Pavlov, I. P. - Psychopathology and Psychiatry

SELECTED WORKS

EXPERIMENTAL PSYCHOLOGY AND PSYCHOPATHOLOGY IN ANIMALS

Objective investigation alone will gradually bring us to the complete analysis of that infinite adaptability in all its manifestations which constitutes life on earth. Are not the movements of plants towards light and the seeking of truth through mathematical analysis essentially phenomena of one and the same order? Are they not the last links of an almost endless chain of adaptation taking place through out the living world?

We can analyse adaptation in its most elementary forms on the basis of objective facts. Is there any reason for changing this method in the study of adaptability in the higher orders?

Work in this direction has been started at different levels of life and has advanced effectively without encountering obstacles. The objective study of living matter, which begins with the theory of tropisms of elementary living things, can and must remain objective also when it reached the highest manifestations of the animal organism, the so called psychical phenomena in the higher animals.

ON INHIBITION AND SLEEP

You have before you some conditioned stimulus, say, a metronome which always evokes salivation. Now I add to the metronome an odour, say, that of camphor, and at this time I will not "reinforce" the metronome, i.e., I will not give the dog food when, in addition to the metronome, the dog is stimulated by the odour. At first, the metronome will evoke salivation despite the effect of the odour. But if this is repeated several times, this combination becomes ineffective: the metronome plus the odour of camphor does not evoke salivation. We call this fact a fact of conditioned inhibition and the added agent-a conditioned inhibitor.

What was the matter? You have an animal which won't stay put, an animal that won't fail either to lick you, snap at you, spring on you, etc. You take this animal, place it in the stand and tie its legs; at first it behaves as it did on the floor; it tries to free itself, begins to reach for you, etc., you fight it, you tie the animal's paws, make fast its head, etc., and finally achieve what you wanted: the dog has grown calmer, but at the same time it has become sleepy, and the whole thing ends in deep sleep. What does this mean? You have inhibited the normal lively reaction of the animal to the surrounding world by various methods of violence. Depression has developed in the dog's nervous system and, continuously increasing, it has spread from the motor area to the entire hemisphere in the form of sleep.
Thus the whole atmosphere was transformed into a conditioned inhibitor. This can be proved as follows: you may gradually reduce the elements of the situation and you will see that along with this the depression will also gradually diminish.

Here is a number of dogs. You have one dog in which a drowsy state-has developed under the conditions of our experiment, and this state has embraced the entire activity of the cerebral hemispheres. Then you have another type of dog which does not sleep in the stand. This means that depression has not reached the highest degree to be manifested in the general inactivity of the cerebral hemispheres. In this "dog the depression is manifested in muscular rest, and the dog stands stock-still. But this depression has not confined itself to the muscular system; it has passed on to the salivary reflex. And now, the last dog. On the floor it is an extremely lively animal. It does not sleep in the stand but it is at muscular rest, it stands as though petrified, and yet this depression of the muscular system is limited and does not spread to the salivary reflexes which prove to be very intense. In different dogs we have different degrees of irradiation of the depression and a certain concentration of this depression from the very same depressing effect of our situation. The last dog has an ideally developed nervous system; in this dog the depression has remained at the spot where we wanted to retain it. It gave the dog muscular rest but did not go any farther; the salivary reflexes remained unaffected and intact.

When we decided about ten or eleven years ago to study the higher manifestations of the dog's nervous activity only objectively, ours was not an easy position. Like everyone else, we had the usual idea that the dog wanted something, thought something, etc. When we assumed the objective point of view, it seemed incredible that we could succeed. However, we had theoretical determination and started working by an objective method, while the field of phenomena we investigated was vast and, on the other hand, we were scarcely in possession of any of our simple facts. It stands to reason that we were in an awful position, because we had no actual proof that our decision was correct. We only had hopes that we would find something and, at the same time, doubts as to whether or not this would be recognised as scientifically adequate.

This was followed by hours of success which encouraged us. In the course of time we accumulated many facts. Simultaneously we acquired greater conviction. We must confess, however, that our doubts also increased, and that these doubts persisted until very recently, although I did not disclose them to my associates. There were times when I asked myself the question: have we a correct attitude by viewing the facts only from the outside, or should we rather regard them from the old point of view? These cases recurred many times; naturally, they drew attention to themselves, and at last, this is what we found. Each time a new number of facts, especially a number of difficult facts, appeared, that is, facts hard to understand from our point of view, our doubts immediately increased. Why was it this way? What was the matter?

It was quite simple, because in these new facts we did not as yet find causal relations, we could not explain the relations between the phenomena, and what was conditioned by what. Then, as we elucidated these relations, as we saw that a cause was followed by an effect, we immediately felt satisfied and reassured. Why had we before turned in a cowardly manner to the former subjective method? The answer is simple: because this is a method of causeless thinking, because psychological reasoning is a deterministic reasoning, i.e., I recognise a phenomenon as coming from neither here nor there. I say:
the dog thought, the dog wants, and I am satisfied. And this is a fiction, and there is no cause for the phenomenon.
It follows that the satisfaction of the psychological interpretation is also only fictitious, groundless. Our objective explanation is truly scientific, i.e., always turning to the cause, always seeking a cause.

CONDITIONS FOR ACTIVE AND RESTING STATES OF THE CEREBRAL HEMISPHERES

As is well known to all who are present here, conditioned reflexes are formed as follows: you take some indifferent stimulus, for example, sound, light, etc., and repeat it with some constant reflex, say, the one the animal has to food, the food reflex. If you repeatedly combine this indifferent stimulus with an unconditioned, constant stimulus, this new agent itself becomes the cause of the same reaction which is produced by the unconditioned stimulus, i.e., in our case, the food reaction. When this formerly indifferent stimulus, for example, some sound, appears, the animal reacts to it as it would react to food. The animal turns to the side from which it is given food, licks its lips and salivates, although there is no food before it. It therefore follows that a new reflex, or as we call it, a conditioned reflex, has formed. It stands to reason that this conditioned reflex forms gradually and, in the course of time, the stimulus you have chosen becomes increasingly more effective.

And yet the following interesting fact subsequently comes to the fore. In all cases, despite the constant reinforcement of this reflex, i.e., its accompaniment by the unconditioned reflex, it sooner or later, within several weeks or months, disappears. And this is the amazing part of it. You constantly strengthen the connection and yet this connection seems to be destroyed. At first, it forms, then strengthens and, finally, disappears.

How is this connection destroyed then? You observe that the longer you repeat the experiments, the more the animal lapses into a-sleepy state and finally falls asleep and sleeps under the most unsuitable circumstances. You take the animal which has not eaten for a day or two, and feed it according to signal, that is, after the beginning of the conditioned stimulus, for perhaps a whole year, and yet, as soon as you bring this signal into play, the animal falls asleep and the positive reaction to this signal is eliminated.

What is this state then into which the animal lapses? It would not be enough to call this state sleep. In many cases it is really distinct sleep with relaxed muscles, so that the dog passively hangs on the straps, falls, snores and does not react to external stimuli. But in many cases we have to extend this definition of the dog's state and say that this is not only sleep, but a state which resembles what we call hypnotic sleep. This will include such cases in which the animal does not exhibit the usual signs of sleep; it does not hang on its straps, does not snore and yet its reflexes disappear and the animal itself seems to be in a state of torpor.

Then there is another fact. Hypnotism, as is well known, engenders dissociation in the functions of the brain. You have a hypnotised subject and you can ask him questions or order him to do something; the subject understands, but at the same time he has lost control over his skeletal muscles and cannot change the position of the parts of his body, much as he may want to do so. Something similar can also be observed in dogs.

Lastly, we feel that there is one more important factor. If you take our stimuli by themselves, without connecting them with an unconditioned stimulus, they do not prove under those conditions to be hypnotic. If you simply apply heat to the dog's skin for the same period of time, the sleepy state will not develop. It will develop only when you transform this stimulus into a conditioned stimulus, when you connect it with an unconditioned reflex.

SOME FACTS ABOUT THE PHYSIOLOGY OF SLEEP
(Jointly with Dr. L. N. Voskresensky)

It should be added that the following precaution was observed by us in order to ensure strict precision in our investigation. The chamber itself had a hypnotising effect on the dog; the moment the lively, mobile and responsive animal was brought into the experimental room, it changed entirely. It goes without saying that the state of sleep deepened when the dog was placed in the stand and prepared for the experiment.

PSYCHIATRY AS AN AUXILIARY TO THE PHYSIOLOGY OF THE CEREBRAL HEMISPHERES

My earlier researches on the circulation of the blood and on digestion led me to the firm conviction that the physiological mode of thinking may derive great help from the study of clinical cases, i.e., from the countless number of diverse pathological variations and combinations of the functions of the human organism. For this reason, during many years of work on the physiology of the cerebral hemispheres I often thought of making use of the world of psychiatric phenomena as an analytical auxiliary to this physiological study. Indeed, instead of applying our usual method which, as a mode of analysis, consists in destroying certain parts of the brain, and is very crude compared with the complexity and delicacy of the mechanism under investigation, one might expect in some cases to achieve a more distinct, precise and detailed decomposition of the work of the brain as a whole into its separate elements, to obtain a delimitation of its functions resulting from pathological causes, which sometimes reach a very high degree of differentiation.

RELATIONS BETWEEN EXCITATION AND INHIBITION, DELIMITATION BETWEEN EXCITATION AND INHIBITION, EXPERIMENTAL NEUROSES IN DOGS

Proceeding from the big difference between the phenomena, we had to distinguish two kinds of inhibition in the work of the cerebral hemispheres-external and internal—according to our terminology. The former appears in our conditioned reflexes at once; the latter develops with the passage of time and is elaborated gradually. The first is an exact repetition of the well-known inhibition in the physiology of the lower part of the central nervous system, which appears when stimuli acting on the various centres and evoking different nervous activities, meet; the second can be inherent only in the cerebral hemispheres. It may be, however, that the difference between these kinds of inhibition is connected only with the conditions of their emergence and not with the essence of the process itself. This question is still being investigated by us. The present article deals only with internal inhibition; further, I shall call it simply inhibition, without the adjective, although each time implying internal inhibition.

There are two conditions, or to be more precise, one condition, the presence or absence of which determines whether the impulse brought into the cells of the cerebral hemispheres from the outside chronically provokes a process of excitation or a process of inhibition. In other words, the impulse will in one case become positive and in the other negative. This fundamental condition consists in the following: if the stimulation coming to a cerebral cell coincides with another extensive stimulation of the cerebral hemispheres, or of a definite lower part of the brain, then it will always remain positive; given the reverse condition it will, sooner or later, become a negative, inhibitory stimulus. Of course this indubitable fact gives rise to the question: Why is this so? But so far there has been no answer to this question. Thus, we must proceed from this fact without having analysed it. Such is the first basic relation between excitation and inhibition.

Physiologists have long been aware of the irradiation of the excitatory process. The study of the higher nervous activity led us to the conclusion that the inhibitory process, too, spreads, under certain conditions, from the point where it originated. The facts underlying this conclusion are perfectly plain and obvious. Now, if the excitatory process spreads from one point, and the inhibitory process from another, they limit each other and confine each other to a definite area and within definite bounds.

Thus, we have to assume that a certain conflict takes place between two opposing processes which normally ends in the establishment of a definite equilibrium between them, in a definite balance. This struggle and this equilibrium confront the nervous system with a difficult task.
We have seen this from the very outset of our research, and we are seeing it now. This difficulty is often manifested in the animal in the form of motor excitation, whining and dyspnoea. But in most cases equilibrium finally sets in; each process is allotted its place and time, and the animal becomes perfectly quiet, reacting to respective stimuli now by the excitatory, now by the inhibitory process.

The second case of a similar character was observed somewhat later (experiment of Dr. N. R. Shenger-Krestovnikova). A conditioned food reflex was brought about in a dog by a circle of light projected on a screen placed in front of the animal. We then began to elaborate a differentiation of the circle from an ellipse of the same size and intensity of light, i.e., the appearance of the circle was accompanied each time by feeding, whereas that of the ellipse was not. In this way the differentiation was obtained. The circle evoked a food reaction, but the ellipse remained ineffective, which, as we know, is a result of development of inhibition. The ellipse which was applied first greatly differed in form from the circle (the proportion of its axes was 2:1). Then the form of the ellipse was brought closer and closer to that of the circle, i.e., the axes of the ellipse were gradually equalised, and thus sooner or later we were able to obtain an increasingly delicate differentiation. But when we applied an ellipse whose axes were as 9:8, the picture abruptly changed.
The new delicate differentiation, which always remained incomplete, persisted for two or three weeks, after which it not only disappeared itself, but caused the loss of all earlier, even the least delicate, differentiations. The dog, which previously behaved quietly in the stand, was now constantly moving about and whining. All differentiations had to be elaborated anew, and the crudest one now demanded much more time than at first.

Under the action of extraordinary, directly inhibiting stimuli on the animal a chronic predominance of inhibition takes place. This manifested itself with particular force in a number of dogs after the unusual flood that occurred in Leningrad on September 23, 1924, when our experimental animals were rescued with great difficulty and under exceptional conditions. The conditioned reflexes disappeared for some time and only slowly reappeared. For a considerable period after rehabilitation any more or less strong stimulus, which earlier would have been regarded as a very strong conditioned stimulus, as well as the application of a previously elaborated and thoroughly concentrated inhibition, again provoked this chronic state of inhibition either in the form of complete inhibition or of its above mentioned preliminary phases (experiment of Dr. A. D. Speransky and Dr. V. V. Rikman). To a lesser degree and for a shorter time the same thing is often observed in more normal conditions, such as transferring the animals to a new environment, to a new experimenter, etc.

On the other hand, a slight change in the application of a well-elaborated positive conditioned reflex, namely, an unconditioned stimulus administered directly, without any interval, after the conditioned stimulus, increases the tonus of the excitation to such a degree that elaborated inhibitions, now under investigation, either fully disappear or greatly lose in constancy and regularity. And often a frequent interchange of positive and inhibitory reflexes brings the dogs, especially the lively ones, to the highest pitch of general excitation (experiments of Dr. M. K. Petrova and Dr. Y. M. Kreps).

However, what has been said above does not exhaust all our facts concerning the relation between excitation and inhibition. In the course of our work we encountered other peculiar cases of the same kind.
We frequently noticed that a distortion of the action of conditioned stimuli took place in certain phases of drowsiness in normal animals.
The positive stimuli lost their effect, while the negative inhibitory ones assumed a positive character (for example, in the experiments carried out by Dr. A. A. Shishlo).

I have already shown in previous articles how normal behaviour is based on the elaborated delimitation of the points of excitation and inhibition, on their grandiose mosaic in the cortex, and how sleep represents irradiated inhibition. We are now in a position to give some details showing how certain variations of normal sleep, as well as separate symptoms of the hypnotic state, can be easily understood when regarded as different degrees of extensiveness and intensiveness of the inhibitory process.

Cases of sleep setting in while walking or riding horseback are not unknown. This means that the inhibition is confined only to the cerebral hemispheres and does not spread to the lower centres established by Magnus. We know also of sleep accompanied by partial wakefulness in relation to definite stimuli, for instance, the sleep of the miller who wakes when the noise of the mill stops, the sleep of the mother awakening at the faintest sound coming from her sick child, but who is not disturbed by other and much stronger stimuli, i.e., in general a sleep with easily excitable points on guard.

NORMAL AND PATHOLOGICAL STATES OF THE CEREBRAL HEMISPHERES

Conditioned reflexes are formed to all manner of agents in nature, for which the given animal has receptor apparatus, and with all unconditioned reflexes. Their biological significance is enormous, since only because of them can the most precise and finest equilibrium be established between the complex organism and its environment, in vast regions of the latter. Innumerable conditionally acting agents signal, as it were, the relatively few and close agents directly favourable or harmful to the organism. Minutest and most remote conditioned stimuli, acting on the eye, ear and other receptors, cause the animal to move towards food, the opposite sex, etc., on the one hand, and away from all harmful and destructive agents, on the other hand.

Above we have cited a positive conditioned reflex in which the conditioned stimulus evokes a process of excitation in the cerebral cortex. But side by side with the positive reflex there are always also conditioned negative, inhibitory reflexes, in which the conditionally acting agent evokes not the process of stimulation, but the process of inhibition.

INHIBITORY TYPE OF NERVOUS SYSTEM IN DOGS

The more we have studied the higher nervous activity of dogs by our method, the more frequently we have come upon distinct and considerable differences in the nervous systems of different dogs. On the one hand, these differences rendered our investigations difficult and often hindered us from completely reproducing our facts on different animals and, on the other hand, gave us a great advantage in that they brought forward, emphasised, so to speak, certain aspects of nervous activity. At last we are in a position to distinguish several definite types of nervous systems.

In September of last year (1924) Leningrad suffered a great flood. The dogs were saved only with considerable difficulties, and under extraordinary circumstances. Within five or ten days, when everything was put in order again, our dog, to all appearances perfectly healthy, greatly perplexed us in the experimental room. All the positive conditioned reflexes had completely disappeared: the dog did not salivate at all and did not take the food offered to it in the usual manner. For a long time we could not guess what was wrong. None of our initial suppositions about the reason for this phenomenon could be substantiated.
Finally it dawned on us that the strong effect produced on the dog by the flood persisted. Then we did the following. We now usually conduct our experiments with conditioned reflexes so that the dog is alone in the experimental room, while the experimenter is in another room from where he acts on the dog, gives it food and records the results of the experiments. For our dog we now made certain changes. Dr. Speransky sat quietly in the room together with the dog and did nothing, while I performed the experiment for him from the other room. To our great satisfaction the conditioned reflexes reappeared and the dog began to take the food. By repeating this method for a considerable period of time, at first infrequently and then more often, gradually weakening it, i.e., sometimes leaving the dog alone in the room, we finally restored the dog in a certain measure to its normal condition.

Then we tried the effect of various components of the flood, so to speak, in the following miniature form.
We let a stream of water trickle into the dog's room from under the door. Perhaps the soft sound of the flowing water or the watered surface of the floor returned the dog to its former pathological state. The conditioned reflexes disappeared again and they had to be restored by the former method. Moreover, when the dog recovered, we could not use the bell, formerly the strongest conditioned stimulus. The bell itself acted as an inhibitor and afterwards all the other reflexes were also inhibited.

A year had passed since the flood and during that time we did everything to protect the dog from any extraordinary stimulation. Finally, last autumn (1925), we were able to obtain the old conditioned reflex also to the bell. But after its very first application this reflex gradually began to diminish, although it was used only once a day; at last it disappeared altogether and along with it all the other reflexes were also affected, now disappearing and now presenting various hypnotic phases ranging between waking and sleep, although this dog had never been sleepy before.

While the animal was in this condition, we tried two more methods to restore the normal reflexes. In this dog, as was already mentioned above, the inhibitory reflexes were unusually stable. We knew that good inhibitory stimuli could induce and strengthen the process of excitation. We therefore applied to the dog the inhibitory stimuli, i.e., the differentiated agents, which I enumerated above. And, as a matter of fact, we saw many times that after that the reflexes appeared and the dog took the food, whereas formerly the reflexes had been absent and the food had been refused, or the phases were transposed toward the normal state during transitional hypnotic phases, under the influence of induction. The other method was only a variation of the one just described. We placed in the dog's room only part of the experimenter's clothing, rather than the experimenter himself, and this was enough markedly to increase the reflexes. The dog did not see the clothing and, consequently, it was the odour that acted.

DIFFERENT TYPES OF NERVOUS SYSTEM. PATHOLOGICAL STATES OF THE CEREBRAL HEMISPHERES AS A RESULT OF FUNCTIONAL INFLUENCES EXERTED ON THEM

Thus the physiology of the cerebral hemispheres changed before our eyes into their pathology and therapy. The pathological states of the hemispheres were manifested very differently in our different animals under the influence of the same harmful conditions. Some animals fell ill seriously and for a long time, others lightly and for a short time, and still others endured the same influences almost without any effect.

Offhand, before establishing a more scientifically substantiated system, I thought that the types of dogs, as I chanced to acquaint myself with them during experiments in the laboratory, in some measure corresponded to the ancient classification of the so-called temperaments. The dogs I have just described must then be recognised as true sanguine types. If the stimuli are rapidly changed, they are energetic and business-like, but, if the surroundings become in the least monotonous, they are sluggish, sleepy and, consequently, inactive.

The other type of dogs, also very clearly defined, must be placed at the opposite end of the classical series of temperaments. In any new, especially somewhat unusual circumstances they are greatly restrained in their movements and continuously inhibit them; they walk slowly along walls on rather stiff legs and frequently, with the least outside movement or sound, completely crouch on the floor.

It would be no exaggeration to regard such animals as the melancholic type. We cannot help considering their life unhappy if they inhibit constantly and without any need the main manifestation of life-motion.

Both described types are apparently extreme types: the process of excitation excessively prevails in one and the process of inhibition in the other. They are therefore limited types with, so to speak, restricted boundaries of life. One of them requires constant change of stimulations, their novelty, which the surroundings may often lack. The other one, on the contrary, needs a very monotonous life's situation which, however, may be replete with variations and changes.

We were studying the analysing activity as regards the extent of discriminating forms of objects with the eyes (Shenger-Krestovnikova's experiments). A light form of a circle was projected on a screen before the dog and the animal was simultaneously fed. When the reflex was formed, we started differentiating from the circle an ellipse of the same lighting and the same size of area with a 2:1 ratio of the semi-axes, i.e., the appearance of the circle was followed by feeding, while no food was given at the appearance of the ellipse. A complete and constant differentiation was obtained quite soon. Then by stages (3:2, 4:3 ratios of the semi-axes, etc.) we began to approximate the ellipse to the circle continuing to elaborate differentiations to these consecutive ellipses. The elaboration proceeded with variations (at first increasingly more rapidly and then slowing down again) smoothly up to the ellipse with a 9:8 ratio of the semi-axes. Now considerable, although incomplete discrimination was attained.

During the three weeks that this differentiation was applied the state of affairs did not improve but, on the contrary, changed sharply for the worse: the discrimination between the circle and this ellipse completely disappeared. At the same time the dog's behaviour markedly changed. Formerly calm, the dog now squealed in the stand, fidgeted, tore off the pieces of apparatus fastened to it or bit through the rubber tubes running from them to the experimenter, something that had never happened before. When brought into the experimental room the dog barked, which was also unusual. When the easier differentiations were tested, it was found that they had also suffered, even the very first one with the 2:1 ratio of the semi-axes. This latter had to be restored to its former precision much more slowly (more than twice as slowly) than was the case during its first elaboration.

During the second elaboration of the easy differentiation the animal gradually grew calmer and, finally, completely returned to its normal state. The transition to finer differentiations occurred even more rapidly than the first time. During the first application of the ellipse with a 9:8 ratio of the semi-axes a complete discrimination from the circle resulted, but not a trace remained from this discrimination when the ellipse was used for the second time, and the dog again returned to an intensely excited state with all the former consequences. At this point all the experiments with the dog were discontinued.

PATHOLOGICAL STATES OF THE CEREBRAL HEMISPHERES AS A RESULT OF FUNCTIONAL INFLUENCES EXERTED ON THEM

When a positive mechanical stimulus of the skin was applied in one experiment directly after a negative mechanical stimulus of the skin without the slightest interval between them, i.e., one frequency of contacts was replaced with another, a pathological state of the cortex resulted. Soon afterwards it was manifested in disappearance of all the positive conditioned reflexes and then for a period of many days in variously departing from the norm, but definitely alternating relations of the emerged salivary effect to the strength of the conditioned stimuli. This pathological state lasted five and a halfweeks. This case must apparently be ranked with the ones described in the preceding lecture. What was manifested in the case of the last dog as a very strong symptom, disappearance of all positive conditioned reflexes, the symptom that persisted for many months, here terminated towards the thirty-sixth day by passing through phases approaching the norm.

At the same time it is clear that the basic mechanism of the origin of the pathological state is the same in all the heretofore cited cases. It is a difficult encounter, a collision of the processes of excitation and inhibition.

In the field of pathological states of the cortex under consideration I still have to describe several cases with a different mechanism producing these states. In these cases the pathological merges with the normal particularly imperceptibly or, rather, it is in them a constant property of a weak inborn nervous system. But before discussing them it would do well, at least briefly, to dwell for the sake of clarity on the question of external stimuli which act as direct inhibitors on the cells of the cerebral cortex. There are three types of stimuli: weak, monotonously recurring, very strong and, lastly, unusual stimuli generally represented either by new phenomena or a new connection, new sequence of old phenomena.

Our life and the life of animals is so full of cases of such action of these stimuli that there is no need giving examples of them here. The biological significance of this fact is more or less clear. If stimuli of considerable strength and, what is more important, constantly changing stimuli condition and must condition the active state of the cortex to maintain a fine balance of the organism with the environment, it is natural that weak and monotonous stimuli which do not require any activity from the organism must dispose to inhibition and rest, to give the cortical cells time for recovery after work.

The inhibitory action of strong stimuli is, apparently, a special passive-defensive reflex, as, for example, in so-called animal hypnosis (properly speaking, real hypnosis), since, on the one hand, the animal's immobility makes it less noticeable to the enemy and, on the other hand, eliminates or moderates the aggressive reaction of a strong rival. Lastly, a generally unusual situation must limit the former energy of the animal's movements, because with the new state of affairs the former mode of action, as perhaps unsuitable in the given situation, may result in some harm to the animal. Thus, with a new, even negligible, variation in the environment two reflexes usually take place: a positive investigating reflex and an inhibitory reflex, a reflex of, so to speak, restraint and caution. The following interesting question remains: are these two reflexes independent or is the second reflex the effect of the first one by virtue of the mechanism of external inhibition? At first sight an affirmative answer to the latter part of the question seems the more probable.

APPLICATION TO MAN OF EXPERIMENTAL DATA OBTAINED ON ANIMALS

If the information obtained on the higher animals, regarding the functions of the heart, stomach and other organs which are so similar to human organs, can be applied to man only with caution, with a constant check-up on the actual similarity in the activity of these organs in man and animals, think of the great restraint we must exercise in transferring the precise natural-science information of higher nervous activity of animals, now being obtained for the first time, to the higher activity of man. Indeed, it is precisely this activity that so amazingly sharply distinguishes man from the animals, places man so immeasurably high above the whole animal world.

It would be extremely light-minded to regard the first steps in the physiology of the cerebral hemispheres, complete only in programme and, of course, not in content, as some solution of the great problem of the higher mechanism of human nature. Any narrow restriction of our work on this subject at the present moment would therefore only denote extraordinary narrow-mindedness. But, on the other hand, temporarily, of course, the extraordinarily simplified treatment of the subject on the part of natural science must not be received with hostility, which, regrettably, is also not infrequently the case.

Science grasps the complex only in parts and in fragments, but it gradually embraces it more and more. Hence, let us hope and patiently anticipate that the exact and complete knowledge of our higher organ-the brain will become our real property and at the same time the main basis of lasting human happiness.

After all that has been cited in the preceding lectures it can hardly be contested that the most general bases of higher nervous activity relating to the cerebral hemispheres are the same in the higher animals and man and that the elementary phenomena of this activity must therefore be the same in normal, as well as in pathological cases. I shall cite but a few normal cases, since they are obvious, and shall now occupy your attention mainly with pathological cases.

Our education, training and all forms of disciplining, as well as our various habits, are apparently long series of conditioned reflexes. Is there anyone who does not know how the established, acquired connections of certain conditions, i.e., definite stimulations, with our actions are persistently reproduced by themselves often even despite the intentional counteraction on our part? This equally applies to the performance of particular actions and their elaborated inhibition, i.e., both positive and negative reflexes. Furthermore, we all know how difficult it is sometimes to develop the necessary inhibition in individual superfluous movements in games, in manipulations in the various arts, and in actions. Practice has similarly long since taught us that difficult tasks are accomplished only when approached gradually and cautiously.

Everybody knows how extra stimulations inhibit and disturb the well-arranged customary activity and how a change in the once established order of movements, actions and the entire mode of life upsets us and makes things difficult for us. It is also generally known that weak and monotonous stimuli make people sluggish and sleepy and even put some people to sleep. We are all likewise familiar with different cases of partial waking during usual sleep, for example, the case of a sleeping mother at the bedside of a sick child, etc.

Now I shall treat of pathological cases.
Modern medicine distinguishes nervous and mental diseases, neuroses and psychoses. But these distinctions are, of course entirely conventional. Nobody could draw a clear line between them because there is really no such line. How could we conceive of a mental disorder without disturbance of the brain tissue, if not structurally, then functionally? The difference between a nervous and mental disease is a difference either in complexity or fineness of the disturbance of nervous activity.
The experiments on our animals also incline us to this idea.

As long as we deal with animals in which our different functional procedures or extraordinary conditions of life (please, remember the case of the flood) or, lastly, minor operations on the hemispheres disturb their nervous activity, we can understand more or less satisfactorily the mechanism of these disturbances in terms of neural physiology. But as soon as we have destroyed large sections of the hemispheres or this is done by growing cicatricial tissue we find it always difficult to conceive fully and clearly the mechanism of the developing disorders in nervous activity and we resort to assumptions which require proof of their correspondence with reality. The difference in our position regarding the subject in either case is apparently based on the greater complexity of the disturbances in the latter case and the inadequacy of the present-day physiological analysis for them.

Observing both groups of animals many physicians and psychologists would most probably say that the animals in the first group were affected nervously and those of the second group mentally.
We, on the other hand, refusing to pry into the imaginary inner world of our dogs, would say that we have before us deranged activity of the cerebral hemispheres, lesser and simpler derangement in the former case, and greater and more complex in the latter case.

PHYSIOLOGICAL TEACHING ON TYPES OF NERVOUS SYSTEM OR TEMPERAMENTS

Temperament forms a most important part of the constitution, and, since the constitution now uncommonly occupies the attention of the medical world, my report to physicians will thus be justified.

The most general characteristic of a living being consists in the fact that it responds with its definite specific activity not only to the external stimuli, the connections with which exist ready-made since the day of birth, but also to many other stimuli the connections with which develop in the course of individual existence, in other words, that a living being possesses the ability of adaptation.

For greater clarity of the subject I shall begin with the higher animals. The specific reactions of the higher animals are, as is well known, called reflexes, and by these reflexes the animals establish constant relations with the environment. Of course, these relations are a necessity because, if the organism did not establish suitable, definite relations with the environment, it could not exist. The reflexes are always of two kinds: constant reflexes to definite stimuli existing in each animal from the day of birth, and temporary, variable reflexes to most diverse stimuli which each animal encounters during its lifetime. As for the higher animals, for example, dogs, with which all our investigations deal, these two kinds of reflexes even appertain to different parts of the central nervous system. The constant reflexes, i.e., what we have always called reflexes, are connected with all parts of the central nervous system, including the cerebral hemispheres, while the hemispheres are the special place, the organ of temporary connections, temporary relations of the animal with its environment, temporary reflexes.

You know very well that until recently, until the end of last century, these temporary relations, temporary connections of the animal organism with its environment were not even considered physiological, and another phrase "psychic relations"—was used to designate them. Current studies have shown that there are no reasons whatsoever to exclude them from the field of physiological research.

It stands to reason, that it is extremely important for the animal under the conditions of its life to be physiologically connected so remotely and so diversely with the favourable conditions which it needs for existence or with the harmful conditions which menace its existence. If, for example, some danger is signalled by sound from afar, the animal will have time to take measures against it, etc. It is clear that the highest adaptation of animals, the highest equilibrium with the environment, is infallibly connected with this kind of temporarily forming reflexes. These two kinds of reflexes we usually designate by two special adjectives:
the inborn, constant reflexes we call unconditioned reflexes, whereas those that attach themselves to the inborn reflexes during the animal's lifetime we call conditioned reflexes.

During elaboration of conditioned reflexes, now positive and now negative, we observe in the dogs an enormous difference as to how rapidly these reflexes are elaborated, how stable they are and to what extent they reach the absolute. In some animals it is very easy to elaborate a positive reflex and the latter is very stable under most diverse conditions; but it is very difficult to obtain inhibitory reflexes in these animals; in some animals it is impossible to elaborate them with complete precision, since they infallibly contain a certain element of positive action.
This characterises some animals. On the other hand, at the opposite end there are animals in which positive conditioned reflexes are elaborated with great difficulty, they are constantly very unstable, and are inhibited from the slightest change in the surroundings, i.e., they lose their positive effect; contrariwise, the inhibitory reflexes develop rapidly and are always very stable.

Between these extremes there is a central kind of dog or a central type of nervous system. This is a type of dog which easily develops both kinds of reflexes and which well inhibits and well forms positive reflexes, a type in which both kinds of reflexes remain stable and may be perfectly precise. It follows that the entire mass of dogs can be divided into three main groups: the excitable group, inhibitable group (extreme groups) and the central group in which the processes of excitation and inhibition are balanced. Since the cerebral hemispheres are the seat of the conditioned reflexes, in the three aforesaid groups it is a question of three types of character and, correspondingly, activity of the cerebral hemispheres.

Can we apply this to man? And why not? I do not think it should prove offensive to man if man and dogs have the same main characters of nervous system. Today we are already so educated biologically that nobody can object to this comparison. We can attribute to man with full justification the types of nervous system established in the dog (and these types are so precisely characterised). These types are apparently what we call temperaments in man.
A temperament is the most general characteristic of each individual person, the most basic characteristic of his nervous system, and the latter leaves a particular imprint on the entire activity of each individual.
In the question of temperaments, general human empiricism with Hippocrates, the brilliant observer of human beings at the head has apparently come closest to truth. It is the ancient classification of temperaments: choleric, melancholic, sanguine and phlegmatic. To be sure, this classification is now being extraordinarily altered.

ON NEUROSES IN MAN AND ANIMALS

What should we understand-and what does everybody usually understand-by the words "interpretation" or "understanding" of phenomena? Reduction of more complex phenomena to more elementary, simple phenomena. It follows that also in the given case of neuroses in man they must be interpreted, understood, i.e., analysed with the help of neuroses in animals as the naturally more simple, and not vice versa.

EXPERIMENTAL NEUROSES

By neuroses we imply chronic (continuing for weeks, months and even years) deviations in higher nervous activity from normal. For us higher nervous activity is manifested mainly in the system of conditioned positive and negative reflexes to all manner of stimuli and, partly (to a slight extent), in the general behaviour of our animals (dogs).
Until now the neuroses were engendered in our animals by the following factors: firstly, excessively strong or excessively complex stimuli; secondly, overstrain of the inhibitory process; thirdly, a clash (direct succession) of the two antagonistic nervous processes, and lastly (fourthly), castration.
The neuroses were manifested in a weakening of both processes separately or together, in chaotic nervous activity, and in different phases of the hypnotic state. Various combinations of these symptoms represented very definite pictures of diseases.
The essential thing here was the following. Whether the disease develops or not, whether it is manifested in one form or another, depends on the type of the given animal's nervous system.

ESSAY ON THE PHYSIOLOGICAL CONCEPT OF THE SYMPTOMATOLOGY OF HYSTERIA

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Concerning the general concepts of hysteria held by the clinicians, some of them give a fundamental general characteristic of the pathological state and some bring forward certain particularly pronounced traits or symptoms of this state. Some clinicians speak, as it were, of a return to instinctive, i.e., emotional and even reflex life; others attribute the disorder to suggestibility, explaining the entire behaviour of hysterical persons and the so-called stigmata of hysteria (analgesia, paralyses, etc.) by suggestion and autosuggestion. Certain clinicians advance to the foreground the desire to be ill, to take refuge in illness; others regard as particularly important the manifestation of fantasticism, the absence of a real perception of life; still others look on the disease as chronic hypnosis, and finally there are clinicians who ascribe it to a reduced capacity for psychical synthesis or to split personality.
I believe that all these concepts taken together fully cover the entire syndrome and the entire nature of hysteria.

Although our life and that of animals is directed by the basic tendencies of the organism-alimentary, sexual, aggressive, investigatory, etc. (functions performed by the subcortex adjacent to the cerebral hemispheres), nevertheless, for the purpose of co-ordinating and realising all these tendencies, indispensably in connection with the general conditions of life, there is a special part of the central nervous system; this part moderates each particular tendency, harmonises them and ensures their most rational realisation in the conditions of the surrounding medium. These are, of course, the cerebral hemispheres. Thus, there are two ways of action. In the first place it is the way of rational action which is effected after, so to speak, a preliminary (though sometimes almost instantaneous) investigation of the given tendency by the cerebral hemispheres and its transformation, in the requisite measure and at the appropriate moment, into a corresponding motor act or behaviour with the help of the cortical motor region. It is, in the second place, the way of affective, passionate action, realised (perhaps even directly through the subcortical connections) under the influence of the given tendency alone, without the above-mentioned preliminary control. In hysterical persons the latter way of action predominates in most cases, and its nervous mechanism is quite clear. The tendency arises under the influence of external or internal stimulation and evokes the activity of a corresponding point or region of the cerebral hemispheres. Under the influence of emotion and due to the irradiation from the subcortex, this point becomes extremely charged.

Hence, a hysterical person lives to a greater or lesser degree not a rational but an emotive life, and is directed not by the cortical, but subcortical activity.

Suggestibility and auto-suggestibility, are directly connected with this mechanism of hysteria. What are suggestion and auto-suggestion? They are a concentrated excitation of a definite point or region of the cerebral hemispheres in the form of a definite excitation, sensation or its trace an idea now called forth by emotions, i.e., excited from the subcortex, now produced abruptly from the outside, now by means of internal connections, associations an excitation which acquires a predominant, undue and irresistible significance. It exists and acts, i.e., passes over into movement, into one or another motor act, not because it is maintained by various associations, that is, connections with many present and past stimuli, sensations and ideas-this would produce resolute and sensible action, such as is usual with a normal strong cortex-but because in a weak cortex with a low, weak tone this concentrated excitation is accompanied by a strong negative induction which detaches and isolates it from all indispensable extraneous influences. This is the mechanism of hypnotic and post-hypnotic suggestion.

But a hysterical person displays a multitude of similar cases even in his everyday life. Not only the horrors of war, but many other dangers (fire, railway accidents, etc.), numerous life shocks, such as the loss of close relations or friends, unfaithful love and other deceptions encountered, the loss of property, collapse of convictions and beliefs, etc., and in general difficult conditions of life unhappy marriage, poverty, violation of self-respect, and so forth all these factors produce in a weak individual, at once or eventually, violent reactions accompanied by different abnormal somatic symptoms. Many of these symptoms, which appear at the moment of strong excitation, are impressed in the cortex for a long time or forever, just as are many strong stimulations in normal persons (kinesthetic stimulations included). But other symptoms, which in a normal subject can be effaced with the lapse of time-whether because of fear of their abnormality, inconvenience, direct harmfulness and merely indecency, or, the reverse, because they are advantageous or simply interesting-become more and more intense, extended (through irradiation) and stable, owing to the same mechanism as in the case of the war hysteria mentioned earlier, as well as to their emotional reinforcement.

Naturally, in a weak subject, an invalid in life, unable to win by positive qualities respect, attention and favour of other people, the latter motive acts most and contributes to the prolongation and fixation of the morbid symptoms. Hence, one of the most striking features of hysteria is the desire to be ill, to take refuge in illness.

Along with positive symptoms, there are negative ones, which are produced in the central nervous system not by the process of excitation, but by the inhibition process, for instance, analgesia and paralysis. They attract special attention, and some clinicians (for example, Hoche in a recent article) regard them as specifically hysterical symptoms which seem absolutely incomprehensible. But this is an obvious misunderstanding: they do not differ in any way from positive symptoms. Do not we, normal people, constantly repress some of our movements and words, i.e., do not we send inhibitory impulses to definite points of the cerebral hemispheres? As pointed out in our physiological introduction, in the laboratory we constantly elaborate, along with conditioned positive stimuli, conditioned negative stimuli. In hypnosis by means of stimulating words we produce anaesthesia, analgesia, general immobility or inability to move certain parts of the body, functional paralysis.

A hysterical person often can and must be regarded, even in normal conditions, as being in a chronic state of hypnosis to a certain degree, since owing to the weakness of his cortex, ordinary stimuli become super-powerful and are accompanied by a diffused transmarginal inhibition, just as in the paradoxical phase of hypnosis observed in our animals. Therefore, besides the fixed inhibitory symptoms, which, like the positive ones, appear at the moment of violent nervous trauma, the same inhibitory symptoms may arise in a hysterical hypnotic as a result of suggestion or auto-suggestion.

Any notion of an inhibitory effect evoked either by fear, interest or advantage, repeatedly concentrates and intensifies in the cortex and, owing to the emotivity of the hysterical person, just as in hypnosis the word of the hypnotist, provokes these symptoms and fixes them for a long time, until, finally, a stronger wave of excitation effaces these inhibitory points.
The same mechanism of auto-suggestion produces in a hysterical person a multitude of other symptoms, some of which are rather ordinary and frequent and some extraordinary and highly peculiar.

Any slight sensation of pain or the slightest anomaly in any organic function genders in a hysterical person the fear of becoming seriously ill; and this suffices not only to maintain these sensations, again by means of the above-described mechanism, but to reinforce them and bring to such a pitch of intensity as to render the subject invalid. However, this time it is not the positive aspect of the sensation that is responsible for its frequent reproduction and predominant action in the cortex, as is the case in war hysteria, but, on the contrary, its negative aspect. This, naturally, makes no difference as regards the essence of the physiological process. Unquestioned cases of phantom pregnancy accompanied by corresponding changes in the mammary glands, by an accumulation of fat in the abdominal wall, etc., are examples of peculiar manifestations of hysterical auto-suggestion. This is further confirmation of what has been said in the physiological introduction to this article concerning the cortical representation not only of the activity of all organs, but of separate tissues. At the same time this testifies to the extreme emotivity of hysterical persons. It is true that in this case the maternal instinct, powerful in itself, reproduces by auto-suggestion such a complex and specific state of the organism as pregnancy, at least certain of its components.

The same mechanism is responsible for the states and stigmas of religious ecstatics. It is a historical fact that the Christian martyrs endured their tortures with patience, even with joy, and when dying, lauded those for whom they sacrificed themselves; this is striking proof of the power of auto-suggestion, i.e., of the strength of concentrated excitation in a definite cortical region, excitation accompanied by a very intense inhibition of all other parts of the cortex representing, so to speak, the fundamental interests of the entire organism, its integrity, its existence. If the power of suggestion and auto-suggestion is so great that even the destruction of the organism can take place without the slightest physiological resistance on its part, then, in view of the already proved high ability of the cortex to influence the processes of the organism, it is easy to understand from the physiological point of view the partial violation of the organism's integrity produced by suggestion and auto-suggestion by means of trophic innervation, the existence of which has been also proved.

Life clearly reveals two groups of human beings: artist and thinkers. There is a striking difference bettween them. The first group, artists of all kinds - writers, musicians, painters, etc., perceive reality as a single whole, i.e., the entire living reality without breaking up or decomposing it. The other group, the thinkers, on the contrary, dismember it, thereby, as it were, killing it and making of it a kind of temporary skeleton; only afterwards do they gradually as if anew assemble its parts and try to revive it, but this, however, they are unable fully to accomplish. This difference is particularly manifest in the so-called eudetism of children.

I recall a case which greatly amazed me forty or fifty years ago. In a family of a marked artistic disposition the parents used to entertain their two- or three-year-old child (and amuse themselves at the same time) by showing him a collection of twenty or thirty photos of different relatives, writers, actors, etc., and simultaneously pronouncing their names. The effect was that the child memorised the photos and then called all the persons represented on them by their proper names. But how great was the general surprise one day when it was discovered that the child could give the right names by looking even at the back of the photo. Apparently in this case the brain, the cerebral hemispheres, perceived the optic stimulations in exactly the same way as a photographic plate reacts to the fluctuations of the intensity of light or as a phonographic disc records the sounds. And this, perhaps, is the essential feature of any kind of artistic faculty.

Generally, such an integral reproduction of reality is inaccessible to a thinker. That is why the combination in one and the same person of great artist and great thinker is an exceedingly rare phenomenon. In the overwhelming majority of cases they are represented by different individuals. Of course, in the mass there are intermediates.

I believe that there are definite physiological grounds, although as yet not very convincing, for interpreting the matter in the following way. In the artist the activity of the cerebral hemispheres, while developing throughout their entire mass, least of all involves the frontal lobes and concentrates mainly in other parts; in the thinker, on the contrary, it is most intense in the frontal lobes.