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THE SPONTANEOUS USE OF A TOOL BY A PIGEON

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ABSTRACT

A pigeon was trained to push a flat, hexagonal box toward a target placed at random positions around the edge of a large chamber. It was subsequently trained to peck a small metal plate, which was positioned at the base of a clear Plexiglas wall. When the plate was moved out of reach behind the wall, the bird stretched repeatedly toward it for more than a minute-and-a-half, then pushed the box toward the plate, thrust it beneath the wall, and, with the box in contact with the plate, pecked repeatedly at the box. The performance was genuinely novel and in several respects resembled the behavior of chimpanzees or children in similar situations. Based on other experiments, a tentative, moment-to-moment account of the performance can be given in objective terms.

Key words: insight; novel behavior; pigeon; problem solving; resurgence; tool use.

Problem solving has been studied extensively by comparative (e.g., Schiller, 1952), Gestalt (e.g., Maier, 1931; Duncker, 1945; Ellen, 1982; Köhler, 1925), and, more recently, cognitive psychologists (e.g., Weisberg and Alba, 1981), as well as by behavioral biologists (e.g., Beck, 1980), but has been relatively neglected by analysts of behavior (cf. Skinner, 1966). A behavior-analytical approach to problem solving could shed light on (a) the role that certain environmental histories play in the emergence of problem-solving behavior (cf. Birch, 1945), and (b) principles that allow moment-to-moment prediction of problem-solving behavior as a function of species, environmental history, current stimuli, and other variables. As such factors come to be better understood, we should be able to produce genuinely novel, increasingly complex instances of problem-solving behavior in organisms that would not normally exhibit such behavior.

Described is a 'Columban simulation' (Baxley, 1982; Epstein, 1981, in press-a, in press-b) in which our current understanding of such factors is put to use to produce behavior that can reasonably be called 'spontaneous tool use' in a pigeon.

METHOD

Subject and apparatus

One male, adult White Carneaux pigeon (282 WP) served as the subject. It had had a variety of laboratory experience prior to the experiment and was maintained at approximately 80% of its free-feeding weight. Sessions were conducted in a cylindrical wire-mesh chamber, 50 cm high and 70 cm in diameter. A standard feeder was attached to the base at the position shown in Figure 1. A removable clear Plexiglas wall was placed at the position shown in the figure during some conditions.

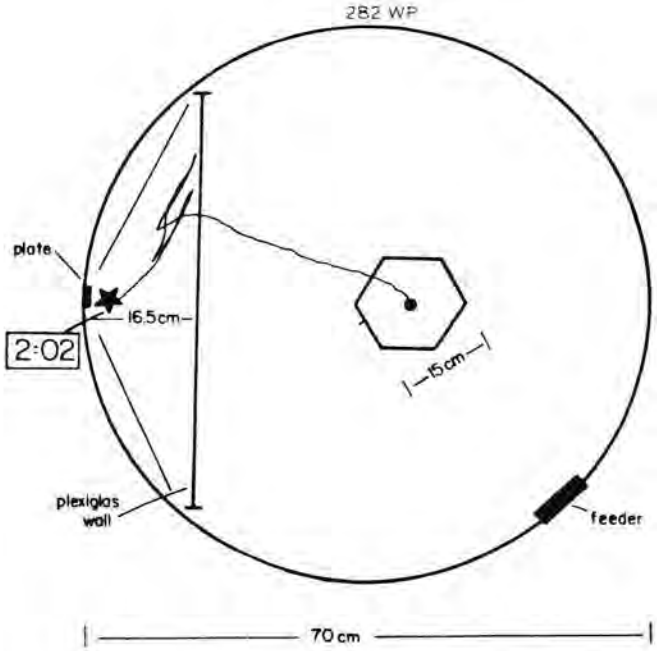

Figure 1. Floor diagram of the cylindrical chamber. The vertical line marks the position of a clear Plexiglas wall, positioned 6.3 cm above the floor. After stretching repeatedly toward the metal plate at left for 92 sec, the bird suddenly pushed the box toward it. When its head reached the wall, it pushed the box back and forth several times; then it stretched again toward the plate and, finally, at about 2 min into the session, pushed the box solidly against the plate and pecked the near side of the box repeatedly, thus activating a high-pitched tone.

There was a gap of 6.3 cm at the base of the wall. A hexagonal cardboard box, 15 cm wide and 2.5 cm high, was employed during some conditions, as was an aluminum plate, 3-cm square, positioned so that its plane was parallel to the plane of the Plexiglas wall. The lower edge of the plate was 1 cm from the floor. The plate was attached to a microswitch. Each peck at the plate produced feedback in the form of a brief high-pitched tone.

Procedure

Two repertoires were established – directional pushing and pecking the metal plate. First, over a 6-month period a total of about 60 hr was spent establishing a repertoire of directional pushing. The basic steps were as follows:

Pushing was established during the first hour through shaping, and then, over the next several hours, the frequency of reinforcement was reduced until the bird pushed for long periods without food. Reinforcement was contingent upon covering as much of the floor space as possible. (The bird had had almost identical training with a larger box in a previous experiment (Epstein, Kirshnit, Lanza and Rubin, submitted)). Then pecks at a small (4-cm diameter) circular green spot, placed at random positions along the base of the chamber, were reinforced on a rich variable-ratio (VR) schedule.

The box was suspended on a thin wire mounted horizontally and attached to both sides of the chamber so that the box could move along it only in a straight line. The spot was placed at one end of the wire and 'sight and push' behavior was established; an obvious head movement in the direction of the spot followed by one or more pushes from behind the box which pushed the box toward the spot were reinforced. The requirement was increased until food was presented only when the box was pushed all the way to the spot. The spot was moved from one end of the wire to the other and the position of the wire changed in the chamber until the bird reliably pushed toward the spot no matter what its position. The wire was removed, the box was placed a few centimeters from the spot, and sight-and-push behavior was reinforced as before. Over a period of months, as the bird became increasingly successful at pushing the box directly toward the spot, the distance from the box to the spot was gradually increased until the bird could push in reasonably straight lines toward the spot, no matter what its position and no matter what its distance from the box. To improve control by the spot, pushing in its absence was extinguished. Pushes were never reinforced in the absence of the spot for at least the last 5 months of training.

The second repertoire was established during the last month of training. The Plexiglas wall was placed in the chamber for about 15 min each day. The box and spot were never present when the wall was in place. The metal plate was positioned at the midpoint of the base of the wall, and pecking it was reinforced on a rich VR schedule. Over 10 sessions, the plate was gradually moved to a position 10 cm behind the wall, so that the bird had to stretch beneath the wall to peck it. With

the plate and the wall removed and the box and the spot restored, directional pushing was also reinforced for short periods each day.

With the two repertoires now well established, the last phase of the experiment began. The box was placed in the chamber as shown in Figure 1. The spot was not present. With the plate still 10 cm behind the wall, pecking the plate was reinforced and behavior with respect to the box was extinguished until it was neither pecked nor pushed for five consecutive, daily 30-min sessions. (The bird pecked the box a few times in only the first of six such sessions.) As was the case above, directional pushing was also reinforced for a short period each day (5–10 min) in the absence of the wall and plate.

A test was then arranged as follows: The plate was placed in a position known to be just out of reach of the bird – 16.5 cm behind the wall. The box was placed in the chamber as shown in Figure 1. The spot was not present. No reinforcers were delivered, and the session was videotaped.

RESULTS

With the plate out of reach, the bird stretched repeatedly toward it. Behavior that might be called 'emotional' appeared: wing raising, turning, and scraping the feet on the floor. As the frequency of stretching decreased, behavior with respect to the box emerged; the bird oriented toward it and pecked it weakly several times. At 92 sec into the session, the bird pushed the box rapidly toward the metal plate. When its head reached the wall, it pushed the box back and forth rapidly several times. Then it stretched again once toward the plate and pushed the box against it, thus activating the high-pitched tone (Figure 1). It pecked the near side of the box repeatedly, producing a steady tone for more than 5 sec until the session was terminated. The first tone sounded at a little over 2 min into the session.

DISCUSSION

Though, in our opinion, a subjective evaluation of the bird's behavior does not in any way contribute to an understanding of it, we offer one for comparison purposes. People viewing the videotape of this performance often reported feeling increasingly tense or excited over the course of the session; they often marked the bird's 'frustration' or 'confusion' and the obvious 'intentionality' of the pushing. In short, we may have in hand a genuine instance of what many call 'problem solving'. The suddenness and directness of the pushing also appear to satisfy Köhler's (1925) criteria for 'genuine' or 'insightful' solutions (cf. Epstein et al., submitted; Koffka, 1924). The course of the performance – from unsuccessful 'brute-force' behavior to a period of 'confusion' or 'pensiveness' to a sudden successful sequence – also resembles progressions reported when both chimpanzees and humans have solved a variety of problems (e.g., Köhler, 1925; Maier, 1931; Duncker, 1945).

Because the bird had not touched the box in the presence of the wall and plate for more than five sessions and because pushing had never produced reinforcement under such circumstances, pushing the box in the test situation would appear to be 'spontaneous'. In lay terms, the bird pushed the box only when it 'needed to'. And because the bird used the box as an extension of its own beak, it could be said that we had observed a legitimate instance of 'tool use'.

A tentative moment-to-moment account of the behavior can be given in terms of objective principles. The behavior one might attribute to 'need' can be accounted for by a simple principle called 'experimental regression' or 'resurgence': When, in a given situation, some response is extinguished, other responses that were reinforced under similar circumstances tend to recur (Epstein, submitted; cf. Epstein and Skinner, 1980; Estes, 1955; Leitenberg, Rawson and Bath, 1970; Lindblom and Jenkins, 1981; Masserman, 1943; Mowrer, 1940; O'Kelly, 1940; Sears, 1941; Staddon and Simmelhag, 1971). Thus, when the plate is placed out of reach, pecking it is quickly extinguished and other behavior – box pushing – increases in strength. The behavior we interpret as 'confusion' is probably produced, at least in part, by competition between the repertoires as they vary in strength. Why the bird pushes toward the plate is still under investigation. It appears at the moment to be a matter of what is often called 'functional' generalization, as opposed to generalization based on common physical characteristics. In other words, based on other experiments and work in progress (cf. Epstein et al., submitted), we conjecture that a bird that had been trained only in directional pushing but never to peck the plate would not push toward the plate in the test situation. We believe the bird pushes toward the plate because of a history of directional pushing *and* because of the history of reinforcement with respect to the plate.

We emphasize that we never trained the bird to push the box toward the plate; that, over the last 5 months of training, behavior with respect to the box had never been reinforced in the absence of the green spot and that such behavior had been deliberately extinguished; that behavior with respect to the box had never been reinforced in the presence of the wall and plate and that such behavior had been deliberately extinguished; that the bird had never been trained to push the box under anything; and that the spot was absent during the test. The bird's performance must consequently be regarded as genuinely novel. Though it can safely be said that previous training was critical to the bird's success (cf. Epstein et al., submitted), the performance may be regarded as exemplary of a general principle of novelty in behavior: Previously established behavior manifests itself in new situations to produce new, yet predictable behavior (Epstein, in press-a; Epstein and Skinner, 1981).

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