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AUTOSHAPING AS A FUNCTION OF PRIOR FOOD PRESENTATIONS[1]

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Young chickens were given 1, 10, 100, or 1000 presentations of grain in a hopper. Subsequently, the key was illuminated before each presentation of grain to study autoshaping of the key-peck response. The number of keylight-grain pairings before a bird first pecked the lighted key was found to be a U-shaped function of the number of prior food-only presentations, with pecks occurring significantly sooner after 100 food-only trials than after any of the other values. Two of five chicks at the 100-trial value pecked on the first illumination of the key. Experiment II showed further that when a series of food-only trials (no keylight) preceded keylight-only trials (no food) 30% of the chicks pecked the illuminated key. Experiment III extended the generality of first-trial pecking to pigeons. After preliminary training with food-only, two of five pigeons pecked on the first illumination of a key. The results suggest a close relationship between autoshaping and pseudoconditioning.

Key words: autoshaping, hopper training, response-independent food, one-trial acquisition, chickens, pigeons

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When a response key is occasionally illuminated and then grain is provided to a food-deprived pigeon, the bird soon pecks the key. This form of learning has been called autoshaping (Brown and Jenkins, 1968). Most interpretations state that key illuminations must immediately precede food for key pecks to occur (Hearst and Jenkins, 1974). Studies supporting this hypothesis show that when keylight and food do not occur in close temporal proximity, pigeons avoid the area of the key and consequently do not peck (Wasserman, Franklin, and Hearst, 1974). Also, if pigeons first experience 900 food-only presentations—the key never being illuminated—the number of autoshaping trials before the first key peck is significantly increased (Engberg, Hansen, Welker, and Thomas, 1972). This last finding, obtained with only one value of food-only presentations, provided the motivation in Experiment I to determine the form of the function relating number of preliminary food-only trials to how rapidly pecking would develop under autoshaping contingencies. Young chickens were given 1, 10, 100, or 1000 food-only presentations. The main question was whether speed of autoshaping decreased monotonically with number of prior food-only presentations. Chickens were used rather than pigeons to extend autoshaping for food to the chicken (Wasserman, Hunter, Gutkowski, and Baker, 1975, showed that chicks would autoshape for heat reinforcement), and because chickens were easier and cheaper to acquire and house than pigeons.

EXPERIMENT I

METHOD

Subjects

Twenty Cornish chickens, approximately 3.5 days old at the start of the experiment, were deprived of food for 8 hr before each session.

Apparatus

The chamber was 30 by 27 by 30 cm. A Gerbrands food hopper with added photocell was centered 9 cm to the right of the midline on the front wall; the hopper contained chick starter mash. A Gerbrands transluscent response disk, 2 cm in diameter and requiring

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0.05 N force to be activated, was 7 cm from the floor on the midline of the front wall. The response disk could be transilluminated by 7.5-W white bulbs. Except where noted, there was continuous illumination from an overhead 7.5-W bulb.

Procedure

During the first session, a small amount of food was placed on the floor of the chamber and, after the chick began to eat, the hopper was operated. The chick was directed to the hopper by the experimenter's hand, which was withdrawn as soon as the chick ate from the hopper. It remained operated for 20 sec during the first trial. During each ensuing reinforcement, the hopper remained operated until the chick had 2-sec access to food. The 2 sec was timed from the moment the chick crossed a photocell beam in the hopper. Throughout this and the other two experiments, the houselight was darkened during food presentation.

The birds were randomly divided into four equal groups that received 1, 10, 100, or 1000 food-only trials during which the key was always dark. The food was delivered according to a variable-time 15-sec schedule (VT 15-sec) spaced according to the Fleshler and Hoffman (1962) distribution, *i.e.,* food was presented independently of behavior on the average of four times per minute. A session ended after 50 food presentations, or when the bird reached its prescribed number of food-only trials. If the chick did not eat from the operated hopper within 90 sec, the hopper was lowered automatically and another trial began. If a chick missed five successive reinforcements, it was removed from the chamber for a few minutes and then returned. These last two contingencies occurred rarely. For the birds in the 100 and 1000 food-only groups, sessions were given twice per day with not less than 9.5 hr intervening. In all cases, the birds were deprived for 8 hr before a session.

Autoshaping training began during the first session after a bird received the appropriate number of food-only trials. All birds were approximately 15 days old at this point. Autoshaping training consisted of transilluminating the key for 4 sec before each food delivery; all other aspects of the procedure remained unchanged. Both key illumination and food occurred independently of the subjects' behaviors. Responses to the disk were recorded but had no scheduled consequences except to produce 30-msec feedback darkening of the lighted key. Each of five autoshaping sessions was terminated after the fiftieth trial.

RESULTS

During the food-only condition, when the key was dark, four birds in the 1000-trial group made 1, 2, 3, and 4 responses, respectively, and one bird in the 100-trial group made two responses. None of the other birds pecked the dark key.

Figure 1, top, shows that the average number of autoshaping trials given before a bird pecked the key was a U-shaped function of number of prior food-only trials. Birds in the 100-trial group pecked after a mean of only 4.4 key illuminations, significantly fewer than in any of the other groups. Two of the five birds in the 100-trial condition pecked the key on its first illumination, before any pairing of keylight and food. The second graph shows a similar U-shaped function for trials to the fifth response. The bottom two graphs indicate that after the key peck was acquired, measures of strength of responding during the remainder of the five sessions varied in a similar U-shaped manner. The third graph gives an index of the average probability (after the first response) that key illumination would be followed by at least one response. To make this figure directly comparable to the above two, the inverse of response probability is drawn, *i.e.,* the average number of keylight presentations between those in which at least one response was made. For the same reason, the lowest graph shows the inverse of average response speed (after the first response) in the presence of the illuminated key, *i.e.,* the time the key was illuminated divided by the number of responses.

Figure 2 emphasizes that preliminary food-only training affected long-term responding as well as response acquisition. Shown there is the average cumulative number of responses to the lighted key for each group during the first 200 trials. The 10- and 100-trial groups responded more frequently throughout training than the 1- and 1000-trial groups.

Since all birds had received a 20-sec period of access to grain in the hopper before training was initiated, and since the hopper remained operated until the bird obtained 2 sec of grain per reinforcement, the birds generally approached and ate from the hopper within the

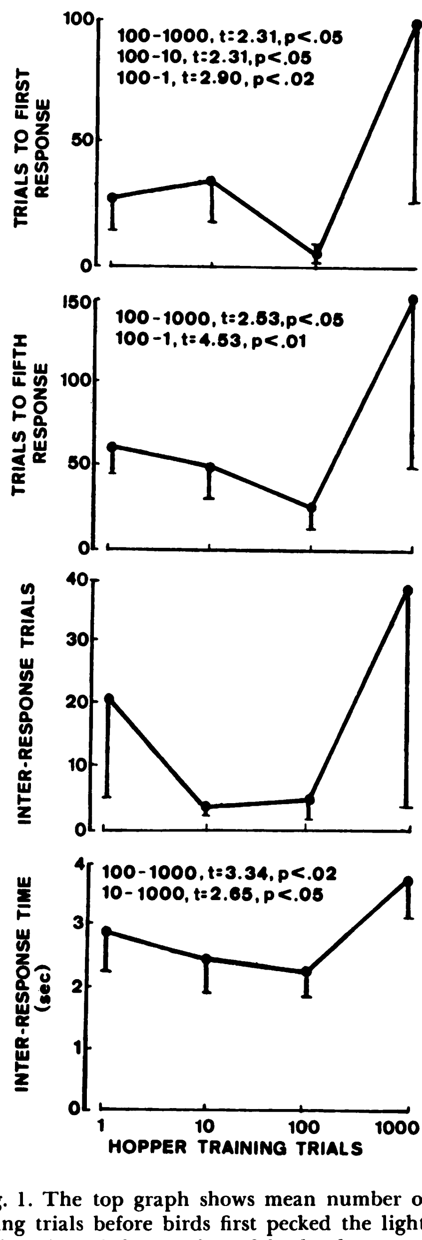

Fig. 1. The top graph shows mean number of autoshaping trials before birds first pecked the lighted key as a function of the number of food-only presentations given previously. The second graph shows the mean number of autoshaping trials before the fifth trial in which birds pecked the lighted key. The third graph shows the mean number of autoshaping trials in which no response occurred divided by the mean number of trials in which one or more responses occurred. Data were averaged across the five sessions. The bottom graph shows the mean interresponse times during autoshaping trials in which one or more responses were emitted. Again the data were averaged across the five sessions. Two-tailed t-tests, df = 8, yielding significant values are given in the inserts. All other comparisons are not significant. Standard deviations are indicated.

first few trials in training, and in all cases ate reliably within 10 presentations of grain. Thus, learning to eat from the hopper was not a significant contributor to the U-shaped functions.

The birds were monitored visually during autoshaping and a record was kept of their orientations to the key during its illumination. Orientation to the key was defined as the bird being located in the quadrant of the cage closest to the key with the bird's head pointed towards the key. Figure 3 shows the average cumulative number of key orientations during key illumination for each group. All groups oriented with a similarly high probability and these group functions represented the individual performances. Thus, birds often oriented to the key for many trials before the first key peck. This was especially true for the 1000-trial birds: they were the most likely to orient to the lighted key, but least likely to peck it. Orientations and key pecks appear, therefore, to be controlled differently.

EXPERIMENT II

The results of the 100-trial group in Experiment I showed that the birds responded within an average of fewer than five pairings between key illumination and food, and that two of the five subjects responded to the lighted key before any pairing. Experiment II tested whether food-only training could alone generate pecking to a lighted key. Chickens were first given food-only trials (without key illumination) and then keylight-only trials (without food). The results of Experiment I suggested that at least some subjects would peck the illuminated key. The parameters used were slightly different than in Experiment I: 50 food-only trials preceded the keylight-only trials and the intertrial duration was increased. Other research in our laboratory indicated that the maximum probability of responding might occur after 50 food-only presentations, and Terrace, Gibbon, Farrell, and Baldock (1975) showed the importance of long intertrial times for rapid autoshaping.

METHOD

Subjects

Fourteen Cornish chicks, 3.5 days old at the start, were deprived for 8 hr before each session.

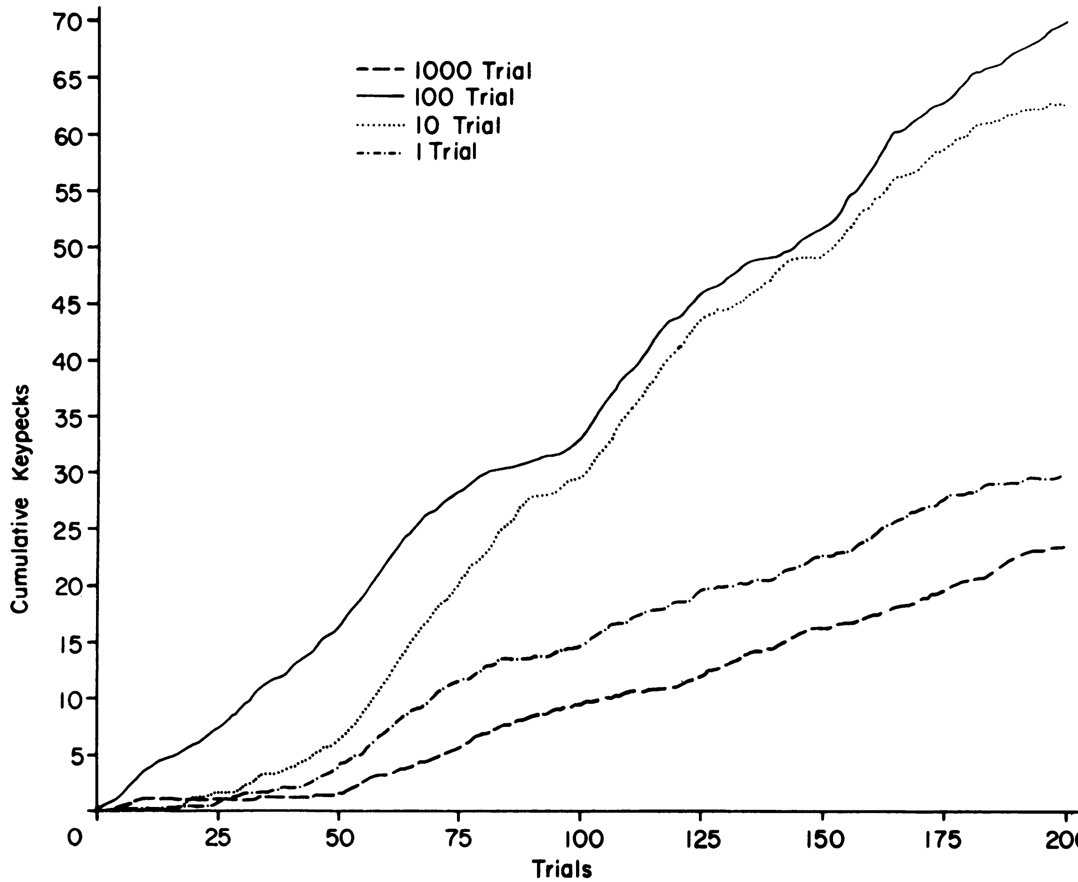

Fig. 2. Cumulative average number of key pecks in each of the four groups during the first 200 keylight trials.

Apparatus

The same as in Experiment I.

Procedure

The birds were divided into two equal groups. The first group received 50 food-only trials, followed by 50 presentations of keylight-only. Thus, food and keylight were never paired for Group I. The second group also received 50 presentations of food-only, identical to above, but then received 50 keylight-food pairings, as in Experiment I. A comparison of Group II with Group I showed whether pairing keylight with food was important. Except for the absence of grain after keylight in Group I, the contingencies were identical for all subjects and were the same as in the first experiment with the following differences: (1) the average intertrial time was increased from 15 to 78 sec, and (2) the first keylight trial for all groups occurred 4 min after the session began, so that the session started with the longest interval. The experiment terminated after 50 keylight presentations.

Results

Two of the birds in Group I, where food-only preceded keylight only, pecked the illuminated key, one bird in the fourth and the other in the fifth keylight trial. All birds in Group II, where keylight-food pairings followed food-only training, responded, with first responses emitted during trials 1, 1, 5, 8, 10, 11, and 25 for a mean of 8.7. Thus, in each of these conditions two birds pecked before any correlation between key illumination and grain in the hopper.

Discussion

That all birds in Group II pecked, whereas only two birds pecked in Group I, indicated that the pairing of keylight and food contributes importantly to the genesis of key pecking

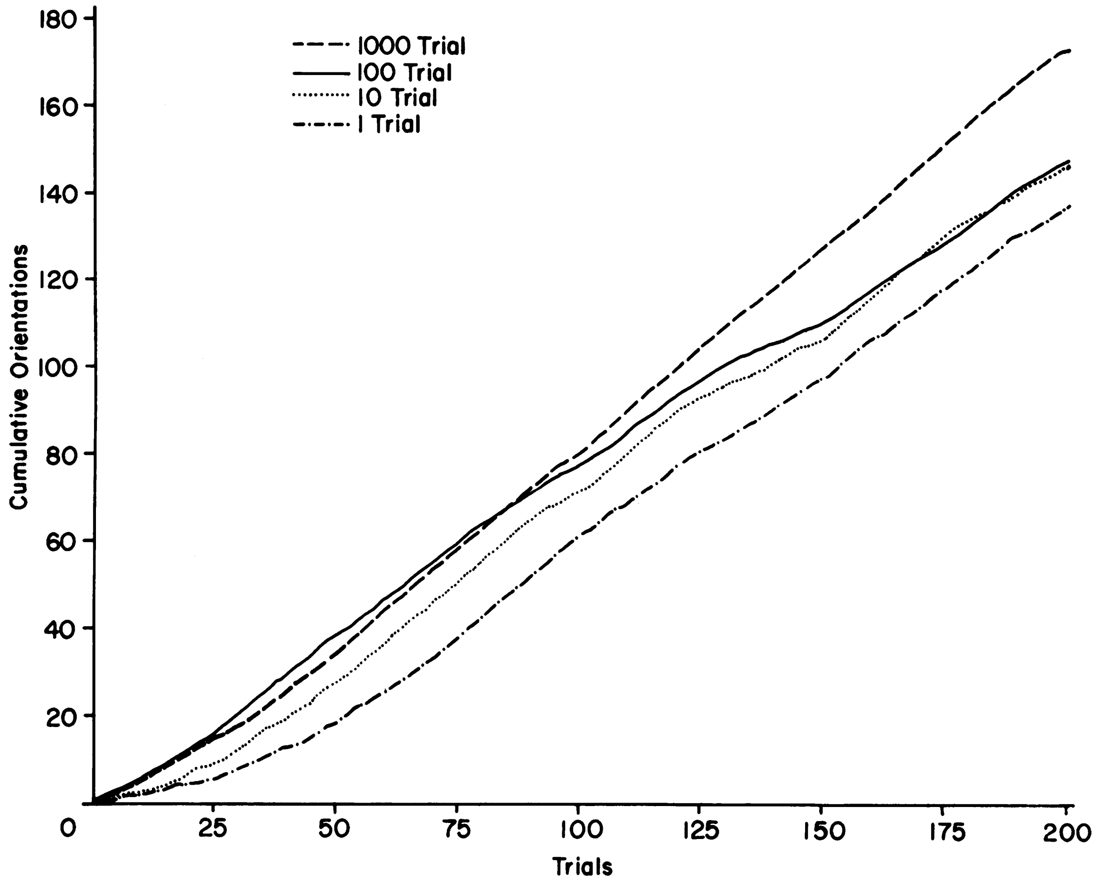

Fig. 3. Cumulative average number of orientations to the illuminated key for each of the four groups.

under autoshaping conditions (see, also, Brown and Jenkins, 1968). The mean number of trials to first key peck in the paired condition of Group II was very low, although it was slightly higher than in the 100-trial case. Thus, our expectations of more rapid autoshaping due to increased intertrial time and 50 food-only trials were not confirmed. However, the present experiment accomplished its purpose of confirming that key illumination sometimes caused key pecks after a subject received food reinforcement but before pairing of illumination with reinforcer.

EXPERIMENT III

Most studies on the autoshaping phenomenon have used pigeons as subjects and we therefore asked whether pigeons, too, will peck an illuminated key after prior experience with food-only trials. We informally observed first-trial pecking after we hopper trained adult German Homer pigeons. The hopper had a Plexiglas door so that we could monitor when the bird's head entered the hopper. We had difficulty, however, training the pigeons to open the Plexiglas door and it took 200 to 300 food-only training trials before the birds were eating consistently. Following this preliminary training, a regular autoshaping procedure was instituted. Three of five birds pecked the key on its first illumination. Experiment III attempted to determine whether this one-trial acquisition with pigeons was reliable.

Method

Subjects

Five experimentally naive, mature White King pigeons were maintained at approximately 80% of their free-feeding body weights.

Apparatus

A 41- by 30- by 30-cm chamber contained a Gerbrands response disk located on the midline of the front panel and a Gerbrands food hopper 12 cm under the disk. Pecks of at least 0.15 N force were recorded. A hinged, clear Plexiglas door covered the opening to the hopper. General illumination was from overhead 7.5-W white bulbs, and both the hopper and key could be transilluminated with similar lights. A fan provided ventilation and masking noise.

Procedure

Each pigeon was placed in the chamber with the hopper door open, the houselight on, and a small amount of grain on the floor near the hopper. When the subject ate the grain on the floor, a VT 15-sec schedule of hopper presentations was begun. The first hopper operation was 20 sec in duration, thereby ensuring that all birds ate; this reinforcement time was gradually reduced, during about 15 trials, to 4 sec. The hopper door was then slowly lowered so that the bird opened the door with its head whenever grain was presented. Reinforcement lasted 4 sec, timed from the moment the head entered the hopper. Fifty food-only trials were given per session until a total of 250 trials. The value of 250 was chosen because of our experience, described above, with German Homer pigeons. The key was dark throughout preliminary training. During the next session (beginning with Trial 251), the key was transilluminated for 8 sec on the average of once every 28 sec. During key illumination, the overhead houselight was darkened. (The present experiment was performed before Wasserman's 1973 demonstration that darkening the overhead lights appreciably *delays* acquisition of key pecking under autoshaping.) At the end of the 8 sec of key illumination, the hopper was automatically operated until the bird ate for 4 sec.

Results

The five pigeons emitted their first key-peck responses during keylight trials 1, 1, 2, 5, and 33. The mean of 8.4 was considerably lower than is generally reported for autoshaping with pigeons (*e.g.*, 45 in Brown and Jenkins, 1968) where many fewer food-only, or "hopper training", trials are given; it is also much lower than the figure reported by Engberg *et al.* (1972), who gave pigeons 900 food-only trials. Importantly, two of five pigeons responded during the first key-illumination trial, just as did two of five chickens in Experiment I.

GENERAL DISCUSSION

Two main findings emerged from the present experiment. First, trials before a chicken's first response under autoshaping contingencies varied as a U-shaped function of number of prior food-only trials. Contributing to the initial decreasing portion of the function, no doubt, is the necessity that birds learn to approach and eat from the hopper before key pecking can be autoshaped. However, birds are generally hopper trained in many fewer trials than the number found in the present experiments to result in the most rapid acquisition of key pecking. In Experiment I, for example, all birds were eating from the hopper before the tenth hopper presentation (whether these occurred during food-only or, as in the 1-trial group, during food-only plus autoshaping), and most were eating after the first few presentations. Thus, the U-shaped function may indicate a motivational process with an optimal number of prior reinforcements engendering most rapid acquisition of new responses (*cf.* Hebb, 1972; Killeen, 1975; Yerkes and Dodson, 1908).

The second main finding was that, after chickens or pigeons experienced food-only training, pecks on an illuminated key sometimes occurred before a pairing of keylight with food. This may be described as an instance of "pseudoconditioning", a term used in the classical conditioning literature when a conditioned response occurs to the conditioned stimulus after the subject had experienced the unconditioned stimulus but before pairing of conditioned and unconditioned stimuli. The important finding in the present experiment was that it was the key peck that was pseudoconditioned rather than other response topographies. We observed no turning of figure eights, for example, or any stereotyped behavior in the presence of the key illumination other than pecking or orienting to hopper or key. Thus, the response engendered by the *pairing* of a particular stimulus and particular reinforcer under autoshaping was the same as the response emitted to that stimulus presented *alone* after the reinforcer had been presented *alone*. These relationships suggest that the pseudoconditioning paradigm may indicate the topography of response that will be conditioned under the autoshaping paradigm. Furthermore, the pseudoconditioned responses call into question the completeness of explanations of autoshaping that state that pairing between stimulus and reinforcer is responsible for responding (Hearst and Jenkins, 1974). Throughout autoshaping, primary reinforcers are presented, and these alone may generate some responses independently of pairing.

The contribution of hopper-training to autoshaping has been underestimated. The present experiment, along with Blanchard and Honig (1976), Engberg *et al.* (1972), Hitzing and Safer (1970), and Wasserman (1972) indicates that it is an important variable. Often in the autoshaping literature the exact number of preliminary hopper-training trials is not specified. In some cases, hopper-training trials, rather than other variables, may account for the results.

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