'Insight' in the pigeon: antecedents and determinants of an intelligent performance

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In 1917 Wolfgang Köhler reported some rather extraordinary instances of problem solving by a number of chimpanzees[1], and his observations have been the subject of controversy ever since[2,3]. The period of quiescence that sometimes preceded the solution, its sudden onset, and its smooth, continuous emergence were proffered as evidence that (1) contrary to suggestions of learning theorists of the day, problem solving was not necessarily a trial-and-error process, and (2) constructs such as 'insight' were necessary for an adequate account[1,4–6]. Here, in an attempt to shed further light on these issues, we have replicated with pigeons a classic problem with which Köhler confronted his chimpanzees. Pigeons that had acquired relevant skills solved the problem in a remarkably chimpanzee-like (and, perforce, human-like) fashion. The possible contributions of different experiences were determined by varying the training histories of different birds. We offer a tentative moment-to-moment account of a successful performance.

Köhler placed a banana out of reach in one corner of a room and a small wooden crate about 2.5 m from the position on the floor beneath it. After a number of fruitless attempts by all six chimpanzees in the room to jump for the banana, one of them paced for several minutes, then suddenly moved the box half a metre from the position of the banana "and springing upwards with all his force, tore down the banana"[1]. Both research[7] and theory[8] suggest that chimpanzees will not solve problems of this sort if they have not first had certain experiences. We speculated that two behaviours had to have been acquired: pushing objects towards targets and climbing on objects to reach other objects. Since a pigeon normally does neither, it seemed an ideal candidate to test the contribution that previous learning might make to success in this problem.

Eleven adult male pigeons served as subjects. Each was maintained at about 80% of the weight it would achieve given free access to food. Most had had a variety of laboratory experience, but none had ever been used in a problem solving experiment. Birds 269WP and 270WP were racing Homers; the others were white Carneaux. All sessions were conducted in a cylindrical wire-mesh chamber 69 cm in diameter, except those of birds 110YP, 233WP and 274WP, which were conducted in smaller rectangular chambers. A cardboard box, 8 cm high and with a base 10 cm^2, was used in some conditions, as was a small facsimile of a banana, 7 cm in length. A standard grain dispenser was attached to the base of each chamber as shown in Fig. 1.

The following history yielded successful performances with all of the birds we tested: (1) A repertoire of 'directional pushing' was established. Each bird was trained to push the box towards a green spot, 4 cm in diameter, which was placed at random positions along the base of the chamber wall(s). Pushing was extinguished in the absence of the green spot. Major training steps included reinforcing aimless pushes; reinforcing pecks to the spot; reinforcing sighting the spot and pushing the box towards it with the movement of the box constrained by a thin wire; reinforcing sight-and-push behaviour with the wire removed and the box close to the spot; and gradually increasing the distance between the box and the spot[9]. Proficient performances were established in 8, 1 and 4 weeks, respectively, for the subjects whose performances are shown in Fig. 1*c*. The banana was never present during this training. (2) Concurrently, each bird was trained to climb onto the box and peck the banana, which was suspended overhead. The box was fixed in place during this condition, and pecking it was never reinforced. The position of box and banana was changed repeatedly. In the presence of box and banana, the bird would reliably climb onto the box and peck the banana. In the absence of the banana and in the presence of the spot, the bird would push the box towards the spot. (3) Each bird was occasionally placed alone with the banana until the bird neither flew nor jumped towards it.

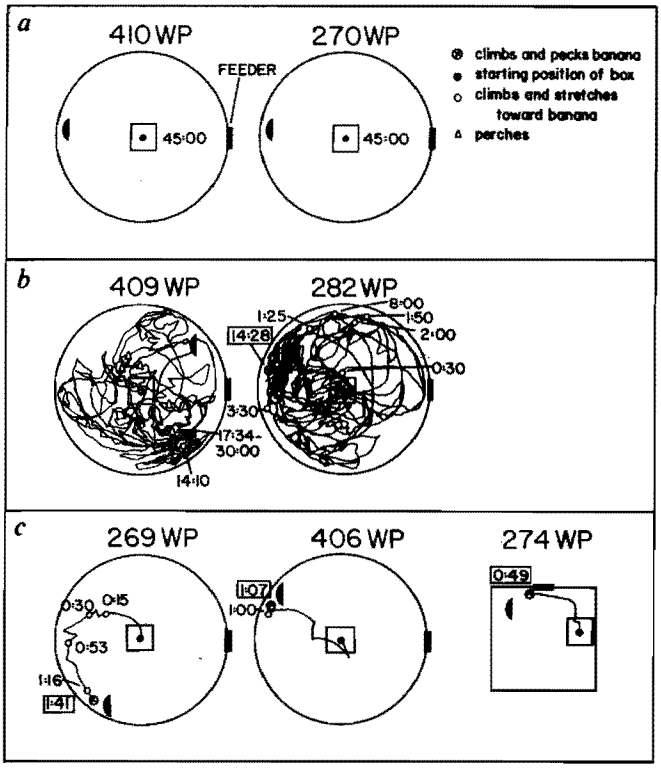

Fig. 1 Birds that had been trained to climb and peck but never to push did not push the box in the test situation (*a*). Birds that had been trained (i) to climb and peck and (ii) to push the box aimlessly for long periods of time pushed the box over much of the floor space of the chamber. The birds rarely looked up while pushing. One of the birds stopped pushing in the appropriate place and climbed and pecked the banana after having pushed for more than 14 min (*b*). Birds that had been trained (i) to climb and peck and (ii) to push the box towards a green spot placed at random positions along the base of the chamber solved the problem efficiently and in a manner suggestive of human problem-solving behaviour (*c*). Other controls are described in the text. The times given are in minutes and seconds. A boxed time is the time to solution.

The following test situation was arranged. The banana was suspended out of reach (41 cm from the floor) at a point (determined by a random number) near an edge of the chamber, and the box was placed elsewhere in the chamber. All test sessions for these and all other subjects were filmed or videotaped.

The performances for the first three subjects were remarkably similar. At first each pigeon appeared to be 'confused'; it stretched and turned beneath the banana, looked back and forth from banana to box, and so on. Then each subject began rather suddenly to push the box in what was clearly the direction of the banana (Fig. 1*c*). Each subject sighted the banana as it pushed and readjusted the box as necessary to move it towards the banana. Each subject stopped pushing in the appropriate place, climbed and pecked the banana.

A fourth bird (233WP) solved the problem after 24 min. The performance was disrupted by 1,000 W of lighting which had been added to facilitate filming. When, after 20 min, the lighting was reduced, the bird solved the problem in just under 4 min.

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We conducted four variations on this training with other pigeons. Two birds (294WP and 273WP) were trained to peck the banana but not to climb. Jumping and flying were extinguished, and the birds were placed alone with the box until they showed no signs of discomfort in its presence. Then the banana was suspended out of reach above it. Each bird stretched repeatedly towards the banana at first. Subject 273WP stumbled onto the box and then fell off. After the first few minutes of each session, attempts to reach the banana ceased. We terminated each session after 10 min. We concluded that the establishment of climbing was probably critical to the solution.

Two birds (270WP and 410WP) were trained to climb and peck but not to push. Jumping and flying were extinguished. Neither bird pushed the box when given the test (Fig. 1*a*). Two birds (409WP and 282WP) were trained to climb and peck and to push the box around the chamber for long periods of time. They were never trained to push towards a target, nor to push in straight lines. Jumping and flying were extinguished. The birds pushed apparently aimlessly when given the test (Fig. 1*b*). We concluded that a repertoire of directional pushing was probably critical to an efficient solution.

With one bird (110YP) we established directional pushing and climbing-and-pecking but did not extinguish brute force attempts to reach the banana. Like Köhler's chimpanzee, the bird jumped and flew repeatedly towards the banana for several minutes, then pushed the box towards the banana, climbed and pecked. The solution appeared after about 7 min.

Based on these and other experiments, a tentative, moment-to-moment account of a successful performance can be given. At first stimuli were present which controlled both behaviour with respect to the banana and behaviour with respect to the box. The behaviour we interpreted as a sign of perplexity was probably the result of competition between these behaviours. Behaviour with respect to the banana quickly disappeared, probably because of the recent history of extinction of jumping and flying when the banana was out of reach (compare the performance of bird 110YP). The birds may have begun to push because, as behaviour with respect to the box increased in relative frequency, the birds faced the box more directly, which was very nearly the stimulus in the presence of which pushing had been reinforced (the green spot was absent). Why the animals pushed towards the banana is unclear and still under investigation. A process similar to what some call 'functional generalization'[10] (as opposed to generalization based solely on common physical characteristics) seems to be involved. Birds that were trained to push towards the spot but not to peck the banana did not push towards the banana in the test situation but did push towards the banana when subsequently trained to peck it. In other words, the birds pushed towards the banana apparently for the 'right reasons'—because they had learned directional pushing and because some history of reinforcement had made the banana 'important'. Directional performances may also have been produced by a summation of prevailing responses: banana-directed pecks may have strengthened banana-directed pushes (N. E. Miller, personal communication). The birds stopped pushing in the right place because of a phenomenon called 'automatic chaining': in the course of pushing towards the banana, they set up for themselves a stimulus (box-under-banana) that controlled other behaviour (climbing and pecking).

We appear to have in hand an instance of 'insightful' problem solving. The suddenness, directness and continuousness of the performances satisfy Köhler's criteria for 'genuine' or 'insightful' solutions[1,11], and people viewing the tapes have liberally attributed a wide range of human emotions and thoughts to the pigeons. A surprisingly common comment was, "Did the pigeon really do that?" We may also have in hand an account of similar performances in chimpanzees and children, for the experiences we provided are ones that they have probably had before they are successful in similar situations, and the behavioural processes we have invoked are fairly general in the animal kingdom[12].

We emphasize that we did not train the birds to push the box towards the banana; that, except during very early stages of training, behaviour with respect to the box was never reinforced in the absence of the green spot and that such behaviour was deliberately extinguished; that pushing the box was never reinforced in the presence of the banana and that such behaviour was deliberately extinguished; and that the spot was absent during the test. The successful performances must consequently be regarded as genuinely novel.

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1. Köhler, W. *The Mentality of Apes* (Routledge & Kegan Paul, London, 1925).
2. Chance, M. R. A. *Man* **60,** 130–135 (1960).
3. Weisberg, R. & Alba, J. *J. exp. Psychol.: Gen.* **110,** 169–192 (1981).
4. Maier, N. R. F. *J. comp. Psychol.* **12,** 181–194 (1931).
5. Duncker, K. *Psychol. Monogr.* No. 270 (1945).
6. Ellen, P. *J. exp. Psychol.: Gen.* **111,** 316–325 (1982).
7. Birch, H. G. *J. comp. Psychol.* **38,** 367–383 (1945).
8. Hull, C. L. *Psychol. Rev.* **42,** 219–245 (1935).
9. Epstein, R. & Medalie, S. D. *Behav. Analys. Lett.* **3,** 241–247 (1983).
10. Bruner, J. S., Goodnow, J. J. & Austin, G. A. *A Study of Thinking* (Wiley, New York, 1956).
11. Koffka, K. *The Growth of the Mind* (Kegan Paul, London, 1924).
12. Epstein, R. *Behav. Analyst* **4,** 43–55 (1981).