OPERANT CONDITIONING IN REDWINGED BLACKBIRDS¹

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An operant conditioning technique for use with passerine birds is described. Two red-winged blackbirds were successfully conditioned to perch-hop for food reinforcement. Continuous reinforcement and fixed-ratio schedules involving substantial ratio requirements were used to maintain this response. The behavior of the two redwinged blackbirds was comparable to that of more conventional organisms working on similar schedules of reinforcement.

Operant conditioning procedures and techniques have been successfully used in the experimental analysis of behavior with a wide range of organisms (Breland and Breland, 1966; Cohen, 1969). With birds, operant conditioning techniques have been employed in experiments using pigeons (Ferster and Skinner, 1957), chickens (Marley and Morse, 1966), quail (Cloar and Melvin, 1968), a black vulture (Witoslawski, Anderson, and Hanson, 1963), hawks (Whitt and Crawford, 1967), a great horned owl (Fite and Blough, 1968), and crows (Stettner, Matyniak, and Brandt, 1966). In all of these experiments the operant response was a key peck. The major reason for choosing this response appears to have been the ease with which it can be conditioned and brought under experimental control in pigeons. Our preliminary observations suggested that a perching or perch-hopping response might be readily conditioned in passerine birds. In the present experiment, perch-hopping was successfully conditioned in two redwinged blackbirds and the effects of several fixed-ratio schedules of reinforcement were investigated.

METHOD

Subjects

Two male redwinged blackbirds (*Agelaius phoeniceus*) were captured in a marsh environment near Delaware, Ohio, in May 1969.

A modified version of chaffinch nestling food (Thorpe, 1958) was used to nourish the 10-day old nestlings. At the age of four weeks they were placed in individual 0.5 in. (1.3 cm) wire mesh cages measuring 36 by 25 by 25 in. (93 by

64 by 64 cm) in which two wooden dowels, 0.5 in. (1.3 cm) in diameter served as perches. The birds were maintained from the age of four weeks on a diet of Purina Pigeon Chow Checkers, Top Choice dog food, and cracked corn. Food and water were available at all times. The birds were housed in a laboratory with a normal seasonal photoperiod (sunlight) and a constant temperature of 24°C. The two subjects were eight months old at the start of experimentation.

Apparatus

The operant conditioning box was constructed of 0.25 in. (0.65 cm) plywood, and measured 36 by 25 by 25 in. (93 by 64 by 64 cm). Figure 1 is a photograph of the box. In accord with the suggestion of Neumann and Klopfer (1969) the effective visual dimensions of the box were increased by incorporating 0.5 in. (1.3-cm) wire mesh into its construction. The "visually open" box thus allowed the bird to see a distance of 25 in. (60 cm) beyond its physical confines. White cloth sheets painted with vertical green and brown hatching were placed behind the ends and along the sides of the box. These cloth panels marked the visual boundaries of the experimental situation.

A 15.75-in. (40-cm) response perch was mounted 11.8 in. (30 cm) above the floor at

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Fig. 1. Operant conditioning box with one side removed.

each end of the box. Microswitches, mounted outside the box, were operated when the bird hopped onto the response perch, or depressed it with a minimum force of 35 g (0.45 N). A pulse shaping circuit connected to the microswitches allowed the detection and recording of discrete microswitch closures. A "dead" perch was placed 2 in. (5.2 cm) above each movable response perch at an angle of 90°. The position of this "dead" perch eliminated shuffling or walking along the response perch and increased the frequency of discrete hopping. A center "dead" perch was mounted parallel to the response perches at a height of 15 in. (38 cm) above the floor of the box. This perch served to reduce flight back and forth between the two response perches.

A food tray was mounted against one side of the box equidistant from the two response perches. The top of the food tray was covered by a retractable lid. Retraction and extension of the lid was accomplished using a Model 1405 R Lehigh Valley Electronics retractable lever. To increase the mechanical advantage

of the retractable lever, a wooden arm and an appropriately positioned fulcrum were used. One end of the wooden arm was connected to the lid and the other to the lever. With this system the 0.75-in. (2-cm) movement of the retractable lever produced a (2.75-in.) 7-cm movement of the food tray lid. Food used during conditioning was identical to that described above. Water was available at all times.

Two identical operant conditioning boxes were placed 4 ft. (1.2 m) apart in a 11.5 by 10 by 8.25 ft (3.5 by 3.0 by 2.5 m) sound-attenuated chamber. Visual isolation was achieved by placing a double thickness of sheeting between the boxes. No attempt was made to isolate the boxes acoustically. The chamber was indirectly illuminated by two shielded 75-w lights. One light was mounted on the top of each box. Intake and exhaust fans provided good air circulation and some masking noise. The temperature was maintained at 24°C. The experimental dependencies were controlled by standard electro-mechanical equip-

ment located outside the sound-attenuated chamber.

Procedure

Before the experiment the birds were placed in individual holding cages. The dimensions of these cages were identical to those of the conditioning boxes. The number of daylight hours was reduced by daily half-hour decrements until a 5-hr photoperiod was reached (8:30 a.m. to 1:30 p.m.). The birds were inactive during the 19-hr darkness interval between the daylight periods. The 5-hr photoperiod was employed to increase the bird's level of activity during the daylight hours when food was available. The birds were maintained on this shortened day for one month before the experiment began.

On the first day of experimentation the birds were placed in the conditioning boxes. The center "dead" perch in each box was removed during this day in order to increase the number of hops onto the movable response perches. The center "dead" perch was then replaced and four days of adaptation followed. During adaptation the food tray lid remained retracted, thus giving the bird continuous access to the food for the 5-hr daylight period. On these adaptation days and throughout the experiment the daily 5-hr session was terminated by turning off the lights and discontinuing access to the food. During adaptation, the number of hops onto each of the two response perches was counted. The perch with the smaller number of responses was designated as the "operant" perch during conditioning. Four daily 5-hr sessions of continuous reinforcement followed adaptation. On these days, reinforcement, which consisted of retraction of the food tray lid allowing the bird 5-sec access to the food, was made dependent upon hopping onto the appropriate perch. Following continuous reinforcement, the birds were given three days of training on each of the following fixed-ratio requirements: FR 2, FR 3, FR 5, FR 7, FR 10, FR 15, FR 20, FR 30, and FR 40. Both the position of the operant perch and the 5-sec reinforcement duration remained constant throughout the experiment.

RESULTS

Figure 2 shows the number of responses made by both birds on each of the two response

perches in adaptation, continuous reinforcement, and while working on each of the ratio requirements. During adaptation both birds showed a preference for the left perch. Continuous reinforcement resulted in an immediate reversal of the initial perch preference. In both birds the number of responses on the operant perch increased as the ratio requirement increased; with training, both birds emitted an increasing proportion of their responses on the operant perch.

The birds developed distinct response sequences. On continuous reinforcement, both birds hopped back and forth between the operant perch and the food tray. On FR 2, the birds hopped quickly from one side of the operant perch to the "dead" perch mounted above, and then to the other side of the operant perch. On FR 3, the response sequence included the FR 2 series of two hops plus an additional hop back to the original side of the operant perch, a total of three discrete responses. On FR 5 and FR 7, the number of back and forth hopping responses increased. The maximum rate of responding with this response sequence was approximately one response per second.

During the last day of training on FR 10, Bird 1 developed a new response mode that was maintained on all the higher ratio requirements. This behavior pattern, which produced response rates of nearly four responses per second, consisted of placing one foot on the operant perch and the other foot on the "dead" perch. By quickly "pumping" the operant perch from this position the bird was able to emit a rapid series of responses. The operant perch was "pumped" from either side of the "dead" perch and with either foot. Bird 2 responded with discrete hops throughout conditioning and never displayed the "pumping" behavior of Bird 1. Consequently the response rates and response totals for Bird 2 were consistently lower than those of Bird 1.

Figure 3 shows cumulative records of the responding of the two birds on selected ratio requirements. These records are similar to those obtained from more conventional experimental organisms working on similar ratio requirements. Both birds showed occasional periods of from 1 to 15 min during which their response rates were very low. During these periods the birds preened, bathed, drank

Fig. 2. Response totals for both birds during the 5-hr period of a representative day in adaptation, continuous reinforcement, and while working on each of the ratio requirements.

water, and explored the box. The majority of hops onto the non-operant perch occurred as part of this activity.

The birds adjusted well to the operant conditioning situation. The average daily food consumption by both birds varied from 12 to 15% of their body weight. At the end of experimentation, both juvenile males had increased their body weights by approximately 9%. The birds remained healthy, alert, and active throughout the experiment.

DISCUSSION

The present results show that a perch-hopping response can be conditioned as an operant in redwinged blackbirds. Continuous reinforcement and fixed-ratio schedules involving substantial ratio requirements were successfully employed to maintain this response.

The free operant situation used had a number of definite advantages. Since the birds

Fig. 3. Selected cumulative records of responding on FR 20, FR 30, and FR 40.

lived in the conditioning box, handling was reduced to a minimum. The only contact between experimenter and subjects took place during daily maintenance activities and weekly weighing sessions. A second advantage was that perch-hopping occurs in the behavioral repertoire of passerine birds. The high operant level of this response obviated the need for shaping.

This experimental procedure may have application in behavioral studies of passerine birds in laboratory situations. Since approximately 60% of all living species of birds are passerines (Peterson, 1963), the present demonstration of operant conditioning in redwings markedly extends the range of potential experimental animals that can be used in operant conditioning experiments.

Comparative studies of avian brain development (Portmann and Stingelin, 1960), comparisons of palatal types (Gregory, 1951), and

phylogenetic investigations of 1-Ascorbic Acid synthesis (Chadhuri and Chatterjee, 1969) have all indicated that passerine birds are more highly evolved than members of the orders Galliformes and Columbiformes. A thorough investigation of the performance of representatives of "more advanced" groups, coupled with the existing knowledge of the behavior of chickens, pigeons, and other less highly evolved birds, should yield a satisfactory appraisal of the learning capacity of the entire Class Aves (Stettner, Schultz, and Levy, 1967). The present technique provides a vehicle for laboratory investigations of passerines and thus may lead to a more truly comparative evaluation of avian behavior.

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