McGinnis, 1971). With respect to schedule-induced attack, responding that is maintained by the opportunity to attack decreases as deprivation level decreases from 85 to 100% free-feeding weight (Cherek *et al.*, 1972). They noted that rate of attack showed changes similar to rate of responding to produce a live target pigeon, but the exact relation between schedule-induced attack and deprivation remains unclear, because in their study target availability as well as attack itself varied as a function of deprivation.

The present study investigated the relation between deprivation and mean rate and variability of schedule-induced attack. A mirror mounted in conjunction with four microswitches served as the target. Such an arrangement was used previously in the context of multiple fixed-ratio fixed-ratio schedules, and responding on the mirror was functionally and topographically similar to responding that results when a live or stuffed target is used (Cohen and Looney, 1973).

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A direct relation has been shown between food deprivation and activity (Hall and Hanford, 1954; Reid and Finger, 1955; Richter, 1922). To determine whether any observed relation between attack and deprivation was a real effect, and not simply a function of deprivation-induced activity, in some sessions the attack-recording mechanism was made nonreflective by covering it with brown paper similar in color to the interior of the chamber.

METHOD

Subjects

Four male White Carneaux pigeons obtained from the Palmetto Pigeon Plant, Sumter, S. C. served. Pigeon 9386 was experimentally naive and approximately 1-yr old. Pigeons 8, 25, and 2175 had served in previous experiments dealing with schedule-induced attack and were 3 to 4 yr old. Pigeons were maintained under constant light conditions. There were no signs of debilitation even when body weight was reduced to 65% of the value when food was freely available.

Apparatus

The experimental chamber measured 35.6 by 30 by 36 cm and was enclosed in a sound-attenuating wooden box ventilated by a small exhaust fan. Two translucent keys on the front wall were not lighted and were inoperative throughout the experiment. A grain hopper could be raised into a rectangular opening 7.6 cm above the floor at the center of the front wall. On the left side wall 4.4 cm from the front wall was a 12.7 by 30.5 cm mirror that served as the target. The mirror was suspended on a frame with mircoswitches attached at each corner. The frame and mirror protruded 2.5 cm into the chamber. A force of 75 g (0.75 N) closed the microswitches. The chamber was lighted and white noise was present throughout each experimental session. Events were automatically controlled by electromechanical equipment.

Procedure

The deprivation levels were 65, 80, and 95% of free-feeding weights. Subjects were initially reduced to 65% weight and then trained over a two-day period to eat from the food hopper when it became available. During these sessions, the tone was not presented and the chamber was dark except for illumination of the hopper during food presentations. In Sessions 3 through 5, the attack-inducing procedure was introduced but no target was present. The procedure, a multiple fixed-time 15-sec fixed-time 120-sec schedule (*mult* FT 15-sec FT 120-sec), required that food presentations of 3 sec duration occurred after either 15 or 120 sec in an alternating pattern. The 15-sec intervals were accompanied by a continuous tone. A Lehigh Valley Electronics Audio Signal Panel 283-01 placed behind the front wall of the chamber produced the 2.8-kHz 68-dB tone. The tone was absent during the 120-sec intervals. On the sixth day of the experiment, the mirror was inserted into the chamber for the first time. The deprivation series of 65, 80, and 95% of free-feeding weights was examined in ascending order, then in descending order, and finally again in ascending order. Sessions were terminated after 30 cycles of the multiple schedule. Ten sessions were held at each of the deprivation levels during the first ascending and descending series. Eight sessions were held during the final ascending series and on the first four of these the mirror was covered with a sheet of brown paper. Four to seven days separated each condition. This was necessary during the descending series to permit weight losses and was inserted in the ascending series as a control measure. Attack rates were calculated in each component of the multiple schedule. The pigeons were weighed after each session, and were given a food supplement equal to the difference between their actual and their designated weights. Food supplements and presentations during experimental sessions consisted of Purina Mixed Pigeon Grains.

RESULTS

Figure 1 shows for each pigeon the mean rates of attack during the first ascending (A), descending (D), and second ascending (A) series of weight changes from left to right. Black bars at the right of each panel show responses recorded while the target was covered with paper. The rates of each individual session were used to derive the means.

Two major trends are apparent. First, an inverse relation existed between body weight and rate of attack for Pigeons 8, 2175, and 9386. Within any series, 65% body weights

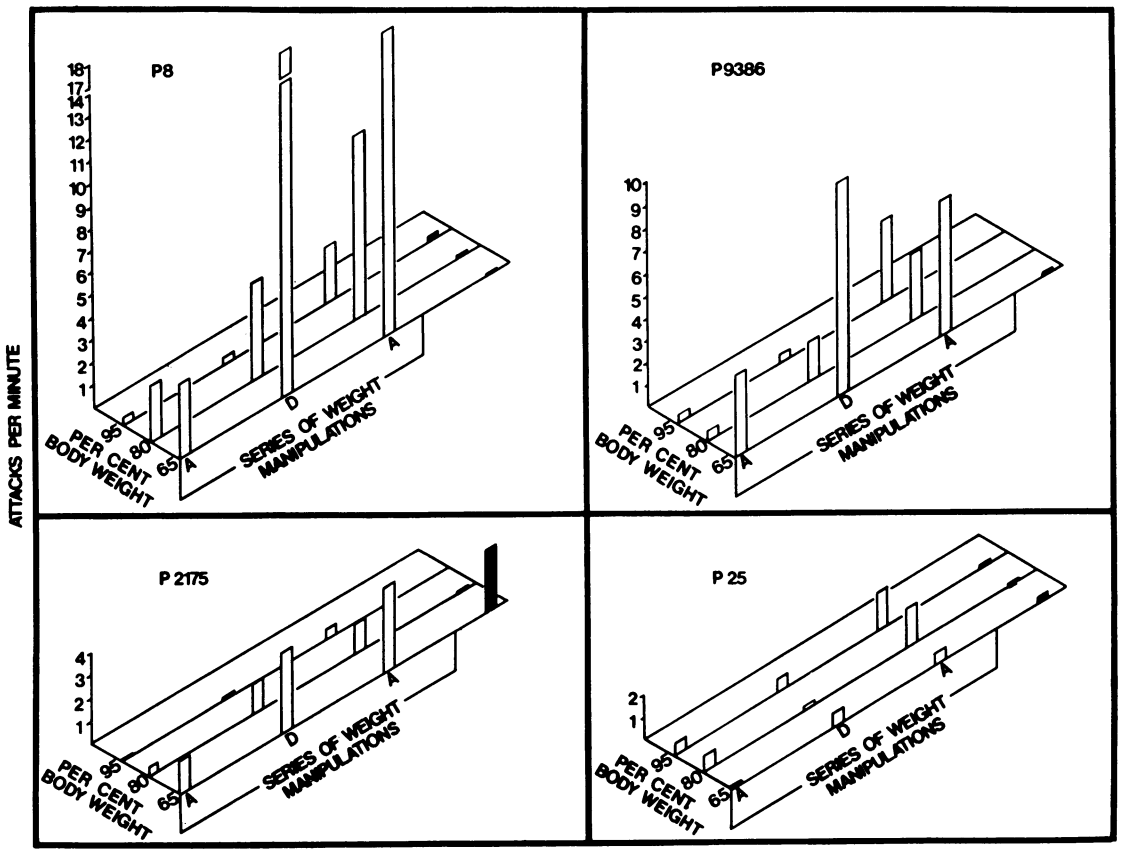

Fig. 1. Shown from left to right for each pigeon are: mean attack rates during the ascending (A), descending (D), and ascending (A) series of weight changes, respectively. Black bars at the right of each panel indicate response rates when the mirror was covered with paper. The rates of each individual session were used to derive the means.

were associated with the highest rates of attack, 80% weights were associated with intermediate rates, and 95% weights were associated with lowest rates of attack. The only exception is Pigeon 9386 during the final ascending series when the mean rate of attack was slightly higher at 95% than at 80%. There was no constant relation between deprivation and attack for Pigeon 25. Analysis of variance applied to the daily rates of each animal individually (*cf.* Gentile, Roden, and Klein, 1972) revealed that the differences were significant beyond the 0.01 level for Pigeons 8 ($F = 16.25$), 2175 ($F = 24.93$), 9386 ($F = 18.06$), but not for 25 ($F = 3.82$). The critical F in all cases was $F = 4.98$; *df* were 2/59.

The second trend is revealed by comparing the mean attack rates of the ascending, descending, and ascending series within each weight level. Attack increased throughout the experiment independently of the level of deprivation. This trend toward higher rates of attack during the second (descending series) and third series (ascending series) of weight manipulations can be seen in the data of each pigeon. Analysis of variance, which compared the rates of attack during the first ascending series with rates during the final ascending series, for individual pigeons showed differences to be significant for all subjects; 8 ($F = 63.85$), 2175 ($F = 7.33$), 9386 ($F = 9.71$), 25 ($F = 17.45$). The critical F was 7.31 and *df* were 1/40.

Rates of attack were computed daily for each component of the *mult* FT 15-sec FT 120-sec schedule. Table 1 shows the means of daily rates from all sessions at each weight level. The means are representative of the rates in individual sessions. For Pigeons 8, 2175, and 9386 when the mirror was reflective, attack

Table 1

Mean rates of responding on the mirror during the FT 15-sec and FT 120-sec components of the multiple schedule. For each weight level, daily rates from the ascending, descending, and ascending series were combined to derive the overall means.

	Pigeon							
	8		*2175*		*9386*		*25*	
Weight	*FT 15*	*FT 120*	*FT 15*	*FT 120*	*FT 15*	*FT 120*	*FT 15*	*FT 120*
				Mirror Reflective				
65%	6.0	12.1	1.2	3.0	0.6	7.3	0.6	0.3
80%	2.5	4.5	0.5	0.9	0.1	1.6	0.4	0.7
95%	0.8	3.6	0.0	0.2	0.7	1.3	1.1	1.0
				Mirror Covered				
65%	0.3	0.1	3.2	2.7	0.2	0.1	0.3	0.2
80%	0.3	0.1	0.9	0.1	0.0	0.0	0.1	0.0
95%	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.1

rates were consistently higher during the FT 120-sec component. The inverse relation between body weight and rate of attack was exhibited in each component of the multiple schedule. In the mirror-covered conditions, the rates in the two components were not systematically different. For Pigeon 25, attack rates were not consistently different in the two components, either in the mirror-reflective or the mirror-covered conditions. Informal observations revealed that attack was most probable during the period immediately following food presentations in both components of the schedule. When the FT 120-sec component was in effect, almost no attack was observed during the last half of the interval.

To check the possibility that the observed relation between attack and deprivation might be a function of deprivation-induced activity, and not a real effect of deprivation on attack, the attack-recording mechanism was made nonreflective in some sessions by covering it with brown paper similar in color to the interior of the chamber. The black bars at the right of each panel in Figure 1 show mean rates of responding on the attack-measuring device during the four sessions that the mirror target was covered at each weight during the final ascending series. Comparison of black bars to adjacent bars shows that low rates of responding occurred during the mirror-covered conditions relative to the mirror-reflective conditions. Only for Pigeon 2175 were substantial rates recorded during the mirror-covered conditions and then only when weight was at 65%. Even in that case, however, rates were substantially higher during the mirror-reflective condition.

All pigeons were observed frequently during the experiment. These observations revealed that switch closures on the attack-measuring device were the result of discrete beak and breast thrusts toward the mirror. This topography was characteristic of all birds during the mirror-reflective conditions. During the mirror-covered conditions, closures were caused by the subjects brushing against the mirror while pacing from side to side in front of it. From the pacing and general head orientation, it appeared as if the subjects were "looking for the target". Frequent episodes of wing flapping were observed in Pigeon 2175 at 65% body weight in the mirror-covered condition. These episodes occurred while the subject was oriented toward the food hopper, and frequently resulted in switch closures, accounting for the moderately high rates of "attack" under that condition. Such wing flapping was seldom observed in other birds or under other conditions for Pigeon 2175.

Coefficients of variation were calculated and plotted for each weight manipulation for each subject. These coefficients are the standard deviation divided by the mean, and multiplied by 100. Coefficients of variation are a more appropriate measure of variability than standard deviations, in the present instance, due to the tendency for standard deviations to be correlated with means, especially as the mean approaches zero (*cf.* McSweeney, 1974). Visual inspection of the plots revealed no systematic

relation between amount of variability and level of deprivation.

DISCUSSION

Several properties of schedule-induced attack have been widely reported. Temporally, the attack is most frequent shortly after food presentation and diminishes in frequency as the interval since food presentation increases (*e.g.,* Dove *et al.,* 1974; Flory, 1969*a,* 1969*b;* Gentry, 1968; Webbe, DeWeese, and Malagodi, 1974). When multiple schedules have been investigated, rate of attack is higher in the component of the schedule with the lower rate of food presentation (Azrin *et al.,* 1966; Cohen and Looney, 1973; Cole and Litchfield, 1969; Flory, 1969*a;* Looney and Cohen, 1974). Finally, the topography of attack includes charging, pecking, and feather pulling (*e.g.,* Azrin *et al.,* 1966; Cherek *et al.,* 1972; Dove *et al.,* 1974; Flory, 1969*a,* 1969*b;* Gentry, 1968). Each of these properties was apparent in the present study, supporting the contention that a mirror is a feasible target for use in attack investigations (Cohen and Looney, 1973), and the argument that the relation observed in the present study was between deprivation level and schedule-induced attack.

Weight levels of 65, 80, and 95% free-feeding weight run in ascending, descending, and ascending orders revealed an inverse relation between body weight and amount of aggression in three of four subjects. No systematic relation was apparent in the fourth. Attack rates were higher during the second series of weight manipulations, a descending series, than during the first ascending series. Two possibilities would account for this result: (1) more attack is generated by a descending than by an ascending series of manipulations, or (2) the tendency to attack increases with exposure to conditions that produce schedule-induced attack, at least over some range of exposure. The first alternative is attractive, given arguments that schedule-induced attack results from aversive qualities of the schedule of reinforcement. The logic of the argument is simple: food rationing at 80% body weight is less aversive if the previous body weight was 65% than if the previous weight was 95%. This logic seems not to account for the data, however, in light of the fact that rates of attack remained high during the subsequent ascending series of weight manipulations. The possibility that attack may increase as a function of exposure to the attack-inducing conditions has been noted previously. Cherek and Pickens (1970) using fixed-ratio schedules, Dove *et al.* (1974) using variable-interval schedules, Azrin, Rubin, and Hutchinson (1968), and Hutchinson, Renfrew, and Young (1971) using shock procedures all reported that attack develops gradually over the initial sessions during which an attack-inducing procedure is in effect. One would not predict from those studies that the tendency toward increasing attack as a function of exposure to attack-inducing conditions would endure as long as it did in the present study. However, there are sufficient differences between the present study and those just cited to account for the difference. The most notable is that blocks of "rest" days were inserted between experimental manipulations in the present study. Further research directed specifically toward changes in attack as a function of recent exposure to various schedules of reinforcement would supply interesting information.

The present results are in general agreement with previous experiments dealing with food deprivation and aggression. They replicate previous reports in which group designs were used and aggression was elicited by electric shock (Cahoon *et al.,* 1971). Present results also complement the finding of Cherek *et al.* (1972) that rate of responding to produce a target is inversely related to body weight, and extend the range over which that relation holds. The finding that little "attack" occurred when the mirror was covered indicates that the relation was not merely an overall increase in activity with increased deprivation. The data indicate that food deprivation is a variable capable of greatly accentuating or attenuating schedule-induced attack when other parameters of the attack-inducing situation remain constant.

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