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Cause, explanation, and theory in a science of behavior

Causa, explicación y teoría en una ciencia de la conducta

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Abstract

Conceptual revolutions in twentieth century science have generated a number of technical and popular works contrasting mechanistic and relational frameworks. In these works, and in the psychological literature, radical behaviorism has been identified as mechanistic and charged with being outmoded in comparison to contemporary scientific perspectives. This paper compares radical behaviorism and psychology's dominant experimental framework from the point of view of their relationship to dualism and to types of causation, explanation and theory that ensue. Additionally, given that contemporary philosophy of science discourages inquiry into the truth value of scientific theories, it invites consideration of the utility of mechanistic and relational frameworks respectively.

Key words: radical behaviorism, mechanistic framework, relational framework, dualism

Resumen

Las revoluciones conceptuales en la ciencia del siglo veinte han generado una variedad de trabajos técnicos y populares que contrastan los marcos de referencia mecanicista y relacional. En estos trabajos y en la literatura psicológica se ha identificado al conductismo radical como mecanicista y se le ha acusado de estar fuera de moda en comparación con perspectivas científicas contemporáneas. Este trabajo compara el conductismo radical y el marco de referencia experi-

mental dominante en la psicología desde el punto de vista de su relación con el dualismo y los tipos de causación, explicación y teoría que se desprenden. Adicionalmente, dado que la filosofía contemporánea de la ciencia desalienta la investigación del valor de verdad de las teorías científicas, invita a considerar la utilidad de los marcos de referencia mecanicista y relacional respectivamente.

Palabras clave: conductismo radical, marco de referencia mecanicista, marco de referencia relacional, dualismo

Psychology and scientific frameworks

Science and the philosophy of science have undergone profound changes in the course of the twentieth century, changes that can be characterised as a loss of certainty; a shift from certainty to something less. Not to uncertainty exactly, which implies that we cannot be confident of science, but to something less than the certainty with which it was once viewed. In science, the shift was brought about when it was found that Newtonian physics, a set of principles thought to be applicable to all natural phenomena, in fact could not account for some types of observations. The turmoil and distress this generated is a matter of record. Some of the leading physicists of that time have written of their confusion, almost disbelief, as they realised that principles so confidently relied on were in some ways deficient.

This loss of certainty in the universal applicability of Newtonian physics generated a literature of popular and technical works considering relations between the old and new physics, and implications of the new physics for knowledge about ourselves and our worlds. Authors spanning a range of disciplines and levels of involvement from Nobel prizewinning chemists to science journalists contribute to the ongoing inquiry generated by the loss of certainty. For example: The Tao of Physics (Capra, 1975); Mathematics: The Loss of Certainty (Kline, 1980); The Death of Nature: Women, Ecology, and the Scientific Revolution (Merchant, 1982); The Turning Point: Science, Society and the Rising Culture (Capra, 1983); Order out of Chaos: Man's new dialogue with nature (Prigogine and Stengers, 1985); Mathematics and the Search for Knowledge (Kline, 1985); The Cosmic Blueprint (Davies, 1987); Chaos: Making a new science (Gleick, 1988); A Brief History of Time (Hawking, 1988); and Does God Play Dice? (Stewart, 1989).

One of the main themes in this inquiry is a contrast between the old Newtonian-Cartesian science as mechanistic, and the new physics as relational. According to Caroline Merchant, the mechanistic view evolved in the context of increasing industrialisation when "The imagery, iconography, and literary metaphor associated with machines extended the experiences of everyday life to the realm of the imagination, where machines became symbols for the ordering of life itself. Out of such symbolic universes evolve conceptual universes as new definitions of reality replace the old. As the machine and clock increased their symbolic power as root metaphors, in response to society's changing needs, wants, and purposes, the symbolic force of the organism declined in plausibility and the organic conceptual framework underwent a fundamental transformation. The images and symbols associated with the machines of everyday life helped to mediate the transition between frameworks" (Merchant, 1982, p. 227).

And a succinct account of the machine metaphor is given in The Turning Point: Science, Society and the Rising Culture:

"Matter was thought to be the basis of all existence, and the material world seen as a multitude of separate objects assembled into a huge machine. Like human-made machines, the cosmic machine was thought to consist of elementary parts" (Capra, 1983, pp. 31-32).

This mechanistic framework is contrasted with that of modern physics which offers a framework for viewing natural phenomena in terms of dynamic relations: "In the twentieth century ... physics has gone through several conceptual revolutions that clearly reveal the limitations of the mechanistic world view and lead to an organic, ecological view of the world ... The universe is no longer seen as a machine, made up of a multitude of separate objects, but appears as a harmonious indivisible whole; a network of dynamic relationships" (Capra, 1983, p. 32). In addition to highlighting a difference between "world views" (at its grandest) or, more simply "scientific frameworks" - that is, a difference between a framework or scaffolding that is mechanistic and one that is relational, Capra also argues that sciences other than physics have traditionally modelled themselves on the old, Newtonian/Cartesian, mechanistic framework: "Whenever psychologists, sociologists, or economists wanted to be scientific, they naturally turned toward the basic concepts of Newtonian physics" (Capra, 1983, p. 32).

Distinctions between old and new science, and between mechanistic and relational frameworks have been called upon in analyses of conceptual and methodological underpinnings of psychology. Within the psychological litera-

ture and the literature of inquiry cited above, radical behaviorism has been placed in the mechanistic tradition and it has been argued that its science is consequently outmoded. For example, Macleod (1970) linked radical behaviorism to the Newtonian scientific tradition by constructing the following argument:

- Newtonian science was the inspiration for a group of philosophers "who were willing to play with the idea that the realm of natural law might encompass the phenomena of human mentality" (p. 209);
- John Locke became the spokesperson for the "Newtonian conception of man" when he argued that it was possible to have a science of mind analogous to the science of physical nature, "This involved the assumption of mental elements analogous to physical particles, and the assumption that to explain anything complex is to break it down into its elements" (p. 209);
- it was Locke's successors who attempted to demonstrate "how all the complexities of human experience and behavior can be reduced to combinations of mental or behavioral elements" (p. 209). (Note that the terms of the argument are suddenly expanded from "human mentality" and "mental elements" to include "all the complexities of human experience and behavior");
- the "Newtonian conception of mind" (p. 210) was elaborated in Britain by the British Associationists, in Germany by Wundt, Helmholtz, etc., in Russia by the Pavlovians, and in the United States by John B. Watson "and his friends" (p. 210).

Outlining the influence of Newtonian science in this way, and expanding the terminology to include not only "mental" but also experiential and behavioral elements, allowed Macleod to link Skinner to the concept of Newtonian science and to conclude that "The most brilliant contemporary representative of the Newtonian doctrine of man is ... B. F. Skinner" (Macleod, 1970, p. 210). From this conclusion it can be implied that radical behaviorism is out of step with modern conceptions of science: "It is interesting to note that long after the physical sciences, prodded by Einstein and others, have given up the elementaristic explanation of physical nature, we still have psychologists who insist that a psychological explanation must involve the reduction of the complex to the simple" (Macleod, 1970, p. 210). Precisely what is meant by "elementaristic explanation" is not entirely clear, but it presumably refers to the prior assertion that a science of mind concerned with "mental elements analogous to physical particles" was a goal for Locke and his successors. If this is the case, then the

claim is that behavior analytic accounts are analogous to accounts of physical phenomena couched in terms of interacting physical particles.

An alliance between radical behaviorism and mechanistic science has also been claimed by Mahoney (1989). Mahoney links radical behaviorism to Newtonian science by claiming a common conception of causation, "billiard ball" causation, and further supports the link by appealing to Cartesian mechanistic/dualistic philosophy as an important influence on the development of Skinner's approach. Descartes, he argues "holds a revered place in the history of behaviorism" (Mahoney, 1989, p. 1373). Linking radical behaviorism to Newton and Descartes, who are cited as the primary movers of mechanistic thinking in science (Merchant, 1982; Capra, 1983), allows Mahoney to assert that radical behaviorism "has isolated itself from and (come) to lag behind changing perspectives on the nature and practice of optimal scientific inquiry" (Mahoney, 1989, p. 1373).

Macleod (1970) and Mahoney (1989) both charge radical behaviorism with "lagging behind" contemporary views of science and with clinging to anachronisms. In a similar manner, Merchant (1982) and Capra (1983) relate it to an old and dying "mechanistic world view". Merchant argues that: "Attempts to reduce human behavior to statistical probabilities and to condition it by such psychological techniques as those developed by B. F. Skinner are manifestations of the pervasiveness of the mechanistic mode of thought developed by the seventeenth-century scientists" (Merchant, 1982, p. 292). And of Skinner's approach Capra states: "this, then, is Newtonian psychology par excellence, a psychology without consciousness that reduces all behavior to mechanistic sequences of conditioned responses and asserts that the only scientific understanding of human nature is one that remains within the framework of classical physics and biology ... behaviorists still adhere to the mechanistic paradigm and often defend it as the only scientific approach to psychology, thus clearly limiting science to the classical Newtonian framework" (Capra, 1983, p. 181).

Thomas Kuhn (1962) directs us to look for the structure of a science in the textbooks used to train successive generations of scientists. In the case of psychology, we typically find that, having been through its own upheavals in the course of this century, experimental psychology has settled into an orthodoxy of group design, statistical analysis underpinned by the concept of normal distribution, hypothetico-deductive reasoning, and a type of theory construction that allows for explanations to be given in terms of internal constructs that mediate between causally related events. Procedures are rather strictly prescribed within this framework, and the psychological community demands rigorous adherence

to the orthodoxy. Unfortunately, in terms of the organisation of psychology's body of knowledge, radical behaviorism is generally reported under a topic heading such as "Conditioning and Learning" or in historical sections describing shifts in psychology's scientific development. It is rarely, if ever, described in terms of its alternative philosophy of science. While much of contemporary experimental psychology adheres to a mechanistic view of its subject matter, radical behaviorism is wrongly cited as underpinned by a machine metaphor. An examination of psychology's relationship to Cartesian dualism and the concepts of causation and theoretical interpretation that ensue illustrates that radical behaviorism and the science it informs, behavior analysis, come closer to Capra's "network of dynamic relationships" than other types of accounts found in the psychological literature.

Dualism and scientific frameworks

As well as subtly pervading much of everyday discourse, literature, drama, and art, the Cartesian view continues to be overtly expressed in several areas of psychological theory and remains a background assumption in others. One of the consequences of dualism is that a concern with behavior is not a concern with what is important about persons, with "what counts", but with the trivial, the superficial, somehow the "surface" of the person. Deese, for example, captures this view in his statement that "behavior is only the outward manifestation of what really counts" (Deese, 1972, p. 99), and the social learning theorist, Bandura, has recently argued that behavior is generated by a core "self" or agent, explicitly ascribing it causal status: "Self-generated activities lie at the very heart of causal processes" (Bandura, 1989, p. 1175). Perhaps Carl Rogers best exemplified this view when he wrote that "Below the level of the problem situation about which (an) individual is complaining -behind the trouble with studies, or wife, or employer, or with his own uncontrollable or bizarre behavior, or with his frightening feelings, lies one central search. It seems to me that at bottom each person is asking, "Who am I, really? How can I get in touch with this real self, underlying all my surface behavior?" (Rogers, 1967, p. 108).

The view that behavior is an indication, manifestation, or expression of something else dominates Western culture. In orthodox psychology, as in the culture at large, behavior takes second place to thoughts, feelings, underlying

physiological or neurological mechanisms, instincts, personality, intelligence, motivation, mental states and so on. It is considered to be:

- an indication of processes taking place inside the person: for example, physiological and/or neurological processes, mental processes such as encoding, storage, retrieval, internal computing, decision making, phonemic storage, lexical searching, etc.
- a manifestation of other kinds of events taking place within the skin: for example, expectations, desires, intentions, attributions, attitudes, feelings, etc.
- an expression of an essential self or core being, a bounded individual separate from and standing behind behavior. In this view, what the person does is of secondary importance to what the person is. The person, the essential self, is both the organizer and initiator of behavior, with behavior standing in a dependent variable position to aspects of the self as independent variables.

Behavioral measures, observed and recorded, provide the evidence from which these other systems are inferred.

Capra himself compared this with views held by other cultures, notably Buddhist culture. In the western view, he writes, "Most individuals are aware of themselves as isolated egos existing 'inside' their bodies. The mind has been separated from the body and given the futile task of controlling it, thus causing an apparent conflict between the conscious will and the involuntary instincts. Each individual has been split up further into a large number of separate compartments, according to his or her activities, talents, feelings, beliefs, etc., which are engaged in endless conflicts generating continuous metaphysical confusion and frustration" (Capra, 1975, p. 28). However, in Buddhist doctrine "there is no ego, no self which is the persistent subject of our varying experiences. Buddhism holds that the idea of a separate individual self is an illusion ... an intellectual concept which has no reality" (Capra, 1975, p. 107). This contrast at least suggests that the bounded and essential "self" may be a property of cultural thinking rather than an empirical reality. Clearly there are ways outside western culture of talking about the person.

Dualism predates the scientific analysis of behavior, and the assumption that "the person" comprises two systems provides the epistemic justification for asserting that behavioral measures count as evidence of other systems. Behavior is regarded as the scientific evidence of the presence or action or malfunction of systems, processes, or events internal to the person. For example:"remembering" (behavior) is said to provide evidence of the structure and function of

complex, computer-like memory systems; "perceiving" (behavior) is said to provide evidence of "information processing" systems; verbal or linguistic behavior is cited as evidence of a person's "intentions", "will" or "attributions"; and behaviour that relates to another event, person, or situation provides clues to "attitudes" towards that event, person, situation. "Behaving aggressively" is said to be driven by "aggression" or the product of an "aggressive personality disorder", and feeling and acting in a hostile way towards one's siblings is the evidence of, for example, an intra-psychic conflict between id and superego that generates the hostility. In each case a person's actions are at one and the same time of secondary importance to another system and counted as "merely" evidence of that other system. Dualism resolved a conflict for Descartes between his materialist interests and important religious concerns of his time by allowing him to distinguish mechanical behavior from behavior generated by something called "free will". And dualism continues to play a large (if unacknowledged) part in contemporary psychology.

Whereas psychology typically subscribes to the notion that persons comprise behavior and something else, and dissects the person along the lines of intention, beliefs, motivation, attribution, perception, memory, and so on, radical behaviorism dispensed with dualism at an early stage in its development. It starts from a strikingly different view of persons in that it does not separate them into behavior and some other internal system (of self or whatever) that is said to give rise to behavior. The person in radical behaviorism is the sum of what they do. They are the focal point of a set of complex interacting variables - including genetic endowment and life experience. Persons are defined in terms of their behavior, with no other entity, no bounded, contained individual assumed to stand behind and generate behavior.

Because radical behaviorism does not assume that behavior counts as evidence of something else, the person is a unity rather than a duality, an interactive part of the environment rather than a contained entity separate from it. The person in radical behaviorism operates in rather than on an environment. With this view, behavior takes primary rather than secondary place, since the person is what the person does. Instead of looking for mechanisms or entities that underlie behavior, the interesting scientific question becomes "how does this person function in their context" or "what are the important relations between this person (i.e. behavior) and the world in which they live?"

Causation and scientific frameworks

The view of persons as duality or unity is intimately related to causation in scientific accounts of behavior. Before drawing out those relations, some issues relating directly to causation need to be considered as well as some distinctions drawn out between the causal mode underpinning behavior analysis and the causal mode encouraged by dualism.

A feature of causal thinking challenged in the 1950s (e.g. Hanson, 1955) is the "chain" metaphor, a type of causation that sets events in a contiguous, successive relation. For example: a headache is relieved following a change in the activity of nerve endings, which follows a change in the constitution of blood, which follows from taking an aspirin. Like a chain, this account gives the causal relations as a contiguous sequential processes. Hanson (1955) pointed out, however, that this conception of causation ignores the background knowledge tacitly involved in causal accounts, ignores whole systems of constructs and properties involved in causal accounts which are not simply given by immediate observation and experience. The chain metaphor ignores the fact that relations are only meaningful as causal accounts within conceptual networks. Drugs, blood, nerve endings, etc., are conceptual units related within a network of conceptual units. Without the network the words themselves have no causal significance. It is the background knowledge, the network that gives them this significance. The chain metaphor ignores the fact that causal accounts involve more than immediate observations of relationships, ignores the conceptual systems that give words meaning as causal explanations: "Genuine causal connexions can be expressed (explicitly or implicitly) only in language that is many-levelled in its generality and its explanatory power. This is why the language of causality is diagnostic and prognostic, and why the simple tick-tock, click-click, links-in-a-chain view of cause and effect is so artificial and inapplicable" (Hanson, 1955, p. 300). Causal dependencies are related not as links in a chain, but as webs or as networks, by the linguistic constructs forming theories. It is the systems of background knowledge that distinguish causal from merely contiguous relations. The one-to-one implication of the chain metaphor does not properly illustrate the web-like character of causal terms.

Hanson traces the illusory power of the chain metaphor to the same source as do Merchant (1982) and Capra (1983). The simplicity and power of the designed machine: "Such machines work with considerable indifference to alterations in environment. Clocks, anemometers, windmills, water-wheels, etc. are made not to stop for thunderstorms, swarms of bees, the barking of dogs or

the crowing of roosters ... from this the temptation grew to construe causal explanation as mechanical explanation; that is, explanation of the perseverance of manufactured machines" (Hanson, 1955, p. 309). And from this construal it is only a small step to think about natural phenomena in a similar manner, functioning as mechanical systems.

The chain metaphor, with its requirement of contiguity, dominates many areas of contemporary psychology. Cognitive psychology is one example in which contiguous causality is satisfied by mediating events or systems. Cognitive accounts consider successive events between the context of the person (environmental or stimulus input) and the behavior of the person (response output). If we examine any number of cognitive psychology texts, we find that the gap between these two endpoints is filled by various components: for example, a computer-like memory system comprising several constituent parts, a "cognitive map", a symbol manipulation system, a lexical store, a semantic network, and so on. Such components may be relatively simple in design, or may involve complex hierarchically organized structures having multiple functions. Their overall role in the explanatory system is that they satisfy the chain metaphor's requirement of contiguity. Less machinelike, more abstract links in the chain are provided by other psychological accounts with mediating constructs such as expectations, intentions, desires, beliefs, attitudes, motivation and other states attributed to the intangible half of the duality. The common feature is that they act as links, they fill spatial and temporal gaps between one event and another, and in doing so give a machinelike account of causal relations.

The mode of causation relied on in behavior analytic accounts is adopted directly from the physicist/philosopher Ernst Mach (Mach, 1893/1960). Among the many scientific contributions Mach is noted for is his contribution to debates and disputes on issues relating to the nature of science and scientific frameworks, significantly the mechanistic framework. Mach repeatedly argued against a mechanistic world view and against appeals to hypothetical, mediating entities as explanations of natural phenomena. For Mach, such accounts do not describe anything in the world - the entities are merely tools to be discarded when they no longer lead to the discovery of functional dependencies.

Laudan (1981) has written of Mach's participation in a major nineteenth century debate known as the "atomic debate": "For Mach, theoretical entities may play an important but intrinsically transitional role in natural science. Once they have suggested those empirical connections that are the warp and woof of scientific understanding, they can be discarded as so much unnecessary scaffolding ... Above all, Mach stresses that we must not confuse the tool with the job by

pretending that the model does anything more than establish functional relations between data (p. 212). Of mechanistic interpretations Mach himself wrote: "The view that makes mechanics the basis of the remaining branches of physics, and explains all physical phenomena by mechanical ideas, is in our judgement a prejudice" (Mach, 1893/1960, p. 596). Furthermore, "A person who knew the world only through the theater, if brought behind the scenes and permitted to view the mechanism of the stage's action, might possibly believe that the real world also was in need of a machine-room, and that if this were once thoroughly explored, we should know all. Similarly, we, too, should beware lest the intellectual machinery, employed in the representation of the world on the stage of thought, be regarded as the basis of the real world" (Mach, 1893/1960, p. 610).

As early as 1931, B. F. Skinner referred to Mach's influence on his own philosophy of the science of behavior, and Mach's position that causation and explanation in science is grounded in the discovery of functional relations or dependencies continues to inform behavior analysis. Behavior analysts adopt a causal mode which carries no requirement to provide mediating links between one event and another, which is not sequential, and does not presuppose contiguity in space and time. Causal relations may be contiguous, but contiguity is not essential in this mode as it is in the mechanistic mode, so that action over time or action at a distance is accommodated by demonstrating relations between events that are often temporally remote.

This causal mode has been compared with the Darwinian mode in biology (e.g. Skinner, 1972; Palmer & Donahoe, 1992). Where the Darwinian account appeals to selection of biological characteristics of a species over time (selection on variation: phylogenetic), behavior analysts appeal to the development of characteristic patterns of behavior, shaped over time out of a wide range of possibilities available to the individual (selection on variation: ontogenetic). In 1972, Skinner noted that: "Selection is a special kind of causality, much less conspicuous than the push-pull causality of nineteenth-century physics, and Darwin's discovery may have appeared so late in the history of human thought for that reason. The selective action of the consequences of behavior was also overlooked for a long time. It was not until the seventeenth century that any important initiating action by the environment was recognized" (Skinner, 1972, p. 353). Selection is a causal mode that does not require gaps between functional relations to be filled by a sequence of contiguous events. Selection occurs over time, not necessarily in an immediate temporal or spatial relationship to the repertoire of interest. It should be noted that causation of this type is not an assumption, metaphor, or hypothetical process; rather, it is empirically vali-

dated in operant conditioning experiments which demonstrate shaping and maintenance of even complex behavior by complex contingencies.

Explaining the subject matter

From the fact that there are at least two different views of the person and two different causal modes operating in psychology, it follows that there will be two types of linguistic systems in which causal accounts are expressed: i.e. two types of theories. On the one hand, theoretical accounts that develop constructs to fill spatial and temporal gaps between dependent relations, and on the other hand a type of theory that develops linguistic terms to describe the relations themselves.

The psychological literature is replete with the first type of theory, with appeals to constructs mediating dependent relationships. Motivation, for example, is said to mediate between environmental events and rates of behavior, as if some environmental event impacts on an internal drive which then generates low or high rates of behavior. What we remember and how much we remember is said to be mediated by some kind of internal structure storing, retrieving, encoding, manipulating the information. A response to an event or class of events is said to be mediated by attitudes, and the clinical literature refers to states such as anxiety states or types of pathology such as schizophrenia that are said to mediate between the person and their context, or between some environmental event and behavior. In all such cases, the theoretical constructs given as scientific accounts are in fact inferences from behavior supported by the presupposition that the world is internally mediated and by the view that related events can only be explained mechanically.

This type of theoretical system was proposed for psychology at a time of great upheaval in the discipline, a time when the discipline was struggling with many of these same scientific issues. It was proposed in the 1920s and developed in the two decades that followed by Edward C. Tolman. Tolman was unhappy with Watson's stimulus response psychology then in vogue and proposed a new behaviorism that would come somewhere between introspectionism and the newly dominant stimulus-response psychology. It would preserve the positivist tone of Watson's behaviorism but would still find a place for some aspects of introspective psychology: "This new behaviorism will be found capable of covering not merely the results of mental tests, objective measurements of memory, and animal psychology as such, but also all that was valid in the results of the

older introspective psychology. And this new formula for behaviorism which we would propose is intended as a formula for all of psychology - a formula to bring formal peace, not merely to the animal worker, but also to the addict of imagery and feeling tone" (Tolman, 1922, in Hillix & Marx, 1974, pp. 221-222). Tolman attempted to bring behaviorism and introspection together by allowing a role for internal mediators between stimulus and response. Psychology in Tolman's behavioral system, moved from a stimulus-response (S-R) to a stimulus-organism-response (S-O-R) framework. When Sigmund Koch asked him to outline and evaluate his position in the late 1950s (see Koch, 1959), Tolman admitted to having lost faith in his system (Tolman, 1959). However, the S-O-R framework persists as the predominant scientific framework in contemporary psychology.

The contrasting view of persons in relation to their context, and a causal mode that does not require "things in between" to explain behavior, generates a type of theory that explains its subject matter by developing linguistic terms for describing relations between behavior and its context. This is a type of theory that describes regularities, states general principles, and integrates uniformities in the subject matter without recourse to unobserved constructs: it is a theory driven by data. In the sense that it integrates relations, it explains without reference to processes or entities beyond observation. It explains in a linguistic framework that describes observed regularities.

"Conditioning" and "extinction", for example, describe the shaping of behavior as a function of events in the context in which it occurs. "Operant behavior" refers to behavior that brings about some other event, and "an operant" refers to a class of behavior producing a particular consequence. "Discriminative stimulus" refers to an aspect of the setting condition in which an operant occurs which is functionally related to that operant. Similarly "reinforcer" refers to the effect of a discrete consequence on behavior. A number of events may be contiguously related to an operant, but perhaps not all are functionally related to it: identifying those that are functionally related is the task of behavior analysis.

Relations between classes of events such as discriminative stimuli, operants, reinforcers, can be expressed as a function of time, rate of response, magnitude of reinforcement, rate of reinforcement, the availability of alternatives, the presence of verbal behavior, etc. For example, in the early days of its development, behavior analysis discovered that rates of behavior and reinforcement were reliably related across a broad range of settings. The linguistic (theoreti-

cal) terms used to describe these relations are various "schedules of reinforcement"; such terms always describe observed regularities.

Whereas in the S-O-R framework entities, models, constructs and components are invented, modified and manipulated in order to account for data, in the behavior analytic framework events are explained by describing functional dependencies within the data rather than by invoking unobserved properties or entities.

Theoretical constructs and their role

Contemporary psychology comprises two scientific frameworks, each with their own rationale, their own view of persons, and it should be noted their own view of what counts as evidence for scientific assertions. The mechanistic framework takes behavior as evidence of internal processes, whereas the relational framework stays close to the data and looks for regularities within those data. An example drawn from each of these frameworks will help to illustrate their possibilities. Mediating entities may not count as explanations -as Ernst Mach argued. They may, however, function as useful tools for generating new experimental questions and thus establishing dependent relations - as Mach also argued. However, Mach's caution should be noted: he cautioned that the unobserved theoretical entities are to be discarded once the functional relations have been established. The literature reveals clearly that this does not occur in psychology. Examining various research areas that use the mechanistic framework reveals that mediating entities play a central role not only in generating research questions, but also in explanations.

For example, an area of motivation research that divides this construct into intrinsic and extrinsic motivation discovered an interesting phenomenon (e.g. Lepper et al., 1973; Deci, 1975; Deci & Ryan, 1980; Deci & Ryan, 1985). Typically, in a first experimental condition activities are made freely available to participants and the length of time people spend on these activities is recorded. In a second condition, some subjects are paid or rewarded in some way for engaging in the activity while other subjects are not. On returning to the original condition where the activities are freely available, it was found that subjects who had been paid engaged at a lower frequency than in the original condition, and at a lower frequency than subjects who had not been paid.

The data themselves are not problematic, and results have been replicated with different types of behavior and different interventions. The experiments

demonstrate a functional relationship: paying subjects decreased the rate at which they would subsequently engage in an activity. What the experimenters concluded however, was that "paid subjects evidenced a significant decrease in intrinsic motivation relative to the nonpaid subjects" (Deci & Ryan, 1980, p. 44). The concept of intrinsic motivation is inserted between functional relations, as if the independent variable affected something called motivation which then affected rates of behavior.

Independent variable	→	Mediating construct	→	Dependent variable
payment	(decreases)	Intrinsic motivation	(decreases)	Frequency/ duration of behavior

Experiments in this field repeatedly demonstrate a relation between aspects of the context in which behavior occurs and a later reduction in frequency or duration of behavior. They do not demonstrate a reduction in "intrinsic motivation". Paraphrasing the authors shows that the mediating construct can be abandoned without any loss to the scientific relations observed: "paid subjects evidenced a significant decrease in behavior (frequency/duration) relative to the nonpaid subjects". The clarity of the data is unquestioned here. What is at issue is the scientific status of "intrinsic motivation": it is superfluous in explaining the relation.

As well as continuing to be used as if they were explanations, mediating constructs are also referred to more explicitly as machine-like components that are defective in some way, or are not somehow being properly used. Where remembering is said to be mediated by constructs such as an "articulatory loop" for example, it has been asserted that dyslexic readers are "not fully utilizing the articulatory loop" (Baddeley, 1982, p. 416). Or where data are said to indicate that dyslexic readers are in fact "using the articulatory loop", it is claimed that this demonstration "does not mean that the system was functioning as efficiently as in normals" (Baddeley, 1982, p. 416). Aside from the considerable philosophical difficulties involved in granting ontological status to hypothetical components, how is reading capability to be strengthened if the source of the problem is said to lie in a malfunctioning articulatory loop? How does a psy-

chologist - clinician, educational psychologist, or teacher restore a hypothetical construct to full and proper functioning?

An example from the clinical literature will serve to illustrate some of these scientific issues as they play out in the relational framework. This example is given by Isaacs et al (1966) who report the successful reinstatement of verbal behavior in the repertoire of a psychiatric patient institutionalised for many years and mute for nineteen years. The patient was described as catatonic schizophrenic, which at the observational level means that very little behavior occurs. The experimenter noticed that the patient's eyes followed the movement of a piece of chewing gum and set up a shaping programme using gum as a discriminative stimulus and reinforcing eye movement by immediately giving the gum over to the patient. (Note that the experimenter had very little to work with in this example: catatonia means that a person simply does not move for long periods of time, so there are few opportunities for reinforcement).

At the end of two weeks (six sessions) reliable relationships had been established between the presence of the gum, eye movement, and the patient being given gum:

Setting condition (S^d)	Behavior (R)	Reinforcer (R^+)
Gum	Eye movement	Receives gum

Having established this relationship, the experimenter then created the setting condition but withheld reinforcement until a slight movement of the lips occurred. In this way a reliable relationship came to be established between gum, eye and lip movement, and the patient receiving gum:

Setting condition (S^d)	Behavior (R)	Reinforcer (R^+)
Gum	Eye movement Lip movement	Receives gum

Next the experimenter withheld the reinforcer until some vocal sound occurred, and at the end of the fourth week (twelve sessions) demonstrated a reliable relationship between the setting condition, three discernible operants, and the reinforcing event:

Setting condition (S^d)	Behavior (R)	Reinforcer (R^+)
Gum	Eye movement Lip movement Vocalization	Receives gum

With this pattern established, the experimenter reinforced sounds that increasingly moved closer to the word "gum", and at the end of the sixth week (eighteen sessions) the patient said "gum please": "This response was accompanied by reinstatement of other responses of this class, that is, (the patient) answered questions regarding his name and age" (Isaacs et al, 1966, p. 200).

At each stage in the shaping process, discrete units of behavior occurred in the presence of a discriminative stimulus and were maintained by a reinforcing consequence. As relations were established, the experimenter used the reinforcing event to select out ever closer approximations to the target. Note that internal events or structures are not required for explanatory purposes: the experimenter does not need to infer that the reinforcer acted on some internal structure present in each session and carried along in time to mediate relations during following sessions. Scientifically, it is sufficient to demonstrate that the events in this case were reliably related. Note also that this patient had not spoken for nineteen years; all other attempts to get him to speak failed, but using reliable principles developed in operant laboratories, the experimenter achieved this remarkable feat in only six weeks.

What happened subsequently and, more importantly, typical responses to what happened subsequently is also an interesting example of these scientific issues. Once the patient had begun to talk again, he did so only in the presence of the experimenter. The experimenter became a discriminative stimulus for the occurrence of verbal behavior; the patient would speak in a number of settings, but only if the experimenter was present. The behavior had not generalized sufficiently and the next task was to draw again on behavior analytic principles to get the behavior to generalise - i.e. to occur in the presence of others, whether or not the experimenter was present.

Presented with this account of the relationship between experimenter and patient, students often object and offer alternative explanations such as "maybe the patient just liked the experimenter", "maybe he hopes the experimenter will give him more rewards", "maybe the patient felt secure when the experimenter was around, and that's why he would talk". Such accounts correspond to the

S-O-R framework in that the functional relations are mediated by emotional constructs such as "liking", "feeling secure", "hoping" or "expecting" - and the same arguments apply.

In the first place, liking, feeling secure, expectancy and so on, are additional to the relations observed; they are inferences from the data that can be modified or multiplied as the observer pleases. In the second place, if such events occur and are causally related, then the responsibility of the experimenter is to persuade the patient to "like" other people, or to "feel secure" in the presence of other people. How this is to be achieved without recourse to behavior analytic methods (which do not in the first place rely on such mediators) is an arresting question. And finally, when would an observer confidently assert that the patient liked or felt secure with other people? The evidence would be available when verbal behavior occurred in their presence. Mediating constructs of this type are superfluous both as explanations and as tools for intervention.

Reliability, truth, utility

An examination of the textbooks that organise psychology's body of knowledge reveals that the predominant framework is one informed by Cartesian dualism where behavior is deemed to count as evidence of internal states that organise and generate behavior. Since these states cannot be observed, they are inferred from behavior and invoked as mediating links between functionally related events. As such, the framework is essentially mechanistic, and on occasions its practitioners even appeal to malfunctioning components to account for deficits in behavior.

The other approach or framework dispensed with dualism at an early stage in its development and does not subsequently appeal to behavior as evidence of systems, components or processes internal to the person. Behavior analysis looks for relations between the person and their context, and in describing those relations provides causal accounts without invoking links-in-a-chain to mediate between environment and behavior. This framework is rooted in a philosophy of science tradition that explicitly rejects mechanistic accounts of natural phenomena. It sees the person and their world in terms of Capra's "network of dynamic relationships".

Shifts in the philosophy of science in this century have dispensed with the notion that science is about "absolutes" and "ultimate truths" by demonstrating that even in the process of validating scientific knowledge there is an element

of arbitrary decision making. In their analysis of paradigm shifts and research programmes, Kuhn (1962) and Lakatos (see Lakatos & Musgrave, 1970) point out that research proceeds in the face of anomalies that should, in a strictly Popperian world, force a programme to be abandoned. Furthermore, the notion of objectivity, of observation independent of theory and uninformed by background assumptions, has similarly been dropped from accounts of how science proceeds (see Hanson, 1958; Chalmers, 1982). Science is no longer seen as the absolutely reliable and straightforwardly logical pursuit it was once thought to be.

In an age which acknowledges that science is not about absolutes and ultimate truths, we cannot ask about the "truth value" of either type of theoretical account. Other kinds of questions about their value are invited. For example, we may (as Mach's views suggest) ask about their heuristic value - their value in generating experimental questions and establishing functional dependencies. We may ask about their explanatory value, or about the nature of their evidential claims. We may ask whether they are progressing or degenerating as research programmes, or we may ask about their pragmatic value, their value in settings where psychology is asked to intervene: for example, clinical, educational, occupational, social work settings.

Despite extravagant assertions to the contrary, the mechanistic framework continues to function usefully in other sciences. Hawking (1988) notes that where it is needed, Newtonian physics continues to satisfy practical, technological challenges. He also notes that the two modern theories used to describe the universe, the general theory of relativity and quantum mechanics, are known to be inconsistent with each other and, as he puts it, "cannot both be correct" (Hawking, 1988, p. 12). Psychologists, and a society that relies on their scientific expertise, are free to ask about the utility of either framework in satisfying technological challenges appropriate to the discipline.

Given that mediating constructs of the mechanistic approach can be dispensed with at the point where functional relations are established, it is difficult to assign them a role in situations where a psychologist is called upon to, for example, improve the performance of dyslexic readers, extinguish delusional verbal behavior, increase on-task performance, reduce the frequency of self-injurious behavior, or in some other way enhance the context and life experience of clients. However, a scientific analysis of how people interact in their worlds offers the possibility of change and enhancement. The success of behavior analytic methods across a broad range of applied settings encourages the view

that this relational framework can address the practical, technological needs of psychologists wherever their expertise is called upon.

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