LECTURES ON
CONDITIONED REFLEXES
TWENTY-FIVE YEARS OF OBJECTIVE STUDY
OF THE HIGHER NERVOUS ACTIVITY
(BEHAVIOUR) OF ANIMALS

IVAN PETROVITCH PAVLOV
van Petrovitch Pavlov's Lectures on Conditioned Reflexes, as Walter B. Cannon states in the introduction to the first American edition, is a "series of reports of progress" covering a quarter-century of investigations into the functions of the cerebral cortex. This research was an outgrowth of Pavlov's earlier work on the physiology of digestion and was influenced by Darwin's theory of evolution as well as Sechenov's reflexology. What emerged from Pavlov's laboratory was a new branch of physiology—that of higher nervous activity—which in turn had a major impact on the mental sciences.

W. Horsley Gantt, a colleague of Pavlov and a leading proponent of the Pavlovian school in North America, translated these writings from the original Russian. In addition, he contributed to the volume an intimate biography of "this great master of science," which, as he explains in the Translator's Preface, "was included without the cognisance of the Author." It is fortunate for the reader that Dr. Gantt took the initiative, for the fervor with which Pavlov lived and worked is indeed inspiring.

To mark the centenary of Pavlov's birth in 1949, Dr. J. Konorski, a prominent Polish neurophysiologist who worked with Pavlov, delivered an address at the Polish Cultural Institute in London. Therein Dr. Konorski traced the development of Pavlov's research within a historical framework, emphasizing the importance of his methodology. For its illuminating and insightful content, the Editors have selected a portion of this address to reprint in the following pages of these Notes.

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It is both a great privilege and a great pleasure to take part in the centenary commemoration of the outstanding Russian physiologist Ivan Petrovitch Pavlov. It is also a privilege to revive the memory of my work with this great scientist—work which, though now belonging to the past, I always recall with great affection.

I shall try to survey briefly Pavlov's work and its significance for modern science. I shall not deal here with the first phase of his work, which was devoted to the physiology of digestion and which alone was already sufficient to establish his permanent reputation, but with the second phase, in which he created a new branch of physiology—namely, the physiology of higher nervous activity.

To begin with, take a look at the study of physiology of the central nervous system at the stage it had reached by the turn of the century—that is, at the time when Pavlov was beginning his work. The rapid development of neurophysiology in the second half of the nineteenth century, achieved by physiologists and clinical workers such as Flourens, Hitzig and Fritsch, Ferrer, Goltz, Sherrington, Hughlings Jackson, Broca—to mention only the most outstanding ones—led to the establishment beyond doubt of the fact that mental processes depend on the function of the brain, more particularly of its highest and most complex part, the cerebral cortex. This does not mean that this fact had not been recognized earlier, but the research carried out by the scientists I have mentioned developed it in a direct and, so to speak, tangible manner.

On the one hand, the experiments of Hitzig and Fritsch, Ferrer, and others demonstrated that certain mental processes are localized to certain parts of the brain—a finding which was corroborated by clinical observation. On the other hand, the experiments of Flourens and Goltz indicated that after the removal

*By I. Konorski, M.D., Head of the Department of Neurophysiology, Nencki Institute of Experimental Biology, Lodz, Poland. Reprinted by permission from the British Medical Journal, October 29, 1949, pages 944-950.
of the cerebral cortex animals remained alive and in good health, but became, it was said, “soulless automatons,” “creatures without memory and mind.” It must be remembered, moreover, that this work was going on in the full tide of nineteenth-century scientific materialism, when the theory of evolution on the one hand and the rapid progress of biochemistry on the other made it seem as though nothing could now impede the triumphant march of science towards the unravelling of all mysteries—even that of life itself. This, then, is the background of the events here reviewed.

It was becoming clear at the time that all our conscious activity and behaviour is controlled by the brain, and as such could be investigated, theoretically at least, by physiological methods, without reference to psychic phenomena.

This idea was already beginning to take hold on a very big scale. It was first clearly formulated by the prominent nineteenth-century Russian physiologist Sechenov in his booklet *The Reflexes of the Brain*. It is not surprising, therefore, to find that at the end of the nineteenth and the beginning of the twentieth centuries widespread attempts were being made to find an experimental approach to the problem in question. Of all the attempts then made two were developed further than any others and became part of the permanent structure of modern science. One line of inquiry was opened up in America at the end of the nineteenth century by Thorndike and later developed into that branch of psychology now known as “behaviourism.” The other began several years later in Pavlov’s physiological laboratory and gave rise to the physiology of higher nervous activity.

Although both these lines of investigation are concerned with one and the same field—namely, the objective approach to the study of animal behaviour—and although they now tend more and more to converge and coalesce, their origins and points of departure were widely different.

Thorndike, aiming at the objective investigation of animal behaviour, rejected introspective explanations. He was not concerned with the problem of what the animal “thought” or “felt” in its activities, but concentrated on trying to discover the laws governing its response to external conditions and stimuli. But, although he was not concerned with the subjective analysis of mental processes, he was nevertheless a psychologist, not a physiologist. Consequently, the physiological explanations he gave from time to time to supplement his arguments, though ingenious and penetrating, were somewhat amateurish. They neither were an integral part of his system nor were they later developed or elaborated.

With Pavlov it was a quite different matter. He was a physiologist through and through. His approach to cerebral activity was purely physiological, and he came to its study from what might appear to be a remote field—the physiology of digestion. It cannot be too strongly emphasized that both his aims and his methods were strictly physiological. Consequently, whereas the behaviourists, who in their investigations discounted mental processes as a link between external stimuli and reaction, had nothing to offer in place of these processes, Pavlov deliberately substituted physiological mechanisms for psychic activity.

*Aim of His Work*

The aim of Pavlov’s work was not so much the description and classification of the phenomena of animal behaviour—the aim, more or less, of the behaviourists—as the explanation of those phenomena with reference to the relevant cerebral processes.

We must now look more closely at the starting point and sources of Pavlov’s work. In contradistinction to Thorndike, Pavlov worked solely on the basis of the physiological data then available. To him the fact that conscious behaviour of the organism depends on the cerebral cortex and therefore can be investigated as an expression of its functions admitted of no doubt. The problem consisted solely in how these investigations could be carried out. It was perfectly clear to Pavlov that experiments in the extirpation of certain cortical areas or in the stimulation of the cortex by electric shock—which were then widely practised—however fruitful and important they might be, did not represent the true method of investigating the normal and, so to speak, everyday activity of this organ. The problem was to find an appropriate method and the best starting point for studying its *normal* activity.

While the work of Sechenov provided Pavlov with the theoretical basis, the practical method had already been formulated in Pavlov’s earlier work. In the course of examining
the activity of the salivary glands he had come across the phenomenon of so-called “psychological salivation.” This occurs when the animal salivates, not in response to the actual presence of food or other stimuli in the mouth, but in response to the sight of food or to the sound of food being prepared—in other words, to the “idea” of food.

Pavlov saw that this simple fact offered a basis for the study of normal cortical activity. For if salivation in response to the presence of food in the mouth is an innate reflex, or, as Pavlov called it, “an unconditioned reflex,” so salivation in response to the sight of food or the other stimuli signaling its imminent presentation may also be regarded as a reflex action—not innate, but acquired through the animal’s experience. This is what Pavlov called a “conditioned” or “conditional reflex.”

The unconditioned reflex occurs by way of existing nerve channels established in the phylogenetic development of the nervous system and is mediated mainly by the lower parts of the nervous system. The conditioned reflex, on the other hand, operates as the result of intercental connections established during the individual animal’s lifetime as a result of its experience—connections which depend, according to experimental evidence, chiefly on the cerebral cortex.

Pavlov argued that if the first of these reflex actions can be studied successfully by physiological methods—and no one can question the validity of these methods for the purpose—there can be no reason to doubt the validity of the physiological method for the study of the second group—that is, the conditioned reflexes.

It is thus apparent that the cerebral cortex (along with some subcortical structures), in contradistinction to the lower parts of the nervous system, may be regarded as a creative organ, a place where new connections, and consequently new forms of animal behaviour, are established. This is its biological role and the essence of its physiological function.

And so we might sum up Pavlov’s chief merit in this first period of his work on conditioned reflexes in the following way: it consists not in the fact that he understood the possibility of a physiological approach to problems of behaviour, for that possibility was well understood at the time and resulted from the general state of knowledge in the biological sciences; his great merit lay in bringing to realization what hitherto had existed only in the realm of possibility—a method whereby cortical activity might be effectively and fruitfully examined.

Here it should be stressed that the method he then worked out for investigating conditioned reflexes in salivation may still be considered classical; for, although many other methods have since been added, his own has never been challenged for precision and scope.

It would be impossible, perhaps even inexpedient, to attempt to give an account, even in general outlines, of the work done by Pavlov’s school during its forty years’ activity. But I should like to touch on some general questions closely related to this branch of science, particularly those which have given rise to some misunderstanding.

**Reaction to His Work**

Almost from the very beginning of the development of the study of higher nervous activity there sprang up a vast literature devoted to criticism, positive and negative, of the subject—criticism of a philosophical rather than a physiological character. This criticism was concerned with such questions as the validity of these investigations, their scope, their general philosophical significance, and so on. This critical literature is perhaps no less extensive than the literature of the subject itself, and often tends to overshadow the question at issue. Indeed, it frequently happens that a purely factual lecture or communication on the study of conditioned reflexes is at once made the pretext for a discussion which has nothing whatsoever to do with the real subject of the lecture but is devoted to such questions as the relation of mind to body, materialism, idealism, and so on, until amidst all these issues the proper subject is completely lost.

And so some people fulminate against the physiology of higher nervous activity, asserting that it denies the existence of mind, that it attempts to explain mechanistically all our conscious activity, or that it oversimplifies the highly complex and subtle phenomena of mental life and tries to force them into the narrow framework of “reflexes,” which these critics dismiss as elementary and primitive nervous functions. Others, on the contrary, extol the physiological method to the skies, dismiss with contempt years of psychological achievements, and maintain that psychology is not a science at all and that
Physiology alone is capable of giving a complete and adequate explanation of all our mental activity.

For some people the so-called intrusion of physiology into a field regarded as the preserve of psychology amounts to nothing less than sacrilege against the dignity of the human spirit. Others, on the contrary, consider the possibility of a physiological and objective approach to our conscious behaviour as the crowning achievement of the human spirit and its ultimate triumph.

Physiology of Higher Nervous Activity

For these reasons it may be useful if we try to clear away some at least of the confusion surrounding these questions and to define what the physiology of higher nervous activity is—and what it is not.

First we must realize that the subject we are dealing with is a branch of the biological sciences and, particularly, a part of neurophysiology. It is an experimental science which, on the basis of the observation of certain physiological phenomena, attempts to draw conclusions regarding their physiological mechanism. It would be no more reasonable to doubt the validity of these conclusions than to doubt, for instance, the validity of the findings concerning the structure of chemical compounds arrived at by chemical experiments.

That, of course, does not rule out the possibility that our present assumptions concerning the cortical functions may prove erroneous and that we may have to revise them more or less in the light of subsequent knowledge. For it must be remembered that this study of the most complicated arrangement of organisms, the brain, is one of the utmost difficulty and, therefore, in Pavlov's phrase, "when you aim so high it is no disgrace to fail." In fact, it is certain that in the development of this science many of our concepts will be proved wrong and will have to be replaced. All such changes, however, must occur in the fire of experiment, on the basis of strictly relevant factual evidence, and certainly not as the result of barren and purely speculative disputes such as I have already described.

But while the direct evidence of the science of conditioned reflexes and the laws formulated on the basis of that evidence cannot be at the mercy of general philosophical disputations—though they can and must be liable to constant and the closest scientific scrutiny—the general question of the application of these laws to various phenomena of animal, including human, behaviour is another matter altogether.

The problem under consideration may be expressed in this way: whether the laws discovered in experiments on conditioned reflexes in animals can be applied to human cortical activity and whether even now all cortical activity can be explained in physiological terms, or whether those laws are, as yet, applicable only to the most elementary cortical phenomena and their extension to the whole field of higher nervous activity is at present impossible.

Pavlov's standpoint was not unequivocal. On the one hand, endowed as he was with a highly critical mind, he realized that his work was only the beginning of the physiological analysis of cortical activity, and that, as he put it, "the mountain of the unknown will long remain enormously greater than the fragments we have managed to detach and study."

On the other hand, with the characteristic sweep of his genius he was always ready to embrace wide fields of phenomena both of animal and of human cortical activity and to subject them to physiological analysis, and he would often apply the laws discovered in his experiments to phenomena far removed from the material on which those laws were originally based.

Two Points of View

As I consider this point particularly important, I should like to examine it in greater detail. Up to now experiments in the field of higher nervous activity have been concerned almost exclusively with certain specific classes of phenomena, chiefly the elaboration of conditioned associations between various external stimuli and specific reflex activities such as alimentary activity, defence activity, and so on. In this way many important experimental results have been obtained and a number of laws governing higher nervous activity established.

If we take the view that these laws can be extended to all associations between various perceptions and experiences, and that associative function (both in the sense of the formation of associations and in the sense of their fading or inhibition) represents the only cortical activity of animal or man, then the
simple conclusion is that conditioned reflexes are the elements of which all this activity is composed—in other words, to revert to Pavlov’s figure of speech, it suggests that we now know with reasonable certainty the substance of which the mountain of the unknown which looms before us is made.

If this were so, then the general scheme of cortical activity in both animal and man would be mastered, and our task would consist only in interpreting and deciphering the more complicated forms of behaviour and in reducing them to their most elementary terms.

The other viewpoint (which I am rather inclined to accept) is as follows. Experimental work on animals, as well as man, in the field of higher nervous activity concerns, as I have stressed, only some particular groups of relatively simple phenomena. And there is no doubt that these groups have already been physiologically analysed more or less thoroughly, or are in the process of being so analysed. Of course, it is extremely important, and very useful, to apply the knowledge we have gained in this work to the phenomena of everyday behaviour—not only of animals but also of children and adult human beings—and to foresee the effects of various experiences on individual behaviour and welfare. This, after all, is the same procedure as that followed by the physicist who, having discovered and analysed a particular phenomenon in the laboratory, tries later to recognize and identify it in the world outside the walls of his laboratory.

But just as a scientist of, say, Galileo’s day would have erred in claiming that he understood why the sun is blue or what is the mechanism of lightning—and any explanation he might have offered would necessarily be inaccurate and pseudoscientific—so, it seems to me, those physiologicalists are equally in error who maintain that they understand those very complex phenomena of our cortical activity which have not yet been submitted to physiological analysis. Thus, while it is unquestionably sound and useful to winnow out from our behaviour those facts which are susceptible of physiological study, and while we should try to explain from this standpoint as much of normal and pathological behaviour as possible, we must avoid giving pseudoscientific explanations for those facts which have not, up to now, lent themselves to physiological interpretation. It seems to me that such “explanations” are all the more harmful because they give the impression that everything has been explained and made clear in a field where there is in fact still very much to be done.

If we accept this view, and try to place Pavlov in his historical perspective, I should say that his role can be compared with that of Lavoisier in chemistry and Galileo and Newton in physics.

Just as Lavoisier, and not the alchemists, pointed the way to modern chemistry, and Newton rather than Aristotle showed the way to Einstein and Rutherford, so, I believe, the work of Pavlov will prove to have opened up the true paths towards the objective investigation of animal behaviour, and he may well be regarded by future generations as the man who laid the permanent foundations of this vital branch of human knowledge.