I

ROUNDABOUT METHODS[1]

WHEN any of those higher animals, which make use of vision, notice food (or any other objective) somewhere in their field of vision, they tend—so long as no complications arise—to go after it in a straight line. We may assume that this conduct is determined without any previous experience, providing only that their nerves and muscles are mature enough to carry it out.

Thus, if the principle of experimentation mentioned in the introduction is to be applied in a very simple form, we may use the phrases " direct way " and " roundabout way " quite literally, and set a problem which, in place of the biologically-determined direct way, necessitates a complicated geometry of movement towards the objective. The direct way is blocked in such a manner that the obstacle is quite easily seen ; the objective remains in an otherwise free field, but is attainable only by a roundabout route. First it is assumed that the objective, the obstruction, and also the total field of possible roundabout routes are in plain sight ; if the obstruction be given various forms, there will develop also a variety of approaches to the objective, and perhaps, at the same time, variations in the difficulties which such a situation contains for the animal.

This test which, on nearer investigation, appears to be the simplest and, in some respects, fundamental for theoretical

[1] Also called *detours, roundabout ways, paths or routes, circuitous routes* and *indirect ways* in this book. No one English word quite covers the meaning of " Uwege " [Tr. Note.].

problems, will, in chimpanzees from four to seven years of age and in the form described, yield no results which cannot be observed in their ordinary behaviour. Chimpanzees will get round any obstruction lying between them and their objective, if they have sufficient view of the space in which lie the possible detours. The path may lie across flat ground, or over trees and scaffolding, or even up under a roof as long as they can grab hold of something. Thus in experiments to be described later, in which the objective

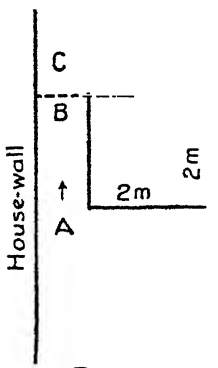

FIG 2.

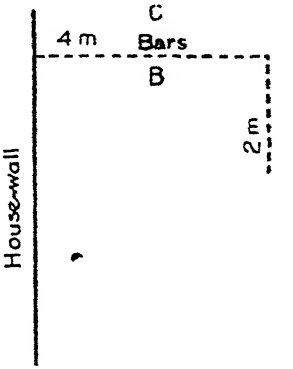

FIG. 3.

hung from the wire-roof of their playground, the first attempt at solution often consisted in their climbing to the roof at the first available point, and thence arriving at the hanging cord. It required strict vigilance to eliminate from the programme this and other detours which only climbers like chimpanzees, and among them only the real acrobats, like Chica, would hit upon. For it must not be assumed that even in bodily dexterity chimpanzees are all alike. One sees the animals twisting, bending, and turning their bodies with equal facility according to the shape of an entrance; but no one expects a chimpanzee to remain helpless before a horizontal opening in a wall, on the other side of which his objective lies, and so it makes no impression at

all on us when he makes as horizontal a shape as he can of himself, and thus slips through. It is only when roundabout methods are tried on the lower animals, and when you see even chimpanzees undecided, nay, perplexed to the point of helplessness, by a seemingly minor modification of the problem—it is only then you realize that circuitous methods cannot in general be considered usual and matter-of-course conduct.[1] But, as chimpanzees do not give us the impression of any particular insight when they take a roundabout route (at any rate in the form so far discussed) no further explanation is here required, because of the non-theoretical form of our problem.

Meanwhile, however, in the simplest experiments of the roundabout type, observation is so easy that a description of such tests performed on other animals is advisable. Taking such a simple case as an example, one becomes aware of a factor which occurs over and over again in all difficult experiments with chimpanzees, and will be more easily observed there after it has become familiar here. Therefore the following examples are quoted.

Near the wall of a house, a square piece of ground is fenced off so that one side, one metre from the house, is parallel to it, and forms with it a passage two metres long; one end of this passage is cut off by a railing. A mature Canary Isle bitch is brought into this blind alley from direction A (cf. Fig. 2), to B, where she is kept occupied with food, her face towards the railings. When the food is nearly gone, more is put down at the spot C, on the other side of the rail; the bitch sees it, seems to hesitate a moment, then quickly turns at an angle of 180° and is already on the run in a smooth curve, without any interruption, out of the blind alley, round the fence to the new food.

The same dog, on another occasion, behaved at first in

[1] Cf. the last section of this book, p. 226, seqq.

the same way. It was standing at B near a wire fence (constructed as in Fig. 3) over which food was thrown to some distance; the bitch at once dashed out to it, describing a wide bend. It is worth noting that when, on repeating this experiment, the food was not thrown far out, but was dropped just outside the fence, so that it lay directly in front of her, separated only by the wire, she stood seemingly helpless, as if the very nearness of the object and her concentration upon it (brought about by her sense of smell) blocked the "idea" of the wide circle round the fence; she pushed again and again with her nose at the wire fence, and did not budge from the spot.

A little girl of one year and three months, who had learned to walk alone a few weeks before, was brought into a blind alley, set up *ad hoc* (two metres long, and one and a half wide), and, on the other side of the partition, some attractive object was put before her eyes; first she pushed towards the object, i.e., against the partition, then looked round slowly, let her eyes run along the blind alley, suddenly laughed joyfully, and in one movement was off on a trot round the corner to the objective.

In similar experiments with hens, one sees that a roundabout way is not taken as a matter of course, but is quite an achievement; hens, in situations which are much less roundabout than those already described, have been quite helpless; they keep rushing up against the obstruction when they see their objective in front of them through a wire fence, rush from one side to the other all a-fluster, and do not fare better, even when they are familiar with the obstruction (or the fence) and the greater part of the circuitous route, as, for instance, round the little door of their place and through the opening corresponding to it. Different hens do not behave in the same way, and, if the detour is shortened while they are still pushing against the obstacle, it can easily

be observed how first one, then another, and so on, stops running up against the obstruction, and runs quickly round the curve; but some particularly ungifted specimens keep on running up against the fence a long while even in the simplest predicaments. The difference is very plain too, when one notices in cases of longer roundabout routes to what an extent chance must help to solve the problem. In their

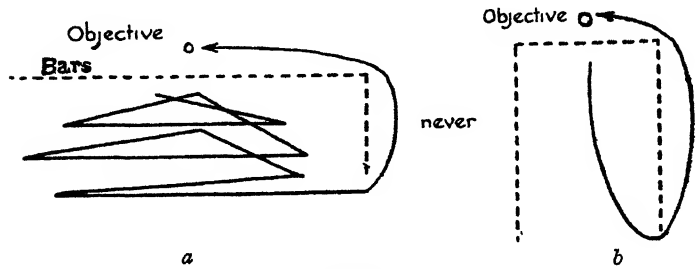

FIG. 4.

oscillations in front of the objective, the hens now and then run into places from which the circuitous route is shorter; but this easing-up brought about by chance will have a very different effect on different animals: one will suddenly rush out in a closed circle, another will still zigzag helplessly to and fro in the "wrong" direction. All the hens which I observed thus managed to achieve only very "straight" roundabout ways (cf. Fig. 4*a* in contrast to 4*b*). Apparently the possible detour must not begin with the direction leading away from the objective (cf. as against this the behaviour of the child and the dog above).

It therefore follows that for those processes which form the basis of this small achievement, variations in the geometrical circumstances are of the greatest importance.[1] The influence of these circumstances will more than once be striking in the

[1] In what way they are dependent can be more exactly determined, and when this is known, definite conditions will exist for every theory concerning the experiment.

case of the anthropoids, in what are, for them, much harder tasks.

As chance can bring the animals into more favourable spots, it will also occasionally happen that a series of pure coincidences will lead them from their starting-point right up to the objective, or at least to points from which a straight path leads to the objective. This holds in all intelligence tests (at least in principle : for the more complex the problem to be solved, the less likelihood is there that it will be solved wholly by chance) ; and, therefore, we have not only to answer the question whether an animal in an experiment will find the roundabout way (in the wider meaning of the word) at all, we have to add the limiting condition, that results of chance shall be excluded. Now (if we take as examples these experiments in roundabout ways—in the narrower sense) since approximately the same path must be followed by the animal, whether as the result of a succession of accidents, or of a real solution of the problem, the objection will arise, that one cannot distinguish between these two possibilities. It is of great importance for what follows and for the psychology of the higher animals in general, that one should not allow oneself to be confused by such apparently " pat " but, in reality, false, considerations. *Observation, which alone may be admitted here, shows that there is in general a rough difference in form between genuine achievement and the imitations of accident,* and no one who has performed similar experiments on animals (or children) will be able to disregard this difference. The genuine achievement takes place as a single continuous occurrence, a unity, as it were, in space as well as in time ; in our example as one continuous run, without a second's stop, right up to the objective. A successful chance solution consists of an agglomeration of separate movements, which start, finish, start again, remain independent of one another in direction and speed, and only in a geometrical summation

start at the starting-point, and finish at the objective. The experiments on hens illustrate the contrast in a particularly striking way, when the animal, under pressure of the desire to reach the objective, first flies about uncertainly (in zigzag movements which are shown in Fig. 4*a* but in not nearly great enough confusion), and then, if one of these zigzags leads to a favourable place, suddenly rushes along the curve in one single unbroken run. Here, the first part of the possible path is swallowed up in confused zigzagging, all the rest is "genuine"—the one type of behaviour succeeding the other so abruptly that no one could mistake the difference in the two kinds of movements.

If the experiment has not been made often, there is the additional fact that the moment in which a true solution is struck is generally sharply marked in the behaviour of the animal (or the child) by a kind of jerk: the dog stops, then suddenly turns completely round (180°), etc., the child looks about, suddenly its face lights up, and so forth. Thus the characteristic smoothness of the true solution is made more striking by a discontinuity at its beginning.

I must explicitly warn my readers against the mistake of thinking that I am implying any supernatural mode of interpreting behaviour: any practised person can observe this, not only in experiments on animals, but in all others. Similar considerations have to be taken into account often enough outside the animal world. Thus, wandering earth-currents, and other rapidly-alternating fortuitous influences, deflect the thread of a badly set-up electrical measuring instrument irregularly to and fro on the scale; but should the thread move constantly to a certain scale division, no physicist would mistake the evident difference, and its meaning. In observing the Brownian movement any experimental error which causes the introduction of a regular

movement into one which is normally irregular would at once be detected, and so forth. Later on, more will be said about this matter, the importance of which does not concern method alone.

[Experiments in roundabout ways of the kind described must not be confused with two other experimental methods: 1. "Frogs without brain and mid-brain still get out of the way of obstacles" (Nagel, *Physiol. des Menschen*, IV, I, p. 4; A. Tschermak). Thus the animals move automatically out of a line of motion which would bring them into collision with an obstacle. Does it follow that the same frogs would automatically take a long way round an obstacle up to an objective? Obviously not. The main point in our experiment does not arise at all in the frog experiment. 2. American animal psychology makes animals (or people) seek the way out of mazes, over the whole of which there is no general survey from any point inside; the first time they get out is, therefore, necessarily a matter of chance, and so, for these scientists, the chief question is how the experience gained in such circumstances can be applied in further tests. In intelligence tests of the nature of our roundabout-way experiments, everything depends upon the situation being surveyable by the subject from the outset.]

I made the experiment more difficult for chimpanzees, in the following way: The objective hangs in a basket from the wire-roof and cannot be reached from the ground; the basket contains also several heavy stones, so that one push of the string and basket will make the whole swing for some little time; the swing is so arranged that the longest sideways movement of the basket makes it nearly reach a scaffolding. Thus the roundabout way is easily recognizable, and available, but only for a few moments.—(19.1 14)—As soon as the basket is swinging, Chica, Grande, and Tercera are let in

upon the scene.[1] Grande leaps for the basket from the ground, and misses it. Chica who, in the meantime, has quietly surveyed the situation, suddenly runs towards the scaffolding, waits with outstretched arms for the basket, and catches it. The experiment lasted about a minute.[2]

Repetitions with other animals (Rana, Koko) also went so smoothly and quickly that one can probably infer that every chimpanzee can solve this problem. Grande, who had seen Chica's solution, duplicated it on an immediate repetition of the test. Judging by everything that happened later, there is no doubt that example is not absolutely necessary, and that, always slower than the others, Grande would, after a little while, have seen the roundabout route of herself.

Sultan, who was not present at these experiments, was tested with the same swing (20.1), but this time, before he saw it, the basket was set swinging in a circle which brought it at regular speed past a beam; the circular swing and the regular speed doubtless made this experiment a little harder. Sultan looked up for a second, and followed the basket with his eyes; when he saw it swinging past the beam, he was up there at once, awaiting it.

[1] In the first few days these animals were far too timid to permit of the isolation of any one of them for experimentation, this circumstance caused the very greatest difficulties, and even after six months it was still impossible to test Chica alone Usually in such cases I gave Tercera or Konsul as companions; for they were not much use anyhow on account of shyness or laziness; but other subjects of experiment were sometimes similarly wasted

[2] In this book I give either no times at all or the approximate time in those instances where it bears on the subject In general the duration of an experiment depends on so many accidental and changing circumstances (e g futile attempts at solution, lack of interest, depression on account of failure or isolation, etc) that measures of time would only give the *semblance* of a quantitative method The time-data in any of these experiments can always be judged or estimated from the description, as far as it is important for our purposes Whether an interval of indifference or complaining, as often occurred, lasted three minutes, i e perhaps ten times as long as the actual time of solution, or half an hour, perhaps a thousand times the length of that, does not matter at all In most cases the solution itself would make up any fraction one liked of the measured " duration of the experiment ".

In experiments such as these, it does not matter at all whether the point which the swing approaches remains the same in successive experiments or not; and neither does it matter whether the vantage-point is a wall, a tree, a scaffolding, or anything else. If variations of this sort are introduced, the animal does not climb up to the spot at which it was successful before; it clambers with complete certainty to the right place for the new situation. In experiments as simple as this I never saw this rule broken, but in harder tasks, mistakes involving stupid repetitions did occur.

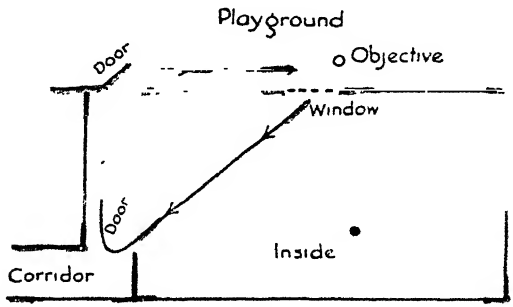

FIG 5.

The experiment is considerably more difficult when a part of the problem, if possible the greater part, is not visible from the starting-point, but is known only "from experience."

One room of the monkey-house has a very high window, with wooden shutters, that looks out on the playground. The playground is reached from the room by a door, which leads into the corridor, a short part of this corridor, and a door opening on to the playground (cf. Fig. 5). All the parts mentioned are well known to the chimpanzees, but animals in that room can *see* only the interior. (6.3)—I take Sultan with me from another room of the monkey-house, where he was playing with the others, lead him across the corridor into that room, lean the door to behind us, go with him to the window, open the wooden shutter a little, throw

a banana out, so that Sultan can see it disappear through the window, but, on account of its height, does not see it fall, and then quickly close the shutter again (Sultan can only have seen a little of the wire-roof outside). When I turn round Sultan is already on the way, pushes the door open, vanishes down the corridor, and is then to be heard at the second door, and immediately after in front of the window. I find him outside, eagerly searching underneath the window; the banana has happened to fall into the dark crack between two boxes. Thus not to be able to see the place where the objective is, and the greater part of the possible indirect way to it, does not seem to hinder a solution; if the lay of the land be known beforehand, the indirect circuit through it can be apprehended with ease.

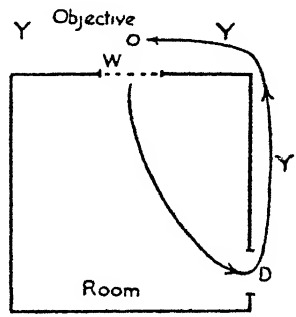

FIG. 6.

In a very similar experiment with the bitch already mentioned, she managed the same manœuvre. From the yard which runs straight and unencumbered around the house, one steps through the door D into a room with its window W looking out on to the yard Y (cf. Fig. 6); the bitch, who is acquainted with the room and the yard from former visits—she does not belong to the house—is brought through the door D into the room, and is tempted, with food, to the open window; from here she can see only the tops of distant trees, not the yard itself. The food is thrown out, and the window at once shut. The dog jumps once against the window-pane, then stands a moment, her head raised towards the window, looks a second at the observer, when all at once she wags her tail a few times, with one leap whirls round 180°, dashes out of the door, and runs round outside, till

she is underneath the window, where she finds the food immediately.[1]

[Thorndike tested large numbers of dogs and cats in order to see what there is in the wonder-stories that are told about these domestic pets. The result was very unfavourable to the animals, and Thorndike came to the conclusion that, so far from " reasoning ", they do not even associate images with perception, as humans do, but remain limited chiefly to the experiential linking of mere " impulses " with perceptions. This investigation did what was necessary in a negative way at the time, but, as is now being shown (also in America), it went a little too far. The tests were based upon those animal stories, and consequently were made so difficult that the result *was bound* to fall out badly, under the influence of the animals' failures in these tests, Thorndike then drew generalizations about their capacities, which do not follow from those difficult experiments. However stupid a dog may seem compared to a chimpanzee, we suggest that in such simple cases as have just been described, a closer investigation would be desirable.

Regarding their principle, I must make a further objection to Thorndike's experiments. They were designed as *intelligence tests* of the same type as our own (insight or not ?)[2], and ought, therefore, to have conformed to the same general conditions, and, above all, to have been arranged so as to be completely *visible* to the animals. For if essential portions of the experimental apparatus cannot be seen by the animals, how can they use their intelligence faculties in tackling the situation ? It is somewhat astonishing to find that

[1] Somewhat different experiments in detours were made by Thorndike (cf the work quoted below) and Hobhouse (*Mind in Evolution*, London, 1901, p. 223 seqq.). I must add that the bitch was not brought through the door from the window-side of the house, so that behind her she can only have had a scent-trail as far as the door ; in any case her sense of smell was not observed to have played any part at all

[2] See foot-note, p. 219.

(in Thorndike's experiments) cats and dogs were frequently placed in cages containing the *extreme end* only of one or the other mechanism, or allowing a view of ropes or other parts of the mechanism, but from which a survey over the *whole* arrangement was not possible. The task for the animal was to let itself out of the cage by pulling or pressing the accessible part of the mechanism; then—the cage door would open of itself. Thorndike also gives an account of experiments in which the animals were let out of their cages if they scratched or licked themselves. He contrasts these experiments with those involving the employment of any mechanical contrivance, as the former apparently imply no direct connexion between cause and effect; but the causation is far from apparent even in the mechanistic experiments.

In the case of the latter, there are at least various *component parts* which can be treated with some amount of insight, and it is of the highest significance to know whether animals react differently to experimental situations which involve a partial possibility of intelligent behaviour than they do to such as involve none—for the difference, if any, is obviously crucial.

The result of these experiments tends to show that prolonged "learning" is necessary before the right action develops, in *both* sets—as the "experiments with a mechanism" were far too difficult, and, in many cases, could not be wholly surveyed either. But when once the animals have mastered both procedures, a noticeable difference is shown: "In all these cases"—of the meaningless type—"there is a noticeable tendency . . . to diminish the required action, till it becomes a mere vestige of a lick or scratch"—and more especially—"if sometimes you do not let the cat out after this feeble reaction, it does not at once repeat the movement, as it would do if it depressed a thumb-

piece, for instance, without success in getting the door open."[1]

Thorndike merely states that he cannot give a reason for the difference of result in the two types of experiment. As these results are among the most interesting which he has obtained—though scarcely what we might expect from his theory—we can only regret that he has not probed further.]

[1] *Animal Intelligence*, New York, 1911, p. 48.