The Importance of I. P. Pavlov for the Development of Neuroscience

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Abstract—By his experimental and theoretical work on the physiology and pathophysiology of the higher nervous activity I.P. Pavlov significantly influenced the development of Neuroscience. During the 1950 Pavlovian Conference in Moscow, Stalin and the Communist Party tried to dogmatize his and his pupils' fundamental theories. But the Pavlovian ideas were developed by his pupils in open discussions with representatives of other schools in a very creative way, opening the doors for a systemic approach to understanding the integrative functional systems of brain and behavior. Pavlov emphasized the high plasticity of the central nervous system, investigated the complex functional systems within the brain and between the organism and its environment, and designed models for pathological deviations of the higher nervous activity. During his last years, he freed himself from the strong deterministic view and characterized the organism and its environment as a self-organizing system.

IVAN PETROVICH PAVLOV (1849--1936) was one of the most influential neurophysiologists in our century. He laid the fundamentals for understanding the scientific basis of the higher nervous functions of animals and humans. He started this work before he received the Nobel Prize for physiology or medicine in 1904 for his investigations on the digestive functions of the organism. Over more than thirty years with many hundreds of pupils and collaborators, many of them from other countries, he carried out extensive experiments on the conditioned reflexes, their mechanisms and rules, their significance for the behavior of animals and human beings and their neurophysiological dynamics in the brain. He founded the Pavlovian school of higher nervous activity that extended its influence all over the world. By his own experiments and ideas, by his pupils' work and in cooperation with many other neurophysiologists he participated in laying the fundaments for the modern integrative discipline Neuroscience.

Much of this progressive development is unknown, because not all of his later work is translated in English and much of his legacy has been falsified by political indoctrinations in the USSR after his death. Therefore we ask: "Which were the most important progressive elements included in and evolving with the development of the physiology of higher nervous activity by I.P. Pavlov and his pupils?"

1. Pavlov used the term "reflex" not in the classical way of the analytic physiology, but in the traditional way of the Russian physiologists like Sechenov as the general reaction of the organism to any stimulus or stimulating situation. This opened the way for understanding the fundamental laws of the behavior of animals and human beings. In the later years, unconditioned reflexes or unconditioned behavior were, for him, synonymous with inborn
instinctive behavior. Conditioning meant adaptive behavioral mechanisms occurring during the individual’s life.

He intended to investigate the fundamental laws of conditioning by restricting and controlling all external influences. Therefore, he built the “Tower of Silence”. But in the interpretation he combined this analytic approach with a synthetic view. This opened the way for the study of study behavioral mechanisms.

2. In his theory he underlined that the excitatory and inhibitory cortical centers interacted with each other forming a well-balanced integrated whole that he called in his later papers a “dynamic stereotype”. In his address to the 1932 Tenth International Psychological Congress held in Copenhagen, Pavlov said: “A continuous stream of numerous stimuli, emanating from the outer and inner environment, having various qualities as well as [coming] in varying quantities, impinge upon the cerebral cortex . . . They all meet, collide, influence each other and ultimately are systematically arranged, balanced, or, to say, they end up as a dynamic stereotype” (Pawlow, 1953).

I.P. Pavlov underlined the systemic character of the nervous processes within the active hemispheres. “This is the unification, the fusion of structure and dynamics” (1953). But he stated that we have not yet a clear conception, how this occurs. P.K. Anokhin (1978) systematically investigated these “functional systems” and extended this term to the whole organism and the interrelations between organism and environment. During the 1950 Pavlovian Conference (Wissenschaftliche Tagung, 1954; Windholz, 1997; Pickenhain, 1998), P.K. Anokhin was hardly criticized and after the conference fired, because he specially investigated these functional systems, analyzed their mechanisms, and extended this approach by additional ideas (reafferent stabilizing mechanisms, the unified central-peripheral systems and others). These were important new discoveries by which the theory of higher nervous activity was developed.

3. By the end of the twenties, Jerzy Konorski, together with his friend Stefan Miller in Warsaw, found that the experiments with conditioned reflexes in dogs activated additional components if one did not restrict the observation to the salivatory effect. He called the effect “conditioned reflexes of type II.” In these situations, the dogs displayed active motor acts. Pavlov was very interested and invited him to work two years (1931–1933) in his laboratories in Leningrad and Koltushi. He discussed these observations with his pupils several times. His interest and his acknowledgment became evident when he organized one Wednesday Colloquium as a “Benefiz” (honorary meeting) for Konorski (Pawlow, 1998). But he did not find an explanation for the new phenomena in his theoretical frame of the higher nervous activity.

During the 1950 Pavlovian Conference, Konorski was condemned for having falsified Pavlovian ideas. But he consequently continued his experimental work on conditioned reflexes in Warsaw, showed connections to Sherrington’s neurophysiological work (Konorski, 1948), and in 1967, he unified all actual knowledge on the higher nervous activity in his book “Integrative Activity of the Brain”. In this way, a broad connection was arranged to the schools of behaviorism with its operant or instrumental conditioning.

4. New fields of research were opened by L.A. Orbeli, especially when he became chief of most of the Pavlovian laboratories after Pavlov’s death. He extended his work to the conditioning of vegetative functions and to the participation of subcortical structures in conditioning. He organized ontogenetic studies on conditioning and established a laboratory for biochemical studies. Orbeli also was condemned during the 1950 Pavlovian Conference, and after this he lost all leading functions. He died in 1958.