CLASSIC EXPERIMENT 1:

THE CONDITIONED REFLEX

If a hungry young puppy, newly weaned from milk but never given meat to eat, is shown a piece of steak, it shows no reaction other than idle curiosity. If the puppy is allowed to put the meat in its mouth, however, it immediately begins to salivate and before you know it, the steak is gone. After the puppy has tasted steak on several occasions, a change will be noticed in its behaviour. The puppy now begins to salivate as soon as it sees the meat, before the food reaches its mouth. Some puppies have even been known to begin salivating as soon as they hear the footsteps of the person who usually feeds them. There is nothing particularly startling about these observations; dog owners have been making them since the beginning of time. Pavlov also noted changes in salivation habits while pursuing his research on digestion (he used dogs as subjects). The difference between Pavlov’s observations and those of millions of other dog owners is that Pavlov began to wonder about them. It is often this way in science. Simple everyday phenomena that most of us take for granted strike a brilliant scientist as worth studying, and sometimes important insights result.

Pavlov’s earlier experiments showed that puppies (and other animals) are born with an innate salivation reflex which is triggered by placing food in the mouth. Actually, there is more than one such reflex. The amount and even the type of saliva a puppy produces depends on the nature of the food in its mouth. Pavlov called the salivation stimulated by food a psychic secretion because he believed it was the result of a brain reflex.

Pavlov knew that nerve fibres from the mouth convey information about the food to the brain where it stimulates another brain site that controls the amount (and type) of saliva produced in the digestive glands. But what sets off the reflex when the food is just seen rather than placed in the mouth? And why should a few tastes of meat cause a puppy who previously did not salivate at the sight of meat to begin salivating whenever meat comes into view? Can reflexes work “at a distance”? Can they be learned? These were the questions Pavlov sought to answer.

Before he began doing his own research, Pavlov consulted with psychologist colleagues to see how they would approach such an obviously psychological problem. But he did not like the advice he received. Psychology at the turn of the century was still largely dualist in orientation. Its main goal was describing subjective experiences and its major method was introspection. To be sure, psychologists did experiments — rats ran through mazes, people pushed buttons — but the results of these experiments were interpreted in terms of how the subjects (animal or human) subjectively felt about what was happening to them. A typical psychological explanation for a rat’s behaviour in a maze might be: the rat turned left because the right corridor produced fearful feelings arising from previous electric shocks received there. In this same spirit,
Pavlov was told to find out why a dog salivates at the sight of meat, he should try putting himself in his subject’s place and think like a dog.

Pavlov, however, was a monist. Like Sechenov, he believed that the mind is not separate from the brain and that introspection is not an adequate scientific method. He rejected the introspective approach and resolved to design a method for observing the human mind from the outside. Following Sechenov’s recommendation, he decided to study reflexes without reference to mental states. Preparing to begin this research, he wrote:

*The first and most important task before us, then, is to abandon entirely the natural inclination to transpose our own subjective condition upon the reaction of the experimental animal, and instead, to concentrate our whole attention upon the investigation of the correlation between the external phenomena and the reaction of the organism.*

In other words, Pavlov set out to study “the mind” as a physiologist studies any other organ of the body — by performing overt experiments and seeing what happens. For the rest of his life Pavlov insisted that what he was doing was properly called physiology rather than psychology. Even to this day Russian scientists interested in learning and conditioning are known as physiologists rather than psychologists as in the West.

Pavlov’s classic experiment was conducted in 1905. (Actually, there were several experiments, but all illustrate the same point.) Pavlov had always used dogs as subjects and he already knew a great deal about salivary reflexes, so he decided to use both in his experiment. However, this experiment was different from any he had done in the past. Now he was after the general principles of learning rather than the physiology of digestion. There is nothing special about salivation in this regard, he could have used any reflex and obtained the same findings (a fact confirmed by many subsequent researchers).

Pavlov’s experiment required that a dog be placed in a special apparatus. The idea was to keep the dog from moving about too much and to keep its head looking forward. A cup fastened to the dog’s cheek collected saliva flowing from its parotid salivary gland which had been surgically redirected to the outside of the cheek through a fistula (duct). The saliva passed from the collection cup into a tube which was connected to an instrument designed to measure with great accuracy every drop of saliva the dog secreted.

The experiment took place in a sound-proof room while Pavlov observed what was going on through a viewing port. Using mechanical “arms”, he could move a food pan within the dog’s reach or place some food into its mouth without entering

![Diagram of Pavlov's conditioning apparatus](image-url)
the room. Pavlov also had the ability to present the dog with a variety of different stimuli: lights, buzzers, bells, even a metronome. In later research Pavlov found that any stimulus will work in a conditioning experiment, so long as the animal notices it.

In the classic experiment, Pavlov began by sounding the bell and noting that the dog did not salivate. And there was no reason why it should. At the outset, there was no connection between the bell and salivation. Then followed a series of trials during which the sound of the bell was immediately followed by the presentation of food. On these trials, saliva did appear in response to the food. After the bell and food were paired a few times, Pavlov presented the bell alone, not followed by any food. This time, the animal salivated to the bell even though no food was presented. The paired (bell followed by food) trials were resumed and after a few more pairings, the bell was again presented alone. Now the dog produced more saliva to the bell than it did before. By alternating paired trials with presentations of the bell alone, Pavlov showed that the salivary response was becoming stronger. Thus, a formerly neutral stimulus, the bell, became associated with the food and came to produce salivation. This is all there was to Pavlov’s classic experiment — no control groups, no elaborate statistical procedures — merely the repeated pairing of two stimuli until both produced the same response. Sounds simple, doesn’t it? Well, it is simple. Nevertheless, this experiment had a profound influence on practically every branch of psychology. Before examining why, it is helpful to understand the vocabulary associated with the experiment.

Pavlov called the process by which the bell came to elicit salivation in the dog conditioning. The neutral stimulus, the bell in the classic experiment, is called the conditioned stimulus or CS. Other than arousing curiosity, the CS produces no response in the animal. The other stimulus in the experiment, the food, is called the unconditioned stimulus or UCS. The UCS receives its name because, unlike the CS, it produces an innate, reflexive response (salivation, in the classic experiment). This reflexive response is known as the unconditioned response or UCR. (The UCS and UCR are unconditioned because no training is required to produce their connection.) The CS and UCS are presented sequentially in a series of conditioning trials. The interval between the presentation of the CS and the UCS is known as the inter-stimulus interval. After a number of pairings, the CS begins to produce a response on its own. This response is known as the conditioned response or CR. The CR and UCR, although similar, are not always identical. For example, the dog in the classic experiment usually produced more saliva at the sight of the food than at the sound of the bell even after many conditioning trials. The important point is that, after conditioning, a previously neutral stimulus produces a response formerly associated only with the UCS.

Pavlov’s classic experiment showed how new “reflexes” can be learned by association with innate ones. This demonstration provided empirical support for Sechenov’s view that behaviour can be understood as learned reflexes and, at the same time, encouraged Pavlov in his belief that psychology can be studied by objective physiological methods. Pavlov went on to show that conditioning works with practically any neutral stimulus and with a variety of innate reflexes, even unpleasant ones. For example, a mild electric shock to an animal’s leg produces an innate reflex — the leg is withdrawn. A neutral CS (say, a bell again) paired with the shock soon begins to produce the same response. What is more, the animal’s fear at being shocked (manifested by heavy breathing, barking and so on) also
becomes associated with the CS and it shows its fear every time it hears the bell. The conditioning of emotional responses by classical conditioning will be seen to form an important part of the reasoning behind John Watson’s classic experiment described later in this chapter.

After conditioning occurs, the CS alone elicits the conditioned response even when the UCS is no longer present. However, if the CS is continually presented alone, the CR gradually disappears. In the classic experiment, repeated presentations of the bell alone produce a little less saliva on each trial. Pavlov called this process extinction. Although the gradual nature of extinction makes it seem as if the animal is simply forgetting what was previously learned, matters turn out to be not quite so simple. If, in the classic experiment, an animal who has stopped salivating to the bell is removed from the room and given a rest it will resume salivating to the bell when returned to the conditioning laboratory. This recovery of the CR will occur even though the bell has not been paired again with food. This phenomenon is known as spontaneous recovery; it indicates that although the dog has stopped salivating to the CS it has not forgotten what it learned. Further evidence that extinction is not the same as forgetting comes from reconditioning experiments in which animals who show complete extinction of the CR are again given a series of conditioning trials. Such reconditioning always requires fewer pairings of the CS and UCS than the original conditioning, indicating that some memory of the original learning is still present. Pavlov concluded that in many cases of extinction, the CR is temporarily inhibited rather than forgotten.

Pavlov spent years exploring the limits of conditioning. He found, among other things, that there are optimum CS-UCS intervals (about one-fourth of a second for the salivary response). Longer intervals lead to less efficient learning. He also showed that presenting the CS after the UCS produces no learning at all. This last finding, by the way, is not one that most “armchair” psychologists of the time predicted. To be sure they believed that learning could occur by “association” but no-one before Pavlov guessed that the order in which stimuli are presented makes any difference.

Although the discovery and exploration of the conditioning process would have been sufficient to earn Pavlov a place in the history of psychology, it is the way he used his discoveries that makes his work im-

FIG. 5. The left-hand graph depicts the acquisition of a conditioned salivary response. Drops of salivation produced to the CS (prior to the presentation of the UCS) are plotted on the vertical axis; the number of conditioning trials appears on the horizontal axis. The CR gradually increases until it tops out at about 12 drops of saliva. After 16 conditioning trials, the experimenter switches to extinction. The results appear in the right-hand graph. Note the CR gradually decreases to zero but then recovers when testing begins again after a delay.
portant today. Pavlov showed how conditioning can be used as a substitute for introspection, as an objective way of learning what is happening in a person’s or even an animal’s mind. His major tools, in this effort, were the related phenomena of generalisation and discrimination.

Pavlov noticed almost from the beginning of his research that animals conditioned to salivate at the sound of a bell would also salivate (but not quite as much) at the sound of a buzzer or the tick of a metronome. He concluded that the animals were generalising their conditioned response to stimuli similar to the bell. Subsequent experiments showed that the degree of generalisation (measured by the amount of saliva produced) is directly related to the physical similarity of the stimuli. Pavlov immediately realised that stimulus generalisation provided a window into the “mind” of the experimental animal. By presenting a series of stimuli and noting the size of the CR, he could tell how similar the stimuli subjectively appeared to the animal. If the CRs to two stimuli were equal, then Pavlov knew that — to the animal — the two stimuli were identical. If, on the other hand, one stimulus brought forth copious amounts of saliva whereas the other produced only a few drops, Pavlov knew that the two stimuli, although related, appeared subjectively different to the dog. Although the implications of stimulus generalisation were exciting, Pavlov soon found that he could learn even more by requiring animals to make stimulus discriminations.

In a typical discrimination experiment, the animal must learn that one stimulus is reliably associated with the UCS and the other is not. For example, in some trials the bell could be paired with food (as in the classic experiment), while in other trials a buzzer could be presented by itself. In the beginning the animal makes salivary responses to both sounds, but after a while it extinguishes its response to the buzzer and salivates only to the bell. When this happens the animal is said to have learned to discriminate between the two stimuli. Of course, if the two stimuli are very similar the animal will not be able to discriminate between them and it will continue making the CR to both. Thus, by increasing and decreasing stimulus similarity, Pavlov was able to determine the exact point at which an animal could no longer tell two stimuli apart, that is, the point at which, to the animal, the stimuli appeared identical. In this way, Pavlov was able to measure objectively an animal’s subjective impressions without engaging in the unsatisfactory enterprise of putting himself in an animal’s (or another human’s) mind.

Thus Pavlov’s simple experiment accomplished several purposes. It showed that reflexes can be learned and that such learning accounts for the way an organism reacts in many situations. In addition, it also provided a way to unite physiology and psychology. Pavlov used his classic experiment to show how the subjective contents of the “mind” can be studied without resorting to introspection. Because the classical conditioning procedure can be applied to questions that are too complex for armchair introspection (whether a dog can discriminate between a bell and a buzzer, for example), Pavlov’s classic experiment paved the way for a scientific psychology based on observing objective behaviour.

Pavlov’s research was conducted on animals, but conditioning affects human beings as well. Experimenters have demonstrated human conditioning using reflexes such as the knee-jerk or the eye-blink caused by a puff of air. Conditioning in humans has even been shown when the CRs are physiological. For example, a mild electric shock (the UCS) temporarily increases heart rate (UCR). This reflex is innate. If a bell (CS) is rung
just before the shock, it will eventually come to produce an increased heart rate (CR) all on its own. It is possible that many of our emotional reactions are learned through conditioning. For example, a baby, who normally looks up at its mother while nursing, learns to associate its mother’s face with the pleasures of food. Soon, through conditioning, the mother’s face alone evokes the same pleasurable feeling. Negative emotions can also be conditioned. Neutral stimuli paired with a fearful experience may come to produce fear entirely on their own. This hypothesis was the motivation for Watson’s classic experiment which is discussed next.

JOHN WATSON: BEHAVIOURIST
John B. Watson was born in 1878 in a small community near Greenville, South Carolina, in southern USA. As a younger he walked three kilometres each way to attend a small country school and spent a great deal of his own free time doing manual work. He became a fair carpenter while still young and, like Pavlov, maintained a life-long interest in working with his hands. As an adult he built a 10-room house by himself over the course of two summers, and even at the age of 55 he spent his weekends building a barn. Although it is hard to generalise from such a small sample, it is interesting to note that the two men most responsible for the birth of behaviourism were both fond of manual work. In later chapters in this book the lives of antibehaviourists such as Lewis Terman are described. By and large, they turn out to be mechanically inept people who hated working with their hands. It seems psychologists may choose scientific viewpoints that fit comfortably with their own personalities.

Watson was a wild and impulsive youth who got into trouble with the police for fighting and for firing guns on more than one occasion. Although he gave up this reckless behaviour when he reached adulthood, some rebelliousness and resistance to authority remained with him throughout his life. In any event, Watson’s troubles were never serious enough to interfere with his school performance. He entered Furman University in Greenville in 1894 when he was 16 years old and emerged five years later with a master’s degree. He supported himself during those five years by working as an assistant in the chemical laboratory, a job in which his manual dexterity served him well.

Watson’s personality is revealed by his profoundly negative opinions of Furman University and of education in general. He felt that school “leads to a softness and laziness and a prolongation of infancy with a killing of all vocational bents”. He looked upon colleges and universities as places “for boys and girls to be penned up in until they reach their majority” at which point the world could “sift them out”. Watson reports that he was the only person to pass Greek in his senior year. He accomplished this feat by going to his room at two o’clock in the afternoon before the final exam with one quart of Coca-Cola syrup and sitting in a chair cramming until time for the exam the next day.

In his fourth year, by “some stroke