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NINE

The Behaviorists

A New Answer to Old Questions

By the late 1890s, humankind, after some twenty-four centuries of speculation about how the mind works, seemed on the verge of understanding it. The followers of Wundt and James were, in their different ways, introspectively examining their conscious sensations and thoughts; Freud was peering into the murky depths of his own unconscious and that of his patients; and Binet was preparing to measure the growth of the intellect throughout childhood.

Why, then, were a number of psychologists and physiologists playing little tricks on animals that could tell nothing about their inner experiences, and calling it psychological research?

How could it advance the understanding of the human mind to offer a baby chick two kinds of caterpillars, one of which presumably tasted bitter? ("Presumably" because it appears that the researcher himself never tasted it.) Or to soak some kernels of corn in quinine, others in sugar water, dye them different colors, and strew them before chickens? The baby chicks pecked at both kinds of caterpillar and shortly began to avoid the bitter ones, and the chickens soon ate only the sweetened kernels of corn, but what did any of that have to do with human learning?[1]

How could any of the great questions of psychology be answered by putting a hungry cat in a slatted "puzzle box" from which it could escape only by stepping on a treadle that opened a door? After placing the cat inside and latching the door, the researcher set a scrap of fish outside.

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The cat, galvanized by the sight and smell of the fish, pressed its nose into the space between the slats, thrust its paws through, then backed away and scrambled wildly around the cage for two and a half minutes until it happened to step on the treadle, causing the door to fall open. Out popped the cat to eat the bit of fish—only to be put back in the box for another try. It did better the second time (forty seconds to escape), worse the third time (ninety seconds), and only after over twenty trials promptly released the door each time.[2] A tiny addition to knowledge, no doubt—knowledge about cats. But what did that have to do with people?

How could it enlighten human beings about their own minds to harness a dog in a box, start a metronome ticking for fifteen seconds, then drop some meat powder in a bowl inside the box, and repeat this process until at the sound of the metronome saliva would drip from the dog's mouth even though the meat powder had not yet been delivered? Many psychologists, when they first heard about this experiment, said that it represented a type of association that accounted for only simple forms of behavior in animals; the researcher, however, believed that the principle he had discovered would explain even the most advanced and complex forms of behavior in human beings.[3]

These experiments and many like them were part of a bold attempt, beginning at the end of the nineteenth century, to answer—actually, to eliminate from discussion—the most perplexing and intractable problems of psychology: those having to do with the nature of mind. Among them:

> —What is it within us that sees, feels, and thinks, every moment we are awake, vanishes temporarily when we sleep (or, if we dream, seems to leave the body and travel elsewhere), and disappears permanently the instant we die? Is it identical with, or a part of, the soul? Or is it something else equally nonmaterial?
> —In either case, how could a nonmaterial essence —not even a vapor, not even a shadow—exert any influence on the material body it inhabits, and how could it feel the body's sensations?

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> —Does it endure after the body dies—and if so, where? And lacking any connection with sense organs and nerves after death, how can it perceive anything of whatever realm it inhabits?

These were but a few of the questions about the nature of mind, mental states, and the processes of thinking that philosophers, theologians, and protopsychologists had long sought to answer, though their efforts created more puzzles than they solved.

There was, however, another and totally different answer to such questions, though it was abhorrent to most philosophers and psychologists. Mind is an illusion; there is no incorporeal self within us; our mental experiences, including consciousness, awareness of self, and thinking, are only physiological events taking place in the nervous system in response to stimuli.

Over the centuries a few materialist philosophers suggested this alternative in vague and unconvincing terms, but as the physical and physiological sciences developed, the hypothesis became increasingly specific and plausible. By the latter half of the nineteenth century, Helmholtz and a number of other physiologists were linking simple sensations to electrochemical events in the sensory nerves, and followers of Wundt were beginning their effort to construct a whole psychology out of the elemental components of sensation and perception.

Toward the end of the century the rejection of "mentalism" (the belief in mind as a separate essence) gained support from a quite different quarter—animal psychology, a field in which interest had been sparked by Darwin's demonstration of the link between humankind and the other species. At first some biologists and psychologists had assumed that animals possess thought processes similar to, though simpler than, our own; in the 1880s, George Romanes, an English biologist, explored animal psychology through "introspection by analogy"; he asked himself what he would do were he the animal in any given situation. But in 1894 the zoologist C. Lloyd Morgan—the researcher who offered two kinds of caterpillars to chicks and two colors of corn kernels to chickens—sliced this approach to the bone with a version of Ockham's Razor:*

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> In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty if it can be interpreted as the exercise of one which stands lower in the psychological scale.[4]

Even the intricate tricks performed by pet dogs, Morgan said, could be explained in terms of reflexes and simple associative learning; there was no need to assume the existence in the animals of higher mental functions.

Jacques Loeb, a German-born biologist, went even further. During the 1890s, when he was teaching in the United States, he argued on the basis of wide-ranging evidence that a good deal of animal behavior consists of "tropisms," a term he used for all involuntary responses of worms, insects, and even higher animals to stimuli. In his view, much or most animal behavior consists of such tropisms, the creature being no more than a stimulus-driven automaton.[5]

The implication of all this seemed clear to a growing number of psychologists: if human beings are related to animals, and if animal behavior can be explained without mentalist concepts, then part of human behavior—perhaps even all of it—can be, too. The answer to the intractable questions about the nature and operations of the mind might be utterly simple: mind does not exist, or if it does, it can be ignored, since it is not only unobservable but unnecessary to the explanation of behavior.

Behavior— overt, visible, indisputable action —*that* is the real subject of psychology, rather than memory, reasoning, will, and all the other unseen processes imagined by mentalist psychologists. Not conjectures and hypotheses about invisible functions, but *laws* derived from observable phenomena, such as the cat's learning to escape from the puzzle box, could be the substance of a thoroughly objective and rigorously scientific psychology. Such was the thinking of many psychologists in the 1890s and the early 1900s, long before the word "behaviorism" had been coined or the theory's tenets set forth.

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Two Discoverers of the Laws of Behaviorism: Thorndike and Pavlov

The animal experiments mentioned above exemplify two different principles of behaviorism: the laws of natural learning (the chickens' associating a particular color with the reward of the sweet-tasting corn, the cat's associating a step on the treadle with escape and food), and the laws of conditioning (the dog's salivating at the sound of the metronome, a stimulus artificially linked to the salivary reflex). These laws were discovered by two men of dissimilar backgrounds, training, and personality, one a brilliant and dedicated psychologist, the other a physiologist who was scornful of psychology and doubted that it could be regarded as a science.

The first was Edward Lee Thorndike (1874–1947), a psychologist of such catholic and diverse interests that some historians have classified him as a functionalist, others as a behaviorist, and he himself as neither.[6] Except for one year, he spent all of his long career in psychology at Teachers College, Columbia University, where he researched and wrote fifty books and 450 articles dealing with educational psychology, learning theory, tests and measurements, industrial psychology, language acquisition, and social psychology. For good measure he produced such unusual items as a teachers' list of the twenty thousand words students most often encountered in general reading, a rating of American cities according to how desirable they were to live in, and a highly popular dictionary. Our interest in Thorndike, however, is focused on his work as a graduate student, when, notwithstanding his later demurral, he was very much a behaviorist.

Born in Massachusetts, Thorndike, the son of a Methodist minister, was a homely, lonely, and painfully shy child who found satisfaction in his studies. Exceptionally gifted, he ranked first or second in all his high school courses and graduated from Wesleyan University in 1895 with the highest average achieved there in fifty years. He found the basic undergraduate psychology course dull but James's *Principles of Psychology* entrancing. He went on to Harvard for graduate work, planning to study English, philosophy, and

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psychology, but after two courses with James he was fully committed to the last of these.

Despite his admiration for James, he chose to do graduate research on a very un-Jamesian topic, "the instinctive and intelligent behavior of chickens." Later in life he said that his motive had been "chiefly to satisfy requirements for courses and degrees…I certainly had no special interest in animals."[7] Perhaps, but no doubt a shy person (as he still was at the time) would find animals easier to work with than people. James approved the project and Thorndike bought a batch of chicks, which, for lack of laboratory space, he housed in his room until his outraged landlady ordered him to get rid of them. When he told James of his problem, James, going far beyond the bounds of professorial duty, allowed Thorndike to install them in the cellar of his house.

There, using stacked books, Thorndike built a maze with three blind alleys and a fourth leading to an adjoining enclosure in which were food, water, and other chicks. When he put a chick in the maze, it raced in and out of the blind alleys, peeping loudly, until it blundered to the exit; when he put it back in again and again, it slowly got better at finding its way out. Clearly, there was no intelligence at work but something much simpler. In Thorndike's words:

> The chick, when confronted by loneliness and confining walls, responds by those acts which in similar situations in nature would be likely to free him. Some one of these acts leads him to the successful act, and the resulting pleasure stamps it in. Absence of pleasure stamps all others out.[8]

Those sentences contained the seed of behaviorist theory.

The following year, after being rejected by a young woman he had proposed to, Thorndike felt it necessary to flee from Cambridge. He transferred to Columbia University to complete work for his Ph.D. under James McKeen Cattell, who was then in the middle of his effort to measure intelligence by anthropometric tests. Though Thorndike too would later do research in mental testing, for his dissertation he continued his animal-learning studies. From fruit and vegetable crates he built fifteen puzzle boxes of various designs, and in the attic of an old

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university building began studying the ability of cats (plus a few dogs) to learn how to escape.

In some boxes his cats could escape by performing a single action: stepping on a treadle, pushing a button, or pulling on a loop of string. In others, escape required multiple actions such as pulling on the loop and then moving a stick, and in one experiment Thorndike released the door only if the cat licked or scratched itself. Driven by fierce ambition—Thorndike meant to (and did) reach the top of his profession in five years—he worked so hard in the attic with his animals that in less than a year he had arrived at several findings that leaders in the field at once recognized as being of major importance. The New York Academy of Sciences invited him to talk about his results at a meeting in January 1898; in June, *Science* published a paper by him on his work; his thesis appeared as a monograph supplement to *Psychological Review* late in the year; and the American Psychological Association had him make a presentation at its annual meeting in December.

Thorndike's findings, though simple, had significant implications. First, the cats had not learned to escape by means of reasoning or insight; rather, by trial and error they slowly eliminated useless movements and made the connection between the appropriate action and the desired goal. They learned nothing from seeing how an experienced cat escaped, or from having Thorndike manipulate their paws to release the door of the box. All the cats learned to escape when only a single response was required, but more than half of them never learned to escape when two responses were required.

From all this, Thorndike formulated a theory of "connectionism," expressed in two laws of learning.

One he called the Law of Effect. The puzzle box was a stimulus that elicited a number of responses; the effects of most were "annoyers" (failures to escape or to reach the food), but one was a "satisfier," which yielded both escape and food. Annoyers and satisfiers selectively "stamp in" (or, as Thorndike later said, "reinforce") certain stimulus-response connections and weaken or eliminate others. The effect of any action thus determines whether it becomes the response to a given stimulus or not.

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The second law he called the Law of Exercise. Other things being equal, "a response will be more strongly connected to a stimulus in proportion to the number of times it has been connected with that situation and to the average vigor and duration of the connection."

Thorndike's monograph had an immediate effect on psychological thinking. It lent new, research-based meaning to old philosophic notions of associationism; it provided convincing support for C. Lloyd Morgan's dictum against assuming higher mental functions if lower ones could explain behavior; and it established animal experimentation as the pattern for most learning research for the next half century.

While later researchers (and Thorndike himself) would somewhat modify the Law of Effect and greatly qualify the Law of Exercise, the two laws became the basis of behaviorist psychology, human as well as animal. For although human behavior is vastly more sophisticated than that of cats, behaviorists argued that it is explicable by the same principles; the difference, Thorndike said, is simply that "the number, delicacy, and complexity of cell structures" in the human brain make for a corresponding "number, delicacy, and complexity of associations."[9] He even held that the reason human culture develops so slowly is that it is the result of trial-and-error learning with accidental success, the same method by which animals acquire associations.

Ivan Pavlov (1849–1936), a very different breed of scientist, was a research physiologist who spent the first half of his career investigating the digestive process. It was in the course of this work that he noticed the odd phenomenon of the salivating dog, and he spent the second half of his career studying what he called "conditioned reflexes."[10] From first to last he considered conditioning a physiological rather than a psychological process, and although the laws of conditioning became as basic to behaviorism as the laws of learning and effect, he had so poor an opinion of psychology that he threatened to fire anyone in his laboratory who used psychological

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terminology. To his dying day he insisted that he was not a psychologist but a physiologist studying brain reflexes.

Pavlov was born in a central Russian farming village. His father was the local Orthodox priest, his mother the daughter of a priest, and Pavlov planned to follow in the family tradition. Czar Alexander II had recently made free education available to gifted but poor students; Pavlov qualified on both counts, and was educated in a primary school and a seminary. But while he was at the seminary he read Darwin's *Origin of Species* and the Russian physiologist Ivan Sechenov's *Reflexes of the Brain*, and underwent something akin to a conversion. Abandoning his plans for the priesthood, he quit the seminary to study natural science at the University of Saint Petersburg (again thanks to the Czar's largesse), where Sechenov was a professor of physiology.

Pavlov graduated in 1875 with a brilliant record and went on to study medicine, but his goal was research, not practice, and he had to support himself—and, after 1881, a wife—on ill-paid assistantships. At that time, Russia offered far fewer opportunities to young scientists than did the Western countries, and despite Pavlov's extraordinary talent and his impressive research studies in physiology, he could eke out only a marginal existence for many years.

He was too absorbed in his work, however, to be concerned about the exigencies of daily living; he was the embodiment of the impractical intellectual. During his engagement, he spent what little money he had on luxuries for his fiancée and only once bought her something practical: a pair of shoes that she urgently needed for a trip. But when she got to her destination and opened her luggage, she found only one shoe. She wrote to ask what had happened, and he replied, "Don't look for your shoe. I took it as a remembrance of you and have put it on my desk." When they were married and living in near poverty, he often forgot to pick up his monthly salary until his wife reminded him. One winter, when he could afford little fuel for their apartment, a batch of butterflies he kept at home to study metamorphosis succumbed to the cold. When his wife complained about their poverty, he answered, exasperated, "Oh, leave me alone, please. A real

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misfortune has occurred. All my butterflies have died, and you are worrying about some silly trifle."

But in the laboratory, Pavlov was practical, perfectionist, and systematic. He expected his assistants to live up to his standards, and castigated or fired those who fell short in any way, whatever the reason. During the Revolution (with which, for many years, he had no sympathy, though eventually he became a supporter of the system), one of his employees arrived late. When Pavlov upbraided him, the man said there had been street fighting en route and he had been in danger of losing his life, but Pavlov angrily replied that that was no excuse and that devotion to science should supersede all other motives. According to some accounts, he sacked the man.

That was long after Pavlov had become successful. In 1891, at the age of forty-two, he was at last appointed professor at the St. Petersburg Military Academy, and a few years later professor at St. Petersburg University. With this solid footing, he was able to organize the Institute of Experimental Medicine, the laboratory in which he conducted his research for forty years. His work during the 1890s was on digestion, which he studied by surgically creating in the stomach of laboratory dogs a little pouch or separate compartment with a fistula implanted in it. This enabled him to observe the gastric reflex (the secretion of gastric juices when the dog began to eat) without the contaminating presence of food. His findings won him a Nobel Prize in medicine in 1904, and in 1907 he reached the height of scientific prestige in Russia when he became an academician, or full member, of the Academy of Sciences.

Sometime between 1897 and 1900, in the course of his gastric-reflex research, Pavlov became aware of an odd and annoying phenomenon: the dogs would secrete gastric juices and saliva at times other than feedings—for instance, when they saw or heard their keeper shortly before a regular mealtime. At first Pavlov regarded this as a nuisance, since it interfered with the data on the quantities of digestive secretions. But he recognized that there must be an explanation for the production of such fluids when there was no food in the dog's mouth or even nearby. An obvious one was that the dog "realized" that

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mealtime was near and these thoughts produced the secretions, but the resolutely antipsychological Pavlov would have nothing to do with such subjective speculations.

Though reluctant to do research on the matter, he finally decided he could look into it, since in his opinion it was an entirely physiological phenomenon—a "psychical secretion" due to a reflex in the brain caused by the stimulus of the sight or sound of the person who usually brought food. In 1902 he began to study how and when such a stimulus, inherently unconnected to the glandular response, was capable of causing it, and he spent the rest of his life investigating the phenomenon.

Although Pavlov was an expert surgeon, he spared himself the labor of creating stomach pouches for this research. Since the dogs produced saliva as well as gastric juices at the sight of their keepers, it was enough to implant a simple fistula in one of the salivary glands and hook this up to a collecting and recording device. The dogs were trained to stand still on a table, and were praised, petted, and fed for doing so. Eager to please, they would jump onto the table without being told to and patiently remain there, loosely harnessed in place and attached to equipment. The harness was necessary to prevent disruption of the apparatus, a rubber tube connecting the fistula to a collecting vessel and a recording drum. The dogs faced a wall with a window in it; directly in front of them, inside the experimental chamber, was a bowl into which food could be mechanically dropped.

As soon as a dog had food in its mouth, its saliva began to flow; since this was a response that required no training, Pavlov called the food an "unconditioned stimulus" and the salivary response an "unconditioned reflex." The matter to be studied, however, was the link between a neutral stimulus and the same reflex. Typically, the experimenter, out of sight so as not to be a signal to the dog, would make a sound—ring a bell, buzz a buzzer—and would cause food to drop into the bowl anywhere from five to thirty seconds later. At first, the sound of the bell or buzzer would produce only a normal reflex—the pricking-up of the dog's ears—but no salivary response. But after a number of these sequences, the sound alone

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would cause the dog's saliva to start flowing. In Pavlov's terms, the sound had become a "conditioned stimulus" to salivation, which had become a "conditioned reflex" to the sound.

Pavlov and his assistants ran many variations of this experiment. Instead of a sound, they would flash a light or rotate an object the dog could see through the window, manipulate apparatus that touched the dog or tugged on a part of its harness, change the length of time between the neutral stimulus and the delivery of food, and so on. In all cases, neutral stimuli could be made into conditioned ones, but with varying degrees of ease; a neutral odor (not of food) might require twenty or more pairings to become a conditioned stimulus, while the rotation of an object in the dog's view might take only five pairings, the sounding of a loud buzzer only one.[11]

A psychologist would have called the conditioning process associative learning, but Pavlov explained it in physiological terms. Acknowledging indebtedness to his mentor, Sechenov, and to Descartes, the first to offer a reflex theory, he theorized that an unconditioned response, such as salivating on taking food into the mouth, was a brain reflex: A direct connection existed between the sensory and motor nerves in the spine or lower brain centers. In contrast, a conditioned response, such as salivating at the sound of a bell or other formerly neutral stimulus, was the result of new reflexive pathways created by the conditioning process in the cortex of the brain.

Pavlov developed this theory of localized brain reflexes in great detail to fit his findings about conditioning. But it was largely ignored except in the Soviet Union, and in America was soon conclusively disproven by the psychologist Karl Lashley, who removed different areas and amounts of cortex from rats, then had them learn mazes, and found that their loss of ability to learn was related not to the destruction of any particular cortical area but to the total amount destroyed.[12]

The fate of Pavlov's physiological theory, however, in no way diminished the enthusiastic acceptance of his laboratory data and laws of conditioning as a major addition to psychological knowledge. These were some of his more noteworthy findings:

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Timing: The sequence of the stimuli is critical. Only if the neutral stimulus precedes the unconditioned reflex does it become a conditioned stimulus, capable of eliciting the reflex. In one experiment, an assistant gave a dog food and five to ten seconds later turned on a loud buzzer; even after 374 such pairings, the buzzer alone did not bring about salivation. When he sounded the buzzer *before* giving the dog food, a single pairing was enough to make it a conditioned stimulus.[13]

Extinction: Unlike an unconditioned reflex to an unconditioned stimulus, the connection between a conditioned stimulus and a conditioned reflex is impermanent. If the conditioned stimulus is repeatedly presented without reinforcement (food), the salivary response weakens and eventually disappears.

Generalization: If a dog was presented with a stimulus similar to, but somewhat different from, a stimulus it had become conditioned to—for instance, a tone higher or lower than the one paired with food—the dog would salivate, but less strongly than in response to the conditioned tone. The greater the difference between tones, or between any conditioned stimulus and a related stimulus, the weaker the response. The dog was, in effect, generalizing from its experience and expecting similar experiences to yield similar results.

Differentiation: After a dog had been conditioned to salivate on hearing a given tone and also on hearing another tone some notes lower, if the first tone was then always reinforced by food but the second one never was, the dog would gradually cease to salivate in response to the second tone. The dog had learned to "differentiate"—the term more often used by English and American psychologists is "discriminate"—between the stimuli.

Experimental neurosis: In seeking to determine the limits of his dogs' ability to discriminate, Pavlov unexpectedly

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precipitated in them something resembling a nervous breakdown. In one historic study, a dog learned to discriminate between a circle flashed on a screen, always followed by food, and an elongated ellipse flashed on the screen, never followed by food. When the dog's salivating at the sight of the circle and failure to salivate at the sight of the ellipse were well established, the assistant began changing the shape of the ellipse, making it ever more nearly circular. The dog kept learning to discriminate between the circle and the rounder ellipses until the ratio of the axes of the ellipse was 7:8. The assistant then tried an even rounder ellipse whose axes had a ratio of 8:9, but at that point, Pavlov later wrote,

> the hitherto quiet dog began to squeal in its stand, kept wriggling about, tore off with its teeth the apparatus for mechanical stimulation of the skin, and bit through the tubes connecting the animal's room with the observer, a behavior which never happened before. [Later,] on being taken into the experimental room the dog barked violently, which was also contrary to its usual custom; in short, it presented all the symptoms of a condition of acute neurosis.[14]

Only after long rest and careful treatment did the dog recover enough to tolerate experiments in easier differentiations.

Pavlov believed that he had identified the fundamental unit of learning in animals and human beings. All learned behavior, he said, whether acquired in school or outside it, was nothing but "a long chain of conditioned reflexes" whose acquisition, maintenance, and extinction were governed by the laws he and his assistants had discovered. His ideas profoundly influenced Russian psychology from early in the century until the 1950s, but in the West remained largely unknown for some years, even though Pavlov had mentioned conditioning in his 1904 Nobel award address.

In 1908 Robert Yerkes (who would later direct the development of the Army Alpha and Beta) and a colleague learned about Pavlov's work from German journals,

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corresponded with him, and published a brief article in the *Psychological Bulletin* describing his method and main findings. They emphasized the usefulness of his research methods but failed to predict the effect the concept of the conditioned reflex would have on American psychology.[15]

But in 1916 John B. Watson—whom we are about to meet—began to spell out how Pavlovian conditioning enlarged the behaviorist theory of psychology, and a few years later he termed the conditioned reflex "the keystone of the arch" of behaviorist theory and methodology.[16] In

1927 Pavlov's book, *Conditioned Reflexes*, appeared in English, and from then on behaviorist psychologists rapidly absorbed his ideas and borrowed his research methods. The number of articles on Pavlovian conditioning published in psychological and medical journals increased geometrically from the mid-1920s on, totaling nearly a thousand by 1943.[17] In 1951, Professor Henry Garrett of Columbia University summed up the impact of Pavlovian ideas on experimental psychology, which had been largely behaviorist for more than three decades:

> There is perhaps no subject in experimental psychology upon which more time and effort have been expended than upon the conditioned reflex. The acquisition of conditioned reflexes by animals, children, and adults; the relative ease of conditioning of various reflexes; the stability of conditioned reflexes, their extinction and reappearance; the relation of school learning to ease of formation of conditioned reflexes… [have all] been subjected to experimental attack… Many psychologists hoped—and the strict objectivists believed—that the conditioned reflex would prove to be the unit or element out of which all habits are built.[18]

Mr. Behaviorism: John B. Watson

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No one did more to sell behaviorism to American psychologists than Professor John B. Watson of Johns Hopkins University. A gifted huckster, he energetically and skillfully peddled himself and his ideas to his colleagues, rose swiftly to the top of his profession while launching the behaviorist movement, and later, having been expelled from academia because of a sexual scandal, had a second and financially lucrative career as psychological adviser to a major advertising firm.[19]

Like the fictional traveling salesman, Watson exuded self-assurance, stated his views flamboyantly and with certainty, and was a lifelong womanizer. Behind the facade, however, he was insecure, afraid of the dark, and emotionally frozen. He could be sociable and charming in company, but if the conversation turned to deeper feelings he would leave the room and busy himself with chores. He was loving to animals but almost incapable of expressing affection to the people in his life. (He never kissed or held his children; at bedtime he shook hands with them.) After the untimely death of his second wife, whom he seems to have cared for deeply, he never spoke of her to their two sons, one of whom later bitterly recalled, "It was almost as if she had never existed."[20] No wonder he was the champion of a psychology that rejected introspection and self-revelation, dealt only with external acts, and as experimental subjects preferred rats to human beings.

Watson's success story was as remarkable as any by Horatio Alger. Born in 1878 near Greenville, South Carolina, he was the son of a petty farmer of violent nature and unsavory reputation, and an upright, devout Baptist woman. Torn between these dissimilar models of adulthood, Watson was a shiftless, indolent small-town boy. When he was thirteen, his father abandoned the family and ran off with another woman, and his mother sold the farm and moved to Greenville. There Watson, teased by classmates for his country ways and upset by his father's abandonment, did poorly in school. "I was lazy," he later recalled, "somewhat insubordinate, and, so far as I know, never made above a passing grade." Like his vanished father, he had a penchant for violence: He often boxed with a friend until one or both were bloody, was much addicted to what he called "nigger fighting" (beating

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up blacks), and was arrested twice, once for racial brawling and once for firing a gun within city limits.

Despite his redneck attitudes and habits, he somehow developed the desire to make something of himself and had either the courage or effrontery to request a personal interview with the president of Furman College, a small Baptist institution in Greenville; he was granted the interview and made a good enough impression to be accepted as a student. He had intended to study for the Baptist ministry—his mother's wish—but, always rebellious, turned against religion. He was never at ease with his fellow students, but when he grew into a strikingly handsome youth with sharp, clean-cut features, a strong chin, and dark wavy hair, he began a lifelong series of affairs. He was serious enough about his ambition, however, to work hard and do well academically, and he particularly liked those philosophy courses which included psychological subjects.

After graduation, Watson taught in a one-room school for a year, but his favorite philosophy professor, George Moore, who had moved to the University of Chicago, urged him to go there as a graduate student. Again Watson was brash enough to go directly to the top. He wrote a boldly self-promoting letter to William Rainey Harper, president of the university, telling him that he was poor but earnest, and entreating him either to waive tuition or let Watson pay it off later. He also persuaded the president of Furman College to write an extraordinarily strong letter on his behalf. President Harper accepted him—on what financial basis is not clear—and off Watson went. He arrived in Chicago with $50 to his name, completely on his own (his mother had died, his father had never been heard from) but ready for anything.

At first he majored in philosophy, but soon realized that it was psychology he cared about, and switched. He worked hard at his studies and supported himself by holding several odd jobs: he waited on table at his boarding house, served as a janitor in the psychology department, and took care of rats in an animal laboratory. At one point, overwhelmed by anxiety and sleeplessness, he suffered a breakdown and had to spend a month recuperating in the country. Another man, after such an

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experience, might have become self-searching and interested in introspective psychology; Watson did his doctoral research in the winter of 1901–1902 on how the level of brain development of young rats was related to their ability to learn mazes and open doors to get food. In part, he was simply falling in with the latest trend in psychology (Thorndike had announced his puzzle box findings four years earlier), but in part he was choosing the kind of psychology he found congenial:

> At Chicago, I first began a tentative formulation of my later point of view. I never wanted to use human subjects. I hated to serve as a subject. I didn't like the stuffy, artificial instructions given to subjects. I always was uncomfortable and acted unnaturally. With animals I was at home. I felt that, in studying them, I was keeping close to biology with my feet on the ground. More and more the thought presented itself: Can't I find out by watching their behavior everything that the other students are finding out by using O's? *21

Watson did such excellent work at Chicago that when he graduated, the department offered him an assistantship in experimental psychology. After only two years he was promoted to instructor, after two more to assistant professor-elect, and a year later, at thirty, was offered the chair of psychology at Johns Hopkins University at what was then (1908) a munificent salary, $3,500.

His swift rise had been, in part, the consequence of carefully cultivated contacts but, in larger part, of splendid experimental work in animal learning. He taught rats to make their way through a miniature replica of the maze at Hampton Court, Henry VIII's royal retreat outside London. At first the rats needed as much as half an hour to find their way, but after thirty trials they could race through in ten seconds. By what means had they learned the route? To find out, Watson deprived them of first one sensory cue, then another, to see which one was crucial to maze learning. He blinded some of the trained rats; their performance dropped off but rapidly returned to what it had been before. He washed the maze to remove odor cues, but trained rats did as well as ever. He surgically

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destroyed the sense of smell of some untrained rats, but they learned the maze as readily as intact rats. Hearing, similarly, proved to play no part in their learning. Watson concluded that kinesthetic cues—muscle sensations—were the key element in the rat's learning process.[22]

From such research and from his knowledge of the work of Thorndike and other objectivists, Watson, rejecting all conjectures about invisible mental processes, began to formulate a new psychology based entirely on observable behavior. He first voiced these views at psychological meetings in 1908 and 1912 (in the latter year he and James R. Angell independently coined the term "behaviorist"), and in 1913 wrote an article, published in the *Psychological Review* and often called "the behaviorist manifesto," that formally inaugurated the era of behaviorism in psychology.[23]

The manifesto, "Psychology As the Behaviorist Views It," started off with a declaration of independence from all schools of psychology that dealt with mental processes:

> Psychology as the behaviorist views it is a purely objective experimental branch of natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its methods, nor is the scientific value of its data dependent on the readiness with which they lend themselves to interpretation in terms of consciousness.

In three sentences, he had proclaimed three revolutionary principles: first, the content of psychology should be behavior, not consciousness; second, its method should be objective rather than introspective; and third, its purpose should be "prediction and control of behavior" rather than fundamental understanding of mental events.

Watson charged that psychology had failed to become an undisputed natural science because it was concerned with conscious processes that were invisible, subjective, and incapable of precise definition. He jettisoned the psychologizing of the Greek philosophers, the medieval scholars, the rationalists and the empiricists, and such

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greats as Kant, Hume, Wundt, James, and Freud, all of whom had been, in his view, misguided.

> The time seems to have come when psychology must discard all reference to consciousness; when it need no longer delude itself into thinking that it is making mental states the object of observation. We have become so enmeshed in speculative questions concerning the elements of mind, the nature of conscious content… that I, as an experimental student, feel that something is wrong with our premises and the types of problems which develop from them.

As some wit said later, "Psychology, having first lost its soul to Darwin, now lost its mind to Watson."

His assault on introspection as a method of research was based on its failure to yield objective data. It so often led to endless debates about subjective and undecidable issues, like the number of sensations, their intensity, or what any individual meant by his report of what he was experiencing, that the method itself had to be judged defective and a hindrance to progress.

For good measure, Watson also dismissed all dualist discussions of mind and body, whether couched in metaphysical terms or modern ones. These concepts, "time-honored relics of philosophic speculation," were of no use either as guides to psychological problems worth studying or as solutions of those problems; he himself would prefer, he said, to bring up his students in total ignorance of such hypotheses.

In place of the psychology he junked, he proposed a new one free of all such terms as "consciousness," "mental states," and "mind." Its sole subject matter would be behavior. Based on the premise that all organisms adjust to their environment and that certain stimuli lead them to make the necessary responses, psychology would study the connections between stimuli and responses, that is, the ways in which rewarding responses are learned and unrewarding ones are not. Since consciousness would be ignored, much of this study could be carried on with animals; indeed, "the behavior of man and the behavior of

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animals must be considered on the same plane as being equally essential to the study of behavior."

Watson's manifesto was actually less original than it seemed; it presented ideas that had been germinating for fifteen years. But it did so in an audacious, forceful, and crystallizing way; it was, in short, a sales pitch. Watson's ideas did not sweep the field overnight, but over the next half-dozen years behaviorism became an important topic at meetings and a formative influence on the thinking of psychologists. By the 1920s it had begun to dominate psychology, and was the ruling paradigm in American psychology and an important one in Europe for well over four decades.

Popular accounts of Watson's life say that the manifesto catapulted Watson to the presidency of the American Psychological Association in 1915, but a careful review of the evidence by the social psychologist Franz Samelson finds it more likely that he was elected because he was highly visible as the editor of the *Psychological Review*, was well known to and on good terms with the three members of the nominating committee, and was a representative of the new generation of genuinely experimental psychologists.[24]

Whatever the reason, he was flying high, but he knew that he had not yet suggested a specific method by which behaviorists could pursue research, and in his presidential address to the APA he addressed this problem.[25] He now had something to offer: the conditioned reflex method. Though he knew only the bare outlines of Pavlov's work, he presented it as a model for behaviorist experimentation not only with animals but with humans. He noted that his student Karl Lashley (who had disproven Pavlov's physiological theory), had already made a removable fistula that could be installed inside the human cheek; with it, he had successfully measured both unconditioned and conditioned salivary reflexes in human volunteers.

Watson himself began to study conditioned reflexes in human beings, although, not surprisingly, he did so with infants rather than adults. The psychiatrist Adolf Meyer, head of the Phipps Psychiatric Clinic at Johns Hopkins, had invited him to set up a laboratory there, and in 1916 Watson began observing infants from birth through much

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of their first year. World War I interrupted the work, but he got back to it in late 1918.

Watson first sought to discover what unconditioned reflexes infants possess, that is, what stimuli would produce reflexes without any learning process. From simple experiments with infants in the clinic he concluded that there are only a few instinctive reflexes in humans, among them sucking, reaching, and grasping. (A famous photograph shows Watson holding a rod from which a newborn is hanging by one hand like a little monkey.) He also found that infants have three innate emotional responses to certain stimuli: fear at hearing a loud sound or at suddenly being dropped (the infant catches its breath, puckers its lips, and then cries); rage when its arm or head movements are forcibly restrained (it stiffens its body, makes thrashing arm movements, holds its breath, and turns red in the face); and love when stroked, rocked, gently patted, and the like (it gurgles, coos, or smiles).[26]

But since these, in his opinion, made up the sum total of innate human responses—later research would find otherwise—his larger aim was to show how virtually all other human behaviors and emotional reactions were built up of conditioned reflexes. He began by enunciating a Pavlovian hypothesis about emotional responses:

> When an emotionally exciting object stimulates the subject simultaneously with one not emotionally exciting, the latter may in time (often after one such joint stimulation) arouse the same emotional reaction as the former.[27]

To verify this hypothesis, in the winter of 1919–1920 Watson and a student of his, Rosalie Rayner, conducted what became one of the most famous experiments in the history of psychology, an attempt to produce a conditioned fear response in an eleven-month-old boy they called, in their report of the work, Albert B.[28] When Albert was nine months old, they placed a white rat near him, and he showed no fear; he did, however, react with fear when a steel bar was banged with a hammer just behind his head. Allowing two months to pass so that the experiences would fade, Watson and Rayner then began the experiment. A rat was put down in front of Albert, who

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reached for it with his left hand; just as he touched it, the steel bar was struck behind him, and he jumped violently, fell forward, and buried his face in the mattress. On a second trial, Albert reached for the rat with his right hand, and as he touched it the bar was struck again; this time Albert jumped and fell forward and began to whimper.

Watson and Rayner delayed further trials for a week "in order not to disturb the child too seriously," as they wrote—a curious comment, since they intended to and did disturb him seriously when they continued. In the course of half a dozen more pairings in which the rat was placed close to Albert and the bar hit behind his head, Albert developed a full-fledged conditioned fear response to the sight of the rat:

> The instant the rat was shown the baby began to cry. Almost instantly he turned sharply to the left, fell over on his left side, raised himself on all fours and began to crawl away so rapidly that he was caught with difficulty before reaching the edge of the table.

Still more experiments showed that Albert had generalized his fear to other furry things: a rabbit, a dog, a seal coat, cotton wool, and Watson sporting a Santa Claus mask. After a month's layoff, Albert was tested again, and, as Watson and Rayner reported with apparent gratification, he cried and was afraid of a rat and a number of furry stimuli shown him without any accompanying clanging of the steel bar.

Shockingly—by today's ethical standards of research—Watson and Rayner made no effort to decondition Albert, who left the clinic several days after the final tests. They did say in their report that "had the opportunity been at hand we should have tried out several methods [of deconditioning]," which they outlined. They then jested that twenty years hence some Freudian analyst might extract from Albert a pseudo-memory of having tried to play with his mother's pubic hair at age three and been violently scolded for it.

Watson paid a high price for what he had done in the course of the collaboration, though not what he had done to Albert. He developed a mad passion for beautiful young

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Rosalie Rayner and began an affair with her. He was seen around town with her, was away from home a great deal, and carelessly (or perhaps by unconscious design) left in a pocket a passionate note from Rosalie that his wife, Mary, found. He had been unfaithful on previous occasions and Mary had known about some of the episodes and weathered them, but this involvement was far more threatening to her and she felt compelled to take action.

She thought up a way to get damning evidence of his involvement, hoping to use it to force him to give up Rosalie instead of risking a scandal that would cost him his professorship. The Watsons dined at the home of Rosalie's parents one evening, in the course of which Mary said she had a headache and would like to lie down for a while in Rosalie's room. Alone and with the door shut, she searched the room and found and made off with a batch of love letters from Watson, who had been uncharacteristically expressive in them and rather explicit about his and Rosalie's lovemaking.

But when she confronted Watson and threatened to expose him, he refused to break off with Rosalie. Mary decided to sue for divorce, and either she or her brother, to whom she had lent the letters and who had made copies of them, sent them to Frank Goodnow, president of the university. At that time and in that place, such conduct by a professor was utterly impermissible. In late September 1920, Goodnow summoned Watson to his office and demanded his resignation; Watson hotly defended himself but had no choice except to comply. When he left the office, he went home, packed a bag, and headed for New York, his dazzling career in psychology abruptly and permanently ended just as the movement he had spearheaded was succeeding.

Watson later married Rosalie and had two sons with her. He landed a job in New York, which eventually earned him a very large salary, as resident psychologist to the J. Walter Thompson advertising agency. There he combined his knowledge of psychology and his gift of salesmanship to conceive some of the firm's most successful campaigns for deodorants, cold cream, Camel cigarettes, and other products. Among his triumphs: a campaign for Pond's Cold and Vanishing Creams using testimonials from the

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Queens of Spain and Romania, one for Johnson & Johnson convincing mothers that it was important to use baby powder after every diaper change, and one for Maxwell House that helped to make the "coffee break" an American custom in offices, factories, and homes.

During the first decade of his banishment from the academic world, Watson continued to write books and magazine articles about behaviorism and child rearing. (He advocated strict behaviorist methods, with all emotionality and affection banned.) But he did no more psychological research and no longer played a role in the field, although his expanded thoughts about behaviorism, presented in his books, were adopted by some of his former colleagues and entered behaviorist thinking.

And popular thinking. Watson's psychology, attributing almost all human behavior to stimulus-response conditioning, was a simple, convenient rebuttal of the hereditarian views of Galton's followers and appealed broadly to liberals and egalitarians—an irony, since Watson was politically conservative. In his popular writings, he waxed messianic: behaviorism could create a better world by scientifically engineering the development of personality. In 1924, in *Behaviorism*, he made what is probably his most famous and often-quoted statement:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, artist, merchant-chief and, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.[29]

From 1930 on, Watson had nothing to do with psychology except as it applied to advertising. He and Rosalie settled into the good life on a large estate in Connecticut, where in his leisure hours he played gentleman farmer. But after some tranquil years tragedy struck: Rosalie contracted dysentery, grew steadily worse despite treatment, and died in her mid-thirties. Watson, fifty-eight, was shattered. He continued to work in advertising (he had recently moved to the William Esty

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agency), but his only real interest lay in puttering about on his farm. There were always women in his life, but he never came close to marrying again. As he aged, he became careless about himself, dressed poorly, grew fat, and was something of a solitary.

In 1957, when Watson was nearly eighty, the American Psychological Association notified him that it was awarding him its gold medal for his contributions to psychology. Astonished and pleased, he went to New York with his sons to receive the award, but at the last moment, afraid that after almost forty years of exile he would burst into tears at the ceremony, he sent one of his sons to stand in for him. The citation accompanying the medal read:

> To John B. Watson, whose work has been one of the vital determinants of the form and substance of modern psychology. He initiated a revolution in psychological thought and his writings have been the point of departure for continuing lines of fruitful research.

It was a gracious tribute. But in fact Watson had oversimplified or overstated many issues, and other behaviorists later had to elaborate on and qualify them. Almost no one today holds as extreme an environmental position as he did, nor does anyone now recommend withholding affection from children and rearing them by frigid behavioral rules. The Pavlovian conditioning that he made the keystone of his system proved not to be the only significant kind; later behaviorists added to it another major model called "operant" conditioning. Most important, at the very time that Watson received the gold medal it was becoming clear that chains of S-R units (series of linked conditioned stimulus-response connections), no matter how long, could not adequately explain complex and sophisticated kinds of behavior.

For all that, Watson was the first and most important spokesman of a radical theory and practice that dominated American psychology for nearly half a century. Raymond Fancher, in his *Pioneers of Psychology*, writes that although many of the developments of behaviorism might have happened without Watson, "he certainly hastened

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their occurrence, and lent a vitality and power to the objective psychology movement that it might otherwise have lacked."[30]

Watson died in 1958, the year after he received the gold medal. To the end, he believed that the revolution he had started, and which had so long been the leading school of psychology in America, was also the psychology of the future. He was wrong. But we'll come to that.

The Triumph of Behaviorism

After a slow start, behaviorism rapidly gained favor among psychologists in the 1920s, particularly in America; it soon became the ruling view and, after a while, almost the only acceptable one, at least in academic circles.

The main reason for its popularity was its claim to be the first truly scientific psychology. Until the nineteenth century, psychology had consisted largely of philosophic speculation, not science. In the nineteenth century, adherents of the New Psychology had sought to turn psychology into a natural science but got no further than explaining a few simple reflexes and perceptions in physiological terms—and even to achieve that much, they had had to rely on unverifiable introspections.

Behaviorists, in contrast, said they could construct a psychology entirely from visible, measurable events—the causally connected stimulus-response units of which, they maintained, the whole range of animal and human behavior was assembled. Such a psychology would be based on reactions as specific and unvarying as those of chemistry or physics, and should enable the psychologist, in Watson's words, "given the stimulus, to predict the response—or, seeing the reaction take place, to state what the stimulus is that has called out the reaction."[31]

Another reason so many psychologists found behaviorism appealing was that by limiting themselves to visible behavior they could dispose of all those intractable questions about the mind that philosophers and psychologists had labored over for more than twenty-four hundred years. Behaviorists said that we not only cannot

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know what goes on in the mind, we don't need to know in order to explain behavior. They often likened the mind to a black box containing unknown circuitry; if we know that when we push a particular button on it, the box will emit a specific signal or action, what is inside is of no consequence. Nor should what goes on in the mind even be discussed, since all talk about mental processes is tantamount to believing in some bodiless entity that runs the brain's machinery—"the ghost in the machine," as the English behaviorist philosopher Sir Gilbert Ryle derisively called it. (Equally derisive was the statement of an antibehaviorist: "The mere mention of the word 'mentalism' offends the sensibilities of a behaviorist in much the same way the word 'masturbation' offends polite company."[32])

There were, moreover, deep-seated social and cultural reasons for the success of behaviorism. It appealed to the twentieth-century personality, especially in America, because it was practical; it sought not ultimate explanations but commonsense knowledge that could be put to use.

At least one historian of behaviorism, David Bakan, has also linked its rise to the urbanization and industrialization of America; these social developments, he says, created an urge to master the incomprehensible and worrisome strangers all around us—exactly what behaviorism promised to help us do.[33]

Bakan adds two other societal reasons for the success of behaviorism. First, World War I evoked hostility to German psychology, and behaviorism served as an up-to-date and available replacement. Second, behaviorism fit in with the endemic anti-intellectualism of America; it justified ignorance of the subtleties of mentalist psychology on the grounds that mental phenomena, being either illusions or unknowable, were not worth one's time and effort.

From the 1920s to the 1960s, behaviorism (or the more complex versions of it known as neobehaviorism) was the regnant force in American psychology and the model that it exported to the rest of the psychological world. Some psychologists still clung to older schools of thought, and a number of others, among them Freudians, developers of

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mental testing, child development psychologists, and Gestaltists, were concerned with mental processes, but on most campuses such people had to adapt their work and language to the behaviorist paradigm. Gregory Kimble, a historian of behaviorism, says, exaggerating only a little, "In midcentury American psychology, it would have cost a career to publish on mind, consciousness, volition, or even imagery," since to use such terms signified that one was a mentalist who believed in outdated, subjective, and mystical concepts.[34]

In consequence, much of the research conducted between 1920 and the 1960s dealt with minute, undeniably objective but not very enlightening topics. A few representative titles from the *Psychological Bulletin* and the *American Journal of Psychology* in 1935 were:

> "Influence of Hunger on the Pecking Responses of Chickens"
> "Comparison of the Rat's First and Second Explorations of a Maze Unit"
> "The Use of Maze-Trained Rats to Study the Effect on the Central Nervous System of Morphine and Related Substances"
> "Differential Errors in Animal Mazes"
> "Circuits Now Available for the Measurement of Electrodermal Responses"

Even when human beings were the experimental subjects, the topics and methods were constrained by behaviorist doctrine. Some typical titles from the *American Journal of Psychology* in 1935 were:

> "The Reliability of the pH of Human Mixed Saliva as an Indicator of Physiological Changes Accompanying Behavior"
> "A Comparison of the Conditioning of Muscular Responses Which Vary in Their Degree of Voluntary Control"
> "Experimental Extinction of Higher Order Responses"
> "The Galvanic Skin Reflex as Related to Overt Emotional Expression"
> "Over-Compensation in Time Relationships of Bilateral Movements of the Fingers"

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The authors of these and similar studies were not really interested in the pecking behavior of chickens or the pH of human saliva but in learning—the acquisition of behavioral responses to different kinds of stimuli. Learning was the central concern of American psychology during the behaviorist era, the assumption being that almost all behavior could be explained by S-R learning principles.[35] An equally important assumption was that these principles held true of all sentient creatures, much as the principles of valence are true of all elements in chemical compounds. What one learned from chickens, cats, dogs, and especially rats applied to human beings.

Rats were the favorite experimental animal because they were relatively cheap, small, easy to handle, and fast-maturing. Countless thousands of them served the cause of research by learning to run mazes, operate levers or push buttons to get food, jump at doors of different colors, depress a bar to turn off an electric current that was making their feet tingle, and a host of other tasks. There was nothing frivolous about these experiments; they were aimed at the discovery of important universal laws of behavior. A few examples:[36]

> —A rat is placed at the start of a simple maze that includes six choice points (each choice point is a T, one branch being a blind alley, the other an alley that continues) and ends at the goal box. The rat begins exploring and sniffing about, and runs a little; it goes into a blind alley, turns back and runs the other way, and after making three wrong choices and three right ones reaches the goal box — and is lifted out and, after a brief rest, put back in the start box. On its seventh run it finds a food pellet at the goal; the rat sniffs it, then bolts it down. Another rat gets the same training but without any food reward, not even on the final run.
>
> For a week both rats get the same training every day. By the end of the week the first rat knows the route perfectly and races through the maze, making no mistakes; the second rat still makes as many errors as ever. But finally the second rat gets a food reward at the end of its run—and,

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remarkably, on the next trial makes no errors. It learned as much from one rewarded trial as the other rat learned in a week. The experiment demonstrates the operation of two principles: *reward produces learning*, exemplified by the first rat's behavior; and *lacking reward, there may be latent learning*, exemplified by the second rat's behavior. (Learning takes place in some sense when there is no reward but becomes activated as soon as a reward is associated with the "right" behavior.)

What has this got to do with human behavior? Any teacher can tell you. A child practicing drawing or any other skill may make little progress until the teacher has a moment to say something encouraging or complimentary; then, suddenly, the child shows improvement. Similarly, a novice at flying may make a dozen bumpy landings, finally "grease one in" half by accident, winning praise from his instructor, and from then on make landings as if he had at last "got the idea."

—One at a time, a number of rats are put in the start box of a simple T-shaped maze. At the end of the right-hand branch is a white door behind which is a bit of cheese; at the end of the left-hand branch is a black door behind which is a metal grid floor that gives the rat's feet a mild but unpleasant shock. The rats learn, after a while, to turn right and push through the white door. But once they've learned, the experimenter switches the situation. Now the white door and food are at the end of the left branch, the black door and electrified grid at the end of the right branch. The rats turn right, get shocked, and soon learn to turn to the left.

Once again the diabolic experimenter reverses things, but now the rats learn almost immediately; they have come to associate reward and punishment with the colors of the doors, not their direction. The experiment revalidates Pavlov's principle of *discrimination*, the determination of the rewarding cue in a two-cue situation.

Does this apply to humans? Of course. A novice at gardening gets only a meager crop of tomatoes

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but sees that his neighbor, who plants a different variety in a sunnier location, gets a bumper crop. The novice tries the neighbor's variety the next year; still no luck. He realizes that the number of hours of sunshine must be the critical factor, fells some trees to get more sunshine, and is successful.

—Another T-maze in which rats learn to turn to the right. This time there is no punishment for choosing the left branch but merely a lack of reward. Some rats are lucky; they find a reward every time they choose the right side. Others are unlucky; they find food there only once every four times. The unlucky rats learn far more slowly than the lucky rats to choose the right-hand branch. The experiment demonstrates that *partial reinforcement* is less effective in learning than is continual reinforcement.

But now the experimenter changes things; there is no reward at either branch for either group. What happens? Oddly, the rats who had previously been lucky lose their conditioning rapidly and begin to alternate their choices, while the ones who were rewarded only every fourth time continue to choose the right branch for a long while. The experiment has demonstrated the *partial reinforcement effect:* the higher the creatures' expectations, the more disruptive a change in the situation; with lower expectations, their learned behavior is more stable when change occurs.

A human analogue: A highly efficient employee has had a generous raise every year; in a year of poor income for the company, he gets only a modest raise, loses his drive, starts taking longer lunches, leaves promptly at 5:00 p.m., and calls in sick now and then. A less capable employee, who has only occasionally gotten a raise bigger than a cost-of-living adjustment, gets only a cola in the poor year; his commitment to his job is unaffected, because, not expecting much, he does not interpret the lack of bonus as a change in the system.

Two Great Neobehaviorists: Hull and Skinner

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As the above experiments show, behaviorists were enlarging their theory and methodology far beyond Watson's formulations. He had described behavior in simplistic terms as "the total striped and unstriped muscular and glandular changes which follow upon a given stimulus,"[37] a view later dubbed "muscle-twitch psychology." For a while, his followers stuck to this view; as one of them, Walter Hunter, wrote in 1928, "All behavior seems to be a combination, more or less complex, of the relatively simple activities of muscles and glands."[38]

Yet to say anything meaningful about complex forms of behavior, it was necessary to see them intact, as acts with an *identity* and *meaning*. A bird building a nest is not just an organism responding to X number of stimuli with X number of reflexes; it is also a bird building a nest—an intricate kind of behavior with a *goal*. As one behaviorist, Edwin Holt, said in 1931, behavior is "what the organism is doing"—hunting, courting, and so on—an organized entity, and not merely the string of reflexes of which that entity is constructed, not just "an arithmetical sum, related only by the *and* or *plus* relation."[39]

But Holt refused to attribute *purpose* to the creature itself; that would have implied the influence of a mind that looked ahead to the goal and set out to reach it. Rather, he ascribed the purposiveness of complicated behaviors to the process by which S-R units were combined: the creature's seeking or avoiding, at each step, assembled S-R units in such a way that the assemblage appeared to be purposive behavior. It was a vague and unsatisfying formulation, but it went as far as any orthodox behaviorist could go.

A more important development was the neobehaviorist effort of Clark L. Hull (1884–1952) of Yale University to make behaviorism a quantitatively exact science modeled after Newtonian physics. Hull, who had started out to be a mining engineer, suffered an attack of polio and remained partly crippled. He switched to psychology, since it was less likely to involve heavy physical activity, but the engineering training carried over, and he set out to develop a kind of calculus of behaviorism. As he wrote in his autobiography:

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> [I] came to the definite conclusions around 1930 that psychology is a true natural science; that its primary laws are expressible quantitatively by means of a moderate number of ordinary equations; that all the complex behavior of single individuals will ultimately be derivable as secondary laws from (1) these primary laws together with (2) the conditions under which behavior occurs; and that all the behavior of groups as a whole, i.e., strictly social behavior as such, may similarly be derived as quantitative laws from the same primary equations.[40]

Hull's central concept was a familiar one: behavior consists of sets or chains of linked habits, each of which is an S-R connection that developed as a result of reinforcement. This was his version of Thorndike's Law of Effect. What was new about Hull's work was his postulation of a number of factors, each of which, he held, enhances, limits, or inhibits the formation of such habits, and his development of equations by which one could calculate the exact effect of each of those factors.

They included the level of the creature's drive (a hungry rat has a stronger drive to food than a sated rat); the strength of the reinforcement (expressed in such terms as "5 grams of a standard food"); the number of times a stimulus had been followed by reinforcement; the degree of "need reduction" achieved by each reinforcement; the degree of "drive reduction" (drives are fueled by needs) due to fatigue and the length of time between one trial and the next trial; and so on and on. As Edwin Boring later said, with consummate understatement, it was a "ponderous" theory.[41]

An example: By means of the following equation one can calculate the extent to which any given number of repetitions of a reinforced act increases the strength of the learned habit:[42]

$$_{S}^{N}H_{R} = M - Me^{-iN}$$

The equation says that the strength of the learned habit depends on the number of reinforced trials (N), the relationship between the afferent and efferent nerve

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impulses in the specific act (${}_SH_R$), the physiologically maximum strength of that particular habit (M) minus—well, it goes on and on.

Hull's work was a major attempt to model neobehaviorist psychology on the physical sciences and thereby have it achieve intellectual respectability. His calculus of learning, appearing piecemeal during the 1930s and in systematic form in his *Principles of Behavior* (1943), was greatly admired and hugely influential. In the late 1940s and the 1950s thousands of master's theses and doctoral dissertations were based on one or more of his postulates; he became the most frequently cited psychologist in the literature of psychological research and the leading figure in the psychology of learning.[43]

But during the 1960s, the unwieldiness of his theory and the dwindling of behaviorism's status made Hull's name and work fade rapidly from sight. By 1970 he was rarely quoted, and today there is virtually no research based on his theory. When Hull died, in 1952, he seemed assured of scientific immortality; now he is a figure of minor historical interest, and few young psychologists and very few people outside the profession know his name.[44]

B. F. Skinner (1904–1990), another leading neobehaviorist, had a very different fate. He became, and remained until his death at eighty-six, the best-known psychologist in the world,[45] and his ideas are in wide use today in psychological research, education, and psychotherapy.[46]

So he must have been one of the great contributors to humankind's quest for self-understanding, right?

Far from it.

Human self-understanding, at least as sought by philosophers and psychologists for so many centuries, was no part of Skinner's aim or contribution. Throughout his long life he held fast to his extreme behaviorist view that "subjective entities" such as mind, thought, memory, and reasoning do not exist but are only "verbal constructs, grammatical traps into which the human race in the development of language has fallen," "explanatory

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entities" that themselves are unexplainable.[47] Skinner's goal was not to understand the human psyche but to determine how behavior is created by external causes. He had no doubt about the correctness of his views; as he wrote in a short autobiography—he also wrote a three-volume one—"[Behaviorism] may need to be clarified, but it does not need to be argued."[48]

Nor did he add much to psychological theory; he considered theories of learning unnecessary and claimed not to have one. Such theory as he did hold can be summed up in the statement that everything we do and are is determined by our history of rewards and punishments; the details of the theory, as he developed them through research, consisted of such principles as the partial reinforcement effect described above, concerning the circumstances that cause behavior to be acquired and those that cause it to be extinguished.

What, then, made him so well known?

Like Watson he was by nature a controversial man, a provocateur, and a superb publicist. On his very first TV appearance he posed a dilemma originally propounded by Montaigne—"Would you, if you had to choose, burn your children or your books?"—and said that he himself would burn his children, since his contribution to the future would be greater through his work than through his genes.[49] Predictably, he elicited outrage—and many invitations for further appearances.

At other times he seemed to take pleasure in offending thoughtful people by deriding the terms in which they talked about and comprehended human behavior:

> Behavior…is still attributed to human nature, and there is an extensive "psychology of individual differences" in which people are compared and described in terms of traits of character, capacities, and abilities. Almost everyone who is concerned with human affairs … continues to talk about human behavior in this prescientific way.[50]

He consistently pooh-poohed the effort to understand the inner person:

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> We do not need to try to discover what personalities, states of mind, feelings, traits of character, plans, purposes, intentions, or other perquisites of autonomous man really are in order to get on with a scientific analysis of behavior… Thinking is behaving. The mistake is in allocating the behavior to the mind.[51]

All we need to know or can know, he said, are the external causes of behavior and the observable results of that behavior; these will yield "a comprehensive picture of the organism as a behaving system."

Consonant with that view, he was a rigorous determinist: "We are what we are because of our history. We like to believe we can choose, we can act… [but] I don't believe a person is either free or responsible." The "autonomous" human being is an illusion; the good person is one who has been conditioned to behave that way, and the good society would be one based on "behavioral engineering"—the scientific control of behavior through methods of positive reinforcement.[52]

Skinner was a deft showman and popularizer; he was fluent, lucid, unabashedly egotistic, and charming. To demonstrate the power of his own technique of conditioning, he taught a pigeon to peck out a tune on a toy piano, and a pair of pigeons to play a kind of table tennis in which they rolled a ball back and forth with their beaks; millions who have seen these performances on TV documentaries think of Skinner as a Svengali, at least of animals. He presented his vision of the ideal, scientifically controlled society in the form of a utopian novel, *Walden Two* (1948), picturing a small society in which, from birth onward, children are rigorously conditioned by rewards (positive reinforcement) to be cooperative and sociable; all behavior is controlled, but for the good and the happiness of all. Despite wooden dialogue and a labored plot, it became a cult book and perennial favorite with undergraduates, and has sold well over two million copies.

But his fame with the public was greater than his standing with fellow professionals. As one admirer, the psychologist Norman Guttman, wrote in *The American Psychologist* some years ago:

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> [Skinner is] the leading figure in a myth… [the] scientist-hero, the Promethean fire-bringer, the master technologist… [the] chief iconoclast, the image-breaker who liberates our thoughts from ancient restrictions.[53]

Skinner was born in 1904 in a small Pennsylvania railroad town, where his father was a lawyer. As a boy, he had a great aptitude for building Rube Goldberg contraptions; later, as a psychologist, he would invent and build remarkably effective apparatuses for animal experimentation. In school and college he aspired to become a writer, and after college spent a year, much of it in Greenwich Village, trying to write. Although he closely observed the manifold forms of human behavior all around him, he discovered after a while that he had nothing to say about what he saw and, deeply dejected, gave up the effort.

But he soon found another and, for him, more practicable way to understand human behavior. In his reading he came across discussions of Watson's and Pavlov's work, read books by each of them, and decided that his future lay in a scientific approach to human behavior, particularly the study of conditioning. "I was very bitter about my failure in literature," he told an interviewer in 1977, "and I was sure that writers never really understood anything. And that was why I turned to psychology."[54]

He proceeded to Harvard. Introspective psychology reigned there, but he was no longer interested in what he called "the inside story," and quietly went his own way, doing behaviorist research with rats. In his autobiography he recalls with pleasure having been something of a bad boy: "They may have thought that someone in psychology was keeping an eye on me, but the fact was that I was doing exactly as I pleased."[55] Despite the teachings of his professors, he became ever more thoroughly behaviorist, and at his dissertation examination, when asked to name some objections to behaviorism, he could not think of one.

Making good use of his mechanical aptitude, he constructed a puzzle box that was a great improvement over the Thorndike model; widely used ever since, it is known as the Skinner box. In its basic form—it has many models—it is a cage, large enough to comfortably

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accommodate a white rat, with a horizontal bar on one wall just above a little food tray and a water spout. When the rat, prowling about the cage, happens to rest its forepaws on the bar, pressing it down, a food pellet automatically drops into the tray. Connected equipment outside the cage automatically records the behavior by drawing a line showing the cumulative number of bar pressings minute by minute. This was a much more efficient way of gathering data than Thorndike's puzzle box procedure, since the experimenter did not have to observe the rat or deliver the food when it pressed the bar but merely look at the record.

The box also yielded more objective data on the acquisition or extinction of behavior than anyone had gathered thus far. The rat, and it alone, determined how much time elapsed between one pressing of the bar and the next. Skinner could base his findings of learning principles on the "response rate"—the rate at which the animal's behavior changed in response to reinforcement—uncontaminated by the experimenter's actions.

Moreover, Skinner could program the box in ways that approximated many circumstances in the real world that either reinforce or fail to reinforce behavior. He could, for instance, study the learning of a response when it is regularly rewarded; the extinction of a learned response when the reward is abruptly discontinued; the effects on learning and on extinction when rewards are delivered intermittently at regular intervals (say, every fourth bar pressing); the effects when rewards are delivered intermittently at irregular intervals; the effects of mixed results of bar pressing (such as a reward coupled with an electric shock); and so on. In each case, the data yielded a curve showing the rate of acquisition or extinction of a behavior under those particular circumstances.

From these curves, Skinner formulated a number of principles that cast light on the behavior of rats—and human beings. An example is his discovery of an important variation of the partial reinforcement effect. After rats had been trained on a schedule in which food pellets were delivered only once in a while and at irregular intervals, the rats would persist in their bar pressing even if

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the food-dispensing apparatus was turned off altogether. Their learned behavior was more resistant to extinction than that of rats trained to intermittent but regular reinforcement.[56] This has been likened by some to the behavior of a slot machine player in a casino: neither the rat nor the gambler has any way of predicting when the next reinforcement is to come, but, being accustomed to occasional rewards, will hang on in the hope of getting one on the next try.[57]

Skinner's most important contribution, however, was his concept of "operant conditioning"; for this alone he merits a permanent place in the Hall of Fame of psychology.

In "classical" (Pavlov's) conditioning, the animal's unconditioned response (salivating) to food is made into a conditioned response to a formerly neutral stimulus (the sound of the metronome or bell); the crucial element in the behavior change is the new stimulus.

In "instrumental" (Thorndike's) conditioning, the crucial element in behavior change is the response, not the stimulus. A neutral response— the accidental stepping on the treadle during random efforts to get to the food—is rewarded and becomes a learned bit of behavior serving an end it formerly did not have.

Skinner's operant conditioning is an important development in instrumental conditioning. Any random movement the animal makes, for whatever reason, can be thought of as "operating" on the environment in some way and therefore, in Skinner's terms, is an "operant"; rewarding the movement produces operant conditioning. By rewarding a series of little random movements, one by one, the experimenter can "shape" the behavior of the animal until it acts in ways that were not part of its original or natural repertoire.

Here is how Skinner shaped the behavior of a pigeon to peck at a small colored plastic disk set flush in one wall of the Skinner box:

> We first give the bird food when it turns slightly in the direction of the spot [i.e., the disk] from any part of the cage. This increases the frequency of such behavior. We then withhold reinforcement until a slight movement is made toward the spot. This again alters the general distribution of

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behavior without producing a new unit. We continue by reinforcing positions successively closer to the spot, then by reinforcing only when the head is moved slightly forward, and finally only when the beak actually makes contact with the spot.

In this way we can build complicated operants which would never appear in the repertoire of the organism otherwise. By reinforcing a series of successive approximations, we bring a rare response to a very high probability in a short time… The total act of turning toward the spot from any point in the box, walking toward it, raising the head, and striking the spot may seem to be a functionally coherent unit of behavior, but it is constructed by a continual process of differential reinforcement from undifferentiated behavior.[58]

(Other experimenters, using Skinner's technique, have constructed far more peculiar behaviors. One taught a rabbit to pick up a coin in its mouth and drop it into a piggy bank; another taught a pig named Priscilla to turn on a TV set, pick up dirty clothes and put them in a hamper, and run a vacuum cleaner over the floor.[59])

Skinner likened the operant training of his pigeons to a child's learning to talk, sing, dance, play games, and in time acquire the entire repertoire of adult behavior. All, in his view, is due to the assembling of long chains of behavior out of tiny links of simple behaviors by operant conditioning. One might call it an Erector-set view of the human being (*Homo erectorus?*)—a mindless robot assembled by operant conditioning from a multitude of meaningless bits.

Skinner was more or less ignored by the psychological establishment for a long while but slowly acquired a number of devotees—enough, finally, to result in the publication of four journals of Skinner behaviorist research and theory and the creation of a special section of Skinner-type studies within the American Psychological Association (Division 25, Experimental Analysis of Behavior, since renamed Behavior Analysis). Skinner boxes and the techniques of operant conditioning have long been widely used by experimental psychologists. In

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recent years Skinner's name and work have been cited in hundreds of behavioral science publications each year (though far less often than Freud's).[60]

Still, it was outside of mainstream psychology that Skinner had his major impact.

During a visit to his daughter's fourth-grade class in 1953, it occurred to him that operant techniques similar to those by which he had taught pigeons to play the piano would make for more efficient teaching than traditional methods. Complicated subjects could be broken down into simple steps in a logical sequence; the students would be presented with questions, and immediately told whether their answers were correct. Two principles would be at work here: the knowledge that one has answered correctly is a powerful reinforcer (reward) of behavior; and immediate reinforcement works better than delayed reinforcement. The result is known as "programmed instruction."

But since one teacher cannot simultaneously provide reinforcement to a roomful of children, new textbooks would have to be written in which questions and answers were presented one by one, each taking a short step toward mastery of the subject and each permitting children to reward themselves immediately by uncovering the answer. Skinner also developed teaching machines for operant self-instruction by comparable means; the mechanical models were a fad for a time, then dropped out of use, but today, computer-based self-instruction with immediate reinforcement is widely used by schools, businesses, and elder-care centers, among others.

For some years the programmed learning movement had a major influence on teaching; courses and course materials designed to teach through operant conditioning were in use in a large proportion of grade schools and colleges in America, and in many schools in dozens of other countries. But eventually educators recognized that the atomistic methods of programmed instruction provide only part of what human beings need; they also need holistic, hierarchical thought structures. And later research showed that in human beings delayed reinforcement often has better results than immediate reinforcement; thinking about one's responses may lead to more learning than

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quickly responding and getting an answer.[61] Finally, the observation of other people's behavior, a highly effective form of learning for humans, even if not for cats, involves no immediate reinforcement. Still and all, Skinner's doctrine of immediate reinforcement has proven useful, is familiar to most teachers, and is incorporated into many curricula and grade school textbooks.

Skinner also had a measurable effect on the treatment of mental and emotional disorders. It occurred to him that a system of tiny rewards for tiny changes from sick acts toward healthy ones might reshape the patient's behavior. Beginning in the late 1940s, he and two of his graduate students made the first experimental trials of what came to be known as behavior modification. They set up lever-pressing stations at a state mental hospital near Boston; psychotic patients received candy or cigarettes for operating the machines in an orderly fashion. Once that worked, the therapists gave tokens to patients for appropriate behavior, such as voluntarily attending meals, grooming themselves, and helping with housekeeping tasks. The tokens could be exchanged for candy, cigarettes, or privileges like choosing a dining companion, talking to a physician, or watching TV.[62]

The rewarding of desired behavior in deeply disturbed people often worked. One depressed woman would not eat and was in danger of dying of starvation, but she seemed to enjoy visitors and the TV set, radio, books and magazines, and flowers in her room. The therapists moved her into a room devoid of all these comforts, and put a light meal in front of her; if she ate anything at all, one of the comforts was temporarily restored. The therapists gradually withheld the rewards unless she ate more and more. Her eating improved, she gained weight, and within two months she was released from the hospital. A follow-up eighteen months later found her leading a normal life.[63]

The behavior modification movement spread to a number of mental hospitals and reform schools. Psychiatrists and psychologists now consider it a useful component of their therapies for severely disordered patients, though a costly one in terms of time and staff effort. Behavior modification is also used by many psychotherapists in the treatment of less severe problems,

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like smoking, obesity, shyness, tics, and speech problems. It is a specialized technique within the field of behavior therapy, most of which is based on Pavlov-type conditioning rather than on Skinner's behavior modification.

Skinner's best-known work, *Walden Two*, has not remade American society or even part of it, but it undoubtedly has influenced the thinking and social concepts of its millions of readers. Only one effort has been made to create an actual utopia on the *Walden Two* model: Twin Oaks Community in Louisa, Virginia, a commune founded by eight people in 1967. After surviving many rocky years, it has grown to a population of eighty-five adults and fifteen children. While still modeled administratively on *Walden Two*, the commune long ago gave up the effort to define ideal behavior and to shape one another's behavior through methods of Skinner reinforcement.[64]

Skinner was sometimes self-deprecating about his impact on the world. "In general," he once said, "my effects on other people have been far less important than my effects on rats and pigeons—or on people as experimental subjects." That was probably not meant to be taken seriously. What he did mean seriously was the following remark: "I was never in any doubt as to [my work's] importance." And he added, on a characteristically perverse note: "When it began to attract attention, I was wary of the effect rather than pleased. Many notes in my files comment on the fact that I have been frightened or depressed by so-called honors. I forgo honors which would take time away from my work or unduly reinforce specific aspects of it."[65]

The Impending Paradigm Shift

As behaviorist research accumulated, it became evident to all but the most dedicated adherents of the theory that rats and other laboratory animals frequently acted in ways that the theory could not explain.

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For one thing, their behavior often failed to conform to supposedly universal principles of conditioning. "Pigeon, rat, monkey, which is which? It doesn't matter," Skinner had written[66]—but it did matter. Researchers could easily train a pigeon to peck at a disk or a key for food but found it almost impossible to train the bird to flap its wings for the same reward. They could easily teach a rat to press a bar for food but could get a cat to do so only with great difficulty. A rat given sour blue water to drink, followed by a nauseating drug, would thereafter shun sour water but willingly drink blue water; a quail, given the same treatment, would shun blue water but drink sour water. These and scores of comparable findings forced behaviorists to admit that each species has its own built-in circuitry that enables it to learn some things easily and instinctively, others with difficulty, and still others not at all. The laws of learning were far from universally applicable.[67]

A more serious flaw in behaviorist psychology was that experimental animals kept acting in ways that could not be explained by the neat rate-of-response curves. Many researchers had found, for instance, that at the beginning of an extinction trial an animal would respond to the stimulus with greater vigor than it had during a long series of reinforcements. A rat that had been getting a food pellet each time it pressed a bar would, if no pellet emerged, press the bar with extra force again and again, although according to strict behaviorist theory the absence of the reward should have weakened the response, not strengthened it.[68]

But of course human beings do the same thing. When a vending machine fails to deliver, the customer pulls or pushes the lever harder a few times, or even hits or kicks the machine, either expressing frustration or acting on the thought that something is jammed and needs an extra jolt. There was no place in behaviorist theory for such internal processes, particularly not for thinking about a problem, yet a number of behaviorists noticed that their rats sometimes behaved as if they were indeed doing rudimentary purposive thinking.

One leading researcher who was aware of this was Edward Chace Tolman (1886–1959), an eminent

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contemporary of Hull's and a leading neobehaviorist of the 1930s and 1940s. He observed that after a rat had run a maze a few times, it would pause at a point of decision, look this way and that, take a few steps, and perhaps turn back, all before making its choice and going on. In his presidential address to the APA in 1938, Tolman said it seemed clear that the rat was performing "vicarious trial and error" in its head. "Anthropomorphically speaking," he added, "it appears to be a 'looking before you leap' sort of affair."[69]

That was only one of many bits of rat behavior that Tolman concluded could be explained solely in terms of processes going on in the rat's head. Years earlier, he and a colleague had built a simple maze with three routes to the goal box. The shortest was a straight path from the start box to the goal box; the second, a little longer, made a short loop to the left, then rejoined the straight path partway toward the goal box; and the third, the longest, made a long loop to the right, then rejoined the straight path close to the goal box. In a series of trials the rat, as behaviorist theory predicted, found its way to the food by all three routes but learned to take the shortest, since that was the most easily established habit.

Tolman then put a barrier across the straight path halfway to the goal so that the rat could reach it only by the longest route. According to theory, when the rat ran down the straight path and came up against the barrier, it should have turned back and tried the next most easily established habit—the medium-length route—but it immediately took the long route. To Tolman this suggested that the rat had built up a sort of mental map of the entire maze and "realized" that the barrier blocked all but the longest route.[70]

Tolman conducted many similar experiments, most of them far more complicated, and all of which supported his belief that "something like a field map of the environment gets established in the rat's brain." Standard behaviorist theory, he said, offered only a partial explanation of maze learning: "We agree… that the rat in running a maze is exposed to stimuli and is finally led as a result of these stimuli to the responses which actually occur. We feel, however, that the intervening brain processes are more

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complicated, more patterned, and often, pragmatically speaking, more autonomous than do the stimulus-response psychologists."[71]

These studies led Tolman to propound a theory he called "purposive behaviorism." Its essence was that rats act not as automata, developing habits solely according to the number and kind of stimuli they experience, but as if, in addition, they are influenced by their own expectations, their knowledge of what leads to what in a given situation, their goals, and other internal processes or states.[72] As one orthodox behaviorist derisively said, Tolman's rats were "buried in thought."[73]

Tolman called these internal factors "intervening variables" (they intervened between stimulus and response) and insisted that they were compatible with behaviorism. "For the behaviorist," he wrote, "'mental processes' are to be identified and defined in terms of the behaviors to which they lead. [They are] naught but inferred determinants of behavior… Behavior and these inferred determinants are both objective, defined types of entity."[74] It was a valiant effort to remain faithful, but Tolman had, willy-nilly, breached the dike of behaviorism and let in a trickle of mind. In time it would be a flood.

If reward and repetition only partly explain rat behavior, they give an even more limited account of the determinants and workings of human behavior. Consider memory, for example. Behaviorists portrayed it in purely mathematical terms: the more trials and reinforcements, the greater the rewards, the closer in time the S and the R, the more certain it is that the S will produce the R. If the stimulus is the question "What comes after five?," the response is "six." If the stimulus is the question "What is your phone number?," the answer is a sequence of seven digits (ten if you include the area code). The first digit is the response to the question but is also the stimulus that produces the response of the second digit, and so on, in a chain of associative links.

But even at the height of the behaviorist era, psychologists knew that human memory was more

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complicated than that. For one thing, we "chunk" some information: we remember area codes, for instance, as units, not as a series of linked responses. For another thing, we have different kinds of memory: we learn some phone numbers only for a moment—we look them up, hold them in "short-term memory" until we dial, and then instantly forget them, but make others a part of our "long-term memory" (the vast stockpile of stored knowledge we draw on as needed). Some things require inordinate amounts of repetition and reward to become fixed in memory (many people can't seem to remember their own Social Security number, though they've looked it up scores of times); other things (the exorbitant price we paid for dinner at a particular restaurant, our baby's first words) remain indelibly fixed in memory after only a single experience. These and many other characteristics of human memory cannot be explained by the confined and rigid formulas of behaviorism.

Throughout the behaviorist era, some psychologists continued to explore, in broader and deeper terms, not only human memory but a number of the psychological phenomena that behaviorism had ignored, like perception, motivation, personality traits, reasoning, problem solving, creativity, child development, the interplay of hereditary tendencies and experience, and interpersonal relations. Gradually, the new data gathered about these subjects, and the questions those data raised that behaviorism could not answer, prepared the way for what Thomas Kuhn, in his famous analysis of scientific revolutions, called a "paradigm shift"—a relatively abrupt switch to a new theory encompassing and making sense of a large accumulation of data that could be accounted for only with difficulty, if at all, by the reigning theory.[75]

Meanwhile, research in a number of other fields was beginning to cast new light on the workings of the mind. From anthropology came studies of how preliterate peoples think; from psycholinguistics came accounts of how human beings acquire and use language; and from computer science came a wholly new way to conceive of thinking—as information processing, proceeding step by step like a computer program.

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The convergence of all these forces achieved intellectual critical mass during the 1960s, resulting in a knowledge explosion and a new conception of psychology. The former cognitive specialties within psychology regained their status, and cognitive science became the hot new interdisciplinary specialty or, more accurately, aggregation of specialties. It was a mind-based science relying on experimental methods by means of which reasonable inferences could be made about mental processes. By the 1980s, cognitive science studies were going on in the psychology departments of nearly every American university, and a handful of universities had created semi-independent institutes of cognitive science. We'll look at this more closely later in this history.

With the advent of the paradigm shift, behaviorism rapidly lost its commanding position in psychology and its claim to be a sufficient explanation of all behavior. Gregory Kimble of Duke University sums up the disenchantment of psychologists with behaviorism:

> Although the classical theories were formulated and tested in terms of simple learning, behind the scenes there was always the presumption that these theories could be applied to all behavior… [and] that most of the basic laws of learning had already been discovered and all that remained was the minor problem of resolving the few systematic issues that separated the main theorists… [But] by the middle of the century it had become clear that the classic theories of learning were limited in scope and that the stature of our scientific knowledge was pre-Galilean rather than post-Newtonian, as Hull and others had thought.[76]

Curiously, it was only when behaviorism was in its decline that its off-shoot, behavior therapy, became a widely used and reasonably successful form of treatment for a limited range of psychological disorders.

What is true of behavior therapy—its usefulness but limited applicability—is similar to what has proved true of its parent, behaviorism. A number of its findings have been put to practical use, an example being taste-aversion

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learning: To inhibit coyotes from killing sheep, researchers put toxic lamb burgers, wrapped in sheep fur, on the perimeters of fenced areas of sheep ranches; coyotes that eat this bait get sick, vomit, and develop an instant aversion to lamb meat and to sheep.[77] Other conditioning mechanisms have been used to counter the aversion cancer patients develop to food if mealtime comes just before painful chemotherapy (the simple answer: separate mealtime widely from treatment).[78] Behavior modification methods have been used in programs with mentally retarded children and adults, psychiatric patients, and prisoners: They earn "tokens" for good behavior that can be traded for privileges. Secondary reinforcement methods have proved useful in the workplace in such applications as giving employees bonus vouchers for getting to work on time.[79] Phobias of various kinds, including extreme fear of snakes, have been successfully treated by step-by-step conditioning of the phobic person to thoughts of, the sight of, and eventually the handling of, snakes.[80]

More generally, behaviorism yielded a legacy often taken for granted but considered essential in most areas of psychology: the need for rigorous experimentation and carefully defined variables. Behavior analysis continues to attract some psychologists as a field of research and application; in addition to the 4,500 members of the Association for Behavior Analysis, another 5,000 or more psychologists are members of local chapters of ABA. But their interest in it is apparently more as an adjunct to other areas of research than a primary identification, an indication being the membership of Division 25 of APA, which peaked at some 1,600 members in the early 1970s, then slid steeply downhill to a little over 600 in the last half dozen years, about 7 percent of APA membership.

In any case, the kinds of studies being performed within the field of behavior analysis these days seem strangulated to cognitivists. Here, for instance, are the titles of typical articles in the January 2006 issue of the *Journal of the Experimental Analysis of Behavior:*

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> "The influence of prior choices on current choice."
> "Resistance to extinction following variable-interval reinforcement: Reinforcer rate and amount."
> "Second-order schedules of token reinforcement with pigeons: Implications for unit price."

And here is a brief excerpt exemplifying much of the work being done by contemporary behaviorists:

> Rats obtained food-pellet reinforcers by nose poking a lighted key. Experiment 1 examined resistance to extinction following single-schedule training with different variable-interval schedules, ranging from a mean interval of 16 min to 0.25 min. That is, for each schedule, the rats received 24 consecutive daily baseline sessions and then a session of extinction (i.e., no reinforcers). Resistance to extinction (decline in response rate relative to baseline) was negatively related to the rate of reinforcers obtained during baseline, a relation analogous to the partial-reinforcement-extinction effect. A positive relation between these variables emerged, however, when the unit of extinction was taken as the mean interreinforcer interval that had been in effect during training (i.e., as an omitted reinforcer during extinction)… 81

It is time for us to move on to something more easily recognizable as psychology.

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* William of Ockham, a fourteenth-century Franciscan, is supposed to have said, "Entities are not to be multiplied without necessity," although some sources claim that what he actually said was "It is vain to do with more what can be done with fewer." In either case, the message is that the best explanation is the simplest one.
* Observers (of their own conscious processes).

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