Chapter 1

THE BEHAVIOR OF ANTHROPOID CHIMPANZEES

Three Stages in the Development of Behavior

In considering the development of behavior from its simplest forms, as observed in the lower animals, to the most complex and highest forms as we see in man, we may easily note that behavior, taken as a whole, passes through three basic stages in its development.

In all animals, inherited reactions or innate modes of behavior form the first stage in the development of behavior. These are usually called the *instincts*, and for the most part are associated with the satisfaction of the basic needs of the organism. They all perform the biological function of self-preservation or continuation of the species. The fundamental and distinguishing feature of the instinctive reactions is the fact that they function by virtue of the organism's inherited structure, without any form of training. As soon as he is born, the child will move his hands and feet, cry out, suck his mother's breast, and swallow milk.

Not all the instincts mature so early as does sucking, and not all of them begin to function immediately after birth. Many of them – for example, the sexual instinct – mature much later, indeed only when the organism has itself attained a sufficiently advanced stage of formation and development. Even those instincts that mature later, however, are distinguished by the same basic feature. This is the innate reserve of reactions provided the animal by virtue of its inherited organization.

The animal does not learn its instinctive reactions in the course of its own lifetime, nor do they arise as a result of trial and error, nor are they the consequence of imitation – these are their principal features. The biological value of the instinctive reactions lies in the fact that they are useful adaptations to the environment, developed in the struggle for existence and reinforced by natural selection in the process of biological evolution.

Their origin may, therefore, be explained in the same way as the origin of the "purposeful" structure and functions of the organism, i.e., the laws of evolution discovered by Charles Darwin. If we turn to the lower animals, for example, the insects and other invertebrates, it is easily seen that their entire range of behavior consists almost exclusively of such instinctive reactions. The spider spinning its web, the bee constructing its honeycomb – all the invertebrates make use of their own instinctive reactions as a fundamental form of adaptation to the environment.

Above this first and basic stage in the development of behavior there is a second stage constructed directly upon the first. This is the stage of training or conditioned reflexes. This second class of reactions is distinguished from the first in that it is not inherited, but rather arises in the course of the animal's own experience. All the reactions in this class are the result of a certain amount of learning or training, or of experience accumulated by the individual. The ordinary conditioned reflex, now quite well known and described in studies by Ivan Pavlov and his school, is a classic example of a reaction at this second stage.

For our purposes, we need only note two points characteristic of this second stage in the development of the reactions. The first is the connection that exists between the reactions of this second stage and the instinctive or inherited reactions. From investigations of the conditioned reflexes, we know that every primary conditioned reflex arises in no other way than on the basis of an unconditioned reflex or inherited instinctive reaction.

Essentially, animal training does not create new reactions in the animal; it only combines the innate reactions, as well as completely new conditioned corrections between the innate reactions and stimuli from the environment. Thus, a new stage in the development of behavior arises directly on the foundation of the preceding stage. Every conditioned reaction constitutes nothing other than an inherited reaction modified by the conditions under which it manifests itself.

The second point characteristic of this stage in the development of behavior may be found in the new biological function performed by the conditioned reflexes. The instincts serve as a means of adaptation to those conditions of the environment that are more or less constant, fixed, and stable. The conditioned reflexes, on the other hand, constitute a far more flexible, subtle, and advanced mechanism of adaptation to the environment, the essential nature of which is to adapt the inherited instinctive reactions to the individual, personal conditions of existence of a given animal. While Darwin explained the origin of the species, Pavlov explained the origin of individuals, i.e., the biology of the individual experience of the animal.

The full development of the second stage of behavior is found only in the vertebrates, though certain simpler forms of conditioned reactions may be observed even in ants, bees, and crayfish. It is only with the vertebrates,

training we are able to achieve in the lower animals, their dominant form of behavior remains instinct. In the higher animals, in contrast, there is a shift towards the dominance of conditioned reflexes in the general system of reactions.

It is in these animals that a plasticity in innate capacities manifests itself for the first time, together with childhood in the proper sense of the term, and the concept of play we associate with the child. Play, itself an instinctive activity, also serves to exercise other instincts, and is the natural school of the young animal, its self-teacher and very own animal trainer. "Young dogs, kittens, and human children," writes Karl Bühler, "play, but beetles and insects, even the highly organized bees and ants, do not. This cannot be accidental, but rather expresses an inner connection: *play is an extension of plastic capacities*." [1]

Finally, we should also note the inverse influence of the second stage upon the first. The conditioned reflexes, which are built upon the unconditioned reflexes, change them in profound ways, and very often as a result of the animal's individual's experience we observe a "distortion of the instincts", i.e., a new direction taken by an innate reaction due to the conditions in which it manifests itself.

A classical example of such "distortion of instinct" is provided by one of Pavlov's experiments in which a conditioned reflex to cauterization of the skin by means of electric current was fostered in a dog. At first, the animal responded to the painful stimulus with a violent defensive reaction, it strained to break out of its stall, seized the device in its teeth, and fought with all its might. But as a result of a lengthy series of experiments, during which the painful stimulus was accompanied by a food stimulus, the dog began to respond to the burning sensations to its skin with a reaction that corresponded usually to feeding. The well-known English physiologist Charles Scott Sherrington, who was present at these experiments, declared, upon looking at the dog, "Now I understand the joy of the martyrs as they went to the stake." [2] With these words, Sherrington implied the vast horizon which this classical experiment opened up. In this simple experiment he discerned the prototype of those profound changes in our nature that are induced in us by education and the influence of the environment.

"Our nature can be cultivated", declared Prof. A.A. Ukhtomskii. "The very foundations must of necessity change as more and more new Pavlovian conditioned links develop. Therefore the instincts are not an immutable and permanent stock, but rather the expanding and changing patrimony of man. Since under normal conditions the most advanced achievements tend to fade most readily, while the most ancient ones remain, this does not mean that the latter are the 'basis of human behavior', while the new and higher ones are not.

The behavior of the ordinary person of today may be understood on the basis of the most ancient animal instincts as much as on the basis of the properties of the ovum and embryo. One might say that *the whole task of man and his behavior is the construction and cultivation of new instincts.* I am convinced that the most important and most joyous thought that comes out of Pavlov's teaching is that intelligent of all the chimpanzees, invented a game involving jumping off a pole. In the game, the animal clambered up a pole held nearly perpendicular to the ground as fast as he could, and once it fell, or even earlier, leaped to the ground or up to some higher spot. The other chimpanzees adopted this game and achieved an astonishing degree of mastery in it.

This technique, which had first appeared in play, later began to be employed by the chimpanzees in the experiments when they had to reach for a piece of fruit suspended high above the ground. Figure 1 depicts one of the chimpanzees, Chica, during such an experiment.

Another chimpanzee would hold a straw in a flow of moving ants, waiting while several ants climbed up onto it, and then licked them off, passing the straw in and out of his mouth. Once this habit of operation had been acquired, it was possible to observe how all the animals at the station would squat down along the ants' path, holding straws in their hands, like a row of anglers on a river's bank.

Figure 1

Using a stick, a chimpanzee might brush dirt off his body, reach out to touch a lizard, the charged wire netting, indeed, anything he did not want to touch with his hands. What was perhaps most remarkable was that the chimpanzee would dig up grass roots with a stick and, in general, loved to rummage about in the ground. The stick served as a real shovel, which was directed and pushed by the hand or foot. Whenever the chimpanzee wished to lift the heavy lid of a tank of water, he would thrust strong sticks or iron rods through a crack and use them like levers.

When playing, the animals loved to tease each other or surprise a good friend by smacking him on the side with a stick. Sometimes, one minute enraged, defensive, or on the attack, they used a stick like a weapon. "These manifold modes of use", writes Bühler, "and the fact that without any teaching, the chimpanzee himself, whether in play or from necessity, would grasp a stick and deftly handle it, compels us to assume, with some certainty that, as a tree-dwelling creature, he was also familiar with it in the wild and was in the habit of using it. At least he must have been familiar with branches as bearers of fruit and, at the same time, a natural path to fruit." [6]

The simplest of the experiments, which was solved by all the animals, is the best example of how the behavior of the chimpanzees in the experiment resembled the natural forms of its behavior as revealed in play. The chimpanzee was placed in a cage; in front of the cage lay a piece of fruit tied to a rope. All the chimpanzees, without thinking and without any superfluous probing or random movements, would drag the fruit closer to themselves by holding onto the end of the rope lying in the cage. They could in this way make use of the rope as a tool for getting a hold of the fruit. It is curious that the same operation proved insoluble for a dog.

Analogous experiments on a dog placed in a cage in front of which was placed a piece of meat showed that a dog will howl while looking at the meat, try to poke its paw through the bars, and get at the meat this way, dash around the cage and run along the bars, but will not be able to resort to the use of the rope extending from the meat to the cage, or to a stick also lying there. It is true that a dog can learn to use a rope or stick without too much trouble, but in this case the dog's new reaction will only be the result of learning or training. Left to itself, a dog will not resort to the use of tools.

There is yet one more curious feature that was found in the behavior of the chimpanzees from further experiments involving the use of a rope. Several ropes stretched into the cage from a piece of fruit lying outside the cage, though only one of the ropes was attached to the fruit, the others simply placed in the space between the animal and the banana. The chimpanzees usually tugged at the rope that appeared to be the shorter one instead of the rope that was attached to the fruit. Only when they had become convinced of the futility of attempting to pull the fruit towards them in this way did they turn to the correct solution of the problem. Figure 2 represents in schematic form the results of five trials (a, b, c, d, e) with Sultan. The digits show the order in which the animal tugged at each of the pieces of rope. In four out of five cases, he selected the cord lying to the right first, which connected the objective to the cage by means of the shortest path. This underscores the importance of visual factors, i.e., the structure of the visual field and the visual contact established between the tool and the objective, in the chimpanzee's solution of the problem.

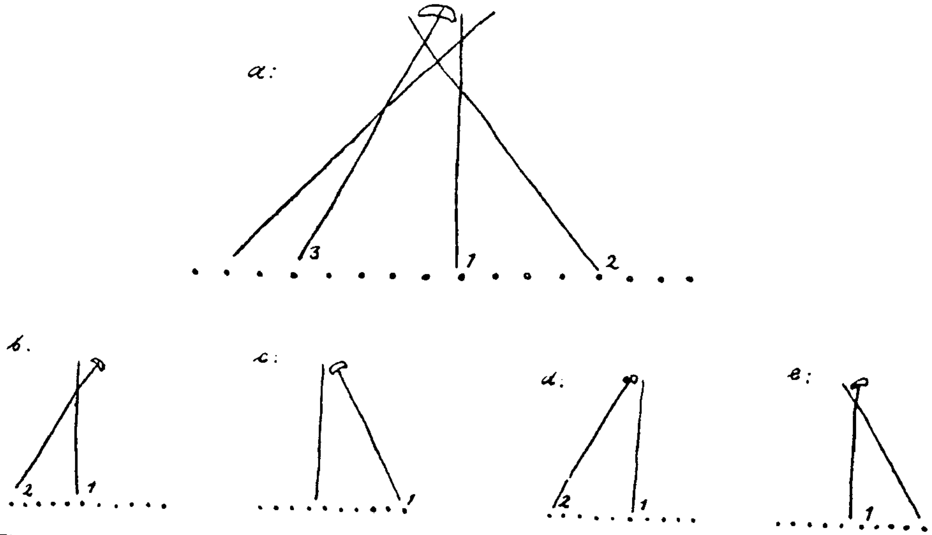

Figure 2

A piece of fruit lay in front of the cage without any rope attached to it, but there was a stick inside the cage (Figure 3). The chimpanzee guessed at using the stick as a tool in order to bring the fruit close enough so he could then reach it with his hands. A curious detail was observed; the chimpanzee was successful only when the fruit and stick were close to each other, in the same visual field, when there was visual contact between them. The stick only had to be so far away that the chimpanzee could not encompass the tool and objective in a single glance, and it proved impossible, or extremely difficult, for the chimpanzee to discover the correct solution to the problem.

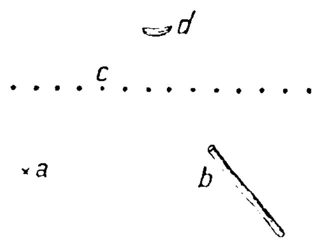

Figure 3. Relative position of animal (a), stick (b), bars of cage (c), and fruit (d).

Here again, the role of the visual factor manifests itself in full force. However, the chimpanzee needed only a small number of experiments to learn how to overcome this difficulty and began to make use of a stick, even one that was not in the same visual field as the objective. If there were no sticks in the cage, the chimpanzee would break off a branch from a tree, begin to make use of a bundle of straw, break off a piece of wood from a box, pull out a wire from the mesh screen of the cage, use a long piece of cloth with which to hit at the banana, and so on.

A more complex technique discovered by Sultan represents a true example of the invention and manufacture of a special tool. A piece of fruit lay in front of the cage screen, and inside the cage, a piece of bamboo too short, however, to reach the fruit. There was also a second piece of bamboo just as short, but thicker and hollow at both ends. Faced with this situation, the chimpanzee took both pieces of bamboo and joined them together in such a way that each became part of the other. He then grasped the joint between the two sticks like a clasp, and with this lengthened stick tried to reach the fruit. Because his hand was in the wrong position, holding the lengthened stick not at one end, but in the middle, at the point where the two sticks were connected, Sultan was unable to attain his objective. He tried to reach the fruit this way for many hours.

Figure 4

Eventually, stepping back from the bars of the cage, he took both pieces of bamboo, sat down some distance away, turned them round and round in his hands, playing with them until the end of one off them slipped into the hole of the other and got stuck there. Sultan at once approached the bars of the cage holding the lengthened stick and dragged the piece of fruit over towards him. From then on, the chimpanzee could always easily find a way out of similar situations. Whenever he had to, he would put together three pieces of bamboo, fitting one inside the other, sharpening the end of one bamboo rod with his teeth if it did not fit into the hole of another, thus producing a lengthened stick which he then employed entirely correctly. The other animals saw this and imitated him (Figure 4).

The animals confronted similar problems when a piece of fruit was suspended from the ceiling of the cage at such a height that the chimpanzees could not reach it whether standing on the ground or by jumping up. In this case, the more resourceful ones would drag over a box that happened to be in the cage and placing it beneath the hanging fruit, clambered up onto the box and thus reached the objective.

Even at play the chimpanzees were just as ready to play with sticks as with boxes, to carry, drag, or push them about, put one on top of another, toss them about and clearly enjoying the noise as they collided with the wall or the floor. In one experiment, one of them climbed up onto a box, jumped up from where he stood, and right in the midst of his leap, tore off a fruit. Sometimes a door that opened into the cage served the same purpose as a box. The chimpanzee would open the door, climb up onto it, and tear off a piece of fruit hanging from the ceiling.

Figure 5

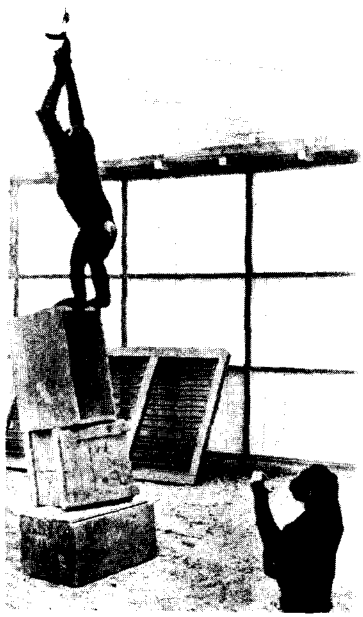

Figure 6

Once a piece of fruit was suspended so high that the chimpanzee had to drag over several boxes, placing them one on top of the other, forming thereby a tower or ladder out of three or even four boxes, to the top of which he then climbed (Figures 5 and 6). Sometimes a chimpanzee would combine the two methods, reaching a piece of fruit using boxes and a stick (Figure 7).

Figure 7

In these experiments with boxes, an extraordinarily interesting detail was discovered in the chimpanzee's behavior. The constructions the chimpanzee would build proved to be loose and unstable. The problem of ensuring that a structure possesses a degree of equilibrium is apparently an extraordinarily difficult one for a chimpanzee. In Köhler's viewpoint, the chimpanzee lacks a true understanding of the statics of his constructions.

"It seems to me," writes Bühler, "that any comparison with the organic structure of a tree makes it easy to understand what the chimpanzee is missing. The various parts of a tree are arranged irregularly, and a branch protruding sideways is nevertheless held firmly in place; obviously, a tree-dwelling animal will not understand that it is an entirely different matter when piling up boxes one on top of another that the higher ones must not protrude beyond the lower ones, that they must come into contact on their flat surfaces and not at their edges and corners, that a structure cannot be stable if the top box is placed with its open side resting on a lower box, and so on.

"Therefore, the chimpanzee will sometimes push a box up against a smooth wall. If it stayed there, his problem would then appear to be solved. The same just like a pole for leaping about or arranging it in a way that does not make technical sense to us, for example, placing the ladder so that it would practically need to be glued to the wall or with only one side resting against the wall, and the other side remaining unsupported, and so on."[7]

Chimpanzees quickly master other experiments that require the use of roundabout paths to the attainment of some objective. In this area, Bühler points out, the chimpanzees' ignorance does not, in general, involve anything that cannot be equally well observed in squirrels, cats, and dogs. Köhler himself established that a dog will also take complex detours to attain an objective. He saw the root of this ability of the chimpanzees to use roundabout paths again in the natural environment in which the chimpanzees live.

"Imagine", writes Köhler, "that in a thicket of branches the chimpanzee sees a fruit which he cannot reach from the branch or tree on which he is sitting. Then, to reach the objective, he will take lengthy detours, for example, he might climb down from one tree and climb up another. This presupposes a definite ability to grasp the situation at a single glance and select the correct path."[8]

Let us present one of the relevant experiments. A piece of fruit is at the bottom of a box, heavy rocks have been placed on top of the box, a horizontal slot has been made rather high up in the board forming one side of the box, and the opposite side of the box consists of vertical bars. Nearby a stick is attached to a rope in such a way that the stick can only reach as far as the slot. The animal must first move the fruit away from himself towards the bars by inserting the stick through the slot, and then, going around to the other side of the box, push his hand through the bars and thus reach the banana. The more intelligent animals correctly solved this problem (Figure 8).

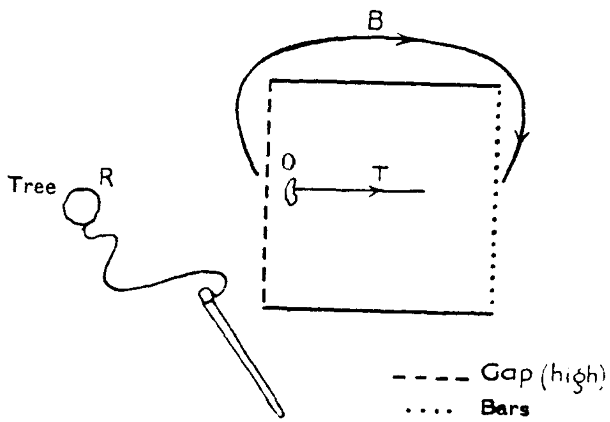

Figure 8

R is the tree with the rope and the stick attached to it; the broken line indicates the side with the gap; opposite the bars are indicated by a dotted line. The lines T and B indicate the two parts of the total procedure running toward each other, one of which is covered by the tool, [illegible] with the animal's bod[illegible]

It is clear that the ape has to work for a later position of its body, which is the reverse of the position taken during the use of the tool.

Learning how to get around the board represented a more difficult problem. Outside the bars of the cage stood a box with three walls, not too different from the box used as a chest, without a front board, and inside there was a piece of fruit. The open side of the box was turned so that its opposite side faced the bars of the cage. Using a stick, the animal first had to push the fruit away from himself, push it out of the box, then roll it over to the side, and only after these steps could he reach the fruit with his hands. Only the cleverest chimpanzee solved this difficult problem. For all the others, the roundabout path required by the problem proved too difficult (Figure 9).

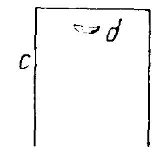

Figure 9

In fact, not only did the chimpanzee have to bring the fruit *closer to himself* using a stick, as he usually had to do in these experiments, but in this case he also had to move the fruit *away from himself*, operating precisely in the opposite direction.

Experiments involving obstacles proved to be far more difficult for the animals than were those requiring roundabout paths. "A climbing animal," writes Bühler, "certainly will bypass obstacles that are in his way in the forest, as he will hardly ever need to remove them," which is why all the problems involving obstacles were very difficult for the chimpanzees to solve.[9]

If there were heavy rocks or sand in a box which the chimpanzee needed and he could not budge it, it occurred to him only with the greatest difficulty that the sand or rocks would have to be removed in order to free the box. If the box was near the actual bars of the cage and covered a spot from which the fruit could be reached, many of the chimpanzees spent hours working with different methods until they finally thought of shoving the box aside. This capacity of the immediate visual situation to affect the chimpanzee's actions proved to be of considerable importance in our efforts to gain a correct understanding of the chimpanzee's overall behavior.

One of the experiments involving boxes described by Köhler was extraordinarily indicative in this regard. It was curious to observe how the animal, having found the correct solution to a problem once before in a given particular situation, could not, for one reason or another, apply it in some other situation. It was then very easy to discover the circumstance that interfered with the correct solution of the problem. In one experiment, Chica tried with all her strength to get a hold of a banana suspended from the ceiling, without attempting to use a box in the middle of the room as support, though she had already used the same box repeatedly as a ladder.

The chimpanzee jumped up, trying to tear down the fruit until she was utterly exhausted. She could see the box, even sat down on it more than once during this time to rest, but did not make the slightest attempt to drag it over towards the objective. All this time another animal, Tercera, was resting on a box. When she accidentally got up, Chica at once seized the box, dragged it over to the objective, and reached it.

The box on which Tercera had been resting was not, to the ape's mind, an "object for reaching a piece of fruit, but only an object for resting." Under these conditions, the chimpanzee does not in any way associate the box with the objective, but incorporates it into a different structure, and, therefore, it could not become a tool in the basic situation of the experiment. "The isolation of any one item from a structure it is part of," writes Kurt Koffka, "and its transference to another, newly created structure proves to be an operation of the highest degree of difficulty." [10]

Finally, the last experiments in terms of complexity were those that combined two or three techniques together. In one such experiment, a piece of fruit lay in front of the bars of the cage, and there was a stick inside the cage. The stick was too short to reach the fruit, but there was another, longer stick outside the bars. The chimpanzee first had to pull the longer stick over towards him using the shorter stick for this purpose, and then reach the banana using the longer stick (Figure 10).

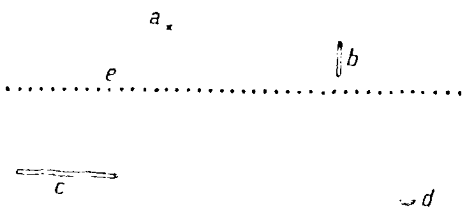

Figure 10. (a) position of animal; (b) stick; (c) longer; (d) fruit; (e) bars of cage.

Yet another experiment. A banana lay in front of the bars of the cage, a stick was suspended from the ceiling, and there was a box in the cage. The chimpanzee had to clamber up onto the box, take the stick, and, using the stick, pull the banana over to him. These types of experiments, which incorporated two or three separate purposeful operations, also involved a kind of roundabout path for the solution of the problem. Between the objective and its attainment the chimpanzee confronted intermediate objectives, for example, the stick that had to be seized. These problems were within the powers of most of the animals, and they usually solved them without making any errors.

The Law of Structure and the Behavior of Chimpanzees

Everything done by the chimpanzees in Köhler's experiments was closely related to spatial perception. Their ability to discover roundabout paths, remove obstacles, and use tools all proved to be a function of their visual field. The chimpanzee perceived this visual field as a known whole, a structure, and as a result each individual element of this field (for example, a stick) acquired the value or function of a part of this structure.

The stick became a tool because, as Köhler demonstrated, it belonged to the same structure as the fruit. The stick only had to be placed far from the fruit – so that the chimpanzee could not encompass both tool and goal in a single glance – and the correct solution of the problem became difficult. In precisely the same way, it was only necessary for another chimpanzee to rest on a box that had usually been employed as a ladder, i.e., it was only necessary for this element to be included in another structure, for the chimpanzee to be at a loss, the box having lost its previous established connection with the operation of reaching the fruit.

Thus, Köhler came to the conclusion that a law of structure basically governs the behavior of chimpanzees in these experiments. According to this law, all the processes of our behavior, as well as our perceptions, do not consist of a mere aggregate of separate elements; on the contrary, both our actions and our perceptions constitute known wholes whose properties define the function and value of each or its components.

Psychologists use the term structure to designate such a whole, which determines the properties and significance of its parts. This concept, which is crucial to our understanding of the ape's behavior, is well illustrated by a simple example. Köhler's experiment elucidating the meaning of structure involved a child, a chimpanzee and a chicken. It went as follows: The hen was presented with grains on two sheets of paper, one light gray and one dark gray. On the light gray sheet, the loose grains simply rested on the surface of the paper, so that the chicken could peck them, whereas those on the dark gray sheet of paper were glued in place.

By means of trial and error, the chicken gradually developed a positive reaction to the light-gray sheet, and a negative reaction to the dark-gray sheet. It would unerringly approach the light-gray sheet of paper and peck at the grains.

Once these reactions had been sufficiently consolidated, Köhler moved on to the critical experiments and presented the chicken with a new pair of sheets, one of which was the same light-gray sheet to which the chicken had developed a positive reaction, and the other a new, white sheet. How would the chicken behave in this case?

It would have been natural to expect the chicken to make unerringly for the light-gray sheet of paper, since it had already been trained to peck at the grains that lay precisely on this sheet. One might have even assumed that because of

that lay precisely on this sheet. One might have even assumed that

the appearance of the new white sheet of paper, the results of the previous training would have been destroyed and the chicken, by trial-and-error would have once again approached first one sheet of paper, and then the other, going to each sheet, by probability theory, 50% of the time. The experiment demonstrated quite the reverse.

The chicken usually approached the new, white sheet of paper that it was seeing for the first time, and reacted negatively to the light-gray sheet to which its positive choice reaction had been strengthened and consolidated by means of lengthy training. How can the chicken's behavior be explained in this case?

Köhler's explanation was as follows. In the new combination, the white sheet of paper had taken the place of the light-gray sheet in the old pair. It implemented the same function of the lighter of the two shades. The chicken's training had been directed not to absolute darkness or lightness of tone, but to *relative* darkness (or lightness). The chicken reacted to the lighter shade. It transferred a relationship from the basic pair, in the first experiments, to the critical one. This explanation was brilliantly confirmed in the next critical experiment.

Immediately after this, the same chicken was presented with a new pair, a dark-gray sheet (the one that had been used in the first basic experiment for purposes of training), and a new, black sheet. We should remember that in the basic experiment a negative reaction had been developed to this same dark-gray sheet. Now the chicken usually approached just this sheet and pecked at the grains there.

Obviously, the functional value of this sheet was different in the new pair. In the previous pair, it had been the darker sheet, but here it was the lighter of the two shades.

These results all make it convincingly clear that the chicken responded to the situation it was presented with as if to a single whole. The elements of this situation (individual sheets of paper) might change, some might disappear, and others might reappear. The situation, understood as a single whole, however, produces the very same effect: the chicken responds to the lighter shade.

We may say that the structure of the chicken's visual perception, as one whole, defines the properties of its constituent elements. That, precisely, is the most important property of the structure, in the sense that the value of each individual part of this situation depends on its relation to the whole and on the structure of the particular whole of which it is a part. The very same light-gray sheet and the very same dark-gray sheet produce first a positive, and then a negative reaction, depending on which whole each is part of. By means of this remarkable experiment, Köhler succeeded in explaining the meaning and role of structures in our behavior.

Certain psychologists also explain the relations that exist between instinct and reflex on the basis of these results. Usually, it is assumed that the reflex is the primary and simplest unit, or element of behavior, and that these units are the links of the complex chain of reflexes which constitute instinct. In fact, there is good reason to believe that instinct is the genetic predecessor of reflex. The

reflexes constitute only residual, isolated parts of the more or less differentiated instincts.

Recall, for example, the behavior of the simplest single-cell organisms. What, in fact, constitutes the reaction of these organisms? It is an integral reaction of the entire organism which implements a function analogous to the functions of our instinct. Only subsequently, at the higher stages of development of the organism, do individual organs become differentiated, each of them having its own role to play in this general differentiated reaction and acquiring a varying degree of independence.

Köhler's experiments on the chimpanzee graphically demonstrate that the use of tools by chimpanzees is, above all, the result of an analogous type of structure of the visual field. Köhler found brilliant experimental proof for this thesis. The problems were always solved by the chimpanzees when it was a matter of perception and the use of data or already created relations, forms, situations, and structures. As soon as Köhler resorted to any sort of mechanical coupling and fastening of things, at that point the "wisdom of the chimpanzees proved exhausted."

Köhler fastened a stick that had served for reaching a piece of fruit at some distance from the bars of the cage. A short rope was tied to the end of the stick, with a metallic ring which was placed on a short vertical nail. The animals could not cope with this extremely simple task (lifting the ring off the nail). They tugged at the stick, gnawed at the rope and broke the stick, but only one of the chimpanzees solved this problem.

Once the ring was attached directly to the stick, the problem became easier. Some of the chimpanzees removed the stick from the nail on their good days, but in most cases this task proved to difficult for them to solve. "For the chimpanzee," writes Köhler in this connection, "a ring on a nail is evidently a visual complex which may be entirely and instantly overcome once it can concentrate properly on the task at hand, but which is more confusing as soon as the animal begins to lack the necessary tension."

In this sense, the first experiment in Köhler's studies of the chimpanzee is highly instructive. A basket with a piece of fruit, as shown in Figure 12, was suspended two meters above the ground in such a way that the cord holding it passed through an iron ring, while the end of the cord was attached by means of an open loop to a branch of a nearby tree. Upon seeing the target and wishing to seize it, the animal stood beneath the suspended basket. To solve the problem, he had to remove the loop from the bough, after which the basket would drop to the ground.

This problem proved too difficult for the chimpanzees. This is how Sultan, the most intelligent of all the chimpanzees, solved it. Several minutes after the beginning of the experiment, Sultan unexpectedly climbed up the tree as far as the loop, remained still for a minute, then, looking at the basket, pulled in the cord so that the basket came all the way to the ring. He then released it again, tugged on it harder a second time to that the basket flew upwards, and one again climbed up, and pulled at the cord so hard that the cord broke and the entire basket fell. The chimpanzee took the basket and sat at a distance in order to eat the fruit.

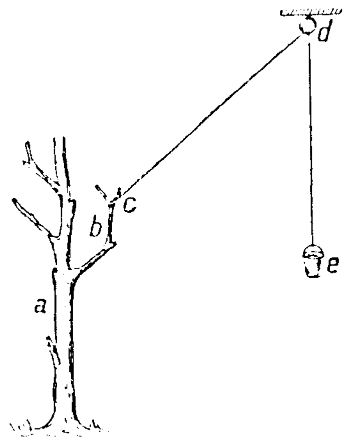

Figure 11

Three days later the same experiment was repeated with several changes in the conditions; this time, the chimpanzee at once resorted to the last technique, i.e., it broke the rope. Thus, the simplest mechanical connections proved to be of the greatest complexity and difficulty for the chimpanzees. On the other hand, the animal felt extraordinarily free wherever visual structures were involved.

In this connection, Köhler's observation showing that an animal watches the actions of others and will, when the need arises, deliberately interfere in another animal's complex activity is most intriguing. Sultan was sitting outside the cage where a piece of fruit was lying, and was watching what another chimpanzee also outside the cage was doing in order to bring the fruit to himself. During the experiment, says Köhler, as no stick was available, the animal being tested had to use a board broken off the lid of a box near the cage.

"Sultan sat outside and for a long time watched without making a move as the other animal attempted to solve the problem without success. Then he began to edge closer to the bars of the cage until he was right up against it, repeatedly glancing over at the trainer cautiously, then quickly ripping off a board from the lid of the box that had been nearly torn off, gave it to his friend.

When we attempted to teach Chica to use two pieces of bamboo, it became obvious that Sultan, in fact, associated the other animal with everything that was happening, i.e., the unsolved problem. I stood outside and in front of the cage; Sultan sat squatting down next to me and watched with an intent look, slowly scratching his head. When Chica had no idea what it was I was asking, I finally gave both pieces of bamboo to Sultan so that he might show what had

other, and did not roll the fruit over to himself, but instead quite lazily moved it to the bars of the cage towards the other animal." [11]

We see that both during play and during genuine experiments the animals transfer experience or problem-solving methods they have acquired to the other animals. Thus, the entire colony of chimpanzees living at Köhler's station distributed their experience among themselves. Especially in games, one animal's invention or discovery at once became the common property of the entire group. This was particularly noticeable in "fashionable" games, which, as soon as they had been invented or introduced by one of the chimpanzees, were at once, as if a new fashion, taken up by the entire colony.

This, however, does not preclude the enormous individual difference between the chimpanzees, which manifested itself in full clarity in Köhler's experiments. The intelligence, creativity, and shrewdness of individual chimpanzees differed greatly. Those chimpanzees who were somewhat more stupid proved entirely unable to solve operations that were accessible to the most intelligent chimpanzee.

Köhler believes that at least in the sphere of intelligence, a new and still unconsolidated function, talent varies no less among the anthropoid apes than it does among humans. We know that, according to a well-known biological law, it is precisely the new and as yet unconsolidated properties that are notable for the highest degree of variability, and that variation is the starting point from which natural selection begins the development of any sort of new form of adaptation.

Intelligence and the Natural Experience of Chimpanzees

Bühler correctly notes that Köhler's experiments revealed a psychological link between the previous experience of chimpanzees living freely in the wild and their behavior at the station that is crucial to a proper understanding of those experiments. He emphasized the fact that, basically, the chimpanzees, in absolutely all of Köhler's experiments, made use of *only two general problem-solving methods*. They solved a problem each time either on the basis of spatial structures or by means of changes that they introduced into these spatial structures. Simply put, they either themselves approached the goal by a roundabout path or brought the goal to themselves.

Bühler is prepared to assume that the "principle of the roundabout path and the principle of reaching the fruit by bending a branch or breaking it off or pulling it towards itself are given to the animal by nature, like other instinctive mechanisms which, taken separately, we still cannot explain but which we must acknowledge as fact." [12]

Thus, in Bühler's opinion, a considerable proportion of the chimpanzees' actions must be ascribed to their instinct and to natural training in the forest. Everything that is novel and outside the scope of instinct and training exhibited by the chimpanzees in Köhler's experiments Bühler is inclined to ascribe to a special form of combination of the chimpanzee's previous experience and its prior reactions.

"It scarcely seems remarkable", Bühler notes, "that the animal is capable of making appropriate use of branches, that it bends branches in order to reach a fruit hanging from the end, or breaks them off, fights with them, and so on, since all of that may be explained by instinct and training. In every case, a tree-dwelling animal must be highly familiar with the connection between a branch and a piece of fruit. However, when the animal sits in its spot behind the bars, and a piece of fruit lies outside without any branch, and inside the cage there is a branch without fruit, from the psychological point of view the principal factor is that the animal, as it were, links them together in its mind. Everything else is self-evident. The same may be said of the box. When in the forest a chimpanzee notes a fruit high up in a tree, it is perfectly natural that it look for the tree trunk it should scale in order to reach it. There is no tree in the cage, but in the chimpanzee's field of vision there is a box, and the psychological operation involves the chimpanzee mentally placing the box in the appropriate spot. Once it has thought a bit, thought is followed by instant action because, while at play, the chimpanzee in any case constantly drags the box around the entire enclosure." [13]

Bühler's remark about the technique of lengthening a stick by inserting one piece of bamboo into another is most interesting. In Bühler's opinion, in the chimpanzee's everyday existence there are also instances when in order to move from one tree to the next, he has to connect a branch of one tree to the branch of another, using his hand as a clasp, grasp their point of connection, and by means of such an artificially formed bridge, make its move.

This, after all, was how Sultan attempted to make a single long stick out of two short ones, and also how he grasped the join between them with his hand. Thus, this detail of Köhler's experiments has, in Bühler's opinion, its own prototype in the chimpanzee's natural forms of behavior.

This convergence of the chimpanzee's reactions in experiments and its prior experience makes it possible for us to arrive at a more or less rigorous explanation of the third stage in the development of behavior, which we have called *intelligence*. Just as the second stage in the development of behavior (conditioned reflexes) is built upon the first and constitutes nothing other than a kind of transformation, alteration, and regrouping of inherited reactions, so the third stage arises naturally from the second and constitutes nothing other than a new and complex form of combinations of conditioned reflexes.

However, just as the second stage is built upon the first, and presents now an entirely new quality, new forms of behavior, and a new biological function, so the third stage, or the intelligent reactions, which arises out of a complex combination of conditioned reflexes, produces a new form of behavior that possesses its own particular biological function.

Let us briefly consider both the similarities and differences between the third and second stages, between intelligence and the conditioned reflexes, as well as the characteristics of intelligence, as a new and distinctive stage in the

development of behavior, which serves as the starting point for the development of all the higher forms of human behavior.

It stands to reason that all the inventions that the chimpanzees created in Köhler's experiments proved possible for them only because in their previous life in the forest, and in the life of their ancestors, situations had repeatedly occurred that were highly reminiscent of those situations that Köhler created artificially in his experiments. This close link between the life of the chimpanzees in the forest and the actions they performed in the experiments revealed itself quite clearly, as already noted, in the chimpanzees' games, when the animals were left to themselves and their "natural behavior" manifested itself with the greatest clarity.

We should remember that in its games the chimpanzee used a stick without any compelling practical necessity, as an object of play, and that this stick, as an object of play, began to serve in a variety of roles: as a pole which it would climb, or, a spoon, enabling it to eat, or as a shovel for digging up roots; lastly the animal used the stick as a "general-purpose tool," in Köhler's expression, by means of which it would touch objects beyond its reach, or those it did not want to touch with its hand for one reason or another, such as dirt on its body, or lizards, mice, charged electric wires, and so forth.

Thus, the ability to grasp a stick does not arise in the chimpanzee all at once, but rather is the result of all his prior experience in the forest. The behavior of the chimpanzees in the experiments becomes more understandable from this point of view. The situation devised by Köhler is truly reminiscent of that encountered by the animal in the forest.

In the forest, the chimpanzee sees a piece of fruit at the end of a branch and sees a branch between itself and the fruit which he wishes to obtain, and knows how to act upon the branch so as to reach its goal. Now the fruit without a branch lies on the far side of the bars of the cage; a branch without any fruit lies within the cage; and the entire operation that the chimpanzee now has to do is to *reestablish the prior situation under the new conditions*, i.e., reunite the fruit and the branch. There can be no doubt that the act of re-establishing prior experience the under new conditions plays an enormous role in the behavior of an ape.

Consequently, there occurs in the chimpanzee a transfer of an old structure to a new situation that is entirely analogous to the transfer of a structure in the experiments with chickens. Other types of transfers have been noted in Köhler's experiments. They are the result of the effect of a law of structure whereby, as we have seen, the individual elements of a situation may vary, but the structure continues to function as a whole, and that the properties of this structure are determined by the structure, as a whole. A *branch acquires such a structural value for a chimpanzee*, and for that reason its value can be transferred from the ape's prior experience to new conditions. Köhler declares, "Let us say that a stick that falls within the chimpanzee's view obtains a definite *functional* value for it in certain situations, and that this value extends to all other objects, of whatever sort, provided they have a roughly similar shape and density. This leads us directly to the only viewpoint that coincides with the observed behavior of the chimpanzees. The edges of a hat or shoe are, of course, are not always perceived visually by the chimpanzees as a stick, but are considered by them as such in the functional sense only in *certain instances* after this or that object, which is roughly similar to it in outward type or appearance, has at least once taken on the function of a stick." [14]

We should remember that a chimpanzee who has solved the problem of reaching a piece of fruit by means of a stick will then apply both a bunch of straw and a long piece of cloth, in fact, virtually all objects that share even the most remote resemblance with a stick. This suggests is the *relative independence of the structure, as a whole, from any change in its individual elements*. There is a similar transfer completed in these instances by the chimpanzees when an old structure is reestablished under changed conditions.

This interpretation of Köhler's experiments enables us to form an idea, albeit conjectural, of the internal processes occurring in a chimpanzee during the solution of a particular problem it confronts in an experiment. It is worth recalling, once again, that in the simplest and easiest case the chimpanzee will solve the fundamental problem when the stick and the fruit act on it simultaneously, like two stimuli. Both these stimuli, though now in a different combination, and associated together (stick and fruit), had already influenced the chimpanzee numerous times in the course of its life in the forest. There is nothing remarkable, therefore, in the fact that both these stimuli, now acting separately, reestablish in the nervous system the activity of those centers which previously had always acted together. Consequently, there occurs something like a short-circuit of nerve current, i.e., a connection between two centers that have been sufficiently strongly excited.

This result may be due to a single extremely important and significant circumstance. The chimpanzee's reaction inevitably manifests itself under a single condition, i.e., when the instinctive and learned reactions fail to function; when the chimpanzee is placed under new conditions that are different from those in which it has been accustomed to live and function; when there is some difficulty, obstruction, or obstacle in its way, for example, the bars of a cage, its distance from its fruit, and so on.

Thus, in each instance, the chimpanzee's intellectual reaction is in response to a particular obstacle, delay, difficulty, or obstruction that is in its way. K. Groos has provided an elegant explanation of the significance of difficulties in the acquisition of new modes of functioning. He writes, "As soon as the repetition of a habitual reaction is interrupted, is delayed, or diverted, consciousness (if I may dare to use such a figurative turn of speech) immediately hurries to take its place in order to resume control of operations it had placed in the care of the unconsciously functioning nervous system.

One of the questions of most direct concern to psychologists is the most general *pre-existing conditions* that mainly constitute the causes for the emergence of mental phenomena. Whenever *reliance on the habitual does not at once elicit an appropriate response*, or *when such a response is not forthcoming at all* (the [illegible] mental appraisal, in what

[illegible] mental appraisal, in what

might call its 'natural' manifestation. While it is not actual consciousness, the cessation thus induced which does stimulate the intellect, is associated either with a simple difficulty in dealing with the unfamiliar or with the conscious expectation of something familiar." [15]

Lipps expressed this phenomenon in a fundamental psychological law, which he referred to metaphorically as the "law of the weir." [16] This law asserts that if the flow of some psychological process encounters a delay or an obstruction, there will occur, at the site of the delay, an increase in nervous energy, and an increase in the force and activity of the process itself, while in response to the obstacle the process will, with greater and greater effort, strive to either overcome the delay or get around it by some roundabout path.

In this "law of the weir", Lipps saw an explanation for the onset of every form of mental activity. Bühler is of the belief that this "law could in fact serve as an important and seemingly biologically predictable condition for the interference of higher levels of our nervous system and mental life in the activity of deeper, underlying levels." [17]

Academician Pavlov has remarked on the motivating value of obstacles for the activity of the purposive reflex which, from his viewpoint, is the fundamental form of living energy of every one of us. "All of life," writes Pavlov, "every improvement in life, every form of life is accomplished by means of a purposive reflex, is accomplished only by those who strive to achieve a particular goal they confront in their lives. The Anglo-Saxon, the highest embodiment of this reflex, is well aware of this. That is why, when asked what is the principal condition for attaining a goal, he responds in terms that seem implausible and unexpected to Russian eyes and ears: the existence of obstacles. He seems to say, 'Let my purposive reflex strain in response to some obstacle, and only then will I achieve my goal, no matter how difficult it may be.' Interestingly, the response entirely ignores the possibility that the goal cannot be achieved." [18]

Finally, we should not forget that all of our thinking also arises out of analogous difficulties. John Dewey has demonstrated in his elegant analysis of thinking that every form of thinking also arises out of difficulties. In theoretical thinking, such difficulty, which is a starting point, is usually called a *problem*. Wherever everything is clear, wherever there is nothing that is difficult for us, wherever there is no problem – there the process of thinking cannot even begin.

If we now return to the behavior of the chimpanzees, we may note that, in the course of the experiments, the most characteristic feature of its behavior was the delay with which the chimpanzee responded to an obstacle it had encountered. From the simplest experiments on the animals, it is easily seen that every delay or obstacle in the path of the chimpanzee's customary activity induces an enhancement and overproduction of movement. The organism compensates for the difficulty it encountered in its path.

Now let us picture the chicken that every day habitually walks through a garden fence to reach the spot where it is fed. One day, as it approaches the fence, the chicken discovers a hole in the fence that is so narrow it cannot get through it. How will the chicken behave in this case?

It will try to squeeze through the too narrow opening. Failure will lead it to repeat the attempt in a second, third, and fourth hole. The new failures will induce in the chicken enormous excitation and what is known as hyperkinesis, i.e., the excessive production of movements. The chicken will dash about, and run, clucking, along the fence, randomly poking at all the holes. The delay induces in it a vigorous rise in all activity. Because of these random and purposeless probes, because of the excessive production of movement, the chicken accidentally comes upon a hole which has been left wide, and through which it can pass.

"The second, third, and fifth times," writes Bühler, "it scarcely changes its behavior, but if it repeats the same action several dozen times, sooner or later it will attain the goal until eventually it ceases its purposeless running about, by pointing straight into the hole. The pleasure gained from success has highlighted this one type of action, while dissatisfaction due to failure has suppressed others. An explicit and sufficiently firm definite association has been formed between these particular sense impressions and the motor complex of the unsuccessful type of actions." [19]

The ant behaves in precisely the same way. When we place an obstacle in its path, it begins to run haphazardly in all directions, as if lost, but enormous biological significance is concealed behind this reaction of confusion. In response to difficulties, the animal puts into operation every capability it possesses. It experiments, dashes about, and searches, and as a result increases its chances of finding the correct roundabout path.

A hungry dog placed in a cage, like a chimpanzee, seeing a piece of meat lying outside the bars of the cage behaves in exactly the same way. Barking, it throws itself at the piece of meat, again and again attempting to push its paw or snout through a hole in the cage, runs along the cage and exhibits great nervous excitation.

From all these data, we may without any doubt conclude that, in and of itself, an obstacle or delay placed in the path of an instinctive or habitual mode of functioning amplifies nervous excitation, and induces a rise in activity. We need only recall that the chimpanzee is capable of sitting for hours on end, eyeing a piece of fruit he cannot reach, and of playing for hours with sticks that were of no use to him in the experiment.

It is clear that the nervous excitation induced in a chimpanzee by a banana itself could never be so steady and thus focus the animal's attention on the goal if the amplifying effect of a delay was not joined to this stimulus. In this case, the delay appears to play a role analogous to a "teasing of instinct," as one psychologist has put it. In fact, if the chimpanzee is shown a banana and it is then taken away from him, the animal is not likely to spend hours yearning for it and concentrating on ways to get it back.

Thus, to our earlier attempt at depicting the processes that occur in the chimpanzee, we must now add the intensifying effect of delay. It would thus

appear plausible to assume that this facilitates a "short-circuit" between the excited centers in the chimpanzee's brain. At any rate, the chimpanzee's outward behavior gives every basis for such a hypothesis.

In fact, how does the chimpanzee's behavior differ from the behavior of the ant, chicken, and dog reacting with an excessive production of movements in response to a delay or obstacle? We could have said that the more highly developed brain of the chimpanzee creates the possibility for other forms and other paths for the diversion of nervous excitation that arises by the law of the weir. Of course, the chimpanzee often behaves just like the lower animals in such cases, it will sometimes dash about time after time, attempting to reach the fruit, though the very first attempt should convince it of the impossibility of doing this by a direct approach.

However, a sharp and abrupt change appears quite soon in the chimpanzee's behavior. Instead of the excessive production of movement, the chimpanzee usually ceases all external reactions, it seems to become immobile, staring at its goal. It exhibits an overall delay or cessation of all movement.

The amplified nervous excitation is not expended externally, on external random movements, but is transformed into a kind of complex internal process. Together with Bühler, we could suppose that from outward trials the chimpanzee seems to switch over to internal trials, i.e., we could say that the chimpanzee's stimulated nervous centers enter into a kind of complex interaction, or interrelation, which might lead to the "short-circuit" by means of which we could hypothetically account for the animal's conjecture.

We are still very far from a real physiological explanation of the intellectual reaction. Accordingly, we may construct only a more or less schematic and more or less plausible hypotheses. But there are grounds for assuming that this reaction is based on a complex interaction between stimuli and prior conditioned links.

Intelligence as the Third Stage in the Development of Behavior

Let us now briefly discuss the new and distinctive features exhibited by the behavior of the chimpanzees in Köhler's experiments that profoundly distinguish it from the second stage in the development of behavior, from the conditioned or learned reactions. There are several such features that are responsible for these unique traits.

The first and the most significant feature that distinguishes their behavior from the reaction of chimpanzee and the conditioned reflex is their genesis.

When we consider how the conditioned reflex arises, how this or that reaction is established as a result of learning or training, we find that it arises slowly and gradually. Imagine you are learning some poetry. After reading it each time, you determine the percentage of errors you made in the reading; after the first reading, this percentage will probably be very high, nearly 100%; after the second reading, the number of errors will be just barely noticeable; after the fifth or tenth reading, it will have fallen even lower, and thus after a certain number of repetitions the percentage of errors will slowly and gradually fall down to zero. If this process of learning and the declining incidence of error after each repetition were plotted on a graph, we would see a flat and gradually descending error curve. A conditioned reflex is usually established gradually and slowly.

The appearance of reactions in apes occurs quite differently. If we wished again to plot on a curve the number of errors made by a chimpanzee's trying to solve various problems, we would find that this curve drops sharply. In its effort to solve a problem, the chimpanzee's error percentage is either 100%, i.e., he cannot solve the problem at all, or, once he has found the correct solution, solves it now without any coaching, repetition, or reinforcement, no matter what the conditions, and the error percentage drops at once down to zero.

What strikes us in Köhler's experiments is precisely this "instant and permanent" memorization that the chimpanzee manifests. Bühler compared this result with well-known facts from the realm of human memory.

"We all know," writes Bühler, "that, for example, mathematical proofs are imprinted differently than are the words of a foreign language or lines of poetry, which require many repetitions. I could establish this impressive recording power wherever the relation is itself found, is 'revealed,' and I think that this is not only a fundamental principle of so-called logical memory, but, if understood properly, of all mnemotechnic systems by means of which the troubadours, with their virtuoso powers of memory amazed the world from the days of the ancient Greeks onwards." [20]

Köhler's experiments proved that the chimpanzee's reactions worked in exactly the same way. For the most part, any one technique only had to produce a single success for the chimpanzee to apply the new method under altered external circumstances.

Some psychologists find an explanation of this "instant and permanent" memorization memory in the law of structure. The chimpanzee discovers a structure to which a given situation is subordinate, and, having discovered this structure, he now finds the place and meaning of each individual component in an analogous situation even under altered conditions. We all know from direct experience that there are some things that must be imprinted or learned by means of multiple repetition, and others that must be understood once in order for us to retain their structure even for lengthy periods of time.

We may further assume a direct link between this greater facility for memorization, and the difficulty and stress that accompanies the chimpanzee's intellectual reaction. As we all know, memory operates through the repeated passage of impulses along the nerve pathways, and we may plausibly assume that in order for those impulses to pass along those pathways so as to leave a "trace", there is a need for lengthy and extensive repetition of nervous stimulation occurring, if that stimulation is weak, in the same manner, all the time. Thus does the wheel slowly and gradually form ruts in the road. The

strong nerve stimulation prompted by a delay may act during the construction of a new nerve pathway in the manner of a short-circuit, like the explosions by means of which tunnels are bored through mountains.

In any case, numerous psychologists have demonstrated experimentally that, under certain conditions, difficulties in the work we do when we engage in recollection may, themselves, stimulate more rapid and more firmly reinforced memory. Paradoxically, it is easier to remember what is difficult than what is easy; that which requires the effort of thought is recalled under certain conditions better than that which, not having induced any effort, slips past our eyes or ears.

The biological function of intelligence is yet another one of the new features which lifts intelligence above the conditioned reactions and distinguishes it from all other reactions. In Köhler's experiments, the chimpanzee makes discoveries, he invents. "Invention in the true sense of the term," writes Bühler, "is also a biological function of intelligence. Man himself creates tools and uses them, while the animals do not. This has been taught for a very long time, on the basis of evident facts, but as we learned in [the experiments carried out in] 1917, it is not true without exception, since the anthropoid apes use tools and, when circumstances require it, themselves create tools." [21]

In each of Köhler's experiments, the chimpanzee found themselves in a new situation. No one showed them or taught them how to behave in order to extricate themselves from the difficulties confronting them. Their conduct was an adaptation to new circumstances, to new conditions, in which instinctive and learned movements would no longer be of any help.

The operation of the intellect therefore begins at the point where the activity of instinct and the conditioned reflexes ends or is inhibited. The chimpanzee's conduct was characterized by adaptation to changed conditions, and adaptation to new circumstances and new situations. The animal in Köhler's experiments adapts to these new circumstances differently from the chicken faced with the garden fence; in other words, it proceeds not by trial and error, but by slowing down its external motions and by means of "internal experimentation."

Bühler wrote, "I would propose to introduce, as a technical term, the word invention to designate such actions on the part of the ape, because it is of crucial importance here that the difficulty posed by the new situation *is overcome not by external devices*, not by assorted attempts, but plainly by an *internal (psychophysical) process* after which a solution suddenly appears. The visible action at once proceeds smoothly, as in the case of deeply ingrained habits." [22]

Köhler gives some curious descriptions of the appearance and the expressive mimicry of animals engaged in solving a variety of problems. "You really have to see for yourself the unutterably dumb look on the face of a chimpanzee that has failed to figure out a solution. It scratches its head while deep in thought, just like a human; and then, all of a sudden, its behavior changes. No more nervous glancing about, no more aimless running to and from; light seems to dawn on its face and in all its movements, as it solves the problem in a few seconds, despite its pointless, ill-coordinated and stupid behavior of the previous few hours." [23]

Bühler compares this sudden change, occurring in apes, to a similar change he had observed in humans he had just asked to solve difficult intellectual problems in his experiments. "Quite often they would suddenly find the right answer; and the only way they could talk about it was by saying that just as they said 'Aha' to themselves, the solution suddenly occurred to them. That is why I called this condition the 'Aha-experience.' I still believe that our language invented the interjection 'Aha!' exclusively to convey this and similar experiences. Köhler's chimpanzees went through that same 'Aha-experience', or something similar."

The discovery made by the apes has a third noteworthy feature: the type of conduct that they found is clearly independent of the specific situation they found it in. By finding the right solution, the ape at the same time acquires the ability to transfer the solution it has found to other situations, in which it may be applied very broadly.

As we have already indicated, tools acquire a "functional value", which can then be transferred to any other objects – a piece of cloth, a bunch of straws, shoes, the brim of a straw hat, etc. In this way the ape resolves the structure, while not getting into the habit of acting with the help of its components; accordingly, the solution it has found proves to be broadly independent of specific components.

If the ability to use tools arose in an ape as a result of teaching or training, it would be connected to the objects used in the training. If, for example, an ape had been trained to reach for fruit using a stick, it would never have been able to do the same thing with a piece of string or with the brim of a straw hat. This transfer of structure from some objects to others also serves unmistakably to distinguish the ape's intellectual reaction from conditioned reflexes.

Edinger writes, "The study of the entire series of animals has shown that in principle, in all the higher and lower vertebrates, the entire mechanism, starting from the end of the spinal cord and ending with the olfactory nerves (which include the primary brain) has a perfectly identical structure; and that, consequently, whether we are talking about man or fish, the basis for all the simplest functions is exactly the same for the whole series." [24]

Edinger assumes that with every new psychological ability or form of behavior that emerges in philogenetic development, we also find a new formation in the animal's brain accounting for the emergence of that new ability. "Starting with the reptiles, the primary brain was augmented by a new brain, increasing in size with immense power, and becoming so big in man that it is draped over the primary brain, like a cloak." [25] Edinger sees in this the basis for the animal's increasing capacity for training. The research of Academician Pavlov has also shown that the cerebral cortex is the organ which serves to lock the conditioned reflexes, that is, the organic basis for the second phase in the development of behavior.

In the words of Bühler, "Hard anatomical facts support the existence of a third phase in the construction of the human brain, because in anthropoid apes and to an even greater extent in humans there is evidence of a new increase, corresponding to the cortex of the forebrain, in the relative weight of the brain. New areas with numerous plexuses of fibers intrude everywhere among the old fibers on the cortex of the forebrain. In man, these primarily involve the permanently crucial centers of speech." [26]

Just as the new brain is built over the old, any new phase stage in the development of behavior, corresponding to the new section of the brain, is also built over the old. Referring to the behavior of the ape, Bühler noted, "The break with the past is not readily apparent. Minor progress in the sphere of concepts, and a slightly freer interplay of associations may well be all that ranks the chimpanzee higher than the dog. The real issue is how well one makes use of what one has. Therein lay the novelty." [27]

We therefore see a new form clearly emerging in the behavior of the ape – intellect, serving as the main prerequisite for the development of work and providing a link between the behavior of the ape and that of man. It is especially important to note that, as Köhler observed, the anthropoid ape in many respects stands closer to man than to other species of apes. As he wrote, "In particular it became evident that its body chemistry, in terms of the properties of its blood, and the structure of its highest organ – the forebrain – are more closely related to the chemistry of the human body and the human brain than to the chemical nature of the lower apes and their brain." [28]

One factor which is quite as important as the experimental data, and which adds immensely to the significance of Köhler's research, is the observations we have already mentioned on the behavior of apes at play. We have found that here, when left to themselves, apes make extensive use of tools, and that they transfer tools and problem-solving devices from their play to serious tasks confronting them; conversely, when at play, they readily use situations they have recently succeeded in mastering in experiments.

The handling of objects at play undoubtedly suggests that the use of tools by apes is not a random occurrence, but psychologically a most decisive factor. As we have noted, sticks occupy a special place in their games. Köhler observed, "The stick is a kind of universal instrument for the chimpanzee – one that they can somehow use in virtually all real-life situations. Once its use proved possible, thereafter becoming a common asset, its functions with each passing month became increasingly varied." [29]

As we have seen, apes use the stick as a lever, spoon, shovel or weapon. Köhler gave detailed descriptions of all such cases in the play of apes.

Such an ability to "handle things" and use them is also manifested in the sphere of adornments. We find apes at play wearing adornments made from casual objects. Köhler reports that apes are fond of putting on large numbers of the most varied objects. Practically every day one can see some animal with a piece of string, a cabbage leaf, a twig or a scrap of wool on its shoulders. When Tschego was given a metal chain, she would promptly drape it over her body.

Enormous numbers of bamboo shoots often cover the whole of the back, and string and a piece of wool usually hang over each shoulder, reaching down to the ground.

Tercera places shoelaces around the back of her neck and over her ears, so that they frame both sides of her face. If these things fall, the ape will hold them up with its teeth. Sultan once decided to adorn himself with empty jam jars, holding them between his teeth. Chica occasionally enjoyed lugging around heavy stones on her back, by way of adornment; at first they weighed about four German pounds, but eventually increased to nine pounds, after she found a heavy piece of lava.

The essential purpose of all these ornaments worn by apes, as Köhler showed, was not their visual effect, but the enhancement of the chimpanzee's "sensation of its own body". The basis for such enhancement is the fact that when our body moves, something else moves with it, thus enriching and making more significant our sense of movement.

Köhler summarized his findings by concluding, "Chimpanzees exhibit rational behavior of the sort inherent in man. On the face of it, their rational reaction is not always entirely similar to human activity. However, under conditions specially chosen for experimental purposes, it is possible to identify beyond a doubt the type of rational human behavior. Notwithstanding the considerable differences between animals, this statement applies even to the most untalented individuals of the species, and can be confirmed in respect of any chimpanzee that is not mentally defective. One thing, in any case, is certain: this anthropoid stands out among the rest of the animal kingdom and is closer to man not only by virtue of its morphological and physiological peculiarities, but also because it exhibits a type of behavior that is specifically human.

From this standpoint, we know very little about our closest neighbor in the evolutionary series; but the little that we do know, and the results of this research, do not exclude the possibility that even where *reason* is concerned this anthropoid may be closer to man than to lower species of ape. (This does not, of course, apply to *volume of* intellect: in that respect the chimpanzee, by virtue of its unquestionably lower general development and organization, is closer to the lower apes than to man.) In this instance, observations coincide with the data of evolutionary theory; the correlation between intellect and the development of the forebrain is confirmed." [30]

The Use of Tools as the Psychological Prerequisite for Work

There are, however, certain highly important features which enable us to demarcate the behavior of the ape from that of man, and to present an accurate picture of the course of the development of human behavior *per se*. These features have been described in the same terms by virtually all researchers. We shall explain them by means of a simple example taken from Köhler.

Lumps of white clay were left on a playground. While playing with the clay, and without any external stimulus, some apes gradually "discovered" drawing. Later on, when given clay once again, the apes immediately began to play with it in the same way. "To begin with, we saw the apes licking this unknown substance, probably exploring its taste. After an unsatisfactory result, they rubbed their protruding tongues, as they had done in previous instances, against the nearest objects, and naturally made them white.

Within minutes, their drawing on iron pillars, walls and beams had turned into a full-fledged game, with the animals picking up paint on their tongues, sometimes in large chunks which they would turn over and moisten in their mouths, forming a kind of paste; then they would start drawing again, and so on. *Their purpose really was drawing and not merely rolling the clay around in their mouths,* because the animal doing the drawing, as well as all his companions, unless they themselves were too busy, took the greatest interest in the result.

As was to be expected, the chimpanzees soon stopped using the tongue as a paintbrush. Holding a lump of clay in one hand and they were able to draw faster and more confidently.

At the same time there was, of course, nothing really to look at, apart from some large white daubed patches, or, where particularly vigorous activity had taken place, entirely whitened surfaces. Later on the animals had an opportunity to use other colors also." [31]

These observations are extremely important for an accurate assessment of the chimpanzee's behavior. As Bühler points out in this connection, "There are certain facts which should deter us from overestimating the actions of chimpanzees. It is a fact that not a single traveler has so far mistaken a gorilla or a chimpanzee for a person. Nobody has found among them the traditional tools or methods, found in different forms among various peoples, which suggest the transmission from one generation to the next of one-time inventions; nor has anyone ever come across any scratched marks on sandstone or clay which could be construed as a *drawing depicting something*, nor even a playfully scratched ornament, nor any descriptive language consisting of sounds standing for the names of things. There must be an internal basis for all of this." [32]

The absence of even the rudiments of speech, in the broadest sense of the term – the ability to make a sign, to introduce auxiliary psychological resources – that everywhere distinguishes human behavior and culture, is what draws the boundary between the apes and the most primitive man. Bühler, in this connection, mentions Goethe's precept about paint: "mixing, daubing and smearing are inherent in man." [33]

Bühler wrote, "Köhler's observations suggest that mixing, daubing and smearing are also inherent in apes; yet as far as we know, it is most unlikely that a chimpanzee has ever seen a graphic sign in the stain left by a squashed berry." [34]

Köhler himself tried to trace the scientific boundaries for a true assessment of the results of his research. In this connection he remarked that all the actions of the apes that he studied pertained to *"the data of the current situation"* and that it was therefore impossible to ascertain how far forward or backward the chimpanzee's time-frame extended.

He noted as follows: "I must say, having spent many years dealing with chimpanzees, that apart from the lack of language, the enormous difference between anthropoids and the most primitive humans lies within very narrow limits in this sphere. The absence of the invaluable technical auxiliary (language) and fundamental limitations with regard to highly important *material* of the intellect, what we call 'concept', are in this instance the reasons why it is impossible to detect even the slightest rudiments of cultural development." [35]

The fact that the chimpanzee's thinking is entirely independent of speech is of immense interest for the history of the development of thought. We see in it a purely biological form of non-linguistic thinking, unmistakably suggesting that thought and speech in the animal kingdom derive from different genetic roots. We could summarize all these factors, which distinguish the behavior of apes from that of humans, as follows: although the ape manifests the ability to invent and use tools, which is the premise of all human cultural development, nonetheless actual work based on that ability has not yet been developed in apes even to the slightest extent. *The use of tools in the absence of work* both unites and divides the behavior of the ape and man.

The biological role played by the apes' use of tools irrefutably confirms this thesis. Generally speaking, this type of behavior is not the basis of the apes' adaptation. We cannot say that the ape adapts to the environment by means of tools.

Tools, which figure so prominently in play, perform a purely auxiliary, secondary function in the process of the ape's adaptation. In fact that adaptation is based primarily on something other than the use of implements.

Darwin is known to have objected to the claim that only man uses tools. He showed that in a rudimentary form the use of weapons was also characteristic of other animals, in particular apes. In the words of Plekhanov, "He was, of course, quite right from his standpoint, in the sense that the much-vaunted 'nature of man' contains not a single trait which is not found in one or another animal species, and that there was absolutely no reason to consider man as some kind of special being, or to set aside for him a special 'kingdom'."

One should remember, however, that *quantitative differences become transformed to qualitative differences*. Something that exists in an embryonic form in one animal species may become a distinctive trait in another. This is particularly true of the use of tools. Elephants snap off branches and use them to wave away flies. This is an interesting and instructive fact. However, in the history of the development of the species known as "elephant" the use of branches to combat flies has probably not played a substantial role. Elephants did not become elephants because their approximately elephant-like ancestors waved branches.

"Not so with man. The whole existence of the Australian aborigine depends on his boomerang, just as the entire existence of modern Britain depends on its machines. Take away an Australian's boomerang, and make him a farmer – and he will be forced to change his whole way of life, all his customs, his mindset and his nature." [36]

We see something similar in the case of apes. Admittedly, the use of tools is immeasurably more developed in apes than in elephants. In the ape's stick, we can already see the prototype not only of tools in general, but also a considerable number of differentiated tools, such as shovels and stakes. Nonetheless, even among the apes, at this high point in the development of the use of tools in the animal world, tools still do not play a decisive role in the struggle to survive. The history of the development of the ape, has not yet reached the point of the great leap forward, from ape to man – a leap which means, for our purposes here, that a working tools becomes the basis of adaptation to nature. In the process of the development of the ape, that leap has been prepared but has not occurred. For that to happen, the ape has to develop a special new form of adaptation to nature – work – which is still alien to it.

As Engels showed, work is the basic factor in the process of the transformation of the ape into man. "It is the first basic condition for the existence of man – to such an extent that we, in a sense, should say that work created the first man." [37]

Engels outlines the following path along which the humanization of the ape proceeded. The first decisive step in the shift from ape to man, in his opinion, was the separation of the functions of hands and feet, attributable to life in the trees; the fact that the hands were no longer needed for moving about on the ground; and the beginning of the attainment of erect posture. It was precisely this differentiation of the duties of hands and feet that caused the hands to begin to perform entirely new functions.

With its hands, the ape can grasp a club and stones, or build nests and awnings. "Yet is precisely here that we clearly perceive the vastness of the distance between the undeveloped hand of even the most anthropoid of the apes, and the human hand, perfected by work over hundreds of thousands of years. Although the number and general disposition of the bones and muscles are identical in each, nonetheless even the hand of the most primitive savage is capable of performing hundreds of tasks which would be impossible for any ape."

Therefore, the liberation of the hand is both a prerequisite and a consequence of the process of work. As Engels observed, "The hand is not only the organ of work, *it is also its product*." [38]

The development of the whole extremely complex organism of the ancestor of man proceeded in parallel with the development of the hand and its transformation into the organ of work. Engels observed, "Man's dominion over nature, which began together with the development of the hand and of work, broadened his field of vision with each new step. Work served to consolidate society. Joint activity and mutual support came to be fundamental. In a word, the people who had been formed reached the point where they felt *the need to talk to each other*. Speech developed out of the processes of work." [39]

Among apes of the species from which man emerged, work in the true sense of the term has not yet played any role at all. "The process of work begins only with the preparation of tools." The most primitive tools are those used for hunting and fishing. However, as is well known, such forms of adaptation have not yet played any role among the apes. "Through the joint working of the hands, the organs of speech and the brain, not only each individual but people in society as a whole acquired the ability to perform ever more complex operations, to set for themselves and to achieve ever higher goals." [40]

In the opinion of Engels, the fact that animals have no capacity for systematic action does not make their behavior substantially different from that of humans. "On the contrary, the systematic type of action exists embryonically wherever there is protoplasm, where living protein exists and reacts, that is, performs even the simplest motions, as a consequence of certain external stimulants.

Yet all the systematic actions of all animals have failed to leave the imprint of their will on nature. Man alone could do that. Put briefly, an animal *uses* only external nature and causes changes in it merely by virtue of its presence. Man, on the other hand, through the changes he makes, compels nature to serve his purposes, he dominates it, and this latter fact is an important distinction between man and the other animals – a distinction which is also due to man's work." [41]

In the sphere of human psychological development, something similar occurs. Here again, we may say that animals merely use their own nature, whereas man compels nature to serve his own purposes and dominates it. For this, too, he is indebted to work. The process of work requires man to exercise a certain degree of control over his own behavior. This self-control, in essence, is based on the same principle as our dominion over nature.

"At every step we therefore find, in spite of ourselves, that we do not in any circumstances dominate nature the way a conqueror dominates an alien nation, like someone situated outside nature. In fact quite the contrary is true, as we, through our flesh, blood and brain belong to nature and are situated wholly within it. Our entire dominion over nature lies in the fact that we, unlike all the other beings, know how to understand its laws and make proper use of them." [42]

Man's active interference in its natural course is in fact based on that understanding of the laws of nature. "And the more this becomes a fact," Engels continued, "the more certain it is that people will not only sense their unity with nature but also become aware of it; and the less anyone will be inclined to believe the meaningless and unnatural notion of opposition between spirit and matter, man and nature, soul and body – a notion born in Europe during the period of classical decline and given its highest development in Christianity." [43]

In the sphere of adaptation to nature, therefore, the ape is divided from man by its lack of work and the attendant dominion over nature. The process of its adaptation is still characterized in general terms as the use of external nature and passive adaptation to it. In the psychological sphere, it is also characterized by the animal's lack of control over its own behavior and its inability to exercise dominion over that behavior by means of artificial symbols, which constitutes the essence of the cultural development of human behavior.

In the opinion of Marx, "The use and creation of the means of work, though inherent in the embryonic form in several species of animals, constitute a specific characteristic of the human process of work, which is why Franklin defines man as a tool-making animal." [44]

"In the tools of work," Plekhanov observes, "man acquires, as it were, new organs which alter his anatomical structure. Ever since his ascension to the use of tools, he has entirely changed the nature of the history of human development: until then it had, as in the case of all the other animals, consisted merely of modifications of his natural organs, whereas now it become primarily the history of the enhancement of his artificial organs, and the growth of his productive forces." [45]

The essence of the work process, in Marx's view, lies in the fact that "an object given by nature itself becomes an organ of its activity (man), an organ which he attaches to the organs of his own body, thus augmenting, despite the Bible, that body's natural dimensions." [46]

Once man had shifted to work as the basic form of adaptation, human development thereafter consisted of the enhancement of his artificial organs and runs "counter to the Bible", in the sense that it involved the enhancement not of his natural organs, but of his artificial tools.

Something similar occurred in man's psychological development. Once symbols enabling man to control his own behavioral processes had been invented and were in use, the history of the development of behavior became transformed, to a large extent, into the history of the development of those auxiliary artificial "means of behavior", and the history of man's control over his own behavior.

While intellect is the essential prerequisite for the development of work, willpower, or control of one's own behavior, is its direct product and result.

In this sense, Engels explains the notion of free will by saying that "freedom is control *over oneself and external nature*, based on an understanding of natural necessity, and for that reason it is necessarily the product of historical development. The first people to break away from the animal kingdom were as lacking in freedom as the animals themselves; but the gradual progress of culture took them forward, step by step, towards freedom." [47]

Thus we can see that, in the sphere of human psychological development, a turning point quite as momentous as that in the sphere of man's biological adaptation occurred when tools were introduced and when they began to be used. Bacon makes the same point in the observation quoted as this book's epigraph: "Of themselves, the bare hand and intellect are worth little; all is perfected by tools and ancillary means" [48]

This of course does not mean that, left to itself, the development of the hand, that fundamental organ, and of the intellect came to an end as soon as man's historical development began. Quite the contrary: the hand and the brain, as natural organs, probably never developed so rapidly, and at such a gigantic pace, as during the period of historical development.

Yet the development of human behavior is already a type of development governed essentially not by the laws of biological evolution but by the laws of the historical development of society. The enhancement of the "means of work" and the "means of behavior", in the form of language and other systems of symbols, serve as auxiliaries in the process of the control of behavior, now becomes pre-eminent, supplanting the development of the "bare hand and the intellect left to itself."

Our overall judgement of the current phase in the development of behavior in apes is that we find in them the rudiments of work, the necessary prerequisites for the beginning of work, in the form of the development of the hand and intellect, which together lead to the use of tools; however, we are still unable to find in apes the prerequisites for self-control or the use of even the most primitive symbols. This latter phenomenon appears only in the historical period of the development of human behavior and constitutes the principal substance of the entire history of human cultural development. In this sense, "work created man himself."

NOTES

[1] Karl Bühler (1879-1963). German psychologist. *The Mental Development of the Child.*
[2] Charles Scott Sherrington (1857-1952). English physiologist. Original source not known.
[3] Alexei Ukhotomsky (1875-1924). Soviet physiologist. Original source not known.
[4] Original source not known.
[5] Wolfgang Köhler (1887-1967). German psychologist. *The Intelligence of Apes, 1925.*
[6] *Ibid.*
[7] *Ibid*
[8] *Ibid.*
[9] *Ibid.*
[10] Kurt Koffka (1886-1941). German psychologist. Original source not known.
[11] *The Intelligence of Apes.*
[12] Bühler: *The Mental Development of the Child.*
[13] *Ibid.*
[14] Köhler: *The Intelligence of Apes.*
[15] Karl Groos (1861-1946). German psychologist. Original source not known.
[16] Theodor Lipps (1851-1914). German psychologist. Original source not known.
[17] Bühler: *The Mental Development of the Child.*
[18] Ivan Pavlov (1894-1936). Soviet physiologist. Original source not known.
[19] Bühler: *The Mental Development of the Child.*
[20] *Ibid.*
[21] *Ibid.*
[22] *Ibid.*

[23] Köhler: *The Intelligence of Apes.*
[24] Original source not known.
[25] Original source not known.
[26] Bühler: *The Mental Development of the Child.*
[27] *Ibid.*
[28] Köhler: *The Intelligence of Apes.*
[29] *Ibid.*
[30] *Ibid.*
[31] Ibid.
[32] Bühler: *The Mental Development of the Child.*
[33] Original source not known.
[34] Bühler: *The Mental Development of the Child.*
[35] Köhler: *The Intelligence of Apes.*
[36] Original source not known.
[37] Original source not known.
[38] Original source not known.
[39] Original source not known.
[40] Original source not known.
[41] Original source not known.
[42] Original source not known.
[43] Original source not known.
[44] Original source not known.
[45] Georgi Plekhanov (1856-1919). Soviet psychologist. Original source not known.
[46] Original source not known.
[47] Original source not known.
[48] Original source not known.