Chapter 1
A Natural Science of Behavior

Contemporary global culture relies heavily on a natural science of just about everything that is real. These sciences share a common philosophy of naturalism which includes fundamental assumptions each of which has arisen by generalization from many empirically revealed particulars.

Natural Science Assumptions

A primary assumption in natural science is that a real event is theoretically measurable in terms of mass, time, distance, temperature, and charge (and perhaps some additional esoteric properties to be encountered in the ken of theoretical physicists). If an event cannot be measured in terms of those fundamental variables, it is not real and need not be taken into account.

A further assumption in a natural science is that any detectable event represents the culmination of a natural history: In the course of a natural history all events are assumed to follow as a direct function of preceding events. Those preceding events are then said to "determine" or "control" those that follow. In keeping with the philosophy of naturalism, the absence of *apparent* functional antecedents, rather than being taken as evidence of an exception, is interpreted merely as evidence of our temporary ignorance of the natural causes. No sequence of events is assumed to have started spontaneously at some mystical moment of creation or origination as if it had no history of real events leading up to that point. Whatever occurs at any given moment is entirely determined by the natural events that have led to it. Therefore, when an event occurs, it is the only event that could occur at that moment given the totality of the functionally related events that have preceded it.

People speak of the *probability* of a potentially impending event, but nature does not operate on the basis of probabilities. When we speak statistically as if it does so, we are conceptually shifting the level of analysis to circumvent our ignorance of some relevant causal functions in a way that enables us to take explanatory advantage of the limited set of causal relations that we *can* describe and measure.

Events that seem to be occurring at random, or chaotically, are assumed to result from a history of such natural events. In such cases, at some point in our analyses, the complexity, rapidity and latency of the natural precursor events simply overtaxes our capacity to detect and measure all of them. It becomes impossible to keep track of their functional interrelations. Thus, randomness and chaos do not represent concepts of unnatural causality. Instead they represent concepts by which we manage our residual ignorance of the prevailing natural causality. Theories of probability and chaos are artifacts of our inability to render absolute predictions based on a *total* accounting of the antecedents that lead to an event of interest. While nature is presumed to determine a given event absolutely, the human spectator is left to predict it only in terms of its probability based on what is always an incomplete accounting of its natural antecedents.

The precursor events that must be taken into account to *completely* explain a current event have two dimensions: First those precursor events chain back in time, each link representing the product of the events that occurred prior to it. Second, any given event is subject to multiple causation, meaning that an event is always the combined effect of a set of immediately preceding events that were acting concurrently. Thus, functionally related events chain back through time, and any given event represents the culminating and *combined* effect of a number of such chains of events all of which have shared in the production of the specified event.

The number of precursor events that contribute to a subsequent event is thus extensive (probably limitless), as we tend to discover if we attempt to take into account *all* of them, including those that play only a minor and often insignificant role in the determination of the event of current interest. It is both impractical and apparently impossible to take into analytical account absolutely *every* causal variable that contributes to the determination of a given event. To be practical, we try to take into account those antecedents that play the larger roles in determining an event.

Nothing about *behavioral* events excludes them from these considerations. For example, if we want to explain why a person said "hello," we may point to a stranger who was just then approaching the speaker. But if we observe our speaker on several similar occasions, we may find that the speaker does not always say "hello" when a stranger approaches. We may find that on a few of those observed occasions the speaker said "good morning" instead of "hello." The reasons for that variability may remain unexplained, and could even imply to some observers that something mysterious inside the speaker determined the form of greeting. However, if we expand the antecedents that we take into analytical account and, to the approaching stranger, add a second antecedent variable consisting of the position of the sun in the sky (it's morning, afternoon, or evening), then it seems more obvious why on certain occasions the greeting was "good morning" instead of "hello." In this simple example, control of the greeting form was shared significantly by *two* important factors (approaching stranger and position of sun in sky).

Thus, variability is not due to some arbitrary and capricious aspect of nature, but rather to changes in antecedent causal factors of which we may remain unaware. Variability tests our powers of explanation and can measure our ignorance, but indeterminism is *not* a fundamental property of nature. A basic postulate of natural science has emerged: If we could take into account *all* contributing causal variables leading up to an event, we could predict accurately the nature of that event. We continually test that assumption by taking into account more of the variables that precede given kinds of events, and by so doing exhibit what prove to be more accurate predictions. Accuracy in prediction is a function of both the number of controlling variables that are taken into account and the share of that control that each such variable exerts.

Because, as a practical matter, we cannot take into account all of the controlling variables, our accounting is never complete, and our predictions are never entirely accurate. Hence, certitude is not a state attainable through the practices that characterize the natural sciences. Put another way, science does not yield absolute proof. We resort to probability theory as a conceptual device with which to manage our ignorance. Its methods allow us to say as much as possible on the basis of what we do take into account. We make probability statements (e.g., we are 90 percent sure that she will turn right at the next four–way intersection"). Such statements do not imply that events can become functionally disconnected from their respective natural histories. Probability statements imply only that we have failed to take into account some of the variables that are sharing in the functional control of those events. Many people seek a mysterious bridging of that residual gap in the capacity to know merely by *claiming* certitude. That widespread self–deceptive practice is generally called *faith*.

Variation provides for selection and thus underlies selective change of which biological evolution is but one common example. However, it is important to note that variation occurs not to a single event but among events. Each event in a series of varying events is strictly determined by the chains of functional antecedent events that have led to it. Thus, variation does not contradict determination, because one of those concepts pertains to each single event, while the other concept pertains to differences among events that have not shared precisely identical functionally causal histories.

The functionally linked chains of accumulating events that define a natural history do not occur *within* time. Rather, they define time. Time has no meaning except in terms of the events said to fill it, but beyond those events there is no "it" to be filled. Time has no fundamental essence that is independent of the events that define it.

Activity in the class called *natural science* is quality–controlled by a philosophy of science that entertains no presumption of a parallel metaphysical universe. Natural science does not allow for an extra–physical universe from which ethereal events and variables can originate to intrude into the natural universe and alter the otherwise natural history of events occurring there. Discontinuities in the natural history of events, including metaphysical intrusions, are not entertained as a possibility within the analytical paradigm of natural science. No real event is truly spontaneous, and complexity does not imply spontaneity; it only complicates the analysis. When our capacity to measure is out–distanced by the complexity of the events of concern, we do not suppose that within that complex milieu, beyond the reach of our measures, natural processes are suspended in favor of metaphysical or mystical happenings.

In behaving in ways that comport with a natural science discipline, a seemingly mysterious event is never accepted as such. Scientists and engineers search for what are assumed to be its hidden causal variables—forgoing the temptingly easy alternative of attributing the unexplained event to invented metaphysical interventions or influences that, typically, are custom crafted to provide an exact accounting.

For instance, suppose that we witness an episode of complex behavior. The natural scientist of behavior does not invent a mystical spirit of some sort (a.k.a. the *self* or the mystical *mind*) and assume that it exists within the organism, conveniently possessed of exactly those powers necessary to compel the organism to behave in the observed manner. Instead, ignorance is accepted as the preferable interim state. The evolutionary pace of modern science affords a criterion for the qualitative measure of that approach. The tenacious and unrelenting search for the relevant functional relations controlling any event have so frequently led to the discovery of such relations that scientists have come reliably to behave in new situations as if such relations exist to account for events of interest. Still, much effort and many resources may be required for the eventual discovery of those prevailing relations.

Once the functional relations that can control a given dependent variable have been described accurately, any subsequent encounter with the particular functional antecedents that were featured in those relations is an occasion to *predict* that the dependent variable will exhibit whatever effect those particular antecedent configurations have been observed to control. Thus, on the basis of the relatively accurate description of the prevailing kinds of functional relations, we can produce relatively accurate predictions in specific instances. That is the realm of science. Additionally, by intervening to manipulate the functional antecedents, we can gain *control* over the subsequent events that those antecedents determine. The latter step, gaining control, is the realm of technology.

A simple example will suffice here: Suppose that in the context of our contemporary culture we are satisfied that when two people meet and one extends an open hand (a proffered handshake), the other party's hand will probably reciprocate by extending and grasping the first person's hand and shaking it. When we then observe two people meeting, and one extends a hand, we confidently predict how the second person will respond to that gesture. With sufficient experimentation to establish the reliability of that functional relation, we can describe, as a scientifically established relation, the controlling effect that the first person's proffered hand will have on the behavior of the second person. We usually describe that effect in terms of probability (e.g., a 93 percent probability that the person in question will grasp and shake the proffered hand of another person).

At that point, we have a way to control certain aspects of a second person's behavior by manipulating the behavior of a first party. Suppose that we select a subject who reliably has responded to an extended hand by grasping and shaking it, but has not previously been the initiating party in episodes of handshaking. If we then arrange for the first person *not* to extend a hand, perhaps through instruction or simply by making the first person carry a box that is so heavy that both hands are required to maintain a sufficient hold, we thereby prevent the second person from extending a hand. This would amount to a simple exercise in a behavior–controlling technology.

Again, we cannot predict with absolute certainty. In a given situation, we cannot detect and measure *all* of the variables that share in the control of an event, nor when deliberately arranging for certain controls to be in place can we entirely eliminate all others. While we do not take into account *all* of the controlling variables that contribute to an outcome of concern, we try to take into account a subset consisting of the more important ones. In the previous example, we took into account only these variables: (a) two people were present, (b) they were "meeting" (i.e., confronting each other following an interval of separation), (c) the first person had previously extended a hand in a manner characteristic of a proffered handshake, and (d) the second person had a history of responding to handshake opportunities but no known history of initiating them. We predicted the next behavior of the second person on the basis of only those four facts. Fortunately, those four preliminary details will allow us to make a prediction that will prove accurate in most such situations, although not in all cases.

If we need greater accuracy in our predictions, we have only to take into account more of the previously neglected antecedent controls. For example, are both parties exhibiting pleasant facial expressions? Has either party previously done unforgiven harm to the other? How clean are the hands of these two people? By adding measures of such additional variables to the set of variables that we take into account, we may increase the accuracy of our predictions—say, from 83 percent to 98 percent. If that improvement is still not sufficient, we can do even better by taking into account still more of the variables that share in controlling the response of the second person to the first person's extended hand.

But note that increased accuracy comes at a price. We must expend energy and other resources to "take additional variables into account." Even when we have already identified them, they still have to be measured. If we cannot yet identify them, they must be discovered. As a practical matter, we simply go to the trouble necessary to get sufficient accuracy for our purposes, and we do not concern ourselves about the remaining variability that must then be tolerated.

The *accessibility* of the functional antecedent variables determines the *feasibility* of an effective technology. For example, the functional relations controlling the launch and trajectory of an arrow shot from a bow feature relatively accessible variables, so a technology of archery has shown substantial progress in its development over the centuries. The much more limited accessibility of the antecedents that yield solar eclipses, while having been described with sufficient accuracy to permit relatively accurate prediction, has precluded comparable progress on a technology that would *control* eclipses of the sun.

Variables in the Natural Sciences

The functional relations that explain events from the natural science perspective feature variables that have been categorized in various ways. Such categorizations begin with the assumption that all real–world events are physical in fundamental nature. Only measurable quantities such as distance, mass, time, temperature, and charge may be used to define physical variables. The dependent and the independent variables featured in a natural science explanation are both drawn from someplace among the categories of physical events. In the natural sciences there is no explanatory appeal to mystical variables that cannot be detected or measured.

In constructing natural explanations for events in the real world, a natural scientist points to functional relations between or among variables. In functional relations, changes in one variable are reflected in corresponding and systematic changes in one or more other variables, and each of the involved variables has some kind of physical status. Energy is regarded as a state of matter.

Any increment of matter exists in some relation to other increments of matter, and those relations can change. Such changes are often called *processes*.

A functionally related group of physically real elements is called a *system*, and *process* manifests as changes in the interrelations among the elements of a system or among systems per se. When under study, physical variables are often categorized according to the systems in which they occur as well as the kinds of processes in which they are involved. Recognized natural science disciplines (physics, chemistry, biology, and behaviorology) are based on such distinctions.

This paragraph presents some examples of functional relations that feature behavior as the dependent variable. In each case, note the physical (i.e., real) nature of the independent variable that is specified: In a two–term cause–and–effect explanation in which a book on a table evokes a behavioral response of pushing the book aside, the dependent variable (effect) is behavioral, while the independent variable, the book, is a physical entity (cause). Similarly, if a falling bomb evokes a shout of "Take Cover!," the dependent variable is behavioral (the shout), while the independent variable is in the category of a mechanical process (a falling object). In providing a physiological explanation of why a temporarily terrified person can run with extraordinary speed we appeal to biochemical processes within the body of that person. Or to explain why certain aspects of an elderly person's behavior may degrade in general effectiveness with age, we may appeal to variables that define the integrity of the person's body. If a person's left hand is reaching for a candy bar, and the person's right hand gives the back of the left hand an admonishing slap, we can describe and explain that slap by describing a particular behavior–behavior functional relation (i.e., both the dependent and independent variables are behavioral).

The realm of non–physical variables is excluded from explanations in the natural sciences. Among such disallowed non–physical variables are autonomous internal selves that are said to operate within the bodies of certain organisms (especially humans), as well as external deities, spirits, ghosts, and other ethereal pseudo–beings. Other commonly evoked non–natural variables include mysterious forces and powers, for example those attributed to water dowsers, faith healers, and fortune tellers. It is often argued, on the basis of faith rather than evidence, that certain non–physical variables are real, but it is always impossible to measure them. Arguments that stubbornly insist on their reality are avoided and their appeal resisted within the natural science community. Control over the events in our environment has been demonstrated reliably only through philosophy, science, and technology that rely on real independent variables. Similar demonstrations of control, putatively through appeal to non–natural independent variables, are always subject to a re–analysis featuring physical variables.

Science and Human Behavior

In general, people have been pleased with the technological control over nature that modern science has made possible. Not only has technology afforded easier access to a variety of reinforcers, it has also facilitated our avoiding the horrors of nature. As technology has afforded increasing capacities for control, the more severe of the *naturally occurring* controls over humans and their activities increasingly have come to be regarded as intolerable. For example, modern technologies of birth control allow a ceiling to be imposed on population expansion below a population level that would disrupt the integrity of the culture. Few people are now prepared to accept the *naturally occurring alternatives* to the technological control of a population, which include starvation, disease, warfare, and predation. Those more natural controls will inevitably impose effective ceilings on population expansions in much more aversive and culturally disruptive ways.

However, the general enthusiasm for technology has been slow to extend to technologies that pertain directly to behavioral variables. Many people who approve of the availability of birth control compounds and devices tend to resist behavioral technologies pertaining to their use.

Unfortunately, in part because behavior has always been deemed mysterious, ineffable, and sacrosanct, a substantial fraction of people do not want a science of human behavior—especially when they begin to discover how different are its implications from those of the comfortable and familiar if arguably mistaken common wisdom about behavior. But we are now entirely dependent on science and technology for the survival both of our culture and of ourselves as individuals. Dependence on technology has permitted extremes of expansion and extension in the control of many matters that are critical to human culture—population and resource distribution systems to name just two. Our species now has before it no viable option to abandon science and technology—and probably has not stood at such a juncture since tool using became the vogue.

Progress toward behavior science has lagged far behind not only progress in the physical sciences—but even behind progress in biology. **Mechanical causation,** so emphasized in the physical sciences, was discovered early. The induction of scientific principles from the effects of familiar pulls, pushes, twists, and collisions proved relatively easy. But the implications of another important kind of causality went unnoticed. It was Charles Darwin's 1859 exposition of **selectional causality** to explain species differentiation in *The Origin of Species* that set the stage for the subsequent adaptation of selection by B.F. Skinner, some 80 years later, to explain the most important kind of behavior change in humans.

Those 80 years were required for the scientific approach to the study of behavior to advance sufficiently to allow the principle of selectional causality to be adapted for application to behavior. When eventually applied to behavioral events, selection could then explain not only the structure of the body that behaves (Darwin's contribution) but also much of the behavior that the body exhibits (Skinner's contribution), although in those respective cases different kinds of things were being selected under different circumstances and according to different time tables. The more intuitive mechanical causality of the physical sciences notwithstanding, the more subtle mechanism of *selection* now informs much of the natural science perspective on behavior.

The selection mechanism for producing either biological or behavioral change applies only to *renewable* resources. The more readily renewable those resources, the faster the change by selection can occur. That is because for selection to work, vast numbers of individual entities must be sacrificed or rejected to yield common residual changes in the surviving set. Life forms, which all reproduce prodigiously, thus lend themselves to selectional causality.

For example, consider the development of a specialized structural feature (such as a human hand) from a primordial species gene pool in which the elements of that hand manifested only as fragments and then only in crude approximations—elements that perhaps appeared in only a few individuals. The emergence of a hand from such disparate basic genetic resources required the selective elimination, prior to individual reproduction, of most of the hand–related genotype in that population. That culling manifests by way of the elimination of individuals, prior to their reproduction, and usually occurs when they fail to meet some environmental challenge for lack of an appropriate form of a particular structure (e.g., a hand) that would facilitate more effective survival behavior. Those continuing losses of individuals are replaced through the typically prodigious reproduction capacity of the survivors. The species gene pool thus becomes more enriched with a hand–related genotype for the production of more effective hand–involved behavior.

Such structural changes within a population are often rendered inconspicuous, because, although perhaps fast on an evolutionary time scale, the selection process is usually slow relative to normal reproduction cycles and typically occurs over a vast number of generations during which many other kinds of evolutionary changes are occurring concurrently. During an evolutionary process by which something like the human hand is produced, the overall selection–produced changes in the involved organisms typically carries that population through a long series of changes at the species level. Humans contribute to the further refinement of their structural features, but most of the developmental history of those features was shared by a long series of ancestral species.

As with bodily structures, behaviors are also readily reproduced, though obviously through different mechanisms. However, when behaviors are lost (in the sense that they no longer tend to occur), other behaviors readily appear. Therefore, behavior is also suited to change through the selection mechanism.

The contemporary natural science of behavior–environment relations relies heavily on the principle of *selectional* causality to account for essential details about behavior—for example, why an organism exhibits a *particular* behavior in a given situation instead of just any behavior at random from among the vast number of different behaviors of which it is capable. A major class of behavior, called *operant* behavior, upon which this book will focus heavily, is said to be available to a behaving organism because, on past occasions, behaviors in that class have been *selected* by their consequences (in fact, some behavior scientists now refer to functional consequences as "selectors"). This refers, in the fallacious everyday language of personal agency, to the fact that we tend to repeat what "pays off" and to ignore or avoid what proves to be ineffective or aversive. A behavior is thus selected to be repeated (or not) by the effectiveness of its outcomes.

The English philosopher David Hume was perhaps the first scholar of note to suggest the possibility of a *science* of behavior. In 1739 Hume summarized his idea of human behavior informed by a philosophy of science founded in the tradition of experiment and observation. Here is Hume's own description of his undertaking (Hume, republication of 1888):

> Tis evident, that all the sciences have a relation, greater or less, to human nature.... 'Tis impossible to tell what changes and im-

> provements we may make in these sciences were we thoroughly acquainted with the extent and force of human understanding, and cou'd explain the nature of the ideas we employ, and of the operations we perform in our reasonings.... ...as the science of man is the only solid foundation for the other sciences, so the only solid foundation we can give to this science itself must be laid on experience and observation. (pp. xix–xx)[1]

But the promising trend toward a natural science of behavior did not evolve directly from Hume's work. A long historical interval would pass before it reappeared.

The first serious attempt to organize a scientific discipline around the study of behavior was launched around the start of the 20th century when the *natural philosophy* movement began to split from mainstream philosophy and to organize independently under the label of *psychology*. While that independence movement carried forward on an emerging *experimental* tradition, much of its experimental work was focused on questions that were cast from what remained a metaphysical perspective. That is, scientific methodology, featuring experimental analysis supported by elaborate quantitative methods (mostly statistical), was applied to questions that often took their substance from residual metaphysical assumptions about the nature of human beings and their behavior.

While some early psychologists would have led that discipline along a natural science track, other influential scholars tended to focus the analytical power of scientific methodology on the kinds of questions that arise through a somewhat metaphysical perspective on the behavioral subject matter. That disparity in the course of disciplinary development was largely resolved at the recruitment table, because the culture at large was heavily mystical and filled psychology classrooms with a vast majority of students predisposed to mysticism and prepared to use science only for the explication of behavioral phenomena construed from that perspective.

In the version of inquiry favored by many emergent psychologists, the ancient explanatory reliance on the influence of *external* deities and spirits was being partially replaced by reliance on *equally metaphysical internal entities.* From its new presumed home within a hypothetical construct called the "mind" (which most who believe in the mind prefer to superimpose on the brain), the resident internal spirit, now self–addressed as "I," "me," or "myself," could affect changes on that part of the physical world represented by the body and could do so through mysterious interventions that go by a variety of names such as *choosing* or *deciding.* From this dualistic mind/body perspective, a vacuous pseudo–entity called a "self" could function as an autonomous or semi–autonomous agent that willed behavior to occur. What the self willed, the body would then do. While a more powerful external autonomous agent, to which many people refer as "God," is putatively possessed of vast powers and "can move mountains," as the expression goes, the mini–deity assumed to exist within the body, called the self, with its lesser compliment of similar mystical powers, is able to command the movement only of certain parts of its host body.

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[1] Hume, D.A. *Treatise on Human Nature* (Edited by L.A. Silby–Bigge), Oxford: Clarendon Press, 1888. Reprinted 1967; originally printed by John Noon, 1739–1740.

For many people, including psychologists and other social scientists of a metaphysical bent, the mind presumably represents an interface between the metaphysical world and the physical or "real" world. Across that physical–metaphysical mental interface the internal spirit (a.k.a., the self or the soul) and an external deity (e.g., "God") are thought to be capable of communicating with one another. The presumed workings of such a mind, featuring a physical–metaphysical interface, have apparently been inferred entirely from observed behavior without direct evidence. That is, behavior has been *assumed* to reflect the workings of a mind. Behavior is then interpreted as revelations of the nature of such a mind. *Mind* has thus been established as an inferred construct.

The study of inferred psyches, autonomous or semiautonomous minds, and similar unnatural constructs thought by some to affect behavior, is now left to psychology, the discipline named for the study of such metaphysical matters. Psychology is often said to be a scientific discipline, but whether the scientific study of the implications of mystical assumptions should be regarded as a scientific discipline is arguable. The answer depends upon what is deemed to be the necessary relation between scientific activity and the kind of philosophy that informs it.

B.F. Skinner's *behavioral* psychology movement, originating in the 1930s, challenged the validity of the sorts of inferences that characterized traditional psychology. In fact, although Skinner worked in psychology, Skinner's emerging science was so philosophically and analytically different from the traditional psychology paradigm that the phrase "behavioral *psychology*" was an unfortunate misnomer. Skinner's behavioral movement was emerging as a unique discipline of behavior–environment functional relations that, by all reasonable gauges, did not fit as a subdivision of psychology. It was a strictly natural science, and it would, in fact, eventually support the independent discipline of behaviorology.

Although certain accidents of Skinner's early graduate training period resulted in his entering a psychology training program and continuing to work under that professional label, an analysis of the science that Skinner subsequently developed supports the conclusion that Skinner never functioned as a scholar of the psyche. That is, beyond the nominal association, it can be argued that he was never actually a *psychologist* of any kind.

Skinner's entrance into a graduate psychology program at Harvard was heavily influenced by the availability of the psychology department's well–equipped machine shop, which appealed to Skinner's practical engineering propensities. But while he was tinkering productively with his experimental equipment in the shop, the curriculum that he encountered in his psychology courses led him to write in 1927 that "…I shall probably continue therein [in psychology], even, if necessary, by making over the entire field to suit myself" (quoted from Skinner's autobiography, Part II., *The Shaping of a Behaviorist,* p. 38; also see pp. 31–32 for a discussion of his attraction to the Psychology Department's machine shop).

Throughout his professional lifetime, Skinner called himself a psychologist, and allowed others to do so, not because he regarded the science that he was developing as an aspect of traditional psychology, but rather because he thought that his fundamentally different science represented what traditional psychology *should become.* Skinner's change strategy was to claim the existing label (i.e., "psychology") for the more effective science that he believed should replace the traditional version.

By the time that Skinner became associated with psychology in the 1930s it was already an established and widely recognized discipline. Competitively displacing psychology with an intruding alternative discipline has loomed as a difficult challenge since the establishment of psychology during the early 1900s. It appeared easier to Skinner to change organized psychology from within by proffering a more effective science. Skinner and his followers hoped that psychologists, once the effectiveness of the new natural science of behavior was demonstrated to them, would accept and adopt it. Skinner spent his professional lifetime trying, with little success, to effect such a disciplinary change through that kind of internal revolution.

Skinner had set forth the basic concept of his science in *The Behavior of Organisms,* published in 1938. An historical trace of the precursors of Skinner's thinking, extending back about 75 years before Skinner published *The Behavior of Organisms,* takes us to Charles Darwin.[2] Darwin, in *The Origin of Species* (1859), established the continuity of species through his theory of evolution by natural selection. Just as Copernicus had removed the earth from the center of a miraculously planned universe, Darwin similarly removed our species from the central role in such a divine plan. Through Darwin's work, much of the behavior of human organisms could be interpreted validly on the basis of behavior observed in non–human species. Furthermore, once Darwin had made clear how the mechanism of selection pertains to biological life forms, the Darwinian concept of the selection of whole organisms could subsequently be adapted, in new levels of analysis, both to the selection of the behaviors of an individual organism and to the selection of cultural practices that are exhibited by many individuals.

Three levels of analysis are implied: (a) The evolution of a species requires that organisms that are possessed of certain characteristics do not reproduce (usually by dying earlier); (b) the evolution of an individual's behavioral repertoire requires that specific behaviors be selected in the sense that they increase or decrease in frequency according to their effectiveness; and (c) the evolution of the common practices that define a culture requires that specific practices be selected for continuation *through teaching.* Skinner accepted Darwin's application of the selection principle at the first analytical level, and Skinner himself went on to apply the selection principle at the second and third levels of analysis.

In 1863, four years after Darwin published *The Origin of Species,* Ivan Sechenov (1829–1905), a Russian physiologist, published *Reflexes of the Brain.* He proposed that what was commonly believed to be nonphysical mental activity such as consciousness and states of mind actually had a physical basis and were kinds of behavioral effects. Sechenov had a strong influence on Ivan *Pavlov* (1849–1936), another Russian physiologist, whose experimental work subsequently established the fundamental principles of reflex, or respondent, behavior. The work of Pavlov is especially important as a major step toward the completely mechanistic account of behavior that characterizes modern be-

[2] The following historical details are drawn largely from Chapter 2 of Michael, J.L. (1993). *Concepts and Principles of Behavior Analysis.* Kalamazoo, MI: SABA.

haviorology. Skinner, in turn, read Pavlov's work and was much influenced by the experimental rigor that Pavlov brought to the study of behavior. Skinner made early attempts to conceptualize the behavior of the whole organism using the terms and concepts that Pavlov had developed to describe reflex behaviors (e.g., terms and phrases such as conditioning, extinction, discrimination, generalization, and conditioned and unconditioned stimuli).

Another thread of influence on Skinner's thought, one of the most important, traces from Ernst Mach (1836–1916) an Austrian physicist and philosopher whose concept of scientific epistemology has greatly influenced modern science and philosophy. Mach published *The Science of Mechanics* in 1883. From that book B.F. Skinner derived much of his general approach to scientific methodology, epistemology, and philosophy in general. Science was seen to be *behavior* characterized by efficient investigation, direct and immediate observation, and parsimonious description. "Cause" was recognized to be nothing more than a functional relation between independent and dependent variables. It was recognized that approximations to truth are to be established by data. Hypotheses and theories were seen often to be unnecessary and in some cases harmful in the sense that over–investment in a favored theory can manifest as unwarranted defense of that theory in the face of contradictory evidence and may preclude the search for such evidence in the first place.

Jacques Loeb (1859–1924), an important American physiologist and biochemist, was also influenced by Mach. Loeb studied the behavior of invertebrates and attempted to explain behavior in strictly mechanistic terms. He eschewed the inference of mental functions as explanations for behavior. Loeb published *The Organism as a Whole* in 1916. Skinner read Loeb's works, and at Harvard University, although Skinner was majoring in psychology, Skinner worked in the physiology laboratory operated by one of Loeb's former students, W.J. Crozier. Crozier was head of the Department of General Physiology throughout Skinner's graduate training years at Harvard. Crozier had a strong and direct influence on Skinner's approach to science, especially Skinner's unwillingness to infer spontaneous mental or neural origins for behavior.

The perspective that Skinner would subsequently pursue received a philosophy–based endorsement from Bertrand Russell (1872–1970), the English philosopher and mathematician who published influentially on the philosophy of science. Russell had studied John Watson's earlier brand of behaviorism, which Watson had in turn developed after studying the work of the physiologists Loeb and Pavlov. Russell applied Watson's brand of behaviorism to traditional epistemological problems and concluded that behaviorism provided a rich and generally sufficient account of "knowledge," both ordinary and scientific.

The only major influence on Skinner from among the historical philosophers was from Francis Bacon (1561–1626). Bacon was a philosophical maverick in his own time, because he alone endorsed experimentation as the only effective scientific methodology (as opposed to passive contemplation). Bacon also held that the test of scientific truth was the ability to control nature. Skinner, while in the eighth grade, read Bacon's biography and several of Bacon's works and later acknowledged that Bacon had been an important influence on his own serious pursuits.

The point of this historical summary of the major influences on Skinner's scientific thought is to suggest that Skinner's very different way of thinking about behavior certainly did not represent a continuation of the traditional psychological thought that characterized the field in which Skinner found himself. Skinner continued an intellectual tradition of natural science that traced back primarily through biology and physics instead of back through traditional psychology into philosophy and religion from which predominant strands of psychology had emerged. In fact, the intellectual tradition of psychology could not have supported the development of Skinner's approach. Organizationally, he was *in* psychology, but intellectually he was not *of* it. And Skinner steadfastly avowed that he intended to *change* psychology.

A general trend in psychology across the past half century has been to de–emphasize, although not abandon, reliance on purely metaphysical spontaneous mental origins of behavior, which has never been fashionable in the broadly construed science community at large. Metaphysical explanations appealing exclusively to an autonomous self within the body ignore compelling evidence that the environment, not some internalized spirit–like self, determines behavior. Modern psychologists have had to acknowledge a role played by the environment, but they have tended to limit that role to one of mere influence rather than strict determination.

The hypothetical construct of *mind* has been retained among the majority of psychologists. In the fundamentally mystical psychological view of behavior that has survived, behavior has been linked to the environment by way of something called *information.* According to this school of thought, an aspect of the environment breaks away in the form of information. Leaving the remainder of the environment behind, this piece of information putatively enters the body. It is possessed, or not, of the attribute of "meaning"[3] but it undergoes various mental transformations that in some models *endow* it with meaning (if it does not already have meaning as an inherent property). After undergoing the necessary internal transformations and transmogrifications (presumably in the mind), what had been the incoming information subsequently emerges in the form of behavior. The label *cognitive psychology* has been attached to the study of that putative sequence of transformations.

In stark contrast, within behaviorology none of these hypothetical constructs and processes (mind, information, and information processing) are deemed to be real, nor, in any case, are they deemed to be helpful. They play no role in behaviorological analyses. Recourse to such fictitious elements is replaced by a very different natural science counterpart called the science of ver-

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[3] Psychologists have tended to treat meaning as a kind of property that can characterize information. Information can exist in meaningful or meaningless states. If meaningful, the mind interprets the information; if meaningless, the mind supposedly imparts meaning *to* the information. In the contrasting behaviorology view, information is not recognized as real, nor is meaning regarded as an intrinsic property of an event. From the behaviorological perspective, the *meaning* of something is the nature of the behavior that it controls. To ask what something means to a person is to ask how it controls that person's behavior and what kind of behavior results.

bal behavior. Most animals have nervous systems, which often include brains, but nervous systems are not the homes of body–driving self–agents. Nervous system mediate the production of behavior, but they do not spontaneously originate it, nor do they proactively concoct behavior using environmental inputs as guides or other resources.

Increasingly, and continuing a trend that was already evident in the mid–1900s, speculations about the workings of the hypothesized mind (based on inferences from observed behavior) have led many modern psychologists to turn hopefully to physiologically based brain science for independent evidence to corroborate their conjectures about mental events. The psychologists search through studies of brain function (because they believe that the construct of mind is conterminous with the brain) seeking physiological evidence for their cognitive constructs and the cognitive operations that they suppose to exist there.

In contrast to the work of psychologists who study brain functions, physiologists, trained as natural scientists, conduct investigations into the real internal physiological events that occur in a person's nervous system while that person is behaving. Such scientists of brain functions, operating from a natural science perspective, conduct *biologically* based investigations. However, their findings are then interpreted by many psychologists to be the physical manifestations of whatever specific *mental* activities that they assume to underlie the observed behavior of the person.

Some psychologists, eschewing metaphysical implications, insist that the mind *is* the brain and nothing more. Although that assumption brings their version of psychology closer to the realm of natural science, it also tends to reduce psychology to a branch of physiology. But however interesting biology–based understandings of nervous systems may be, that repertoire is of limited practical use for supporting applied behavioral technologies (such as teaching, to cite but one of many possible examples). Behavior technologies rely primarily on a different level of analysis from that pursued in physiological brain studies—namely, on relations between parts of the environment and the behavior exhibited by a body while it is being affected by energy inputs from those aspects of that environment.

Traditional psychology had its conceptual roots in philosophy and religion, from which it emerged. The independence movement of the increasingly emergent field of psychology, when it began its protracted divorce from philosophy around the beginning of the twentieth century, was spurred by attempts to bring the scientific practices of quantification to bear on questions that often had origins in the philosophy of mind. That trend toward adopting scientific methods strained relations with traditional philosophers who had little or no use for measurement and experimentation.

Clearly, Skinner's science, to which he referred as "the experimental analysis of behavior," had entirely different roots. It was based on trains of analytical thought shared with the natural scientists in general and more particularly with physicists and biologists. Not only was Skinner's science not derived from mainline psychology, it was antithetical to it. About the only thing shared with traditional psychologists were certain questions about behavior, and even then those questions often had to be recast from a behavioral perspective before receiving the Skinnerian kind of attention.

Within the psychological community, reactions to the challenge posed by Skinner's work has been inconsistent. Many psychologists wanted to distance themselves and their field from Skinner's alternative analytical paradigm. But as a practical matter, the prospect of Skinner's science, operating in parallel with psychology as an independent and alternative disciplinary competitor was also unattractive.

One solution to that dilemma within the psychology community has been for psychologists to assert that Skinner's science represents just another, if somewhat peripheral, aspect of general psychological thought that can be a valuable conceptual tool for psychologists, although (as they are often quick to assert) only in certain limited contexts. That incongruous contention is politically based. In reality, the two camps are largely antithetical in their basic philosophical assumptions. They are so different in their scientific principles that they seldom allocate equal energy to the study of any given phenomenon. In everyday language: They are not always interested in the same things.

Within psychology training programs, fragments of Skinner's science, under the label "*behavioral* psychology," are typically shuffled among other schools of psychological thought as if behavioral psychology simply represented another facet of a larger integral psychology discipline. To make that integration seem more logical, the historical derivation of the behavioral perspective and its fundamentally different philosophy of science are often de–emphasized in psychology courses. Furthermore, because the behaviorological perspective is fundamentally very different from the psychological perspective, the behaviorological approach to various topics often leads to results that conflict with those derived through a traditional psychological analysis. Psychology texts often preclude such conflicts by omitting certain behaviorological treatments that would yield the more extreme contradictions. Under such conditions, the conceptual integrity of Skinner's science is destroyed in the effort to make it appear to fit into the psychological mainstream.

Unfortunately, Skinner's lifelong strategy of trying to change psychology from within played into the hands of those psychologists who worked for a conceptual integration of Skinner's science into traditional psychology—often by fragmenting and misrepresenting it, much to Skinner's continual dismay.

Another approach to that attempted integration has been to recognize the conceptual disparity but argue, in effect, that a *discipline* need not have conceptual integrity, although that contradicts a traditional implication of the term *discipline*. The discipline of psychology could then include *fundamentally* disparate and even antithetical schools of thought. Thomas Hardy Leahey, a modern historian of psychology has written that "I now believe that there has never been a paradigm in psychology, and to think so obliterates vital differences between thinkers lumped together in a supposed shared paradigm."[4] However, both alternatives (i.e., an ill–conceived conceptual integration and a heterogeneous coexistence under a single disciplinary banner) have been rejected

[4] Quoted from the preface to the second edition of *The History of Psychology: Main Currents in Psychological Thought* (reprinted in the front of the fourth edition, 1997, p. xvii), Prentice Hall.

by the behaviorological community where those efforts are seen more as political contrivances that make little or no scientific and philosophical sense.

The Emergence, Nature, and Capacity of Behaviorology

The discipline of behaviorology has been organized as an entirely independent discipline since 1987 when The Behaviorology Society was formed. Within the first year, that original name was changed to The International Behaviorology Association (TIBA). In 1997 TIBA became The International Society for Behaviorology (ISB), a name thought to connote a more purely scientific mission. In 1998 a second organizational entity, The International Behaviorology Institute (TIBI) and its related professional association were formed to focus more intensely on the training mission.

The discipline that those two coexisting organizations (ISB & TIBI) were established to represent is experimentally founded and has evolved out of various parent fields, among them the experimental analysis of behavior, philosophy of science, ethology, physiology, and evolutionary biology. Behaviorology now makes possible a philosophically informed application of natural science to the study of all behavioral events and to the production of specified behavioral effects. A book authored largely by Stephen Ledoux in 2002, entitled *Origins and Components of Behaviorology,* includes a seven chapter sequence jointly authored by Lawrence Fraley and Stephen Ledoux, which comprehensively details the early history of that disciplinary independence movement.[5]

Let us now consider ***behaviorology as a science.*** Behaviorological science, while relying on a properly working body for the production of behavior, does not pertain to the internal workings of the body. Nor are descriptions of the physiology of nervous systems relevant to the behavioral engineering that is developed on the basis of behaviorological scientific foundations. While the body of the behaving organism is necessary, and how it works internally may be interesting, its internal workings at a physiological level of analysis are of little or no practical importance to the interventions by which a teacher, lawyer, administrator, or most any other kind of behavior–related professional can produce effects in the behavior of those whom they serve.

Consider this example: Suppose that an automobile driver, who is ignorant of the internal mechanical details of a car's steering mechanism, is informed accurately that a certain mechanical part in the steering linkage is attached to another mechanical part and that, as a result of that linkage, those two internal parts work together in a certain way as the car is being steered. It remains unlikely that the driver's now being able to describe those mechanical details will affect that person's driving. In general, one's performance as a driver does not improve when one becomes able to render such descriptions, because those details about the internal workings of the car, however interesting, play no functional role in the stimulus control of driving behavior. That is why the highly skilled driver of a car and the highly skilled mechanic for that car can often be two different persons.

[5] Ledoux, S.F. (2002). *Origins and Components of Behaviorology—Second Edition.* Canton, NY: ABCs.

Applying a similar argument to behavior, the internal workings of the body are usually irrelevant to the scientific and technological activities of a behavior engineer. Descriptions of what putatively occurs within the nerves of a person, including the large ball of nerves at the top of the spine, normally contribute little if anything to an effective technology of behavior. Behaviorological technology depends on relations between behavior and events in the behavior–controlling environment. Few long–term cultural experiments are as well failed as the century–long effort to build effective technologies of behavior on a foundation of descriptions and theories about the internal workings of the nervous system—especially the superimposed hypothetical construct called the mind.

In general, details about how nerves function during episodes of behavior do not enhance the skills of a parent, teacher, lawyer, or administrator, because such details do not function as antecedent controls over those peoples' job–related behaviors. For example, the practices by which a parent conditions a child to make the vocal sound *dog* in the presence of the family's pet beagle do not ordinarily require that the parent be capable of describing the physiological details of what is occurring within the child's nervous system during that episode of language training. Thus, descriptions of nerve functions represent an impractical level of analysis for most behavior–related practitioners.

It is the work of the physician or the surgeon—people who tinker with the structure of the body—that is aided by such details. One may take pleasure in knowing accurately what is happening inside one's nerves as one thinks about how fireflies produce their glow, …or in knowing what occurs in the brain as one ponders the geometry through which the return of a comet can be predicted, …or in knowing what neural activity precedes one's saying "cat" when a cat comes into one's range of vision. However, such facts about internal neural events have little and often nothing to do with the practices of a person whose task is to produce those intellectual skills in the repertoires of students.

Just as the physiological level of analysis is largely irrelevant to practical behavior engineering, so is the psychological level of analysis, but for a different reason. Metaphorical models and constructs that people invent to suggest how a mind works are based on the fundamental assumptions that those analysts bring to the task. That is, those models and constructs of mind depend on the basic philosophical ideas that function as starting points in the design of those hypothetical constructs. Psychologists, for instance, tend to start with assumptions about the nature of human beings and reality that differ from the fundamental assumptions of natural scientists such as behaviorologists. Therefore, the models and constructs that psychologists develop to suggest mechanisms that comport with their kind of basic assumptions about the nature of human beings and their behaviors seldom comport with the very different basic philosophical assumptions that are entertained by natural scientists.

The natural science approach to the analysis of a behavioral event of concern—an approach much appreciated by natural scientists—typically involves the early identification of the independent variables in the prevailing functional relations in which that behavior serves as the dependent variable. It is important to determine the prevailing functional relations in which that behavior plays a dependent role because behavior technologies must, of necessity, be based precisely on interventions that change the independent variables in those relations so as to insure the emergence of a desired behavioral effect. Thus, with respect to behaviorology, the fundamental scientific approach results in the identification of the variables that will have to be changed to produce the desired behavioral effects. Therefore, in behaviorological practice, the points of potential intervention are identified routinely in the normal course of scientific study or inquiry. Thus, practicality inheres in behaviorological method.

Behaviorology, featuring its own level of analysis, is a comprehensive and generally applicable scientific repertoire that is of practical use to all who must solve problems in human behavior. This book presents an introduction to that science in somewhat comprehensive detail. Because behaviorologists are concerned with behavioral events, behaviors are the usual *dependent* variables identified during behaviorological scientific activity, while the environmental events that functionally control those behaviors are treated as the *independent* variables.

Behaviorology functionally relates accessible independent *environmental* variables to the corresponding dependent *behavior* variables. Those relations provide the basis for a kind of behavior engineering in which behavior variables are controlled by manipulating the functionally related and accessible independent variables in the behavior–controlling environment. The functions that, from a psychological perspective, are performed by an internal self that acts as a body–managing agent, are assigned in behaviorology to the behavior–controlling environment. That leaves nothing for a spirit–like internal agent to do.

Behaviorology as a discipline. A *science* is a verbal repertoire of principles, descriptions of relations, and prescriptions of method. In that sense, a science of behaviorology manifests among the behaviors of those who are said to practice it.

We also speak of the *discipline* of behaviorology, which generally implies a broader concept. Behaviorology, as a basic *discipline,* features a natural science, which has been described above and which also goes by the name *behaviorology.* However, in addition to the behavioral repertoire of described relations, principles, and general methods of the science, behaviorology as a discipline also includes the relevant philosophy of the science and also the behavioral *engineering* (which usually implies both tools and applied practices) by which a practitioner produces behavioral effects. Furthermore, when we speak of an "*organized* discipline," we expand the concept still further to include professional organizations, academic departments, the published literature, and other features that link together the members of the verbal community in question.

Behaviorology encompasses the processes by which behavior is changed. Behavioral events are described, analyzed, predicted, and subsequently controlled. Behaviors of all kinds—motor, verbal, and emotional (to use some traditional categories)—are viewed as *producible products.* This discipline provides the basic foundations by which practitioners in any behavior–related field gain a practical engineering control over the behaviors of concern.

Behaviorology is the appropriate basic scientific discipline with which to conduct the study of how a nurse comes to care, how a teacher produces the capacity of a student to exhibit a new repertoire of skills, how a leader cultivates followers, how an artist appeals to an audience, how a community influences a citizen, how laborers take pride in their work, how a friendship is strengthened, and how a sense of duty is instilled. Behavior of any kind, being natural, is determined by theoretically controllable antecedents, and, as such, like the surface of a highway, is subject to production to preceding specifications.

Behaviorology is the discipline through which we can produce, to specification, a feeling of freedom, a new "want," a feeling of pride, or a sense of guilt, sin, or shame. It is not only the discipline of values and ethics, but of how to produce them to specification. Families, religious institutions, governments, and other agencies claim rights to practice processes of behavior construction, but they lack proficiency in the science by which to do that most effectively. All behavior is determined by its functional antecedents, and the only valid issues remain who or what will control the relevant antecedent variables, how that control will be exercised, and the behavioral objectives that are to prevail. *Personal freedom* validly implies no lack of behavior control. It is merely the state in which the prevailing controls elicit no aversive feelings in the controllee.

None of the diverse potential behavioral outcomes are of mysterious origin. Instead, they occur naturally, in some cases by accident. However, a discipline of behaviorology exists, and it supports rapidly developing behavioral engineering technologies for a wide variety of different applied fields in which outcomes like these and others are important. Practitioners in any field that features challenges to produce such behavioral effects can now study the behaviorologically informed scientific foundations of their own respective behavioral business and can enjoy the advantages of behavioral technologies relevant to their respective applied concerns (i.e., gains in efficiency and effectiveness).

Curriculum. Students gain basic principles of behavior in a comprehensive core of conceptual, experimental, and applied learning activities. Those foundations are then applied to behavioral problems encountered in the students' respective chosen fields. A behaviorology core typically includes advanced course work in conceptual foundations, measurement of behavior, behaviorological research, and verbal behavior—all substantially different from corresponding course work in psychology and other social sciences that operate beyond the ken of the natural sciences.

Relation to other disciplines. On the one side, behaviorology, which focuses on the behavior of individuals, overlaps biology, in which studies of behavior range from ethology to physiology, the latter of which can carry the study of behavior to the intraneural molecular level. And on the other side, behaviorology overlaps culturology,[6] which studies behavior mainly at the group level and deals almost exclusively with human behavior.

Just as chemistry can be considered as a special branch of physics, behaviorology can be considered as a special branch of biology—specifically, as an extension of ethology. Ethology is a branch of biology devoted largely to the study of the instinctive or "inherited" behavior exhibited by the various animal species. Ethologists have been concerned less with "learned" behavior (behavior conditioned during the lifetime of individual animals), although ethologists

[6] See Chapter 6 (p. 146*ff*) of Fraley, L.E. & Ledoux, S.F. (2002). Origins, status, and mission of behaviorology. In S.F. Ledoux, *Origins and Components of Behaviorology—Second Edition.* Canton, NY: ABCs.

could have expanded their investigations in that area, a trend that inevitably would have carried ethology further into the arena of human behavior.

As a student, B.F. Skinner could have entered a biology–based graduate program at Harvard University and eventually taken the lead in such an expansion of biology. Instead, Skinner affiliated with psychology, a move that is now viewed in some quarters as a mistake.[7] Nevertheless, it has become obvious that human behavior is too vast in scope and too important for the organizational arrangements for its study to remain appended to organized biology. Furthermore, the behaviorological level of analysis, while practiced in biology, is not prevalent there. An embryonic behaviorology discipline could perhaps have been nurtured better under the protection of a parental natural science like biology. However, at present, the contingencies that favor the organizational independence of the behaviorology discipline have become as obvious as those that favor the organizational independence of chemistry.

Disciplines and Fields

A distinction must be made between an *applied field* and a *basic scientific discipline.* Applied fields are named and defined according to variables located in the respective environmental settings and subject matters that are of interest. That is, a *field* is defined in terms of variables that are located in the behavior–controlling environment. Examples of applied fields are law, education, nursing, and entertainment. These are fields in which effective practice depends heavily on a relevant basic science of behavior. Hundreds more could be named. For example, the field of social work is defined by the nature and status of the clients being served and by the kinds of problems that must be solved on behalf of those clients.

However, a social worker could approach that job with any basic repertoire of principles pertaining to the nature of behavior. Behaviorology represents one such basic repertoire. Thus, behaviorology is not an applied field; it is a basic science discipline that can inform the work of practitioners in any behavior–related field. In contrast with a field, the definitive variables of a *basic discipline* reside in the verbal repertoire of the practitioner, not out in the part of the environment upon which the practitioner's work is focused. That is, *discipline* connotes the practitioner's intellectual approach or epistemological style, while *field* connotes the part of the environment that comes under study.

Within our culture there are many behavior–related fields but only a few basic behavior–related disciplines—distinctly different *major* approaches to analytical thinking *about behavior.* Here is what is meant by that: If one is preparing to become a nurse, an advertiser, a teacher, a counselor, a politician, or a practitioner in any other applied field in which behavior is important, the culture offers only a few major ways to think about the relevant behavioral events that one will encounter.

[7] See, for example, page 58 in Vargas, E.A. (2000). Diversity in the communities of behavioral science and the species specific character of behaviorology. *Behaviorology, 5,* 1, 38–63.

We can name those that are obvious and familiar. One can think **behaviorologically** by considering the functional relations between environmental variables and behavioral events, with a heavy explanatory reliance on selection mechanisms at several levels of analysis. Behaviorology consists of broadly applicable repertoires of science and philosophy, and, existing as it does independently of the applied fields, can be applied to the behavior–related problems that are encountered in *any* of them.

Alternatively, one can think **psychologically**, relating behavioral events to internal cognitive transformational processes inferred to occur within the nervous system of the behaving organism. Depending on the particular psychologist, the psychological way of thinking about behavior may or may not include appeals to metaphysical influences, but modern psychology is characterized by the prevalence of such thinking. Among psychologists who entertain such possibilities, examples include explanatory appeals to (a) an autonomous or semi–autonomous behavior–managing self–agent and (b) influences on behavior that are exerted by external deities or their celestial agents. Psychological theories are often bolstered by adducing evidence of intra–neural events that are detected while a person is behaving. Such a correlation between internal physiological events and behavioral events is then interpreted in a way that appears to lend verisimilitude to the internal hypothetical constructs upon which psychological accounts rely.

For example, brain activity that is detected while a person, who upon facing an automobile, says *"sedan"* may be interpreted as evidence of information being processed by a proactive mind. Presumably, that mind comparatively relates that fresh information to the contents of mentally archived information on classes of automobiles. That mind then proactively withdraws the proper class of automobile from among the stored categories of automobile, transforms it into speech, and controls its manifestation as the vocal utterance of the word *"sedan."* The underlined items (information, mind, and stored categories of automobile) represent the kind of internal hypothetical constructs that psychologists invent to take the place of the real and demonstrably functional independent variables that could be discovered through a behaviorological analysis.

While psychological thinking tends to feature a blending of scientific and metaphysical references, one can also think in terms of purely **metaphysical concepts** by relating behavioral events more–or–less exclusively to metaphysical variables in other–world domains, a tendency that is especially common among ecclesiastically endorsed approaches where behavior may be attributed to a human spirit or to a soul within the body. In most versions of the metaphysical approach, the internal ethereal entity that controls the body is, in turn, influenced or controlled through communications with equally ethereal outside entities such as those classed as deities. The realities of the environment are, of course, also taken into account, but instead of exerting any *direct* control over the behavior of the person, the environment is surveyed by the internal agent who takes environmental circumstances into account and then makes its own arbitrary decisions about how the body will be directed to react with respect to the environmental circumstances.

Obviously, these disciplinary differences are based on differences in ontology and epistemology. That is, they represent differences in what is deemed real and how "knowledge" is to be developed and established. They represent substantially different approaches to knowing—that is, differences in what is meant by *knowing* as well as differences in how people come to know. Most people lack intellectual integrity insofar as they do not consistently exhibit one of these intellectual modes. Instead, the behavior of most people appears to alternate among these intellectual modes with changes in the situations in which they find themselves.

Through most of the twentieth century, psychology has been the way of thinking most widely taught to behavior–related professionals in our culture. For example, all students in education, as in many behavior related fields, have long been required to study psychology in order to acquire their basic analytical approach to behavior. Therefore, today almost all educators, like practitioners in most applied fields, are predominantly applied psychologists as far as their basic analytical philosophy/science repertoires are concerned.

Inevitable questions about the qualitative ranking of philosophical perspectives usually resolve to questions about which approach supports the most efficient and effective practical actions. The relative worth of alternative basic disciplines can be established on that basis.

A Definition of Behaviorology

Put simply, behaviorology is the science and technology of behavior–controlling relations. This may appear similar to the way some other disciplines define themselves. The following elaboration should distinguish behaviorology from other disciplines.

Behaviorology is a comprehensive discipline with philosophical, experimental, analytical, and technological components. It is the natural life science of functional relations between behavior and the environment in which that behavior occurs. Behavior is explained as a direct, natural, innervated reaction to environmental events, without any causal contribution by putative behavior–directing agents within the body. The body only mediates the production of behavior. Behavior is always reactive. It cannot ever be proactive.

From a behaviorological perspective, an instance of *learning* represents a change in behavior that results because behavior–change processes have resulted in small–scale physical changes to the body that behaves, although the molecular details of those bodily changes remain irrelevant at the behaviorological level of analysis. However, because those molecular scale intra–neural changes have occurred, the body thereafter mediates differently the functional relations between environment and behavior. Thus, after those changes have occurred, bodily contact with the same environment will be followed by behavior that is measurably different from the behavior that was mediated by the same body prior to those changes.

Behaviorologists discover, interpret, and gain control of the environmental variables that functionally determine the behaviors of individual organisms. Those are the independent variables in functional relations that feature behavior as the dependent variable. One or more of such behavior–controlling functional relations may be operating concurrently. Furthermore, any number of independent variables may be sharing in the control of a single behavioral response.

Behaviorology relies strongly on the causal mechanism of selection. Other than automatic reflexes, a kind of response that proves more effective and perhaps more efficient than others in producing favorable consequences tends to be repeated on future occasions, and in that sense it is said to have been selected by its consequences. In common terms, we say that responses that prove effective tend to happen again on appropriate future occasions. The focus is often on the kind of behavior that is conditioned during the lifetime of the individual organism, although behaviorologists also consider the perpetuation of specific behaviors both as a result of inherited body structure and as a result of cultural practices such as teaching that can transcend the lifetimes of those who first exhibit the behavior that thereafter is taught. Behaviorology takes into account both planned and accidental behavior–controlling relations. To get more complete explanations for behavior, behaviorologists also take into account determinants of behavior that inhere as residual products of the biological history of the species.

Human behavior is of special importance to most behaviorologists, although practitioners of the discipline are in general well prepared to deal with behavior–related issues pertinent to other species. For example, behaviorologists may be found working in agricultural settings to solve problems that arise in connection with the behavior of livestock, while other behaviorologists may work in the fields such as domestic animal training and wildlife management.♣