

Ivan Petrovich Pavlov (1849–1936)

VLADIMIR O. SAMOILOV

Department of Normal Physiology, Military Medical Academy, St. Petersburg, Russia

This article contains a brief description of the scientific biography of the first Noble Prize laureate in the area of Neurosciences,¹ I.P. Pavlov. Special attention is paid to the concept of neurism, which infused Pavlov's research on circulation, digestion, and higher nervous activity. The sources of Pavlov's interest in studying psychological processes and phases of "hard intellectual struggle" in the development of a new chapter of physiology are traced to their beginnings.

Keywords *neurism, synthetic physiology, integrative functions of the body, chronic experiment, higher nervous activity*

Introduction

Neurism was a guiding star of the scientific path of I.P. Pavlov. He understood Neurism as the direction in physiology attempting to spread the influence of the nervous system on possibly increasing numbers of the functions of the body. This definition of Neurism was formulated in the scientific school of François Magendie (1783–1855). The outstanding member of this school was Claude Bernard (1813–1878). It is from him that the idea of Neurism was inherited by I.P. Pavlov. Live intermediaries between Bernard and Pavlov were his mentors: I.F. Tsion (1842–1912) and S.P. Botkin (1832–1889) who worked in the laboratory of the famous French physiologist.

Describing his first steps in physiology, Ivan Petrovich reminisced: "being a physiology student, I studied French so that I could read the wonderful and immortal lectures of Claude Bernard — examples of classic and unique writing" (Pavlov, 1975). On the library card of the student of St. Petersburg University Ivan Pavlov there are several books of C. Bernard. Pavlov referred to him as the "true inspiration" in his life in Physiology.

The works of Bernard served for him as a basis not only for the concept of neurism but also the concept of synthetic physiology. This is a branch of Physiology concentrating mainly on the integrative functions of the body supported by the subtle interaction between the body and the surrounding environment. Pavlov stated that the process of understanding should combine analysis and synthesis harmoniously. He suggested not limiting the studies to the analysis of the physiologic processes alone. Instead, by including

This paper was translated by Vlad Zayas MD.

¹Editor's note: In JHN's Special Issue on Neuro-Nobel Prizes, Pavlov is not listed as winner of a Noble Prizes for the Neurosciences. In fact he received it "in recognition of his work on the physiology of digestion, by which, in essential respects, he has transformed and enlarged our knowledge of this subject"; (see Sourkes, 2006).

Address correspondence to V.O. Samoilov, M.D., Ph.D., Professor, Corresponding Member of the Russian Academy of Medical Sciences. Department of Normal Physiology, Military Medical Academy, Zagorodnyj proezd 47, St. Petersburg 198013, Russia. E-mail: cell@infran.ru



Figure 1. Ivan Petrovich Pavlov (1849–1936).

the synthesis in the study of body functions, physiologists acquired a power tool in physiology research of a complete body rather than a partial organism. Hence, the methodology of synthetic physiology and neurism becomes complete. Pavlov followed this idea in all of his research.

The studies were concentrating on the physiology of circulation, digestion, and higher nervous activity. His achievements in all of these three areas of physiology were, obviously, unequal. In 1924, V.V. Savich, one of the closest students of Pavlov, said about this, figuratively:

If the works of I.P. (Pavlov-author) in the area of circulation could be compared to the touch up work in the specific rooms in a house built by somebody else, and I.P.'s works on digestion could be compared to a major rebuilding project inside the preexisting structure using a new plan, then, his works in the area of higher nervous centers could be compared to the building of a solid foundation on the previously unsteady ground with "psychological deviations". This construction, though preliminary, of a new grandiose building is successfully added to, guided by the coordinated thrust of the laboratories united by the energy of I.P. (Savich, 1924)

Truly, in the physiology of circulation I.P. Pavlov established several new facts regarding the regulation of cardiac contractions and vascular tone. He restructured the physiology of digestion on the base of chronic experiments. After discovering the system of interaction between the organs of the elementary tract guaranteeing the integrity of the digestive functions, he shared this with the medical and physiological communities. In the decision on giving Pavlov the Nobel Prize, the committee concluded: "for the work on physiology of digestion that allowed a clear understanding of vitally important aspects of this question" (Nozdrachev et al., 2002). However, Ivan Petrovich committed a feat of scientific heroism

by creating a new area of physiology, which did not exist previously. This is the physiology of higher nervous activity. It is for this work, in 1929, that he was again nominated for the Nobel Prize for Physiology or Medicine. The decline of the noble committee was motivated by strict adherence to the principle that the Nobel Prize cannot be given twice to the same scientist in the same field of research.

The sources of interests of I.P. Pavlov in the Study of Psyche

Pavlov's interests in penetrating the secrets of psyche arose in the years of his youth. He was the son of a priest, an extraordinary and well-educated man who was previously teaching at a seminary. Since his childhood, Ivan heard the conversations about the soul. During his first ten years of life, he lived in a monastery for 1.5 years, where he was educated by a Father Superior who was also his godfather. Further education in the preseminary and in the seminary solidified Pavlov's interest in the spiritual life of a man. This theme was the core of the discussions amongst the seminary students about life and their role in it. Discussion about the soul follows humanity since prehistoric times and became more significant for Russia in the period of reforms in the 1860s.² K.A. Timiriazev wrote that "the generation for which the beginning of its conscious existence coincided with the so called 60's, was without a doubt the happiest generation ever born in Russia" (Timiriazev, 1908).

The drive for emancipation became a moving force of change of all aspects of Russian life. Every citizen of the emerging state, in the words of the well-known publicist N.V. Shelgunov, was undergoing liberation wherever and in which ever way and whatever he needed to be liberated from. The all inclusive idea of freedom was everywhere. The criterion of human value during the change of Russia from the feudal state to capitalism became the labor of making life more beautiful. There were attempts to make life more beautiful by changing nature. The Archimedean *Fulcrum* for this change was science. Thoughts and feelings of the avant-garde Russians were spread into the most remote corners of the Russian state. They had reached Riazan where the seminary student Ivan Pavlov with his friends started painstakingly thinking in particular about the meaning and the goal of their lives. A strong influence on the future physiologist came from Jacob Moleschott (1822–1893) convincing his readers that the social question can find its solution if one can only discover a true distribution of the substances related to the life of thought and the will. In the beginning of 1868, the Riazan library received I.M. Sechenov's book *Reflexes of the Brain*. A year and a half before that, the whole edition of this book was confiscated right at the printing presses. The book was censored by the chancellery of the Mayor of St. Petersburg while the author was awaiting trial. However, the trial was never held and the book was released. Needless to say that when the book was released from confinement it was extremely popular amongst the readers who were dreaming about the emancipation.

Reflexes of the Brain was of special interest for Pavlov since its author announced the possibility of defining psychological processes as physiologic ones. After struggling with his doubts and overcoming the resistance of his profoundly respected father, the 18-year-old Ivan Pavlov decided to quit the Seminary one year before completion and began preparing

²In 1861 tsar Alexander II proclaimed the emancipation of about 20 million privately held serfs. The emancipation was closely followed by reforms of local government, judicial reforms, and reforms in the financial, educational, and cultural spheres. The regime also sought to reform the military.

for the admission to St. Petersburg University to study Natural Sciences and to discover the secrets of Human Psyche.

In September 1870, at age 21, he fulfilled this plan. However, along with the joys of university life there were disappointments. The deeper he studied Chemistry (under D.M. Mendeleev, A.M. Butlerov, and H.A. Menshutkin), Physics (under F.F. Petrushevski), and Biology (under A.N. Beketov and K.F. Kessler) the less he believed in achieving his cherished goal. Between these sciences and Psychology he discovered an unbridgeable abyss.

During his first year he was rushing time in the expectation of his meeting with Physiology. Relying on Sechenov, he tied with Physiology the possibility of the overcoming of the abyss between Psychology and the Natural (“positive” as they were called back then) Sciences. However, in the physiology lectures, Pavlov did not find that which brought him to the university. Even when professor-ordinary and the Member of the Academy F.V. Ovsianikov tried to avoid the sticky points in the questions of the possibility of studying psyche using physiological methods, his assistant professor extraordinary Tsion denied this possibility, criticizing Sechenov for his “empty and harmful fantasies” and invited the students to study what is available to physiology.

Pavlov met Tsion at the peak of this extraordinary man’s energetic activity. He impressed the student enormously by his brilliant surgical skills and his unshakable opinions. In his autobiography Pavlov wrote about Tsion:

We were truly stricken — by his masterfully simple way of describing the most complicated physiologic questions and by his truly artistic ability to conduct experiments. You remember a teacher like that for the rest of your life. It is under his guidance that I conducted my first work in physiology. (Pavlov, 1999)

The development of the concept of neurism in Pavlov’s works on the physiology of circulation and digestion

The first scientific work of Pavlov as a student was on the cardiac innervation and not on the study of psychological processes. Later on, after overcoming to some degree the influence of Tsion, he would call *Reflexes of the Brain* “the genius flight of Sechenov’s thought” undefended by the bastion of experimental facts.

The results of the first scientific works of Pavlov were not published in scientific journals. However, in the *Works of the St. Petersburg Society of Natural Science Experimentation in 1874*, there is a short abstract of two combined presentations by I.P. Pavlov and V.N. Veliki at the meeting of the Zoology Society (Veliki & Pavlov, 1874). In their experiments on dogs, the authors of the presentations showed that the signals increasing the frequency of cardiac contractions are conducted to the heart not via the fibers of the laryngeal nerves, as was described by Moritz Schiff, but via the spinal fibers (through the stellate ganglion) as was established by the Tsion brothers as well as by Betsold. In addition, the students discovered that from the canine heart and aortic arch to the central nervous system, the signals causing decrease of blood pressure in the systemic circulation (similar to n. depressor in rabbits) is conducted by one set of nerve fibers, while stimulation of other afferent branches of the cardiac nerves causes the opposite effect.

Therefore, Pavlov conducted even his first steps in science following the ideas of neurism. The same could be stated about his next scientific work “On nerves regulating the work of the pancreas.” It was conducted by Pavlov and his classmate M.I. Afanasjev to

participate in a competition “to be awarded medals for the best scientific work” of the university. To complete this work, Pavlov stayed at the university for an extra year after his last year. The work received a golden medal in 1875. Three years later, an article was published in *Pflüger’s Archive*, using the materials of this original work (Pavlov & Afanasjev, 1878). The authors proved the presence of nervous system control of the secretory processes in the pancreas, opening a scientific discussion with Rudolf Heidenhain (1834–1897) — the most authoritative researcher of the digestion.

After graduating from the university, Pavlov continued his education at the St. Petersburg Medical-Surgical Academy (MSA) combining his study with work. At the beginning he was an assistant-lecturer at the Department of Physiology of the Veterinarian Department of the MSA. Later on (during his fourth year) he was allowed to manage an experimental laboratory at the Department of the Academic Faculty of Therapy of Professor S.P. Botkin. For nine scientific works conducted during the period of study at MSA (1875–1879) he was awarded the great golden medal of the academy.

Since he received his medical diploma with distinction, Pavlov, after finishing the MSA, was allowed to continue his training for three more years at the so called Academy Institute for Physicians — a forerunner of the postgraduate education. After becoming institute physician, Pavlov, having finished more than ten scientific studies in the area of circulation and digestion, spent the first year unable to choose the topic for his doctoral dissertation. Initially, he wanted to research whether “there are nerves regulating hemopoiesis, the production of the blood itself.” Having realistically evaluated the possibilities of experimental study of the neuroregulation of hemopoiesis, he realized that there is no existing method of researching this problem.

In this unrealized plan of Pavlov it is easy to notice his drive toward the development of the ideas of neurism — to spread the influence of the nervous system on the hemopoietic organs. This intention is quite logical, since the previous works of Pavlov in the area of circulation and digestion were developing the idea of neurism as well. Ten years prior to that, Pavlov’s passionate desire to uncover the secrets of the psyche had been extinguished. Ideas of neurism were realized in this study of the vegetative processes. However, deep in his mind there remained a thought about the necessity of studying psychological activity by physiologic methods. For a long time, three spheres of human activity were defined, i.e. the vegetative, somatic, and psychological spheres of activity. Two of these have been covered by physiologists for a long time. The study of the third sphere was tabooed not only by the religious authorities but by clear-cut materialists. For example, the father of electrophysiology Emil Dubois-Reymond (1818–1896) pronounced his paternoster-like statement “ignoramus et ignorabimus” (we do not know and we will never know) the mechanisms of psychological processes.

In Riazan, Pavlov, inexperienced in sciences, did not know about these taboos. However, after obtaining two degrees in the best institutions of higher education of Russia, he understood the reason behind the warning of these serious scientists. Despite that, he continued to feel a spiritual discomfort since he was striving for the “endless depth in the understanding of the truth.”

The renewal of interests in the studies of the psyche

Spiritual torment of the 30-year-old Pavlov manifested in his letters dated the 1880–1881 academic year. Having decided not to continue studying the neuroregulation of hemopoiesis, this academic physician, during the first year of his postgraduate studies talked about his plans to stop the work on his doctoral dissertation and to become a middle school

teacher, so that he could study the psychological development of the children through observation. It is not by accident that the Pavlov's favorite writer was F.M. Dostoyevsky, in whom F. Nietzsche acknowledged the "only psychologist" from whom he had "learned something" and the only human being who "deciphered Christ." Pavlov was shaken to the core by F.M. Dostoyevsky's novel *The Brothers Karamazov*, which he was reading in the *Russian Messenger*, anxiously awaiting every new issue of the magazine in 1879–1880. Ivan Petrovich found a lot in common between the nihilist Ivan Fiodorovich Karamazov and himself. His friends were of the same opinion especially after reading certain chapters like "Revolt," "Grand Inquisitor," and "Brother Ivan Fiodorovich." However, he did not enjoy this similarity for too long. After reading that Ivan Fiodorovich became a patient in the psychiatric hospital at the end of the novel, Ivan Petrovich was at a loss. He wrote: "Ivan Fiodorovich is an unfortunate attempt of the mind to accept everything into its domain, to conduct everything through consciousness, to intellectually motivate everything including nature and man himself." "But is it possible? Where is the science of human life," "it does not exist at all" (Pavlova, 2004). This was the science that the 30-year-old Pavlov wanted to create.

However, for the second time in his life he suppressed this desire. On the second year of his postgraduate training he soberly analyzed his capabilities and decided to choose the theme for his doctoral dissertation to be innervation of the heart since he already had a significant amount of data for the dissertation. He successfully defended the dissertation *Afferent Nerves of the Heart* on May 21, 1883. In this work he found small nerve fibers in the dogs that, when stimulated, led to the increase in the strength of the contractions without the increase in the frequency of the contractions. The author explained the discovered effect as a manifestation of the trophic influence of the central nervous system on the heart. The idea of neurism was celebrated in the dissertation.

After defending his doctoral dissertation, Pavlov was sent abroad by the MSA to perfect his skills in the laboratories of famous German scientists, including Heidenhain in Breslau and Carl Ludwig (1816–1895) (who were irreconcilable scientific opponents). Neither the former nor the latter were adherents of neurism; by then, Pavlov was strong enough in his scientific convictions not to be shaken by even these titans of physiology. With all deep respect and even admiration for them (their portraits were on the walls of his home study room), he later became their serious opponent regarding the development of neurism as well as synthetic physiology.

The path to the Nobel Prize

In his research on the innervation of the heart and blood vessels (mainly in surgical experiments) Pavlov was unable to achieve the desired result — to understand the regulation of the circulation deep enough to achieve an all encompassing/unifying concept. The necessity for the development of the whole system of chronic experiments arose in Pavlov's mind. The whole complex of these experiments would allow the study of the whole chain of complex mechanisms of neuroregulation of a particular function of the body.

By the end of the 1880s Pavlov's attention turned again to the system of digestion step-by-step. Previous experience in this area, although with little joy and a lot of disappointments, still allowed him to help pave the path to the development of a new methodological direction in the study of the neuroregulation of the secretory and motor processes in the gastrointestinal tract. His first significant success was achieved with the operation of

esophagotomy in combination with a gastric fistula. During the experiments of “pseudo feeding” of the dogs after esophagotomy, Pavlov and E.O. Shumova-Simanovskaya proved that gastric secretion occurs without the delivery of food into the stomach. Secretion stops after bilateral vagotomy. Thus, neuroregulation of the gastric secretion was proven. In 1894, this thesis was supported by the experiments on the isolated stomach of a dog (using methods of Pavlov). In parallel, there were continuous experiments on the pancreas due to Pavlov’s ability to insert the chronic fistula of the pancreatic duct, which Claude Bernard had tried unsuccessfully for so many years. During the 1890s, a system of chronic experiments was conducted in Pavlov’s laboratories, studying all organs of the gastrointestinal tract. The success was supported by the fact that, during the 41st year of life Ivan Petrovich became a Chief of the Department of the Military Medical (former Medical-Surgical) Academy (MMA) (1890–1895 at The Department of Pharmacology and in 1895–1925 at The Department of Physiology) as well as the Division of Physiology of the Institute of the Experimental Medicine (1891–1936). Until the age of 40, Pavlov was in the position of a laboratory assistant, but Botkin under whom he worked from 1878 to 1887 did not limit his independence and initiative. Pavlov was able to develop the system of chronic experiments due to his surgical talent, which he began to develop under the leadership of Tsion. Eventually, the student surpassed his teacher due to his study and work at MSA (MMA after 1881). It is important that Ivan Petrovich not only perfected the technique of surgical operations but also used the development of surgery in his experiments (anesthesia, aseptic, and antiseptic techniques). Many physiologists tried to reproduce the work done by Pavlov, but very few succeeded.

Summarizing 15 years of work of Pavlov’s laboratories on the physiology of digestion, it could be stated that Pavlov with his students, using the surgical technique, created artificial “windows” into literally all organs of the gastrointestinal tract, through which he was able to observe the intimate life of the digestive system. This life has never completely



Figure 2. Pavlov in the operating room.

opened up in its fullness, in interaction between the separate elements guaranteeing unity and coordination of the heterogeneous complex.

Until Pavlov used a systemic approach in the study of the physiologic problems of not only the gastrointestinal system but any other anatomic-physiologic system, such an approach had never been realized. He stated that the principles of the systemic approach towards the processes to be studied, he had learned during his medical education. He saw this as an important adjunct to the analytic physiology he learned at the university. These principles formed the bases of synthetic physiology, aimed at the understanding of the whole picture of the true sequence of physiologic processes. It should be stressed one more time that in his works, systemic approach towards the study of digestion is based on the ideas of neurism.

Creation of the new branch of physiology

In the process of studying the digestion, Pavlov returned to what made him become a physiologist. Again (for the third time) he turned his thoughts to the study of psyche. However, this time these thoughts were supported by action. For some, this switch in the work of a large work group from digestion to psyche looked illogical. Even now, to someone who is not familiar with the torments of young Pavlov on the path to the secrets of human psyche and his torturous apprehension of the 30-year-old Pavlov, this change in direction looks illogical as well. It is important that the work of his mind in this direction was emotionally laden. Because of that, he was ready for the study of the human psyche all of his conscious life, but he did not find a physiologic method for this study.

In his research, he strongly adhered to the principles of scientific methodology. Scientific methodology has three attributes: experiments, measurement, and mathematical analysis. In his works on physiology of digestion, he was striving to reveal strict quantitative correlations between the stimuli and reactions to them in secretory glands and in motor activity of the gastrointestinal tract.

In the course of chronic experiments (unlike in acute ones) Pavlov stumbled on to the fact that the so called power relations (between stimulus and reaction) were frequently disturbed; quantitative relationships remained statistically insignificant. Soon it was discovered that the external disturbances associated with the presentation of the studied stimulus cause interference. Such are sight, sound, smell, and other factors associated with the stimulus. Coworkers in Pavlov's laboratories were struggling to get rid of these interferences. Somehow, the term "psychogenic secretion" arose to describe these hindrancing effects.

They were able to overcome the psychogenic secretion of the gastric glands and the pancreas and had established precise power relations for them. However, during their research of the secretion of the salivary glands in the chronic experiments, significant difficulties occurred in eliminating the "psychogenic salivation." In his report "on experiments of Dr. Glinsky on the function of salivary glands" on May 13, 1895, Pavlov contrasted "reflexive and psychogenic salivation reactions." He seemed to have forgotten Sechenov's statement that psychological processes by mechanism of their development are reflexes.

In 1897 Pavlov's *Lectures on the Function of the Main Glands of Digestion* appear. It should be noted, that this particular book in German translation (Pavlov, 1898) was reviewed by Nobel Committee, which led to the Nobel Prize being given to Pavlov (1904). In 1917, the second edition of the *Lectures* was printed. In the foreword to the second edition, the author addressed several "points" that were corrected from the first edition.

The first point relates to the so-called psychogenic excitation of the glands which I sharply contrasted with the reflexive excitation. With great enthusiasm and zeal, I wrote about the thoughts, desires and feelings of the experimental animals. At this point of the development of my physiologic thinking I have arrived at a different conclusion on this topic. (Pavlov, 1917)

The path of the development of Pavlov's physiologic thought on psychogenic secretion was quite difficult and tortuous despite nearly 30 years of thinking about the necessity of studying the psyche by physiologic means.

In March 1898 Pavlov's student S.G. Woolfson defended his doctoral dissertation on "the participation of the psychogenic element in the function of the salivatory glands." The dissertation stated that the regulator of the psychogenic salivation is the soul of the animal. Pavlov agreed with the author and added "in this study of the secretion of the saliva psychology wins over physiology."

In December 1899, at the meeting of Society of Russian Physicians in St. Petersburg, Pavlov said, "in the psychology of salivatory glands discovered by us, we see all the elements of what is called the activity of the soul — feelings, desires, the thoughts about the qualities of the oral content." In 1900 Pavlov lamented, "all the trouble is that in all of us there is this ingrained dualism according to which the soul and the body are something separated from each other; in the eyes of the natural sciences, of course, this split is impossible." One of Pavlov's close students L.A. Orbeli remembered that one of his classmates asked him during the lecture in the spring of 1901 whether psychogenic salivation could be considered a reflex. The lecturer answered negatively, but with some uncertainty and tension. Perhaps, even then he was ready to agree with a student but something was in his way.

In the autumn of the same year an event — a catalyst of sorts — occurred that accelerated the movements of Pavlov's thought in this new direction. Under the guidance of Pavlov, the psychiatrist A.T. Snarsky was working on his doctoral dissertation that was very much to the liking of his adviser who saw in him "the living mind and understanding of the researching thought." However, when it was time for defense of the dissertation, Snarsky refused to accept any compromises between psychology and physiology in the explanation of the results of the research on the secretion of the salivary glands. He was basing his explanation on the positions of classic psychology even though, in Pavlov's laboratories, this search for the points of contact between the psychological and physiological interpretation of the results of their experiments lasted already about five years.

Pavlov wrote:

Doctor Snarsky remained convinced of the subjective interpretation of the events; I, on the other hand, was stricken by the fanaticism and scientific infertility of this attitude toward the posted question, started looking for a different outcome from this difficult situation. After long thinking on the subject and after an uneasy intellectual struggle, I finally decided that even facing the so-called psychological excitation I should remain in a role of a pure experimentalist...

Towards the realization of this decision I started working with a new coworker, Dr. I.F. Tolochinov..." (Pavlov, 1924, p.383)

Snarsky defended his doctoral dissertation on January 24, 1902.

During the next 2–3 months Ivan Petrovich overcame his long-standing doubt, as well as negative attitude, towards his new approach to some colleagues and close people. Even his wife, who was helping him during their whole life together, was crying and complaining “what are you doing?! This will lead to materialism!” She was begging him to stop his research of the psyche based on scientific methodology. However, Pavlov felt that he finally found the key to the secrets of psyche and in parallel with his research of digestion conducted experiments that initially, in the laboratory, were called “conducting psychology.” They were conducted three times a week. At 1600 hours, the psychiatrist Tolochinov would arrive along with Pavlov and with his assistant Charitonov. A dog with a fistula of the salivary duct would be shown a flask containing a mixture of hydrochloric acid tinted with gentian violet, after which the content of the flask was emptied into the dog’s mouth. The dog would have copious salivation. After several experiments, the dog would start salivating as soon as it was shown the flask filled with the tinted liquid.

Slowly, the experiments were becoming more complex. By the summer there were enough data for a presentation. These data were presented by Tolochinov at the Congress of Physicians and Natural Scientists of Northern Europe. The congress was held at Helsingfors (Helsinki) between July 7, and July 12, 1902. The presentation by Pavlov and Tolochinov was published in the reports of the congress in 1903 under the title “The Materials for the Study of Physiology and Psychology of the Salivary Glands.” For the first time, the terms such as conditional and unconditional reflexes were used. The principal difference between the former and the latter was defined in terms of biologic significance of the conditional reflexes contained in their signal role.

In 1903 there was a 15th International Medical Congress in Madrid. Pavlov participated as a representative of the MMA and delivered a speech entitled “Experimental Psychology and Psychopathology of the Animals.” As reported by S.V. Pavlova who accompanied her husband to Madrid, the presentation of Ivan Petrovich did not draw much interest from the participants of the Congress. However, he was not perturbed. He did not doubt that his new work will have a difficult fate. After returning to St. Petersburg, as a half-joke he would frequently tell his coworkers, “Down with physiology of digestion! All of you will be studying the psyche.” Soon, this threat was materialized. In the report on the scientific activity of the Physiology Department of the Institute of Experimental Medicine in 1903 was written: “in addition to the research on the secretory function of the alimentary canal and various kinds of activity of the digestive ferments, the work was directed towards the study of the questions of experimental psychology of the animals” (Gureeva & Chebysheva, 1969, p. 103). Pavlov spent one-third of his speech during the Noble Prize ceremony in Stockholm on December 12, 1904, describing his research of the psychological activity of the animals. In these experiments (referred to in the previous paragraph) he followed the scientific methodology; salivary glands turned out to be a convenient object for the analysis of psychological processes. The exact count of the number of the excreted drops or marks on the scale, which was connected to the fistula of the salivary duct through the water-air connector, was measured. Measuring some parameters of the motor activity of the animal in the experiments was much harder (practically impossible). In addition, the interpretation of the somatic reflexes was associated with an anthropomorphic interpretation of the results, which to a much lesser degree is associated with the analysis of salivation. Vegetative reactions in comparison to the somatic ones are better protected from disturbing exogenous factors. The simplicity of Pavlov’s experiments seemed to some physiologists to be incompatible with the possibility of the discovery of the secrets of the psychological activity. Some mentioned sarcastically that Pavlov started studying what is well known to any forest ranger. Those who did

not master scientific methodology did not understand the difference between the observation and the experiments; they did not understand the role of the measurements and subsequent mathematic analysis of the results of the experiments.

It is striking how perspicacious the expression “higher nervous activity” coined by Pavlov was. With the development of Cybernetics it became clear that good management could be guaranteed if the machine, at the point of time t “knows” what to expect at the point of time $t+1$, i.e. a good regulation is a proactive (fore post) kind of regulation. Conditional reflexes developed during the lifetime of the animal or a human guarantee a fore post regulation of the organism in the stochastic environment. Because of that, conditional reflexes represent a higher (in comparison with adaptation to the already occurred events) nervous activity.

Some psychologists criticized Pavlov’s refusal to use psychological terminology. It is true that for didactic purposes he prohibited the use of psychological terms by his coworkers; instead, he led them in the development of the new “physiologic” vocabulary to characterize psychological concepts. He insisted that since psychology has not reached the point of exact science, a physiologist has no reason for turning to psychology. However, after his coworkers created and thoroughly learned the new vocabulary, Pavlov started to compare and to contrast physiologic and psychological terms. Some of them turned out to be similar, while others differed significantly. The analysis of the differences and similarities became a supplementary method of development of the physiology of the higher nervous activity.

Conditional reflexes and structural lesions of the central nervous system (CNS) were studied in 1906–1907. It was concluded that under natural conditions, temporal relationships are established between the centers with the highest degree of plasticity. In mammals, this quality is present in the cortex of the brain.

Since 1907, Pavlov started writing “continuing research of the activity of the hemispheres and the sensory organs” in the reports about the work of the Physiology Section of the Institute of the Experimental Medicine (Gureeva & Chebysheva, 1969, p. 123).

In the same year Pavlov was elected a member of the Emperor’s Academy of Sciences; the academic physiology lab was given to him for supervision. He became a leader of three institutions: the Physiology Department of the Institute of Experimental Medicine, the Department of Physiology of Military - Medical Academy and the Physiology Laboratory of the Academy of Sciences. Nearly all who worked in these institutions were working on the development of the new branch of physiology — physiology of the higher nervous activity. Such numerous scientific groups did not exist in any other country. It is not in vain that Pavlov used to say that he developed a new division of physiology “with an army of coworkers” even though the overwhelming majority of them were volunteers.

The period of 1910–1914 was the most productive in the development of the Pavlovian teaching of higher nervous activity. Active research on multiple problems was conducted, such as the structural organization of temporal relationships, interrelationships of unconditional and conditional reflexes in the behavior of animals, functions of the analyzers (sensory organs), inhibition of the conditional reflex activity, and spread of the excitatory and inhibitory processes in the cortex in the formation of the conditional reflexes.

On September 5, 1913, at the 9th International Physiology Congress in Groningen, The Netherlands, Pavlov was given a high honor to deliver his speech “Research of the Higher Nervous Activity” during the closing plenary session. This presentation was announced as the main event of the whole Congress. Pavlov was looking forward to the opening of the International Meeting of the Psychiatrists, Neurologists, and Psychologists in Switzerland planned for 1914. For this meeting he prepared a presentation entitled “True Physiology of the Brain.”

He was literally raring into battle, looking forward with all his passion to openly polemicize with the famous Swiss psychologist Edouard Claparède (1873–1940). He was planning on proving his points that physiology of the central nervous system, even during the short time of its existence (physiology), shed more light on the secrets of psyche than many centuries of psychology. However, World War I prevented Pavlov from realizing this plan.

The only free citizen of Russia

After the Russian army suffered one defeat after the other, Pavlov, who was following the course of the war carefully, blamed the inept command and the Tsar's government. He addressed rather audacious comments to Rasputin, the Empress and the Emperor. He viewed the February Revolution of 1917 with caution, however, hoping to see the renewal of Russia striving toward liberty. His optimism dissipated as soon as A.F. Kerenski became leader of the temporary government. Pavlov knew him personally and did not have a high esteem of him.

Pavlov responded to the October Revolution quite painfully and withdrew into himself. When it was possible to get him talking, he foresaw disasters in the lives of all and everyone. Members of the Cheka³ conducted numerous searches in Pavlov's apartment, confiscating gold items including his medals received for scientific achievements. He and his son, who lived with his parents, were detained for a brief time. His second son was killed during the Civil War; his third son, an officer of the regular army, remained abroad.⁴

From the political standpoint, Pavlov thought that the war with Germany should be continued to the "victorious end." Because of that, he viewed the Brest Peace Agreement, signed by the Bolsheviks, as treason to the interests of Russia. He was infuriated, seeing the disintegration of the country with the separation of Finland, Poland, Baltic countries, Transcaucuses, Middle Asia, and Ukraine.

Reacting negatively to the dictatorship of the proletariat, Pavlov with his coauthor and student M.M. Gubergrits published an article "The Reflex of Freedom" in the journal *Russian Physician*. He devoted a significant portion of his three public lectures (April 28, May 20, and May 27 of 1918) to this theme under the general title "On the Mind in General and on the Russian Mind in Particular" (Pavlov, 1999, p. 119–166). This theme attracted a wide and unequivocal interest in the Petrograd society. Since then, the author of these lectures gained a reputation of a dissident, a national symbol of political resistance. In a personal conversation, the omnipotent Zinoviev threatened him, "we can really hurt you, mister professor." He was ostracized by the proletariat press, discrediting him not only personally but attacking his theory of higher nervous activity as well. However, Pavlov was not frightened. He continued to speak the truth not only in personal conversations with his colleagues and during his lectures at the Military Medical Academy but in his letters to the government, including a personal letter to V.I. Lenin.

Some unconscientious contemporary "writers" pulled quotes out of Pavlov's Spring 1918 public lectures, published in their complete form by us only in 1999. They even painted Pavlov as having anti-Russian sentiments. On the contrary, the lectures show his national patriotism, his pain for the fate of Russia, and his militant position toward the actions of the new regime with which he was in disagreement. While trying to answer the question why their revolution succeeded in Russia specifically, Pavlov analyzed the peculiarities of the higher nervous activity of a Russian; not a Russian peasant or a scientist,

³The Soviet secret agency's full name was *All-Russian Extraordinary Commission for Combating Counter-Revolution and Sabotage*, but it was commonly abbreviated to Cheka.

⁴He returned to Russia only in the end of the 1920s.

but an average Russian citizen regardless of his ethnic background. Considering that the higher nervous activity “consists of two halves, excitation and inhibition” and “the culture of animal and human is defined by the balance of these two halves,” Pavlov reproached Russian citizens in the deficiency of inhibition (“discipline,” “breaks”) and the clear-cut excess of excitation (freedom approaching the degree of the all-permissiveness). In contrast to the members of the “leading nations” (Anglo-Saxons and Germans, according to Pavlov) Russians (being Russian, Ukrainian, German, Jew, Armenian, or a person of any other ethnic background) stride not toward freedom but toward anarchy (all-permissiveness). The reason for this Pavlov saw not as much in genetics as in upbringing. He stated that in the lives of the “leading nations” there is a combination of discipline and freedom from “the little to the big” issues. This occurs due to the consciously practiced “numerous breaks,” religion, legislature, prudent and unwavering enforcement of the law by the state, controlled by fines, respect of customs, etc. Russia’s reality, however, survives without these breaks. Religion in Russia was discredited since the time of Peter the Great; as a result, Russian intelligentsia of the beginning of the twentieth century considered going to church to be in bad taste. Russian law was imperfect, and existing laws were not followed by the state itself. The fines were collected in the pockets of representatives of the law enforcement structures. Traditions were laughed upon. The most serious cause of the Revolution Pavlov saw in a “wild abyss between the rich and the poor,” which was splitting the Russian society.

Throughout his life under the Soviet regime, he called the October Revolution of 1917 a “Bolshevik experiment.” Opposite to A. Einstein, who stated that this is a “wonderful experiment” that “deserves to be conducted.” In 1918, Pavlov screamed angrily, “I would not submit a frog for an experiment like this!” However, at the Moscow Kremlin on August 17, 1935, during the formal reception of the delegates of the 15th International Physiology Congress in the presence of 1500 people, he proposed a toast “to the great social experimenters!” meaning the Soviet government.

Pavlov’s words in the Kremlin quickly became known in the old world and in the new world. They were discussed widely in the press. Scientists, politicians, writers, and journalists were lost in guessing the reasons behind this cardinal metamorphosis in the political views of a man, who was considered in the West to be “the only free citizen of Russia.” Some commentators presupposed that Pavlov’s toast suggested that the Bolsheviks threatened Pavlov into submission. Others thought that they had paid him off. Yet the third group thought that he was fooled by the Bolsheviks due to his political naiveté. I dare say that Pavlov was not threatened into submission, paid off or fooled, but he changed his attitude towards the Soviet regime not because of conformity but because of the cardinal change in the state’s policies. From the infamous proletariat internationalism and the idea of permanent revolution, the power had shifted to the strengthening of the state and to the rebirth of powerful Russia from its ruins. For him, who was saturated with the spirit of Russian state patriotism, this was the most important. “Whatever I do, I constantly think that I serve my fatherland with all that my strength allows” (Pavlov, 1951, p. 15).

Following Lenin’s orders, the communist leadership of the country was fighting for Pavlov for a long time cautiously, patiently, thoroughly, and persistently. However, speculating on Pavlov’s state patriotism would not lead Bucharin and his cohorts to a desired result. Only the verisimilitude of objective reality to Pavlov’s ideal of the motherland, which the world took into consideration, allowed him to acknowledge himself as a citizen of the USSR with all due consequences in the thought and deed. With all that, he reserved the right to tell the government the truth, to protest against what he thought to be incorrect and harmful to the Russian state. I think that nobody else in the USSR saved as many people from repression as Pavlov did. He realized the importance of his mission and not

long before his death he willed to P.L. Kapitsa⁵ to continue to carry the heavy cross of the defender of justice in the totalitarian regime.

Strengthening the statehood presupposed not only strengthening the army and law enforcement structures but the development of education and science, which Pavlov especially enjoyed. Wars and revolutions slowed down the progress of physiology of the higher nervous activity. However, Pavlov did not surrender to the circumstances and, risking his life, succeeded in 1924 to obtaining the rebirth of his scientific laboratories. The work acquired an even larger scale than in the beginning of the century. Pavlov's book *Twenty Years Experience of Objective Research of the Higher Nervous Activity (Behavior) of Animals* was entered into the prestigious list of most outstanding books published in Russian in 1924, compiled by the institute of the intellectual cooperation at the League of Nations in Lausanne.

In the postrevolutionary years, Pavlov together with his coworkers conducted research in the following directions of physiology of the higher nervous activity: comparative physiology, types of nervous activity and their inheritance, dynamic stereotype, experimental neuroses, problems of interhemispheric interactions, primary and secondary signal systems, biochemistry and histology of the brain, sleep, influence of narcotics and x-ray radiation on the higher nervous activity, internal inhibition, and the physics of hearing. Many of these problems were studied not only in the animal experiments but in the neurology and psychiatry clinics founded at the Institute of Physiology of the Academy of Sciences of the USSR, into which the academic physiology lab was transformed in 1925. *Conditioned Reflexes, An Investigation of the Physiological Activity of the Cerebral Cortex* was published in 1927. The lectures were published nearly simultaneously in Russian and in English (Pavlov, 1927).

The Triumph (conclusion)

In the beginning of the 1930s, a scientific complex for the study of genetics of higher nervous activity was built near the village of Koltushi near Leningrad. Excellent conditions for living and for productive work of the scientists were created. Experimental animals were taken care of as well. In the so-called "Dogtown" containing up to 700 dogs, "ideal hygienic conditions" were created. The village of Klotushi contained, in addition to the dogs, many other animals, including chimpanzees Roza and Rafael. In August of 1935, the numerous participants (900 participants from 37 countries and 500 participants from the USSR) of the 15th International



Figure 3. Pavlov at the 1935 congress.

⁵P.L. Kapitsa (1894–1984) was a Russian physicist who discovered superfluidity in 1937. Kapitsa won the Nobel Prize for Physics in 1978 for his work in low temperature physics.



Figure 4. Claude Bernard and Ivan Petrovich Pavlov; sculptures by Oswald Wenckeback in front of the Physiology Laboratory at Leiden University.

Physiology Congress in Moscow and Leningrad visited Koltushi — the “capital of conditional reflexes” — as well as other physiology institutes. They were impressed by the colossal scope of research in the USSR. The participants associated this with Pavlov’s high reputation. In the official address to the delegates of the Congress at the closing plenary session in the Big Hall of the Moscow Conservatory on August 17, 1935, Professor D. Bardger of Edinburgh University bestowed the title “first physiologist of the world” (*princeps physiologorum mundi*) on Pavlov. This title has never been bestowed on any scientist in the history of physiology. Pavlov was honorary member of nearly 130 scientific societies, universities, academies, including more than 60 foreign ones. Upon his return home, one of the cochairmen of the Physiology Congress, L. Lapik wrote in a French newspaper:

introduction to the Soviet physiology was a true epiphany... conversations with the scientific youth shocked and enriched me. It is characteristic in the USSR for the scientists to hold a primary place in society... the strongest impression I brought out of the Soviet Union is the impression of the might of its scientific movement. (Lapik, 1937).

The credit for this belongs to Pavlov. After the Congress where the 87-year-old impressed everyone with his zest and youthful energy, Pavlov continued his scientific work. Even in the winter he visited Koltushi weekly. One of these visits turned fateful — the car broke down and Pavlov got a cold while the car was being fixed. He came down with pneumonia

that killed him within a week. He died at 02:52, on February 27, 1936. The whole country mourned for him as a national hero. His remains rest at the Literary Mostki of Volkov Cemetery in St. Petersburg.

There are many names in the history of Physiology. It is hard to choose even ten outstanding names. However, during the construction of the new building of Physiology Laboratory of Leiden University — the cradle of modern physiology and medicine — sculptor Oswald Wenckebach⁶ carved four sculptures in the walls of the main entrance. There is W. Harvey with a heart in his hands, C. Bernard with a liver in his hands, A. Berthold holding a rooster to his chest, and there is I.P. Pavlov holding the brain in his hands.

References

- Gureeva NM, Chebysheva NA (1969): *The life and work of I.P. Pavlov*, vol. 1 (1849–1917) Commentaries of V. L. Merkulov. Leningrad, Nature.
- Lapik L (1937): Opinions of foreigners about the USSR. *Za rubegom*, No. 11.
- Nozdrachev AD, Marianovich AT, Poliakov EL, Sibarov DA, Havinson VH (2002): *Noble Prizes in physiology and Medicine – Last 100 years*. St. Petersburg, Gumanistika.
- Pavlov IP, Afanasjev MI (1878): Beiträge zur Physiologie des Pancreas. *Pflug. Arch* 16 H.2–3; 173–189.
- Pavlov IP (1898): *Die Arbeit der Verdauungsdrüsen. Vorlesung*. Autoris. Übersetzung aus dem Russ. von Walther. – Wiesbaden.
- Pavlov IP (1917): *Lectures on the function of the main glands of digestion*, New edition. Moscow, Nature.
- Pavlov IP (1924): *20 years of experience in the objective research of the higher nervous activity (behavior) of the animals. Conditional reflexes. Compilation of the articles, presentations, lectures and speeches*. 2nd edition with additions. Leningrad, State Publishers.
- Pavlov IP (1927): *Conditioned reflexes, an investigation of the physiological activity of the cerebral cortex*. Transl. and ed. by F.C. Anrep. Oxford, XV, pp. 430.
- Pavlov IP (1951): On the work perspectives in 1935 given to the newspaper “The news” No. 157 on July 6, 1935 In: *I.P. Pavlov complete works*. vol.1, Moscow-Leningrad: 1951.
- Pavlov IP (1975): *The unpublished and obscure documents of I.P. Pavlov*. Leningrad, Science.
- Pavlov IP (1999): *Autobiography in I. P. Pavlov: Pro and contra. Anthology*. St. Petersburg, RHGE.
- Pavlov IP (1999): About the mind. About the Russian mind in particular. Basis of animal and human culture. In: *I.P. Pavlov: Pro and contra. Anthology*. St. Petersburg, RHGE.
- Pavlova SB (2004): *From reminiscences, I. P. Pavlov — First Russian Noble Prize laureate vol 2*. Pavlov as he was (memoirs of S.V. Pavlova, A.F. Pavlov, M.K. Petrova). Editor and authors of the commentaries A.D. Nozdrachev and E.L. Poliakov, E.A. Kosmachevskaya, L.I. Gromova, K.N. Zelenin. Sankt-Petersburg, Gumanistika.
- Savich VV (1924): *Ivan Petrovich Pavlov. Compilation dedicated to the 75th anniversary of I.P. Pavlov*. Leningrad, EAM, p. 69.
- Sourkes T (2006). Introduction: Neuroscience in the Nobel perspective. *J Hist Neurosci* 15: 306–317.
- Timiriazev KA (1908). Awakening of the natural sciences in the third quarter of the century. *History of Russia of the XIX century*. Sankt-Petersburg, Brothers Granat and Co, vol 7, p. 1.
- Veliki VV, Pavlov IP (1874): Abstract of the presentation of V.V. Veliki and I. P. Pavlov: a) “On the influence of the laryngeal nerves on the circulation”; b) “On afferent accelerators of the pulse.” *Documents of the Sankt-Petersbur Natural Sciences Experimentors*, v5 p. LXVI–LXVII.

⁶Son of the well-known Dutch cardiologist Karel Frederik Wenckebach (1868–1940), after whom the cardiac rhythm disorder was mentioned.

Copyright of *Journal of the History of the Neurosciences* is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.

Copyright of *Journal of the History of the Neurosciences* is the property of Taylor & Francis Ltd and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.