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Guest Editorial

Ivan Petrovich Pavlov (1849-1936)

Our mouth waters when we think of our favourite food, and so does that of a dog. But can we know what a dog is thinking about? An experimental entry to a dog's mind was achieved by Pavlov through a rather convoluted chain of studies performed at the beginning of the century that is now coming to an end. His approach is now common knowledge . If presentation of food is preceded every time by a bell, and the sequence is repeated several times, a stage is finally reached when the dog starts salivating immediately on listening to the bell. It may be reasonably assumed that by now the bell makes the dog think of food. In technical terms, an inborn reflex has been used to establish a conditioned reflex wherein the animal responds to an ordinarily neutral stimulus (in this case, the bell), which is henceforth called a conditioned stimulus.

Ivan Petrovich Pavlov was born in 1849 into a family of priests in the town of Ryazan in Russia (1). He was expected to follow in his father's footsteps. So, as a teenager, Pavlov studied for priesthood at the Ryazan Ecclesiastical Seminary. In the 1860s, the cultural environment in Russia changed dramatically as the ruler, Czar Alexander II, permitted the publication of Western scientific work in the Russian language (2). Pavlov read some popular publications and was greatly influenced by Darwin's theory of evolution. This was a turning point in his career. He decided to abandon the family tradition in favour of natural science. He matriculated in 1870 at the Faculty of Physical-Mathematical Science of the University of St. Petersburg. During this period Pavlov got a chance to work under the physiologist, I.F. Cyon, and was greatly impressed by him. In 1875, Pavolv enrolled in the third-year course of the Medico-Chirurgical Academy. His love for Physiology can be best expressed in his own words, "I did so not for the purpose of becoming a physician but with the idea that after getting the degree of Doctor of Medicine, I would qualify for a chair in physiology". In 1890 Pavlov was appointed Professor of Pharmacology and then, in 1895, Professor of Physiology at the Imperial Military-Medical Academy in St. Petersburg. In the meantime he had got married and was the father of a son. His wife, Sara Vasilievna, was a perfect homemaker which allowed Pavlov to pay undivided attention to his work.

To begin with, Pavlov started with research on the digestive processes. Throughout the 1890s, Pavlov deployed his coworkers along standardized lines of investigation for each digestive gland. He first sought to establish nervous control over each gland; then to devise a dog technology for the precise quantitative measurement of its secretory products during normal digestion; then to establish the specific exciters for each gland; and finally, to describe quantitatively the gland's secretory patterns. As Pavlov considered the gastric and pancreatic glands most important for digestion, research concentrated on these glands. Pavlov found that digestive secretion occurred in two phases: he called the first one psychic secretion, and the second neural chemical secretion. He postulated that neural chemical secretion was produced when the psychic secretion acted on the food in the stomach. For the salivary gland the psychic secretion was essentially identical in quantity to the nervous-chemical secretion. From this Pavlov concluded that in case of salivary gland 'psychology over-shadows physiology'. He went to the extent of saying that the salivary gland 'literally has a mind of its own'. In spite of the importance given to the psyche, it remained black boxed till Pavlov turned to some psychology experts for help. The first of them was Snarsky. Snarsky found that repeated introduction of black coloured acid into the dog's mouth produced profuse salivation. Afterwards, water coloured black also produced salivation. A similar effect was obtained even when the animal was only shown a bottle containing any black liquid. Snarsky interpreted the results of this experiment as a manifestation of the animal's specific psychic activity. Snarsky explained 'psychic secretion' to be the result of an association or as a habitual reflex. The next psychologist to work with Pavlov was Tolochinov. Tolochinov coined the expression 'reflex at a distance' because salivation occurs while food is still at some distance from the mouth. Gradually Pavlov's research drifted more towards psychology. He chose to replace the term psychic secretion by the term 'conditional reflex' . Why he chose the term conditional reflex is best explained in Pavlov's own words, "Our experiment in physiological form always gives one and the very same result ... ... this is an unconditional reflex; the basic characteristic of the psychic experiment, on the other hand, is its inconsistency, its apparent capriciousness. Nevertheless, the result of the psychic experiment also recurs, otherwise we could not even speak about it. Consequently, the entire matter is only in the great number of conditions influencing the result of the psychic experiment as compared with the physiological experiment. This will be, then, a conditional reflex" (3). The term has since been modified to conditioned reflex.

Further study in the area of conditional reflex gave a new paradigm of learning based on association which was initially refined using animal experiments but has important implications for human learning too. The learning theory given by Pavlov came to be known as classical conditioning. Through this process a neutral stimulus, if repeatedly paired with an unconditional stimulus, gradually acquires the ability to elicit the conditional response even when presented in the absence of the unconditional stimulus. Now the neutral stimulus becomes the conditional stimulus. The principles of conditioning and counter-

conditioning came to be used in modern behaviour therapy to modify behaviour (4).

Several other experimental paradigms based on the same principle have been devised by other scientists after Pavlov's original epoch-making experiments. These include the ability of a conditioned stimulus, repeatedly paired with an unconditional stimulus eliciting fear, to acquire the ability to increase heart rate when presented alone. Similarly a puff of air leads to the blinking of the eye. A conditioned stimulus signaling the puff of air can also lead to blinking when presented alone. Lesion studies have established the regions of the brain involved in forming these conditioned reflexes (5).

Classical conditioning primarily involves associative learning. A close temporal association between two events helps the organism learn from experience and predict the future. A close temporal relationship between the two events may be causal, or only casual. But in either case knowledge of the association may lead to learning and useful modification of behaviour. For example, learning that a dark overcast sky is frequently followed by rain makes us carry an umbrella when it is likely to be needed most. Further, association may not prove a cause-effect relationship, but is frequently the first clue to such a relationship, which can be examined by further experiments. For example, discovery of the association between smoking and lung cancer was the first step in the establishment of causal relationship between the two. Thus associative learning is a basic tool in our acquisition of knowledge about the universe. Hence any experimental tool which helps us explore the mechanisms of associative learning has far-reaching implications.

Pavlov's work also forms the bedrock of modern concepts of nervous and chemical regulation of digestion. Paradoxically, even though his work on classical conditioning is better known, he got the Nobel Prize in 1904 for his work on digestion, when his psychological studies had just begun.

Like Descartes, Pavlov believed in the mechanistic model of life. He was convinced that it should eventually be possible to explain every biological phenomenon in physicochemical terms. It was the irony of fate that he had to grapple with the black-box of psychology. But that did not shake his faith in the mechanistic model, and this tenacity worked to the advantage of both psychology and physiology. Psychology acquired a solid experimental foundation: Pavlov's studies demonstrated that quantifiable and reproducible observations on animals can contribute to progress in psychology. Experiments in psychology, which could stand the rigors of hard-core science, broadened the scope of physiological studies. Pavlov predicted " a stage when the physiological and psychological, the objective and the subjective, will really merge, when the painful contradiction between our mind and our body and their contraposition will either actually be solved or disappear in a natural way". The emergence of the new field of psychoneuroimmunology may be considered the realization of Pavlov's dream.

Pavlov was a contented man. He "renounced practicality in life with its

cunning and not always irreproachable ways", and did not regret it (1). Though science was Pavlov's first love, he actively participated in the social and political life in Russia. He opposed some of the Soviet regime's restrictive policies and defended human rights and academic freedom. Pavlov was himself an atheist, but was tolerant towards the religious expression of others. He bequeathed the qualities of consistency, perseverance and passion to the young.

This tribute to Pavlov during his 150th birth anniversary may be concluded with his advice to the youth: "Learn the ABC of science before you attempt to scale its peaks ... ... Study, compare, accumulate facts ... ... Without them (facts) you will never be able to take off, without them your `theories' will be barren ... ... But when studying, experimenting and observing, do your best to get beneath the skin of the facts. Try to penetrate into the secrets of their origin. Search persistently for the laws governing them ... ... Do not let pride take possession of you. It will result in you being obstinate when you should be conciliatory. It will lead you to reject useful advice and friendly help. It will deprive you of the ability to be objective ... ... science requires your whole life. And even if you had two lives to give they would not be enough. Science demands of man the utmost effort and supreme passion" (6).

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