Transfer of persistence in the domestic chick: Imprinting, punishment, and resistance to extinction of a food-reward running response*

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Four groups of domestic chicks received imprinting, imprinting-shock, shock, or control treatment in the first week of life, and later learned a hunger-motivated running response in a runway under either continuous- or partial-reward conditions. When the running response was extinguished, a partial reinforcement effect (PRE) was shown in all four treatment groups. In the imprinting-shock treatment, persistence was enhanced following both partial- and continuous-reward acquisition training. Implications for counterconditioning views of persistence are discussed.

Recently, a general theory of persistence has been proposed (Amsel, in press) which treats the $S_F \rightarrow R(\text{approach})$ mechanism of frustration theory as a special case of a more general rule. In the more general case, as in the frustration theory, persistence is treated as a separate dimension of behavior (Amsel, 1967) whose defining characteristic is the continuation of ongoing behavior in the face of disruptive stimulation. The more general approach deals with a wider class of disruptive events than frustration—in fact, with any stimulus (S_X) capable of evoking an unconditioned response (R_X) that interferes with the ongoing behavior (R_O). The counterconditioning of S_X to R_O is regarded as a mechanism that contributes to persistent responding in some class of subsequent disruptive situations.

An implication that can be derived from the theory is that the resistance to extinction of an instrumental response may be manipulated in situations not closely related to the acquisition situation (Wong, 1971), and that the development of general persistence may depend on factors which operate during critical early periods of life.

Domestic chicks exhibit approach and following responses to a large class of moving or conspicuous objects, and these responses together with preference for these objects define imprinting (Sluckin, 1964). It has been demonstrated that flickering light is an effective imprinting object (James, 1969). The general theory predicts

that if the approach response evoked by this imprinting object is disrupted by a series of shocks, but the chick comes to perform the response despite these disruptions, this treatment should subsequently increase the resistance to extinction of a food-rewarded running response in a different runway.

There is also the possibility that the imprinting treatment without punishment might build persistence in young chicks. The rationale depends on the observations of several investigators (Ramsay & Hess, 1954; Sluckin & Salzen, 1961) that young birds are seemingly in a state of approach-avoidance conflict in the imprinting situation; the approach or following response occasionally appears to be disrupted by the tendency to flee or freeze, and this conflict behavior has been attributed to fear of the novel situation (Salzen, 1962; Sluckin & Salzen, 1961).

Our main purpose was to determine if imprinting, with and without shock obstruction, increases the resistance to extinction of a subsequently trained, continuously food-rewarded running response. Partially rewarded groups were also included so that the presence of the PRE in very young domestic chicks could be demonstrated and any summation of persistence effects as a result of both imprinting and partial reinforcement training could be detected.

SUBJECTS

The Ss were 48 Cornish x White Rock chicks hatched in the laboratory. All Ss were moved to 8 x 8 x 8 in. individual brooder compartments when they were about 6-12 h old. A white fluorescent light, mounted on the ceiling of the brooder, was on at all times. Brooder temperature was kept at the following levels: first 2 weeks, 92°F; third week, 82°F; throughout the remainder of the experiment, 72°F. All birds were maintained on locally prepared starter krums and tap water.

APPARATUS

The chick runway was the same as that

described in Wong & Amsel (1970). A noise-operated relay, carefully adjusted to record only high-pitch and intense cheeps characteristic of "distress" calling, was connected to three microphones which rested on a Plexiglas lid in the center of each 1-ft segment of the runway. These centers, of 1½-in. diam, were perforated with ¼-in. holes. The raising of the startdoor activated the first series of two counters, and the lowering of the goalbox door activated the second series of two counters, each counter registering distress calls emitted within a 15-sec interval.

The imprinting apparatus was similar to that described by James (1959). It was a 3 x 1 x 1 ft wooden alley painted flat black with an open top. A shock grid extending the length and width of the alley served as the floor. The visual-auditory imprinting stimulus was one interior end wall of the alley. The visual stimulus was a light flickering at a rate of .5 sec on and .5 sec off through a diamond pattern of four holes of ¾-in. diam, 4 in. apart, illuminated at 68 fc. The auditory stimulus, synchronous with the flicker, was emitted at the same end of the alley as the light stimulus by a small PM speaker. The intensity of this stimulus was measured to be 75-80 dB at 6 in. from the source. The sound spectrum was similar to that of a metronome.

DESIGN

Imprinting and shock were combined factorially, resulting in four treatment combinations: imprinting-shock (imp-shock), imprinting-noshock (imprinting), no imprinting-shock (shock), no imprinting-noshock (control). Within each of these treatments there was further subdivision into CRF and PRF conditions. Six birds were assigned randomly to each of the eight groups at the time of being removed from the incubator.

PROCEDURE

Imprinting

The Ss were approximately 12-20 h old when first exposed to the imprinting situation. The imprinting phase lasted for 6 days with two trials per day, 5 min per trial. On each trial squads of eight Ss were run, including one S from each of the eight experimental conditions. Running order of the six squads and Ss within each squad was according to a predetermined random sequence, the only necessary restriction being that within any squad an imp-shock bird always preceded its yoked shock mate.

Imprinting procedures were conducted in a darkened room with a masking fan on continuously. As soon as S was placed at the far end of the alley, the imprinting stimulus was switched on at the other end. It was switched off before the bird was removed at the end of each trial. Imp-shock birds received the same treatment except that, 6 in. away from the imprinting object, a 6 x 12 in. segment of the grid was electrified. Shock intensity was gradually increased such that on the first 2 days it was 1 mA, on the third and fourth days, 2 mA, and during the last 2 days, 3 mA. To reduce resistance to shock, the chick's feet were dipped into saline solution immediately before each trial (applied to nonshock birds as well). Each shock bird was yoked with an imp-shock S so that on trials on which the latter crossed the shock grid the former received a shock of about the same duration, delivered randomly within the 5-min interval. The control birds were simply placed in the imprinting alley.

Distress calls were recorded twice during the 5-min interval, on each occasion for 30 sec, starting at 2½ min and 4½ min. Calls were registered by two counters, each operating for 15 sec.

Runway Training

All Ss were maintained on the following deprivation schedule: Days 7-8, 4 h access to food; Days 9-10, 2 h; Day 10 until end of the experiment, 1 h. All Ss were fed about 15 min after the last S had completed its test trial.

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Fig. 1. Imprinting data. Upper panel shows percentage of chicks imprinted. Lower panel presents mean log time to approach within 6 in. of the imprinting stimulus.

Runway training started with 5 days of pretraining, two trials per day: Days 8-10, goalbox feeding; Days 11-12, shaping. During goalbox feeding, birds were placed directly before the foodcup, one at a time. Thirty seconds of feeding within a maximum interval of 5 min was allowed on each trial. At the end of this phase of training, birds that never ate in the goalbox were discarded, leaving five Ss per group. Each shaping was immediately preceded by 30 sec of goalbox feeding. On Day 11 the bird was placed 2 ft from the goalbox; on Day 12 it was placed inside the startbox. On these shaping trials only, if a bird failed to enter within 5 min, it was gently guided into the goalbox and allowed to feed for 30 sec.

Starting on Day 13, Ss received 96 acquisition and 40 extinction trials, 4 trials per day on the first 2 days of acquisition and 8 trials per day thereafter. On any trial, the running sequence within each squad of 20 Ss was randomized. Reinforcement consisted of 30 sec access to starter krumbs. Partially rewarded Ss were rewarded on a 50% random basis. The minimum intertrial interval was about 25 min. A maximum of 3 min was allowed on each trial. If a bird failed to break the last photobeam within this time, it was placed in the goalbox. Any time score greater than 60 sec was recorded as 60 sec, and in case S did not meet the 3-min criterion, all three scores were recorded as 60 sec.

RESULTS AND DISCUSSION

Imprinting

There is some suggestion of better imprinting for the imp-shock group up to Trial 4 in the percentage data (Fig. 1, upper panel). The imp-shock birds began to avoid the shock grid on Trial 5 (i.e., Day 3). This was probably due to increase in shock intensity and age (Kovach & Hess, 1963). However, on any trial, only about 30% of the imp-shock birds failed to cross the live part of the shock grid, and even these birds traversed a large segment of the alley and stopped just short of the shock-grid, about 1 ft away from the imprinting object.

The average log time for the two imprinting groups to approach within 6 in. of the imprinting stimulus is shown in the bottom panel of Fig. 1. Analysis of variance on these log time measures revealed significant shock effect ($F = 8.0$, $df = 1/22$, $p < .01$).

The trial effect ($F = 2.09$, $df = 11/242$, $p < .05$) and the Shock by Trial interaction ($F = 3.75$, $df = 11/242$, $p < .01$) were also significant. On the first day of imprinting, all birds emitted distress calls, suggesting a fear reaction to the novel imprinting situation (Fullerton, Berryman, & Sluckin, 1970). Mean frequencies of calls for the imp-shock, imprinting, shock, and control groups in the first trial were 9.7, 8.4, 13.0, and 10.7, respectively. About 60% of the birds approached the imprinting object on the first trial. When a bird did approach during early imprinting trials, it did so very slowly, and the behavior was often interrupted by halts coupled with a burst of distress calls.

While distress calls gradually dropped out in both imprinting groups, there was little or no habituation of distress calling in the nonimprinting groups. On the last trial, the mean numbers of distress calls of the imprinting groups and nonimprinting groups were 1.8 and 11.7, respectively. Analysis of variance on distress calls averaged over the four 15-sec intervals revealed that imprinting ($F = 34.19$, $df = 1/44$, $p < .01$), trial, and Imprinting by Trial effects ($F_s = 9.81, 11.48$, $df = 11/484$, $p < .01$, in both cases) were significant. It is possible that the mere presence of an imprinting stimulus is sufficient to lower the level of distress calling in a novel situation. But this would be difficult to test without restraining the birds.

Runway Training

Five Ss were discarded for failure to eat in the goalbox, and in order to maintain equal Ns three more Ss were eliminated. Time scores were transformed into speeds (ft/sec), and analyses of variance were performed on the speed data from 40 Ss, 5 per group. Since all three measures showed essentially the same patterns of results, only data from the run measure are presented; statistical analyses are reported for all three measures.

Figure 2 shows that all eight groups acquired the running response, as confirmed by the main effect of days ($F_s = 55.38, 35.37, 159.21$ for start, run, and goal, respectively, $df = 11/3040$, $p < .01$ in all cases). The two shock groups initially showed slower rates of acquisition, but all groups reached almost identical terminal levels of performance, resulting in a significant Treatment by Days interaction ($F_s = 3.60, 5.01, 2.36$, $df = 33/3040$, $p < .01$ in all cases). The initial inferior performance of shock groups may reflect some generalization of fear from the imprinting situation, evoking responses incompatible with running.

Figure 2 also indicates a clear PRE for all four conditions, and Fig. 3 shows extinction performance

compared across groups, including a trial-by-trial plot of the first block of eight trials. In terms of an overall comparison, the PRF groups exhibited for all measures a higher level of responding than did the CRF groups, i.e., a significant reinforcement effect ($F_s = 8.32, 12.49, 8.02$, $df = 1/32$, $p < .01$ in all cases), and a slower rate of extinction, i.e., a significant Reinforcement by Days interaction ($F_s = 10.79, 8.34, 10.76$, $df = 4/1248$, $p < .01$ in all cases).

While the treatment main effect was not reliable, the Treatment by Days interaction was significant in all three measures ($F_s = 1.89, 2.47, 2.81$, $df = 12/1248$, $p < .05, < .01, < .01$, respectively, for start, run and goal). In both the start and goal measures, the Reinforcement by Treatment by Days interaction was significant ($F_s = 2.55, 3.41$, $df = 12/1248$, $p < .01$ in both cases), while in the run measure it approached significance ($F = 1.55$, $p < .10$). Because of the triple interaction, a separate analysis was performed for each level of reinforcement. Under the PRF conditions, there was a reliable Treatment by Days interaction in all three measures ($F_s = 2.48, 2.34, 3.97$, $df = 12/624$, $p < .01$ in all cases). The nature of this interaction is apparent in the left panel of Fig. 3, which shows that over the first eight trials, the persistence of all four groups is about the same, but that the level of responding remains higher in the imp-shock group. In the start measure, while the performance of all other PRF groups gradually decreased over days, the performance of the imp-shock group showed an increasing trend, mean speed (ft/sec) over

Fig. 2. Mean speeds in the run measure during acquisition and extinction showing separate comparisons of PRF and CRF (the PRE) for each of the four treatment groups.

Fig. 3. Mean speeds in the run measure during extinction following CRF and PRF acquisition training. The first eight trials were plotted individually.

successive days being 1.71, 1.57, 1.87, 1.61, and 2.28. A similar pattern of responding was also observed in the goal measure.

Under the CRF condition, the Treatment by Days interaction was significant only in the run and goal measures ($F_s = 1.78, 2.44$, $df = 12/624$, $ps < .05, < .01$, respectively). The right panel of Fig. 3 shows that the imp-shock and imp groups were more resistant to extinction than were the other two groups, particularly over early extinction trials. A similar result was obtained in the goal measure.

Considering all three measures, there was reasonably good evidence of enhanced persistence following imp-shock treatment, and there was some suggestion that both imprinting and imprinting-shock treatments increase persistence after CRF acquisition. Such transfer from approach to a flickering light-sound stimulus to hunger-motivated running to food may depend on some kind of general mechanism, such as the one proposed earlier. The kind of transfer of persistence we have under consideration is more general than has been demonstrated before (e.g., Brown & Wagner, 1964) in at least the sense that here the transfer is across different incentive systems and across very different learning situations; the prior "persistence" training takes place at a very early and, presumably, critical period of the chick's life and is separated from the extinction test phase by 7 days of pretraining and 13

days of acquisition in the runway; and the counterconditioned response in the imprinting-shock situation is a slow and hesitant form of approach behavior, while the running response to be extinguished in the runway is a very vigorous one.

Distress Calls and Elimination

Since the first two counters also registered calls emitted in the goalbox if a bird entered it in less than 30 sec, only calls registered by the last two counters during the 30-sec goalbox confinement were analyzed. During acquisition, in each of the two 15-sec intervals, the PRF groups emitted more calls than did the CRF groups. Mean numbers of distress calls for PRF and CRF groups averaged over both measures were 1.95 vs 0.25, respectively ($F = 8.29, 7.55$, $df = 1/32$, $p < .01$ in both cases).¹ However, the level of distress calling by the PRF group gradually declined over days, and by the end of acquisition was approaching the same level as the CRF group (i.e., zero calls). This was supported by a significant Reinforcement by Day interaction in both measures ($F_s = 7.64, 7.01$, $df = 11/3040$, $p < .01$).

Only three PRF and two CRF birds emitted distress calls throughout extinction, likely because distress calling is an age-specific emotional reaction, prevalent only through the first 15 days. Candland, Nagy, & Conklyn (1963) found that after this age only about 20% of birds emit distress calls.

Throughout acquisition, there was only one instance of elimination in the

CRF group, while 16 out of 20 PRF birds defecated in the runway. However, during extinction, there was a sharp rise in the occurrences of elimination in the runway in both CRF and PRF groups, which reached its peak on the fourth day of extinction.

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NOTE

1. This difference could not be attributed to the fact that CRF birds could not make calls while eating, because Wong & Amsel (1970) observed that CRF birds did not emit distress calls in the goalbox even when they were not eating. Further, in a pilot study, we found that PRF birds emitted more calls than CRF birds even in the start and run segments of the runway, suggesting that even anticipation of frustrative nonreward was capable of eliciting distress calling.