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W. W. NORTON & COMPANY, INC.
70 Fifth Avenue New York

BEHAVIORISM

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NEW YORK

W. W. NORTON & COMPANY, INC.

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Whose unfailing interest in both
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box, to take the cork from a bottle, to stick the end of his rattle into a box, to close and open the lid of the box. This whole complicated group of habits starting with reaching we call *manipulation*. Anyone who thinks that manipulation is an instinct should work daily with a baby from the 120th day to the 200th day. The baby learns to manipulate objects and even its own bodily parts literally by the sweat of its brow.

I do not want to mislead you here into thinking that habits of manipulation involve only arm, hand and finger movements. You understand perfectly from all that has gone before that any movement such as reaching for an object brings about an adjustment of practically every muscle of the body—and let us include the viscera here as well. In other words, every movement accurately executed involves a response of the whole body in each and in every part. This is what we mean by a total reaction. This is what we mean by perfect integration. Movements of the shoulder, the arm, the elbow, the wrist, the palm, the fingers, the trunk, the legs, the feet, yes, even breathing, circulation, etc., all have to take place according to a certain order. This order must be beautifully timed and the amount of energy in each muscular group must be just right before any fine act of skill, such as hitting the bull's eye with the rifle or making a perfect shot at billiards, can take place.

With these early basal habits of reaching and manipulation established, the infant begins his mastery of the world. The steps from fashioning his implements of clay and mud to fashioning them from tempered steel; from bridging a stream by crudely felling a tree to bridging a part of the ocean with steel and concrete; from building houses of rough grass and clay to building the skyscraper of concrete and steel, are largely but illustrations of the growth of manual habits.

Example of the Growth of a Habit

To make the whole process a little more concrete, let us put in front of the three-year-old child, whose habits of manipulation are well established, a problem box—a box that can be opened only after a certain thing has been done; for example, he has to press inward a small wooden button. Before we hand it to him, we show him the open box containing several small pieces of candy and then we close it and tell him that if he opens it he may have a piece of candy. This situation is new to him. None of his previously formed manipulation habits will completely and instantly work in this situation. None of his unlearned reactions will help him very much. What does he do? That depends upon his previous organization. If well organized by previous handling of toys, he goes at the problem at once—

(1) he picks the box up, (2) he pounds it on the floor, (3) he drags it round and round, (4) he pushes it up against the baseboard, (5) he turns it over, (6) he strikes it with his fist. In other words, he does everything he has learned to do in the past in similar situations. He displays his whole repertoire of acts—brings all of his previously acquired organization to bear upon the new problem. Let us suppose that he has 50 learned and unlearned separate responses at his command. At one time or another during his first attempt to open the box, let us assume that he displays, as he will, nearly all of them before he pushes the button hard enough to release the catch. The time the whole process takes, we will say, is about twenty minutes. When he opens it, we give him his bit of candy, close up the box and hand it to him again. The next time he makes fewer movements; the third time fewer still. In 10 trials or less he can open the box without making a useless movement and he can open it in two seconds.

Why is the time cut down, and why do movements not necessary to the solution gradually drop out of the series? This has been a hard problem to solve because none of us, I believe, has ever simplified the problem enough to really bring experimental technique to bear upon it. I have tried to explain on what we may call a *frequency* and *recency* basis, why the one movement finally persists whereas all the rest die away. I think I can make clear to you what we mean. Let us designate each of the separate acts of the three-year-old by a number. We will designate the final act—pressing the button which opens the box—number 50. Then on the first trial all of the 50 acts will occur (and many may appear more than once), let us say, in chance order:

47, 21, 3, 7, 14, 16, 19, 38, 28, 2, etc.....50

On the second trial:
18, 6, 9, 16, 47, 19, 23, 27, etc.....50

On the third trial:
17, 11, 29, 66, 71, 18, etc.....50

On the ninth trial:
14, 18, etc.....50

On the tenth trial and all succeeding trials:
50

In other words, number 50 tends to come earlier and earlier in the series and by doing so there is less and less opportunity for other movements to appear. Why? On our premise we can see that response number

50 is the only one that occurred on each and every trial; that is, the environment in the shape of the person conducting the test arranges the series in such a way that 50 has to be the end of the series—the infant then gets food; the box is closed and is handed to him again. Act number 50 is therefore the one most frequently repeated—more frequently, that is, than any of the other 49 acts.

Again, since act number 50 is always the last response in the previous trial, there is some reason for believing that it will appear sooner in the series of acts on the next succeeding trial. This is what is called the factor of *recency*. The recency and frequency factors as explanations of the formation of habit have been criticized by some writers—among others: Professor Joseph Peterson, of George Peabody College, Nashville, Tennessee, and Professor Bertrand Russell. No experimental test, that I consider crucial at any rate, has ever been made in this very important field. Only a few psychologists have been interested in the problem. Most of the psychologists, it is to be regretted, have even failed to see that there is a problem. They believe habit formation is implanted by kind fairies. For example, Thorndike speaks of pleasure stamping in the successful movement and displeasure stamping out the unsuccessful movements. Most of the psychologists talk, too, quite volubly about the formation of new pathways in the brain, as though there were a group of tiny servants of Vulcan there who run through the nervous system with hammer and chisel digging new trenches and deepening old ones.

I am not sure that the problem when phrased in this way is a soluble one. I feel that there must come some simpler way of envisaging the whole process of habit formation or else it may remain insoluble. Since the advent of the conditioned reflex hypothesis in psychology with all of the simplifications (and I am often fearful that it may be an oversimplification!) I have had my own laryngeal processes stimulated to work upon this problem from another angle.

The Relation of Habit to Conditioned Reflexes

The relationship, theoretically, between the simplest cases of the conditioned responses we have studied and the more complicated, integrated, spaced and timed habit responses we are considering tonight, seems to me to be quite simple. It is the relationship apparently of part to whole—that is, the conditioned reflex is the unit out of which the whole habit is formed. In other words, when a complicated habit is completely analyzed, each unit of the habit is a conditioned reflex. Let us go back a moment

to the type of conditioned reflex we have already considered in previous lectures:

S.....R	
Electrical Contact (Noxious)	Movement of the foot
<i>When conditioned,</i> the visual stimulus of circle	Calls out same movement of foot

This is a simple type of conditioned response. Now by hypothesis every complicated habit is made up of just such units. I shall try to make this a little clearer. Suppose in place of conditioning my subject to withdraw his foot when a visual stimulus of a circle is shown, I condition him to turn, say, one step to the right. When he turns to the right he faces a visual stimulus of a square. To this stimulus he is conditioned to walk forward five steps. He then faces a triangle. To this stimulus he is conditioned to move two steps to the right. This puts him face to face with a cube. In response to this he has to step up three steps instead of turning to right or left. You can see from this simple illustration that I can lead him all around the room and back to the starting point. I do this by arranging a series of visual stimuli to each of which I condition him so that he must move in a certain way—that is, turn to the right, to the left, move upward, downward, forward or backward, put his right hand up, stretch out his left hand, and the like. Now suppose each time I begin experimenting upon him, I run him through the whole series from the beginning. Isn't this a description (after the whole system has been turned over to kinaesthesia—see p. 176) of just what happens when the rat or the human learns, say, a complicated maze? Does not every alley, bypath or turn in the maze represent a unit in the whole process of learning the maze? Isn't typewriting, piano playing and every other special act of skill resolvable or analyzable into just such a set of units? Of course in real life, in establishing separate conditioned reflexes making up the whole habit, we sometimes use food or we pet the child to condition it when the right response is made; we may cuff it or otherwise punish it for a wrong response or allow it to run itself down into blind alleys, bringing on partial fatigue (which is an equivalent of punishment).

And why are these units timed and spaced as they are? Why is the series arranged as it is? There is no order or sequence as such in the world we live in—except in a few such things as the sun, moon, stars, etc., and even these are obscured for days and weeks sometimes. Even they are not orderly enough for us to steer a ship by, hence the compass and sextant. The answer is this: *Society*, or the *accident of environment places them that way*. By *society* I mean the men and women constituting it who have set up complicated patterns of response that must be literally fol-

lowed. Words have a certain number of letters and they follow one another in definite sequence established by Mr. Johnson or Mr. Webster and our other early lexicographers. The holes of the golf course must be played in a certain sequence, pool balls must be shot into certain pockets. By *accident of environment* I mean, for instance, the simple fact that if you are to go from your own home to the old swimming hole you must (1) go to the right of a certain hill, (2) cross a small stream, (3) pass through a grove of pine trees, (4) follow down the left bank of a dry stream until you (5) get to the cow pasture, (6) then from behind a clump of large willow trees (7) you have come to your desired haven. Each of the numbers represents a visual stimulus that must be reacted to, at least during the learning stages.

You may say "Yes" to all this, "but what of it? Is the explanation of the formation of a conditioned reflex any simpler than the explanation of this phenomena we have been calling habit?" My answer is: Even though we cannot "explain" a conditioned reflex, we have by our analysis reduced to simpler terms a complicated process which we have neither been able to solve nor, apparently, to begin experimentation upon. I believe we can now turn our formulation over to the physiologist or to the physiological chemist for solution.

The problem we leave with him is:

Stimulus X will not now call out reaction R; stimulus Y will call out reaction R (unconditioned reflex); but when stimulus X is presented first and then Y (which does call out R) shortly thereafter, X will thereafter call out R. In other words, stimulus X becomes ever thereafter substitutable for Y.¹

The physiologist may come back at once with some such explanation as this: "You are wrong in your assumption about X not stimulating the organism. X does stimulate the whole organism and consequently does faintly arouse reaction R, only not strongly enough to appear as an overt response. Y does call out R overtly because the organism is biologically built to respond overtly with R when stimulated by Y (unconditioned response). But after Y has called out R, resistance or inertia in this whole sensory motor segment is lessened to such an extent that X, which only faintly called out R, will now call out R overtly." Certainly if the

¹ This is not an exaggeration. I have seen a conditioned response firmly set up in a child by one contact with a hot radiator, a conditioned response which has been retained for two years without further training. If we should keep our old habit terminology, we should have in this example a habit formed by a single trial. There can be then in this case no "stamping in of the successful movement" and no "stamping out of the unsuccessful movement."

physiologist attempts to explain the various phenomena underlying conditioned responses at the present time, he will have to couch his explanations in terms of resistance in the nervous system, interference, summation, inhibition, reinforcement, facilitation, all or none law, etc., because these are the phenomena he works with; but they are very complicated phenomena, far too complicated for us even to attempt to describe them. Until he has reduced them to electrical and chemical processes I am afraid he cannot help us very much.

Fortunately we can continue our work in behavior without awaiting the true explanation of these biological phenomena couched in physico-chemical terms.

Some Details of the Learning Curve

Below (fig. 16) is the curve showing the records of 19 rats in learning the complicated Hampton Court maze (modified). The horizontal line shows the number of trials the rats were given. Each rat was tested separately. Each point on the vertical line shows the average number of minutes it took the rats to reach the food on the various trials. Note that

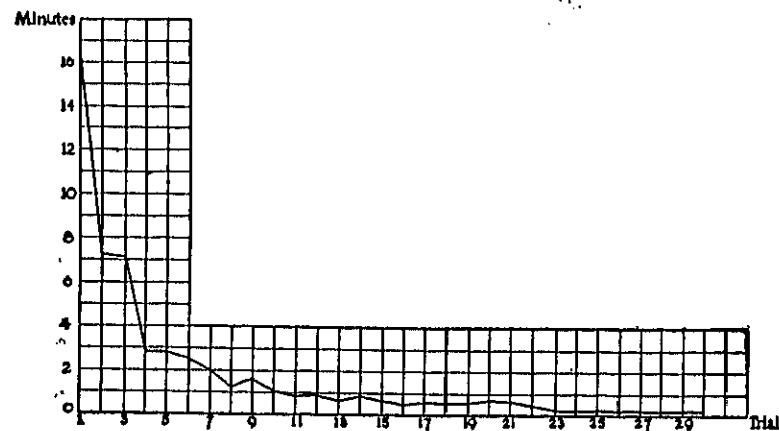


Fig 16

This curve shows the progress 19 white rats made in learning the complicated Hampton Court Maze. The vertical line shows the number of minutes required to get to the food. The horizontal line shows the number of trials given. Thus, on the first trial an average of 16 minutes was required; on the thirtieth trial approximately 20 seconds. Note that improvement at first was very rapid and then went on more and more slowly.