

TWO METHODS OF SUBJECTIVE LEARNING IN THE MONKEY *MACACUS RHESUS*

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The studies of the learning processes of monkeys have led to some disagreement as to whether or not monkeys learn by the imitation method or through perseverance of trial and error or by both methods. The researches of Kinnaman, Shepard, Watson, Thorndike, and Haggerty show that the monkey learns principally by the perseverance method, but also, if the problem with which he is confronted is not too complex and contains only such elements or steps to be associated together for success as he has already mastered, by imitation.

A review of the researches of the above observers shows that practically all the studies of the monkey's learning processes have been through the problem method, requiring the monkey to *manipulate in a certain manner or sequence* objects of a general type for which all monkeys have a great natural fondness and interest.

One factor that has made some of the studies of learning not altogether convincing has been the unnaturalness of some of the movements required of the ape and other animals to solve the problem or to imitate another animal's movements. The animal often simply does not have the reactions or reflex systems in its repertory and lacks neurologically the capacity to acquire the necessary movements or associations of movements, or associations of sensations and sensory images, to solve the problem. Also the factor of internal, emotional distractibility has been underestimated. The uneasiness of the subject caused by the nearness of the human is so persistent and reflex in type that it always causes more or less distractibility, presenting a proportionate degree of incoördination, like the pupil who fears his teacher and cannot learn from him, or the uneasiness produced in a speaker by the mere presence of a crowd. For example:

Shepard says that he placed the glass tube and stick in the cage with the animal "to see if he could push out the food in the tube *after his attention had been attracted and he had been shown by the experimenter how the stick was to be manipulated* for obtaining the banana or peanut." Monkeys are not only afraid of a man but are ready to flee when a stick appears in one's hands. Although the monkeys saw the experimentator use the stick from 72 to 228 times, none of them showed any signs of imitation. If, as is most probable, the monkeys were the hosts of even slight fear reactions from the hand or stick, imitation, above everything else, could not be expected. Kinnaman similarly spoke of making *suggestive movements* with a key (an object in the hand) to indicate its necessity in procuring the food. The monkeys did not imitate.

Otherwise this work has so thoroughly covered this phase of the monkey's learning methods that perhaps further contributions are not needed. However, quite by accident the monkeys themselves revealed that they had other problems to master besides the *objective ones* of manipulating objects in proper sequence or manner; problems of a more *subjective* nature, such as when they knew perfectly well what they wanted to do, and in a way, how to do it, and saw how other monkeys performed an act, but to acquire the same results they had to learn how to control and manipulate their own muscles, of the body, arms and hands, in a certain manner.

Since this seems to be an important condition of the learning process of the monkey it is thought to be worth reporting.

The following observations were made from six *Macacus rhesus* monkeys. Three of them, A, B, and C, are immature, well formed and presumably half grown. A and B are males. C is a female. They differ markedly in disposition but a study of their personalities need not be given here, except to state that A is very timid and gives way to the demands of all the others. He is forced to adapt himself to their demands in any other way than by using force.

B is a very active, aggressive monkey and frankly competes for food with any of the others. He rarely fights back at D, E, or F, and I only observed once that he tried to take food from one of the larger monkeys. B dominates A and C. C is very much like B in disposition and used to dominate him,

but ever since F punished C when B, C and F were caged together, B punishes her and she submits to his aggressions.

D, E and F are about matured males. E is the largest and most powerful and dominates the band. D is next in strength and dominates all but E. That is, he punishes all but E. F is not liked by the other monkeys, and they all have preferences for some other monkey than F. F dominates A, B and C.

The studies were conducted in a basement where they live in three cages. Besides one or two boxes, a barrel and a chair, there is no other furniture in the room. My presence during the studies could have had very little influence since they all are used to me. They are more or less timid toward me, but pay practically no attention to me when I am quiet and remain at a distance.

The problem studied was accidentally suggested. The cages are all raised 18-19 cm. from the floor by blocks, one under each corner. There is an aperture about 4 cm. wide and 80 cm. long between the flooring of the cages and the lower horizontal wooden bar to which the screen is attached. This aperture is closed by a movable wooden bar to keep the sawdust in the cage and is easily removed for cleaning the cage and watering. A small wooden box, 25x30x16 cm. happened to be at hand. One evening I noticed some of the monkeys trying to reach to the floor for some peanut shells. It occurred to me to drop a few peanuts into this box and push it up to the cage and see the monkeys reach for the nuts.

A, B and C were in this cage. They promptly reached through the wires into the box but the distance was too great to reach the peanuts. The bar was then removed and A, B and C immediately returned to grab peanuts. B and C returned first and, true to their habits, overlooked the new opening and utilized as before, the nearest wire screen area above the box. They repeatedly reached through the spaces but could not quite touch the nuts. A tried to reach from this place also but was pushed away by B and C, whereupon he tried it lower down and pushed his hand through the horizontal aperture between the floor and the crossbar and then extended his hand into the box containing the nuts. He chuckled his delight as he drew out the nut. Immediately B and C tried this aperture and succeeded in reaching the nuts. (Objective learning through

imitation.) After that they all promptly used the lower space and abandoned the wires for reaching food from this box. They seem to be equally quick at it, often requiring only about one-half a second to make the movement.

The food box was then presented to D, E and F, who were caged together. D, E and F saw A, B and C feed from the box and F may have imitated them, but since he had often reached to the floor before, this is not likely to have been the case. He immediately placed himself in the proper position and reached the food. D and E could not reach the food, although they extended their hands through the proper aperture.

Before relating D and E's methods of finally acquiring the food from the box it is necessary to make clear the type of movement required to reach the food. The extreme simplicity and naturalness of the position necessary to acquire the food should be given the most consideration.

To take a nut from the box the movement of A, B, C and F was simply that of crouching close to the floor on all fours with the body parallel to and near the aperture, then extending the forearm of the arm nearest to the bar through this aperture, pronating the hand so that the palm faces the food and simultaneously pushing the arm through the aperture up to the shoulder. A, B, C and F did this within a few seconds from the beginning and quickly became so expert that they could perform the movement in less than a second. All monkeys learn this crouch in infancy, as do most four-footed animals. It is one of their most natural and frequent positions. To crouch on the perch in this manner and reach over the edge with one hand to scratch another monkey below is a very frequent movement for all of them to make. So in this movement probably no new motor coördinations were required or sensory stimuli given, and on the other hand one of their most frequent positions and movements was necessary to reach the food. One thing must be added, however. When the monkey's head remained above the cross bar and near the wire netting he could see the food while he reached for it; and when he crouched close to the floor and extended his arm through the aperture beneath the cross bar, his face would be beneath the cross bar, and he would be unable to see the food or his hand when he reached. He would have to depend upon touch to orient himself. On

the other hand every monkey is fond of sticking his fingers into places where he cannot see what he touches.

For three months, in which time the problem was placed before the monkey from about a quarter of an hour to an hour at a time on an average of three times a week, D and E were unable to get anything out of this box. Although they had innumerable opportunities to watch and did watch very closely while in the presence of A, B, C, or F, or several, or all of them, or when by themselves. They also tried to solve the problem when alone. It is perhaps needless to add that they were urged to do so by the odor and sight of many tempting fruits, nuts and vegetables, during states of great, little, or no hunger and they were unable to learn. Their efforts to reach into the box at times were perfectly ridiculous and grotesque. They would twist themselves into the most awkward positions, even for a monkey, stand on their hands, pushing their faces into the aperture and hold to the wires with their hind feet, almost standing on their heads, or climb up the wires backwards, turn their backs to the food and try to reach it, twist themselves around and around in a circle, call for the food, get angry, punish the other monkeys and what not.

They were helpless and would probably have starved if their struggles for food had been the sole means of living.

They learned to snatch food from the other monkeys and when this failed, at times they would sit by the box and shake it back and forth or drive the other monkeys away. D and E would often sit by the aperture and watch another monkey reach for the food and then snatch it as he drew it through the aperture. F then adjusted to this by pressing his face into the aperture and pushed the nuts into his mouth without raising his head. When he had several in his pouch he would then dash away.

B would frequently grab food out of the box and dash to the top of the cage and eat it. E would cautiously climb up to get near enough to grab him. As soon as E would be far enough from the box B would dodge him, dash to the box, grab food and be away before E would get back to the box. Occasionally B would make an enticing chuckling sound to E which was very similar to the sound made when wishing sexual play. This

would usually induce E to come away from the box and give B an opportunity to dash by him.

In the beginning the study was not intended for publication, so a count of the distinct attempts to reach into the box was not made. It is safe, however, to estimate that D and E each made more than two hundred, probably twice that number of attempts to reach the food and neither seemed to make any progress. They repeated over and over again about the same futile movements. D and E would both often crouch at right angles to the box, look over the bar into the box and thrust their arms through the aperture up to the elbow. Although they would pronate the forearm they could not bend the elbow to lower the hand into the box, being anatomically impossible in the narrow aperture with the body at right angles to the opening and the head above the bar. They would then usually shake the box back and forth or try to lift it or turn it around.

The observations of two periods are given here to make clear what happened. The period of April 8 is typical of all the periods previous to it. During the period of April 19 D succeeded for the first time in his efforts to obtain food.

OBSERVATIONS

April 8.—D and F are in the cage together. Several prunes were dropped into the problem box. D reached through the aperture to the elbow. F pushed his way to the aperture, crouched and extended his arms through the aperture and helped himself to the prunes. *D crouched right beside F, watching him intently, especially F's hand reaching for food, and he moved his forearm through the aperture the way F did but did not turn his body properly. He clearly tried to imitate F's method of reaching.* (Subjective learning through imitation.) *F grabbed all the prunes.* A few minutes later F grabbed all the nuts and bread without exception. This is about what occurred each time the problem was tried throughout twelve weeks.

April 19.—D and F in a cage together. One dried peach was dropped into the box. F grabbed it. D pursued F to take it from him. Piece of dried bread dropped into the box. F grabbed it. Bread again dropped into the box before F finished eating. D turned the box around and pulled it back and forth;

placed himself in many awkward positions. Extended his hind legs and body in a vertical position, holding to the wire netting with his hind feet. He turned around, finally standing upside down in a vertical position with his head near the aperture. He succeeded in scratching the bottom of the box but could not reach the food. Then he seemed to lose his balance and fall over on his side. This accidental position was correct for reaching the food. He pulled out the piece of bread. He ate the bread. A peach was lying in the box. He tried repeatedly to reach it but could not and did not assume the proper position again. F grabbed the peach. Handful of peanuts were dropped into the box. F grabbed most of them.

Now D tried all types of movements, squirming into one position after another in a most useless and fruitless manner. Twice his body happened to get into the proper position to easily reach the food but each time he changed his reaching hand from the one beside the aperture to the one on the opposite side of his body. He continued to try, raised his body and hind legs into the upside-down vertical position, holding on to the screen with his hind feet, then reached into the aperture with the off side hand and pressed his face into the aperture. His hand touched the nuts and he extracted four despite the awkward position of his hand. He then left the box to eat. Then he returned to get more nuts and seemed to be unable to reach them or resume his old position. He shook the box fruitlessly.

The next day the observations were repeated and D seemed to learn all over again. He went through a series of trials and errors and finally, more quickly than the day before, assumed his unique, awkward method. This method he developed until he became fairly dexterous.

He places his right hand on the wires just above the cross bar to steady himself and raises his body and hind legs above his head and shoulders, placing himself in a more or less vertical position. The abdomen and chest are pressed against the wires. He extends the left hand, which is on the opposite side of the body, through the aperture, this allows the arm to remain nearly straight, and *scrapes the back of the fingers* over the box floor until he happens to touch a nut. He required 5, 3, 3, 4, 10, 10 and 156 seconds for each trial to extract a nut.

The presence of F bothered D somewhat instead of assisting him to learn. But D was often tried alone and rarely did more than to pull the box around or twist himself into awkward positions.

E seemed to have even more difficulty in learning than D, although he had the longest arms of the six monkeys. Like D, he was given the opportunity to watch B, C and F take food from the box. He seemed to watch very closely but he never showed so clearly efforts to *imitate* as D tried to imitate F. That is he never sat beside B, C or F and moved his arm forward automatically as the other monkey's arm passed into the box.

Most of E's trials were made in company with B or alone. He would usually drive B away and shake the box back and forth or extend the arm to the elbow through the aperture. B probably interfered with E's learning process because of his quick dashes to the box and disconcerting eating when E was hungry. E preferred to take food from the others rather than try to procure his own. Despite this he made a great many trials with no result. Like D he seemed to bungle about the wires, twisting himself around in the most awkward positions, until he fairly fell into a crouch near the aperture. Then his hand easily reached the food. That it was an accidental association of movements was evident because after he seized the second nut he was unable to repeat his method. It happened as follows:

April 24—E and B were in the cage together. B was isolated in the rear compartment. E tried a variety of futile movements in order to reach the food. He extended his arm up to the elbow into the box and tried repeatedly. Finally he supinated the forearm and raised the posterior part of the body above his head, similar to D's method. This failed and with his arm still through the aperture, seemingly fatigued, he lowered his body to a crouch and rested. He looked at me as he crouched there; then he gradually extended his arm further. His position happened to be correct and his arm easily passed through to the shoulder. The hand reached the bottom of the box and he easily extracted food. He repeated this arm movement a second time and then changed his position to eat. After eating he tried to obtain more food and seemed unable to repeat his method. He pushed the box back and forth. After some time he resumed D's method and extracted an onion. Then B was readmitted.

B immediately dashed to the box and obtained food. E took it from him after a chase. A handful of nuts were dropped into the box. E tried awkwardly to reach them. Finally he reached in with the back of the hand towards the food—D's method—and extracted a nut. After this E learned rapidly. He gradually modified the position of his body until he no longer uses the wires to raise himself but forces his head tightly against the bar or floor and is able to reach the food with either hand. D also abandoned the vertical screen position but still keeps the posterior half of his body elevated. Both D and E now place their bodies nearly parallel to the aperture. The tendency is still to use the arm on the off side with the back of the hand facing towards the food in the box unless the hand is extremely extended, when the thumb also reaches the food—the most awkward position of the hand for grasping.

E and D are good specimens of the *Macacus rhesus*, well developed young adults. That spontaneous subjective learning should be so slow and laborious a process, even in an organism so highly developed as this species of monkey, when trying to adapt well developed movements to a new situation is surprising upon first estimation.

CONCLUSIONS

The observations seemed to show repeatedly that the following phenomenon occurred. D was the host of a motive—to acquire food. This motive discharged itself through a manifold of more or less incoördinated movements to acquire the food. A novel, accidental association of movements permitted complete expression of the motive. Hence there was a tendency to repeat similarly associated movements, eliminate the unnecessary and finally *reach a maximum of efficiency whereby the hunger motive could express itself with a minimum of effort*. In other words, the motive was the force, the box, etc., the mold, and the repertory of movements the material to be molded. A novel or accidental association of movements finally made the molding possible.

That is to say, D did not strictly try one movement and then another as a process of elimination of the useless movements but more aimlessly seemed to be the host of a stream of force that caused a continuous pressure for expression and ac-

cidentally the proper series of sensorimotor neurones became connected up and the motive flowed out through the series of effectors that acquired the food and placed it in the mouth.

In the cases of B and C watching A, and of D watching F, B and C imitated A in that they saw where A reached and did the same thing. D saw where and to an extent how F reached and reached from there also, but could only imitate the first one of F's movements even though he had probably made very similar movements under other circumstances.

The utilization of the fit and the elimination of the unfit, *whereby a maximum of the desired result is developed for a minimum of expenditure of energy*, is the great fundamental principle of force underlying all evolution, progress and efficiency.

Imitation seems possible only when similar movements under similar circumstances have already been previously acquired by the organism. Imitation seems to permit of a very limited margin for new modifications of the old repertory of movements. Trial and error gives much more extensive possibilities for learning; requires more time, energy and perseverance.

Subjective learning, in the sense of learning to manipulate the body, is a very important element in the development of the individual. It occurs through imitation and through the perseverance method of trial and error.

Subjective learning depends largely upon perfect freedom, the absence of fear and the urge of a motive.

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