3

Psychological Perspectives on Behavior: From Purposeful to Purposeless

From a purposeful perspective on behavior . . .

The pursuance of future ends and the choice of means for their attainment are thus the mark and criterion of the presence of mentality *in a phenomenon. We all use this test to discriminate between an intelligent and a mechanical performance. We impute no mentality to sticks and stones, because they never seem to* move for the sake of *anything, but always when pushed, and then indifferently and with no sign of choice. So we unhesitatingly call them senseless.*
—William James (1980, p. 8)

. . . to a purposeless one (one hundred years later) . . .

It is possible to step back and treat the mind as one big monster response function from the total environment over the total past of the organism to future actions.
—Allen Newell (1990, p. 44)

In moving from philosophical to psychological perspectives on behavior, we should first consider what distinguishes them from each other. Both are concerned with many of the same issues, such as the nature of perception, thought, and consciousness; what and how we are able to learn from our environment; and the underlying causes of behavior. So it is not so much their contents that differentiates the two disciplines as their methodologies. Philosophy relies primarily on verbal reasoning, logic, and sometimes mathematics to understand the world, our perception of it, and our actions within it; psychology for the most part claims to be an empirical science based on data derived from both laboratory-based and naturally occurring data.

Wundt's Voluntaristic Psychology

It is fitting that Wilhelm Wundt (1832–1920), who founded in Leipzig the first laboratory for experimental psychology in 1879, is widely considered to be the father of psychology. Wundt believed that psychology, like the older and respected science of physics, should rely on experimental methods to test and refine its theories. But Wundt saw the domain of "raw," immediate human experience, comprising both feelings and sensory perceptions unmodified by reflection or abstraction, as the primary subject matter of psychology. Relying on introspective reports of trained subjects who would report their experiences to controlled stimuli such as a ticking metronome, Wundt attempted to understand human psychological experience by relating it to its basic elements, an approach that has been described as a type of mental chemistry. As part of this project, he developed his tridimensional theory of affect, by which all emotions can be classified according to the three dimensions of pleasantness-unpleasantness, strain-relaxation, and excitement-calm.

Wundt held that a careful analysis of immediate experience would reveal to the psychologist the basic properties of the human mind, including its lawful changes from one state to another, a principle he referred to as "psychic causality." But whereas he made a distinction between psychic and physical causality, he nevertheless recognized the psychological importance of the physical function of the brain and nervous system, stating that "there is no psychical process, from the simplest sensation and affective elements to the most complex thought-processes, which does not run parallel with a physical process" (1912, p. 186). Wundt's contrasting of psychic and physical processes might make him appear to be a mind-body dualist, which indeed is the usual description of him in psychology textbooks. But that is not an accurate characterization. Instead, he maintained that there were both psychological and physical aspects to thought, perception, and animate behavior, and both had to be studied in order to understand the underlying phenomena (see Blumenthal 1988, p. 196).

Still, he felt that there were serious limitations in restricting oneself to physical approaches to studying animate behavior:

> Wundt acknowledged . . . the theoretical possibility of reducing psychological observations to physiological or physical descriptions. Still, he argued, these physi-

cal sciences would then describe the act of greeting a friend, eating an apple, or writing a poem in terms of the laws of mechanics or in terms of physiology. And no matter how fine-grained and complicated we make such descriptions, they are not useful as descriptions of psychological events. Those events need be described in terms of intentions and goals, according to Wundt, because the actions, or physical forces, for a given psychological event may take an infinite variety of physical forms (Blumenthal 1988, p. 198).

We see here that he recognized the importance of purpose in understanding animate behavior and that many different behaviors can be effective in achieving the same goal. Indeed, the notion of purposeful animate behavior played such a central role in his psychology that he referred to his psychological theory as "voluntaristic," based on the Latin word *voluntas* meaning "will." For Wundt, such purposeful behavior required central control processes that were fundamentally different from mechanistic processes of physical causality.

William James: Varying Means to a Fixed End

At the end of the nineteenth century and beginning of the twentieth, no one had a greater influence on psychological theory in the United States than William James (1849–1910). James was (and still is) widely respected for his two-volume *Principles of Psychology* that took him twelve years to complete before being published in 1890.

In the opening chapter of the *Principles*, James took great pains to make what he considered to be an important distinction between the behavior of physical objects and that of living organisms. First, he described the behavior of iron filings in the presence of a magnet and the behavior of air bubbles blown into the bottom of a pail filled with water. We observe the filings "fly through the air for a certain distance to stick to its [the magnet's] surface" and the air bubbles "rise to the surface and mingle with the air" (1890, p. 4). But if obstacles are introduced, such as a card placed on the magnet or a water-filled jar inverted over the bubbles, neither the filings nor the bubbles will end up as before. Instead, now the filings will stick to the intervening card and the bubbles will remain trapped inside the jar.

James went on to contrast the behavior of the iron filings with that of Romeo in the presence of Juliet and the behavior of the bubbles with that of a frog, and showed how living organisms can circumvent such obstacles, achieving their goals in spite of disturbances.

> Romeo wants Juliet as the filings want the magnet; and if no obstacles intervene he moves towards her by as straight a line as they. But Romeo and Juliet, if a wall be built between them, do not remain idiotically pressing their faces against its opposite sides like the magnet and the filings with the card. Romeo soon finds a circuitous way, by scaling the wall or otherwise, of touching Juliet's lips directly. With the filings the path is fixed; whether it reaches the end depends on accidents. With the lover it is the end which is fixed, the path may be modified indefinitely.

Similarly, the frog will not, like the bubbles,

> perpetually press his nose against its [the jar's] unyielding roof, but will restlessly explore the neighborhood until by re-descending again he has discovered a path around its brim to the goal of his desires. Again the fixed end, the varying means! (1890, p. 4)

Thus living things distinguished themselves from nonliving objects in their purposeful behavior and intelligence in obtaining fixed goals by varying their actions. A nonliving thing showed only "a mechanical performance" and naturally "we impute no mentality to sticks and stones, because they never seem to move for *the sake of* anything, but always when pushed, and then indifferently and with no sign of choice" (1890, p. 5).

It would seem that James was a soul-body dualist in dismissing the possibility that the apparently purposeful behavior of living organisms could have mechanical explanations. But he also considered mental phenomena and the behavior of humans and animals to be aspects of the same natural world in which we find nonliving objects. So in keeping with the provisional and undogmatic character of his treatment of complex and controversial topics, he admitted that brain and mind "hang indubitably together and determine each other's being, but how or why, no mortal may ever know" (1898, p. 119).

The Rise of Behaviorism

In addition to the immediate impact that James's *Principles* had on psychological thought, other events in Russia and the United States a short time later had an even greater influence on the growth of the still-young field of psychology, leading to the rise of what eventually became known as *behaviorism*.

In St. Petersburg, physiologist Ivan Pavlov (1849–1936) was studying the digestive system of dogs in the 1890s when he and his assistants noticed a curious phenomenon. The animals would secrete gastric juices not only when food was placed in their mouths but also at the mere sight of food and even at the sight of anyone who regularly fed them. Pavlov explained this change in behavior (now known as Pavlovian, classical, or respondent conditioning) as modification of a stimulus-response reflex. This involved linking a new stimulus (for example, the sound of a bell that regularly preceded the introduction of food into a dog's mouth) to an old response (in this case, salivation).

It is interesting to note that Pavlov's student, Anton Snarsky, who had done the original research on Pavlovian conditioning, attempted to explain this change in behavior by appealing to the dog's higher mental processes involving feelings, expectations, and thoughts. But Pavlov rejected this interpretation, wishing to remain "in the role of a pure physiologist, that is, an objective observer and experimenter" (quoted in Boakes 1984, p. 121). He therefore rejected all mentalistic interpretations, preferring to consider all animate behavior as the result of one-way stimulus-response reflexes, and all changes in animate behavior as the result of environmentally caused modifications of these reflexes.

While Pavlov restricted his research to dogs, American psychologist John B. Watson (1878–1958) applied Pavlov's theory to both animals and humans. In an influential paper published in 1913 entitled "Psychology as the Behaviorist Views It," Watson criticized the method of introspection used by Wundt and his followers, and declared that psychology should abandon all study of consciousness and mental processes, and be concerned only with publicly observable behavior and its causes. He even went so far as to hold that thinking was actually a form of silent speech that involved tiny, imperceptible movements of the larynx.

Pavlov and Watson explained animal and human behavior as the functioning of stimulus-response reflexes and learning as the pairing of new stimuli with old behaviors. Edward Thorndike (1878–1949), however, was interested in understanding how new behaviors were learned and spent considerable time observing how animals such as dogs and cats managed to escape from a box that required a new action, such as pulling on a loop of string, to open the door. Based on this and other animal research, Thorndike concluded that all learning in all animals (including humans) followed certain fundamental laws. The most well-known of these is his law of effect, stating that behaviors that are followed by "satisfaction to the animal" will most likely recur, while actions followed by "discomfort to the animal" will be less likely to recur.

Thorndike was the first psychologist to propose that all new learned behavior results from the selective reinforcement of random responses. It was fellow American B. F. Skinner (1904–1990) who made behaviorism widely known among both psychologists and the larger public in the second half of the twentieth century. Skinner called such learning "operant conditioning" since it involved organisms learning new ways of operating on their environments. Like Thorndike, he saw such new, useful behaviors as resulting from the reinforcement of those actions that were followed by a rewarding consequence. So, for example, if a hungry rat's push of a lever resulted in the delivery of a food pellet, the rat would soon learn to push the lever repeatedly. In addition to his extensive technical research on animal learning, Skinner, who had originally intended to be a novelist, wrote several popular books about behaviorism and its application to social and educational problems (1948, 1971, 1974). Skinner's name remains most firmly connected to the theory of *radical behaviorism*, a perspective that denies a causal role to internal mental states, purposes, and thought processes, and instead sees animate behavior and all changes in animate behavior as determined by the environmental consequences of actions.

It is important to realize that Skinner did not deny that human thinking and consciousness existed. But, like Watson, he did not see how such mental phenomena could offer any useful explanation of animate behavior, stating that "behavior which seemed to be the product of mental activity could be explained in other ways" (1954, p. 81). And consistent with his stimulus-response view of learned behavior, he denied that motives, desires, or purposes could provide an explanatory account for animal or human behavior. He argued instead that "a person disposed to act because he has been reinforced for acting may feel the condition of his body at such time and call it 'felt purpose,' but what behaviorism rejects is the causal efficacy of that feeling" (1957, p. 224).

Behaviorism can be seen as a bold attempt to make the study of animal and human behavior as objective and as scientific as the physical sciences.

It was reasoned that since behavioral scientists cannot have objective access to the subjective experiences of another animal or person, such mental states must be omitted from study. Instead, what could be studied objectively were overt behaviors of organisms and environmental factors that caused them. As described by Gardner (1987, pp. 11–12):

> A strong component of the behaviorist canon was the belief in the supremacy and determining power of the environment. Rather than individuals acting as they do because of their own ideas and intentions, or because their cognitive apparatuses embody certain autonomous structuring tendencies, individuals were seen as passive reflectors of various forces and factors in their environment. . . . It was believed that the science of animate behavior, as fashioned by such scholars as Ivan Pavlov, B. F. Skinner, E. L. Thorndike, and J. B. Watson, could account for anything an individual might do, as well as the circumstances under which one might do it. (What one thinks was considered irrelevant from this perspective—unless thought was simply redefined as covert behavior.) Just as mechanics had explained the laws of the physical world, mechanistic models built on the reflex arc could explain human activity.

In other words, the behaviorist approach could be characterized as an attempt to extend Newton's one-way cause-effect mechanics to living organisms. From this perspective, animate behavior is not autonomous or purposeful in any way but is composed of mechanically determined reactions to physical forces, with the reflex arc as a type of connecting rod between environmental inputs (causes or stimuli) and consequent behavioral outputs (effects or responses).

Such a characterization may be an accurate description of Pavlov's and Watson's classical conditioning in which one stimulus (such as the sound of a bell) becomes substituted for another (such as food). But it does not do complete justice to Thorndike's and Skinner's view of learning in which new, adapted behaviors are acquired. For an animal to learn a new response, behaviors that have not occurred before must occur spontaneously. These random behaviors, as shown by cats and dogs in Thorndike's puzzle boxes, and rats and pigeons in Skinner boxes, are not reactions to environmental stimuli but are rather emitted by an active organism seeking food, water, or escape from an unpleasant situation. So an essential component of Thorndike's law of effect and Skinner's operant conditioning is behavior that is essentially *uncaused* by the environment. In this way this view of animate behavior departs from a one-way cause-effect model.

But whereas operant conditioning requires such spontaneous, random behavior, this does not make it any less mechanistic or more purposeful for the behaviorists. Although neither Thorndike nor Skinner speculated on the precise cause of such emitted behavior, it could be readily accounted for by some type of random behavior-generator within the organism that performed the equivalent of tossing a die or selecting a value from a table of random numbers and acting on the result. Nonetheless, for both men the environmental consequences of a random action—for example, the degree to which it was successful in obtaining food for a hungry animal—determined the likelihood that such an action would be repeated in similar circumstances. So Gardner is essentially correct in the quotation concerning behaviorists' "belief in the supremacy and determining power of the environment." Living organisms, unlike inanimate pieces of matter, emit spontaneous behaviors uncaused by their physical environment, and it is from this repertoire that some behaviors are selected. But the environment nonetheless determines the behavior that is learned during this process in much the same way that environmental factors determine the motions of nonliving objects.

Skinner saw a striking analogy between his theory of operant learning and the theory of natural selection for biological evolution, remarking that "in certain respects operant reinforcement resembles the natural selection of evolutionary theory. Just as the genetic characteristics which arise as mutations are selected or discarded by their consequences, so novel forms of behavior are selected or discarded through reinforcement" (1953, p. 430). In the same way that Darwin's materialist and mindless theory of natural selection replaced a purposeful God in providing a scientific explanation for the evolution of species, Skinner considered the mechanical and mindless selection of animate behavior by the environment to be a replacement for the notions of mind and purpose operating at the level of individual organisms. We will return to his theory of learning and its curious mix of Newtonian and Darwinian causality in chapters 7 and 11.

Tolman's "Purposeful Behaviorism"

Skinner and the earlier behaviorists removed all consideration of mind and purpose from their analysis of animal and human behavior. This was possible, however, only by ignoring what Wundt and James had earlier emphasized—that animate behavior often varies markedly while its consequences remain constant. A rat does not take the exact same steps every time it runs through a maze, nor does it push a lever exactly the same way each time to obtain food. Neither does a man move the steering wheel of his car exactly the same way each time he drives from home to work. Skinner showed that he was aware of this phenomenon by defining the term "operant" as a class of animate behaviors that all had the same effect on the environment. But he provided no explanation as to how reinforcing individual actions could serve as a reinforcement for the infinity of actions not performed that also produced the same environmental effects. For example, if individual actions are selected by their consequences, how would reinforcing a rat with food for pushing a lever with its right paw lead it subsequently to push the same lever with its left paw or with its nose?

Edward C. Tolman (1886–1959) identified this problem in Skinner's behaviorism and recognized the goal-directed nature of animate behavior. He made a distinction between what he called *molar* and *molecular* descriptions of animate behavior. A molar description referred to the consequences of the behavior, and a molecular description referred to the specific muscular and limb movements performed by the organism. As examples of molar descriptions of behavior he offered (1932, p. 8)

> a rat running a maze; a cat getting out of a puzzle box; a man driving home to dinner; a child hiding from a stranger; . . . my friend and I telling one another our thoughts and feelings—*these are behaviors* (qua *molar*). And it must be noted that in mentioning no one of them have we referred to or, we blush to confess it, for the most part even know, what were the exact muscles and glands, sensory nerves, and motor nerves involved.

To demonstrate that rats do not learn specific, fixed responses when learning new tasks, Tolman and his associates at the University of California in Berkeley conducted a number of ingenious and influential experiments from the 1920s to 1950s. Among the best-known was one conducted by Tolman's student D. A. Macfarlane in which rats learned to swim through a maze to obtain a food reward (see Tolman 1932, pp. 79–80; Boakes 1984, p. 232). After they had learned to do this well, a raised floor was installed in the maze so that the rats now had to wade through the maze to get to the box containing the food. It was hypothesized that if the rats' learning consisted of acquiring specific swimming behaviors (that is, specific responses to specific stimuli), they would have to relearn the maze in the wading condition, as the movements and stimuli involved in wading are very different from those involved in swimming. It was found instead that after a very brief period of adjustment to the new situation (just one run through the maze), the rats performed as well in the wading condition as they had in the swimming condition. This was a clear demonstration that what the rats learned while swimming the maze could not be described as the formation of stimulus-response connections. Rather, the acquisition of a more abstract form of knowledge about the location of the goal box and how to get there was involved, since it made no difference to the rats whether they swam or waded to their destination. Similarly, once a person knows how to reach a specific location by driving a car, he can also go there by bicycle (if he knows how to ride one) or by walking (if it is not too far). The destination can be reached despite the fact that stimuli and responses differ greatly from one mode of transportation to another.

But in spite of these findings and many others like them, Tolman was never able to eliminate the concept of stimulus-response connections from the very core of his theory of purposeful behavior. Indeed, his attempt to explain how animate behavior can vary and yet reach a consistent goal involves imagining long, complicated chains of such connections existing within the organism in the form of intervening variables, and conceiving of responses not as specific muscular contractions but rather as a "performance." With respect to the latter, Tolman wrote (1959, p. 100):

> It is to be stressed . . . that for me the type of response I am interested in is always to be identified as a pattern of *organism-environment rearrangements* and not as a detailed set of muscular or glandular activities. These latter may vary from trial to trial and yet the total "performance" remains the same. Thus, for example, "going towards a light" is a *performance* in my sense of the term and is not properly a response (a set of muscular contractions).

But substituting the word "performance" for "response" does nothing to explain how an organism is able to accomplish a repeatable "organism-environment rearrangement" by responding to stimuli; it simply states that it somehow happens. If "behavior may vary from trial to trial and yet the total 'performance' remains the same," how is it that the organism is able continually to adjust its behavior to arrive at a desired goal?

Tolman made an important initial step toward solving this problem in his realization that sensory feedback was important; that is, the rat's behavior changed the stimuli it perceived and this feedback was essential in guiding the organism toward its final goal (1959, p. 103). But he never provided an explicit model for how such a system could work, so he never managed to break free of the behaviorist tradition of regarding stimuli as causes of animate behavior.

Hebb's Bridge from Behaviorism to Cognitive Psychology

Another important and influential North American psychologist who attempted to overcome the shortcomings of behaviorism was Donald O. Hebb (1904–1985) of McGill University in Montreal. Hebb was particularly interested in applying newly discovered principles of brain functioning to understand better how the brains of humans and animals worked to influence behavior. Watson and Skinner considered the brain as a type of black box whose inner workings were both invisible and irrelevant for understanding animal and human behavior. In contrast, Hebb dared to try to peer inside the brain and was convinced that it was only by understanding details of the brain's operations that animal and human behavior could be explained. He called his brain-based approach to animate behavior "neuropsychology."

He saw animal and human behaviors as varying along a continuum with respect to the amount and type of brain processes involved in the behavior. At one end of this continuum were behaviors that appeared to involve automatic, rapid reactions to stimuli, such as the startle response to a loud, unexpected sound, or withdrawing a hand from a hot surface. At the other end of the continuum were behaviors requiring a great deal of brain, or cognitive, processes between stimulus and response, such as finding the answer to a complex problem in mathematics or making a difficult decision. Since these brain processes occurred between stimulus and response, he referred to them as "mediating processes" in which thought, ideas, and images were involved. Toward the middle of this reflex-cognitive continuum were activities that were more than automatic responses to stimuli but did not require a great deal of mental activity, such as easy arithmetic tasks.

Hebb was thus able to build a bridge between the stimulus-response behaviorist psychology that was beginning to wane in the second half of the twentieth century and the "cognitive revolution" that was gaining momentum. In addition, he considered the neural mechanisms by which such cognitive processes could work. The behaviorists' conception of the brain was that of a one-way telephone switchboard that directly connected incoming stimuli to outgoing responses (with learning being a modification of these direct connections based on experience). Hebb instead imagined more complex brain processes that could account for cognitive processes such as thought, motivation, and attention (1949, 1972). In so doing he replaced the stimulus-response model of behaviorism with what has been described as a stimulus-organism-response model of animate behavior.

Hebb's major contribution in this regard was his theory of the "cell assembly," a group of brain cells (neurons) that formed a closed circuit in the brain and could remain active for quite some time after an initial stimulus by a type of nervous reverberation. These reverberations, which he believed were the basis of all higher cognitive processes, mediated or intervened between incoming sensory information and outgoing motor responses. An example he used involved presenting a schoolboy with the words "please add" followed five seconds later by the words "four, seven" (1972, pp. 85–86). The schoolboy's response of "eleven" is evidence that the initial stimulus of "please add" was somehow being kept active in the brain until the words "four, seven" were heard. Even though there was no immediate response to the initial words, they influenced behavior regarding the words subsequently heard and thus mediated the response to the numbers (the response would have been different if the instructions "please subtract" had been given instead). Thus all cognition could be understood as such mediating brain processes between stimulus and response.

This neuropsychological-based stimulus-organism-response account of animate behavior had important advantages over the direct stimulus-response theories of the behaviorists, but it still encountered difficulties in accounting for voluntary and purposeful animate behavior. This is because animate behavior was still ultimately determined by sensory stimulation, either directly (as in reflexes) or through mediating cognitive processes involving the reverberation of circular neuronal circuits in the brain. As Hebb put it (1972, p. 84):

> The typical problem of higher behavior arises when there is a delay between stimulus and response. What bridges the S-R gap? In everyday language, "thinking" does it: the stimulus gives rise to thoughts or ideas that continue during the delay period, and then cause the response.

But if "higher behavior" involves stimuli eliciting thoughts with thoughts in turn causing responses, how can this mechanistic, one-way cause-effect system account for the goal-directed nature of animate behavior in which behavior varies as it must to produce a consistent outcome? If, as Hebb believed, "all behavior is under sensory guidance, through the switchboard of the central nervous system" (1972, p. 92), it would appear that animate behavior could not be any more purposeful or voluntary than the behavior of wind-blown clouds or falling drops of rain.

The Cognitive Science Approach to Behavior

Hebb recognized the mechanistic implications of his neuropsychological theory of animate behavior and consequently dismissed the notions of will and voluntary behavior, stating that "in modern psychology the terms 'volition' and 'will' or 'will power' have disappeared" (1972, p. 92). He could have easily added "purpose" to his list. Although cognitive psychology in the 1980s and 1990s developed in ways that he could not have foreseen, it has remained purely materialistic and for the most part continues to see animal and human behavior as the mechanical product of sensory stimulation processed by a brain that consequently produces behavioral outputs.

As mentioned, behaviorists thought the brain was analogous to a telephone switchboard that permitted only direct one-way connections between stimuli and their corresponding responses. To this switchboard Hebb added reverberating groups of neurons that he called "cell assemblies." Cognitive scientists of the second half of the twentieth century replaced the switchboard theory with one based on the digital computer, and used these electronic machines to attempt to simulate animal and human brains and the behavior they produce.

But a particularly intriguing development occurred around the middle of the twentieth century that promised to provide what had until then appeared unimaginable—a completely materialist, mechanistic model of purposeful animate behavior. In a 1943 paper with the title "Behavior, Teleology, and Purpose," Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow proposed that machines designed in a certain way could demonstrate goal-directed behavior. It seemed that during the early decades of the twentieth century, while psychologists were not paying attention, engineers found a way to build machines called "control systems" that, like Shakespeare's Romeo and James's frogs, could vary their behavior as necessary to produce consistent outcomes.

We will save for the next chapter a more detailed account of the revolution begun by Rosenblueth, Wiener, and Bigelow. But it should be pointed out here that this new approach to understanding animate behavior constituted the first real break with the one-way cause-effect view that was a part of all previous theories. Instead of seeing external events as causes for animate behaviors, this new "cybernetic" approach recognized that the behavior of a living organism (or that of a machine designed as a control system) has an effect on its environment. Therefore its behavior must also affect what it senses or perceives of this environment. So instead of a one-way behaviorist stimulus-response, or a one-way cognitive stimulus-computation-response conception, cybernetics closed the loop by connecting response back to stimulus while maintaining the normal Newtonian cause-effect relationships for components within the overall system. But if it is the case that response influences stimulus and stimulus influences response, one can no longer speak of independent external causes for animate behavior. This is because the one-way causal chain has been turned into a closed loop in which stimulus and response both *cause* and *are caused by* each other. The familiar one-way, push-pull, cause-effect model inherited from Newton, in which an independent environmental stimulus causes a dependent behavior, was for the first time replaced by something quite different, a theory of animate behavior based on a closed loop exhibiting *circular causality.*

A number of other pioneering cognitive scientists were influenced by cybernetics (see Miller, Galanter, & Pribram 1960); however, this new field and its radically different view unfortunately had little lasting impact on behavioral and cognitive science. With few exceptions, behavioral scientists working in the last decades of the twentieth century stuck with the familiar one-way cause-effect approach.

This is not to say that important recent advances have not been made in understanding the brain, cognitive processes, and their roles in animal and human behavior. But the dominant view in behavioral and cognitive sciences remains consistent with—and seriously limited by—the input-output, stimulus-organism-response model developed by Hebb in the 1950s in which animate behavior remains dependent on past and present environmental influences. "Cognitive psychology comes in various forms, but all share an abiding interest in describing the mental structures and processes that link environmental stimuli to organismic responses . . ." (Kihlstrom 1987, p. 1445).

Conclusion to Part I: Embracing Materialism, Spurning Purpose

It is obviously not possible to provide a comprehensive account of 2500 years of human thought on inanimate and animate behavior in just two book chapters. But this summary does indicate two important trends.

The first trend is movement away from immaterial, psychic theories of behavior to materialist, physical ones. The animism of early nontechnological societies, including the panpsychic physics of Plato and Aristotle, gradually gave way to the materialist physics of Newton and Laplace that remains with us. And what is true for physics is also true of psychology, a discipline that became thoroughly and unashamedly materialist in both its behaviorist and cognitive versions in the twentieth century.

The second trend is movement away from a conception of behavior as goal-directed toward a view of it as being essentially purposeless. For the behavior of inanimate objects this is linked to the trend from psychic to materialist theories in physics. Whereas Plato and Aristotle shared a goal-directed view of the universe, Newton, Laplace, and their successors were able to purge all notions of purpose from the behavior of nonliving objects and systems. Concerning animate behavior, Wundt's voluntaristic psychology and James's emphasis on purposefulness were replaced by twentieth-century theories of purposeless animate behavior by psychologists, whether they be in the behaviorist or cognitive camp.

The result of these two long-term trends is that today mainstream philosophical and psychological theories of both inanimate and animate behavior are thoroughly materialist and overwhelmingly purposeless in orientation. One could make a strong argument that the popularity of materialism is justified by the success of our modern, materialist science that discovered physical mechanisms and forces underlying a broad range of phenomena—from sickness to supernovas—that could previously be understood only as actions of gods or angels or other forms of spirits and ghosts. Newton's physics relieved angels from their full-time jobs of pushing the planets around in their orbits and required only an occasional helpful shove from God himself; Laplace's improved mechanics did away with God completely. Even more amazing was Darwin's audacity and success a century later in accounting for the diversity and complexity of living organisms without God's help. Some scientists continue to include God or other spiritual entities in their science, but they constitute a small minority whose work is excluded from mainstream scientific journals.

But does a thoroughly materialist view of the universe necessarily lead to a purposeless view of all its behavior as well? One reason that this might appear to be the case has to do with a conception that requires purposeful behavior to be caused by a future event or state. In this view, if the purpose of rain is to allow trees, flowers, and grass to grow, the *future* growth of these plants would have to somehow influence the *present* actions of clouds and raindrops. According to our present conception of physics, effects cannot precede their causes, or causes follow their effects. So it may well be the case that attributing purpose to naturally occurring inanimate behavior is inconsistent with modern materialist science.

Can the same case against purposeful behavior be made for living organisms? Our everyday observations certainly suggest otherwise. What William James noticed in the behavior of Romeo and frogs—variable actions leading to consistent consequences—we see everyday in the behavior and achievements of animals and humans. Our experience as human beings—each with our own long-term financial, career, and family goals together with our more mundane daily trials against the unpredictable disturbances provided by traffic, illness, accidents, and often uncooperative family members and co-workers—makes it obvious that our behavior is goal directed and purposeful. This is the case even if such behavior can ultimately be reduced to the buzzing of neurons and the twitching of muscle fibers.

Fortunately, we do have a thoroughly materialist, physical explanation for the purposeful behavior of living organisms that does not involve spiritual agents or require that the future influence the present. Unfortunately, it is not widely known and appreciated by behavioral and cognitive scientists. Having its roots in nineteenth-century biology, we will see that in its modern and expanded form this theory provides a revolutionary framework for understanding the what, how, and why of animal and human behavior.