REMINISCENCES OF PAVLOV¹

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When I met Pavlov on October 29, 1922 and saw his experiments on the conditional reflex, demonstrated by him, I wrote in my notes: "This is the happiest day I have spent in Europe." Having obtained leave for a period of four months from the University of Maryland Hospital where I was interning, to spend a summer in Russia with the American Relief Administration under Herbert Hoover, my plans and my life were profoundly altered by this "happiest day". On account of this meeting with Pavlov, I remained in Russia more than seven years. Before coming back to America, I learned Pavlov's language, and learned to live as a Russian.

This was one of the important accidents of my life. Many of the most momentous events of one's career are accidents. So little was heard of Russia at that time, it was not known that Pavlov was alive; his obituary had been published in the 1918 *Encyclopaedia Britannica*, which had him dying in 1916. He had the distinction of outliving his obituary 20 years.

At that time, I was unaware of the conditional reflex research although it had been described by John B. Watson in his APA presidential address in 1916. I knew of Pavlov only for his work in the physiology of digestion, for which he received the Nobel Prize in 1904.

It was Pavlov who first imbued me with the idea that psychiatry could be studied by objective methods. The experiments he showed me on October 29, 1922 convinced me that mental phenomena—at least some of them—could be reduced to the clarity of a simple experiment.

Life

Pavlov, who was born on September 22, 1849, was the eldest son of a village priest in

Ryazan, in central Russia. His grandfather was the church sexton, a peasant. Sickly as a child, Ivan Petrovich strengthened himself by physical activity, which he kept up to the end of his life. He was quick to become involved in brawls and fistcuffs. He enrolled in the local seminary to study for the priesthood, but having read a copy of Lewes' "Physiology of Everyday Life", after one year at the seminary he decided to enter medicine at the University of St. Petersburg.²

Graduating with honors in medicine, he received the Wylie Fellowship for two years of study in Europe. These years he spent in Leipzig with Carl Ludwig, the great physiologist of the cardiovascular system, and with the gastrointestinal physiologist Heidenhain, in Breslau. Ludwig gave Pavlov the foundation for his work on the heart. In Breslau, Pavlov improved the Heidenhain pouch (which severed the vagal nerves to the isolated miniature stomach) by leaving a bridge of tissue between the main and miniature stomachs in which the vagal nerves were preserved; thus, a true reflection of gastric secretion was obtained in the externalized pouch.

After Pavlov returned to St. Petersburg, he spent the next decade in research on the cardiovascular system. Here he discovered the trophic nerves to the heart, simultaneously with, but independently of, the English physiologist Gaskell. He also made important advances in the study of blood pressure. He was the first modern physiologist to record blood pressure in a normal unanesthetized dog. He was so skillful that he could insert a cannula into the femoral artery of the awake animal and measure blood pressure to various agents. This feat was not accomplished elsewhere routinely until within the past decade, when it

¹Based on a lecture at the Annual Meeting of the American Psychological Association, Washington, D.C., September 2, 1969. Reprints may be obtained from the author, Pavlovian Research Lab, V.A. Hospital, Perry Point, Md., 21902.

²Lewes was a British physiologist, the spouse of George Eliot. Pavlov showed me the well-worn preserved copy of this book in the 1920s.

was made easy with modern electronic equipment.

In the decade 1890 to 1900, Pavlov's main research was on the physiology of digestion. For this he used the method of the "chronic fistula". The Pavlov gastric pouch and externalized ducts of the salivary glands, of the pancreas, and of the gall bladder made it possible to take measurements without interfering with the life or health of the dog. Besides these operations, Pavlov has devised the esophageal fistula in which the esophagus was divided and externalized so that the food was swallowed but did not reach the stomach. The method of the chronic fistula enabled Pavlov to see the normal secretion of digestion. For this work on the digestive glands he received the Nobel Prize in 1904.

Due to the principle of using the normal, unanesthetized dog, Pavlov was enabled to make observations that led to the discovery of the conditional reflex. In the course of measuring

the gastric secretion to various amounts of food, he found exceptions to the general rule that the secretion varied linearly with the amount of food. The discovery of the cause of the irregularities was the result of careful observations combined with intuition. The irregular secretion began before the dog ate, when he saw the pan with the food, or the person who brought the food, or even heard his footsteps. These were the conditioned signals for food. Later, he used artificial signals for the food—tone, bell, light. He saw the necessity of excluding all other stimuli, and therefore constructed a soundproof room, the "camera silenta".

By this procedure, he could obtain a quantitative measure of the intensity of the new acquired response, the conditional reflex, and to minimize subjective explanations. Pavlov did not belittle the importance of subjectivity, but he saw no way of working with it scientifically except through its objective correlates.

Fig. 1. Pavlov and co-workers in his laboratory at the Institute of Experimental Medicine. The photograph was taken in the Winter of 1922. The laboratory was so cold that several of the people are wearing overcoats. Standing (left to right): K. M. Bykov, A. V. Ponomarev (in white coat), the diener, A. P. Selheim, an unidentified man, and G. V. Volborth. Seated: V. V. Savich, W. H. Gantt, I. P. Pavlov, and E. A. Heineke. On the table is a dog with a choledochus fistula

Fig. 2. Pavlov at the operating table. Assisting him is A. D. Speransky. I. S. Rosenthal's head is partially blocked by Pavlov's. The others have not been identified. The photograph was taken by W. H. Gantt, probably in 1926.

Laws of the Conditional Reflex

Using these objective quantitative measures, Pavlov was able to see relationships that he considered to represent the laws of the conditional reflex. These were related to current neurologic concepts: excitation, inhibition, irradiation, and induction. Pavlov's inhibition developed from the conditioned excitation; it was a new concept in physiology.

As Pavlov continued to work with the excitatory and the inhibitory conditional reflexes, he saw disturbances in the behavior of some of the animals. The dogs became agitated and might refuse food. One of the circumstances giving rise to this pathologic behavior was the approximation of the physical nature of the signals. If a circle was made the signal for food and an ellipse for no food, a disturbance of behavior resulted when the ellipse was made very similar to the circle. Pavlov thought of this as a "collision" in the brain of the opposing processes of excitation and inhibition in the brain. He postulated that excitation and inhibition were represented in the brain by chemical substances. This was many years before the discovery of excitatory chemical transmitters by Loewi. The pathologic disturbance in reactivity could be detected not only in motor behavior but in the relationship of the balance between the excitatory and inhibitory conditional reflexes. Under these conditions, the pathologic variation in reactivity might vary from a relationship in which the animal reacted by giving (1) no secretion and no observable response to the usually excitatory conditional stimulus (inhibitory phase) but a secretion to the inhibitory conditional stimulus (CS) to (2) where the responses were equal to the excitatory and the inhibitory conditional stimuli.

When Pavlov saw that sleep sometimes resulted from a frequent juxtaposition of inhibitory conditional stimuli, he formulated the conception that sleep was due to a summation of internal inhibitions.

Since Pavlov was an accurate observer, he saw pathologic behavior under other conditions. One such occurrence was during a tidal flood in Petrograd in 1924, when the dogs were removed from their usual kennels, and lived in overcrowded conditions with strange companions. Some dogs easily succumbed, showing either extreme excitation or extreme inhibition;

in others, the behavior was only slightly altered, with either a preponderance of excitatory conditional reflexes or, in the opposite direction, with a preponderance of inhibition. After this observation, Pavlov divided his animals into four constitutional types, without rigid ideas of the extent to which these were genetic or acquired. His related formulations, however, gave preference to the genetic basis for his four functional types.

Pavlov found in castrated dogs a rigidity and stereotypy of the conditional reflexes that did not adapt to external conditions. He thought, therefore, that he had established experimentally the theory that paranoia was related to a loss of sexual interest.

Schizophrenia, Pavlov thought, might result from excessive stimulation because he found that, when the conditional stimuli were excessively intense, they did not produce more intense conditional reflexes but passed over into inhibition, a state he called supramaximal inhibition. He suggested that schizophrenia be treated by quiet and rest as a form of therapy; this was much used formerly in the USSR but without specific success.

Critical Evaluation of Pavlov's Concepts

Pavlov was accurate in his facts. He used to assign the same problem to two different collaborators in separate institutions so that each did not know what the other was doing. Perhaps his concepts tended to be somewhat restricted to the then-current neurological concepts. Again, in his typology, he adhered to the ancient Hippocratic one; all dogs do not easily fall into these categories. His postulation of excitatory and inhibitory substances in the brain found confirmation in the later discovery of acetylcholine by Loewi, of sympathin by Cannon, and, more recently, in developments pioneered by Axelrod, Von Euler, and others.

Pavlov probably did not use the cardiovascular system in the measurement of conditional reflexes for two reasons: (1) the difficulty at that time of routine recording in the unanesthetized dog, and (2) salivation was simpler, having few connections in the body economy, except with food.

Owing to my use of heart rate measures routinely since 1939 (with Hoffman, Dykman, Robinson, Teitelbaum, Stephens, Lynch, Reese, Gliedman, Newton, Perez-Cruet, Andrus, and others) we have been able to see and

measure what Pavlov could not observe except in extreme cases, *viz.*, the influence of the experimenter, the Effect of Person. This term is meant to cover all effects of one individual on another, whether man on dog, dog on dog, insect on insect, *etc.*, whether this effect be inborn or acquired. The influence of the individual, seen in our experiments by recording heart rate, may act as an acquired signal for what has been his relation to the subject in the past, or as the result of inborn relationships. The inborn "effect of person" is evident throughout the animal kingdom, though its mechanism remains a mystery.

Pavlov did, however, note the effect of the experimenter, but as he did not use the heart rate, he saw it only in certain instances, which he considered arising from a master-subject relation.

With the use of cardiovascular measures of the conditional reflex, accurate relations are seen that are not evident when only the motor or the motor and the secretory responses are included. Cardiovascular changes, like salivary and gastric changes, are autonomic responses; but unlike digestive secretions, the cardiovascular response is a general, supporting activity, preparing the body for an emergency, quickly supplying blood to activated organs involved in the emergency. In 1939, Hoffmann (Oslo) established the fact that the heart rate in the cardiac conditional reflex is parallel in intensity to the quantitative salivary conditional reflex. The cardiac conditional reflex, however, differs from the specific conditional reflexes in two special respects: it is the first to form and the last to disappear. It sometimes forms with a single pairing of the conditional stimulus with the unconditional stimulus. However, when the salivary conditional reflex or the motor conditional reflex is extinguished and the dog appears to be completely inhibited and quiescent, his cardiac conditional reflex may be as active as if there were no extinction of the conditional reflex. The persistence of the heart rate in the conditional reflex and its resistance to adaptation through extinction is what I term *schizokinesis*. There is not only a schism between cardiac function and observable superficial behavior, but it reproduces a maladaptation or lack of harmonious activity of the various physiological systems. The organism may be quiet and adjusted in one function and violently agitated in another. This

could be the cause of hypertension and other cardiac diseases—the body reacting to old and long forgotten episodes with the heart but not with the somatic system.

Pavlov rejected subjective explanations and assumptions, not because he considered them unimportant but because of the difficulty of treating them scientifically.

In certain dogs, Pavlov recognized a split (*schizokinesis*); he saw that some dogs would salivate while remaining rigid and motionless in their postures (*cataleptic*) but he thought this was exceptional. I, however, consider *schizokinesis* as the rule rather than the exception, an advantage gained by adding the cardiac measures.

Personality

The personality and the character of Pavlov are unique in the history of science. He was a believer in physical exercise—he called it "muscular gladness". At the age of 80 he outplayed the younger members of his staff, playing from 8 a.m. till 9 p.m. during the "white" nights of the Russian summer.

The regularity of his habits was exceptional. He arose about 6 a.m., and until the last few years of his life, walked the three miles to and from the laboratory, ate his dinner at 6 p.m., rested or slept from 7:30 to 9:30; drank tea with any visitors from 9:30 till 10:30 p.m. and worked from 10:30 p.m. till 1 a.m.

In everyday affairs outside of the laboratory he was poorly adapted. He said he traveled like luggage. He could not be trusted, relates his wife, to buy a railroad ticket or a suit of clothes by himself.

Outside of the laboratory he was impatient, impetuous, dogmatic; he could not sit in a barber's chair for three minutes without jumping up and fussing about the waste of time. In surgical operations he was the most skillful of all surgeons I have seen. He was quick to anger and also quick to apologize afterwards if he saw he was wrong.

In his advice to young scientists in his Last Will and Testament he said, "Be not overcome by vanity, . . . vanity will cause you to reject useful advice," and he exhorted them to humility.

He had little interest in material things. For the early part of his career he was impoverished. When at about age 50 his wife was bemoaning the fact that he did not get an ap-

pointment as full professor and a better salary, Pavlov, at that time interested in the development of the butterfly larva, exclaimed: "Do not bother me about such trifles, do you not see that my butterflies have died?" (due to the freezing temperature in the apartment).

Extraordinary was his stand for what he considered the truth and the right. This was the more remarkable when one considers how he carried this out in the face of such ruthless dictatorships.

In 1923, distressed by the general destruction and cruelty of the Revolution, he requested from Lenin permission to transfer his laboratory abroad. Lenin refused, but told Pavlov he should have all he needed personally and for his work. This was during the famine and, though he and his family underwent severe privations and chronic hunger, Pavlov refused: "Unless you give these rations to each one of my collaborators I will not accept them." When, in 1927, the sons of priests were expelled from the medical schools, Pavlov resigned: "I also am the son of a priest, and if you expel the others, I will go too!"

He protested to Stalin the admission of Communist professors to the Russian Academy of Sciences—"On account of what you are doing I am ashamed to be called a Russian!" In a public lecture he vehemently stated: "You call this a social experiment, but for this kind of experiment I would not sacrifice a frog's hind leg!"

I left Russia, after seven years, in 1929, returning to visit Pavlov in 1933 and again in 1936 at the time of the International Physiological Congress. In 1933, when I asked him

why he was less vehement against the government, he smiled and said it was too hard on his heart to get so angry. In 1935, a year before his death, he firmly stated that he hoped to see the success of the Russian social experiment, although he had earlier vociferously denounced Marxism.

In my opinion, his change of attitude was due to two reasons: being a Russian patriot and seeing war clouds on the horizon (with Japan), he felt he should support his native land; secondly, he became impressed by the handsome support of the government to science and apparently forgot about their repressions.

Toward religion, Pavlov was disinterested until the persecution of the church after the Revolution, when he strongly supported the church and religion: "I envy no one anything except my wife her religious faith," and he said that life was "easier and happier with religion."

Over the portals of the new laboratory Pavlov had cut in stone "Observation and Observation." He carried out this dictum to the end of his life. He was working at the laboratory within a week of his death (from pneumonia), and up until the last half hour of his death he was recording observations on his own behavior. His death occurred at age 86 on February 23, 1936. Never has there been in the whole list of heroes who have stood for the truth one who was more vehement and outspoken than Pavlov; and, paradoxically, against the most repressive and absolute dictatorship, he lived to die a natural death.