

Understanding, Explanation, and Reductionism: Finding a Cure for Cartesian Anxiety¹

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This chapter is about the historical changes that have occurred in scientific methodology as it applies to the empirical sciences, especially since the 1950s. Methodology is complementary to, but distinct from, methods. A methodology describes the general rules of science that guide and constrain the elaboration of methods and measurement models, which are the specific techniques for designing, conducting, and evaluating empirical inquiry. My focus in this chapter is on a rule that was central to the methodology called *neopositivism* and has continued to influence the descendants of neopositivism: the rule of *reductionism*.

Clarity demands that any discussion of reductionism include a distinction between analysis and reductionism. Analysis and synthesis stand in a dialectical relationship of parts and wholes. Analysis is about the differentiation of parts of a whole; synthesis is about the integration by the whole of the parts. In contrast, reductionism and synthesis stand in destructive, not dialectic, opposition. Any reductionism worthy of the name does not aim at analyzing how wholes are put together from parts, but rather at explaining wholes away. Reductionism constitutes, therefore, what Dewey (1929) viewed as an adolescent quest for absolute certainty at the expense of com-

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plex understanding.² The history of analysis is as long as the history of mankind and there are precursors to reductionism that go back to pre-Socratic Greek distinctions between appearance and reality. However, reductionism as a final solution to ontological and epistemological uncertainty has a much shorter history.

It may be profitable to begin a consideration of reductionism in the context of the thought of the later Wittgenstein (1958)—the Wittgenstein of *Philosophical Investigations*. Within this frame, it becomes possible to recognize that reductionism is just a picture, a part of a story, a feature of a particular Wittgensteinian language game. This language game is called “The Story of Empirical Science as Narrated Through the Imagery of Modernity.” The story is captivating and comforting, but it also produces problems because there has been a tendency to get so caught up in this particular language game, so ensnared in it, so captured by it, that it is often though not to be a game at all, not a story, but a mirror reflection of the way things really are and always will be. Some come to believe, with great passion, that, if it is a story, it must be a story of fact and not of fiction. But here let me just note that the notion that some things are absolute facts and some things are absolute fiction is itself a part of the very same language game. It is a language game that splits all of our phenomenal experience into necessarily being this or that, into either-one-or-the-other, and—having so split the world—it directs us to choose which of the split alternatives constitutes the absolute certainty of the Real and which constitutes the chimera of mere appearance.

There are, of course, those of us who would argue that the story containing reductionism lacks intelligibility and coherence. We would argue that it is a degenerate language game containing lessons that will ultimately harm those who play it. It is a language game that requires modification or replacement as we enter the millennium. An alternative narrative is one that eschews absolute certainty and split-off, either-or dichotomies, that celebrates a dialectical understanding of the world—an understanding composed of relational categories that entail both complementarity and distinctiveness. However, giving up the promise of absolute certainty is not an easy thing, for it raises the specter of absolute relativism and the fear of absolute relativism can unleash powerful resistant forces in both the individual and the community. The psychoanalyst R. D. Laing (1960), among others, described madness and the process of going mad as the stark terror

²The concept of *methodological reductionism* used by Gottlieb and his colleagues (Gottlieb, Wahlsten, & Lickliter, 1998) to reference their systems approach to development might be considered an exception to this rule. Methodological reductionism, however, entails the analysis of parts in relation to wholes and the reciprocal relationship of parts and wholes, rather than the classical forms of reductionism, which they explicitly reject.

that arises in the context of a sense of absolute relativism. The erosion of a fundamental certainty of being and certainty of continuity of being was termed *ontological insecurity* by Laing. In the 17th century, René Descartes sought to save Western civilization from ontological insecurity by arguing for the necessity of an absolute foundation to knowledge as the base for absolute certainty.

It is against this backdrop of potential terror of relativism—this potential Cartesian anxiety (Bernstein, 1983)—that any language game, and particularly the language game called *empirical science*, must be articulated. As a consequence, an important question to be faced in today's postmodern era is whether it is possible to describe a methodology of science that abandons the quest for absolute certainty while at the same time avoiding the anxious terror engendered by relativism. The thesis to be developed in this chapter is that such an articulation is available and it is discovered in a relational scientific methodology that represents a coordination of physical sciences' methodology of causal explanation and behavioral and social sciences' methodology of hermeneutic understanding.

I will describe some of the main features of this integrated methodology of the empirical sciences by first briefly sketching a history of the rules of reductionism, causal explanation, and inductivism as these developed in the culture of modernity. Following this, I will present a short history of hermeneutic understanding and its role in the story of science, again, as told in the context of the modern project. Finally, I will examine the outlines of the integrated relational methodology that emerged and continues to evolve out of the revolutionary events of the 1950s.

SPLIT SCIENTIFIC METHODOLOGY

The critical place to begin the story of contemporary scientific methodology is in the 17th century with the dawn of the modern age or modernity. The narrative of modernity is defined by both a quest for absolute certainty of knowledge (Toulmin, 1990) and an effort to expand individual freedom, especially freedom of thought. Building knowledge on rational and reasoned grounds, rather than on the grounds of authority and dogma, was understood as the key to each of these goals. The early protagonists who developed the basic story line were Galileo Galilei and his physics of a natural world disconnected from mind, René Descartes, whose epistemology elevated disconnection to a first principle, and Thomas Hobbes, who saw both mind and nature in a vision of atomistic materialism. Of the three, Descartes was to have the greatest and most lasting impact on the text and subtexts that we now refer to as modern scientific methodology.

Splitting and Foundationalism

Descartes' major contributions entailed the insertion and articulation of splitting and foundationalism as key interrelated themes into the story of scientific knowing. *Splitting* is the formation of a dichotomy—of an exclusive either-or relationship—and *foundationalism* is the claim that one or the other elements of the formed dichotomy constitutes the ultimate real. Nature and nurture, idealism and materialism (form and matter), reason and observation, subject and object, constancy and change, biology and culture, and so forth can all be—and under the influence of Cartesian epistemology are—thought of as split-off competing alternatives. Choose the one as the real—as the foundation—and it follows under a split interpretation that the other is mere appearance or epiphenomenal.

The foundation here is the final achievement of absolute certainty and the end of doubt. The foundation is not a vantage point, standpoint, or point of view and certainty and doubt are not dialectically related as an identity of opposites. Descartes' foundationalism describes the final, fixed, secure base. It constitutes an absolute, fixed, unchanging bedrock—a final Archimedes point (Descartes, 1969).

With splitting and foundationalism in place, the theme of reductionism is firmly planted in the story and virtually all change to the present day represents elaboration and variation. Eliminative reductionism, ontological reductionism, property-ontological reductionism, theoretical reductionism, definitional reductionism, causal reductionism (Searle, 1992), radical or leveling reductionism, microreductionism, smooth reductionism, semantic reductionism (Shanon, 1993), and that ever-favorite biosociological reductionism (Bunge & Ardila, 1987)—while each making interesting and valuable discriminations to the plot line—add little to the theme.

Materialism and Objectivism

Cartesian splitting and foundationalism came to operate as a permanent background frame for modernity's scientific story. However, the specification of the nature of the ultimate foundation remained at issue. It was left to Hobbes and later empiricists to operate within the frame of subject split from object, mind split from body, and ideas split from matter, and to build into this frame the materialist identification of atomistic matter as the ultimate ontological foundation—the Real. Furthermore, the epistemological rhetoric of Locke, Berkeley, and Hume operated to suppress subjectivity, mind, or ideas, thereby creating objectivism, or the belief that the ultimate material reality exists as an absolute—Independent of mind or knower (Searle, 1992). This constituted, as Putnam (1990) said, an epistemological God's-eye view.

Objectivist matter thus came to constitute the ontological Real to which the manifold of common-sense experience would be reduced to arrive at

the goal of science, a systematized body of certain empirical knowledge. It must be cautioned at this point that there is a critical distinction to be made between the use of the term *real* in everyday common-sense life and the foundational Real. No one argues, or has ever argued, that there is a lack of reality or realness in the experienced everyday world. This is common-sense realism. Common-sense realism accepts the material existence of a real, actual, or manifest world and all ontological or epistemological perspectives treat people, animals, and physical objects as having such a real existence. The ontological issue of the Real with a capital "R" (Putnam, 1987) is a very different issue. It concerns the current issue of having an absolute base or foundation from which everything else emerges. In this limited sense, the *Real* is defined as that which is not dependent on something else and cannot be reduced to something else.

Support for the materialist foundation arose and was further defined by Newton's contributions. Central among these contributions was the redefinition of the nature of matter in a way that conceived of all bodies as fundamentally inactive. Prior to Newton, matter was understood as inherently active. Matter had been conceived of in terms of the relation of being (static, fixed) and becoming (active, changing). Newton, however, through his concept of inertia, split activity and matter and redefined matter as inactivity (Prosch, 1964).

The redefinition of bodies as inert matter and the assumption of the atomicity of matter (i.e., bodies are ultimately aggregates of elemental matter that is uniform in nature and, in combination, yields the things of the world) were basic for Newton's formulation of his laws of motion. However, they were also ideas that a later generation generalized into a metaphysical world view that identified the nature of the Real as fixed inert matter and only fixed inert matter. This world view has been called the "billiard ball" notion of the universe, "the notion that basically everything . . . was made up of small, solid particles, in themselves inert, but always in motion and elasticly [sic] rebounding from each other . . . and operating mechanically" (Prosch, 1964, p. 66). With these themes at hand—splitting, foundationalism, materialism, objectivism—it was a short step to the formulation of a complete scientific methodology, termed *mechanical explanation*, that, with relatively minor modifications, has extended to the present day as the basic methodology of neopositivism and later instrumentalism, conventionalism, and functionalism.

Mechanical Explanation

The methodology of mechanical explanation continues the splitting process by dichotomizing empirical science into two airtight compartments: description and explanation. There are three steps to mechanical explanation.

The first step is considered descriptive and the second two are considered explanatory.

Step 1: Reduction Description. The first step of mechanical explanation entails addressing the common-sense object of inquiry and reducing it to the absolute material, objective, fixed, unchanging, foundational elements or atoms. Terms like *reductionism*, *atomism*, *elementarism*, and *analytic attitude* all identify this step. In psychology for many years the atoms were stimuli and responses. Today they tend to be neurons and behaviors or contextual factors and behaviors—the story line changes but the themes remain the same.

I briefly consider here the impact of this first step on developmental inquiry. Immediately, stages of development and mental organizations that change during development become suspect as being somehow derivative. At best, under this story line, they can only function as summary statements for an underlying, more molecular Real. In fact, the drive throughout this step is toward the ever more molecular in the belief that it is in the realm of the molecular that the Real is found. This is particularly well illustrated in the recent enthusiasm for a so-called microgenetic method (e.g., Kuhn, García-Mila, Zohar, & Anderson, 1995; Siegler, 1996) as a method that offers “a direct means for studying cognitive development” (Siegler & Crowley, 1991, p. 606). In this approach, an intensive trial-by-trial analysis reduces the very notion of development to the molecular bedrock of visible behavioral differences as they appear across learning trials.

It is important to recognize that the aim of Step 1 is to drive out interpretations from the common-sense phenomena under investigation. Under the objectivist theme, common-sense observation is error laden and it is only through ever more careful neutral observation that science can eliminate this error and ultimately arrive at the elementary bedrock that constitutes the level of fact or data.

Step 2: Causal Explanation. Step 2 of mechanical explanation begins to move inquiry into the second compartment of compartmentalized science—explanation. Step 2 consists of the instruction to find the relations among the elements described in Step 1. More specifically, given our objects of study—behavior and behavior change—this step directs inquiry to locate antecedents. These antecedents, when they meet certain criteria of necessity and sufficiency, will be termed *causes* and the discovery of cause defines explanation. The antecedents are also often referred to as *mechanisms*, but the meaning is identical.

This is the most extraordinary feature of the whole narrative. The word *explanation* comes to be defined as antecedent-consequent relation, or the efficient-material cause of the object of inquiry, and *science* comes to be

defined as the (causal) explanation of natural phenomena. It is critically important to remember here that Aristotle (Randall, 1960) had earlier produced a story of scientific explanation that entailed a complementary relation among four types of explanation. Two of these were causal explanations (i.e., antecedent material and efficient causes). Two, however, were explanations according to the pattern, organization, or form of the object of inquiry. Aristotle's *formal* (i.e., the form or organization of the object of inquiry) and *final* (i.e., the end or goal of the object of inquiry) explanations were explanations that made the object of inquiry intelligible and gave reasons for the nature and functioning of the object. Today, the structure of the atom, the structure of DNA, the structure of the solar system, and the structure of the universe are all familiar examples of formal pattern principles drawn from the natural sciences. Kinship structures, mental structures, mental organization, dynamic systems, attachment behavior systems, structures of language, ego and superego, dynamisms, schemes, operations, and cognitive structures are familiar examples of formal pattern principles drawn from the human sciences. Similarly, reference to the sequence and directionality found in the second law of thermodynamics, self-organizing systems, the equilibration process or reflective abstraction, the orthogenetic principle, or the epigenetic principle are all examples of final pattern principles.

Both formal and final pattern principles entail interpretations that make the phenomena under investigation intelligible. Both, within the Aristotelian (Randall, 1960) relational scheme, constitute legitimate explanations. However, within the split story of mechanical explanation, as guided by reductionism and objectivism, formal and final principles completely lose any explanatory status. At best, within the mechanical story, they may reappear in the descriptive compartment as mere summary statements of the underlying molecular descriptive Real discussed in Step 1.

Step 3: Induction Of Interpretation-Free Hypotheses, Theories, And Laws. Step 3 of mechanical explanation installs induction as the foundational logic of science. Step 3 establishes the prescription that ultimate explanations in science are found in fixed, unchanging laws and these are to be inductively derived as empirical generalizations from the repeated observation of cause-effect relations found in Step 2. Weak generalizations from Step 2 regularities constitute interpretation-free hypotheses. Stronger generalizations constitute interpretation-free theoretical propositions. Theoretical propositions joined as logical conjunctions (i.e., *and* connections) constitute interpretation-free theories. Laws represent the strongest and final inductions.

Deduction later re-enters modernity's story of science as a split-off heuristic method of moving from inductively derived hypotheses and theoretical propositions to further empirical observations. When later editions of

the story introduced a Hypothetico-Deductive Method, it was simply more variation on the same theme. The hypothesis of hypothetico has nothing to do with interpretation, but is simply a data-driven empirical generalization that then serves as a major premise in a formal deductive argument. Similarly, when instrumentalism moved away from the Hypothetico-Deductive stance to the employment of models, models themselves functioned merely as the same type of interpretation-free heuristic devices.

Another important variation—but a variation nevertheless—on this same theme was called the *covering law model* of scientific explanation. This was introduced by Carl Hempel (1942, 1967) and became the prototype of all later explanations formulated within this language game (cf. Suppe, 1977). The covering law model was particularly important for developmental inquiry because it treated historical events as analogous to physical events in the sense that earlier events were considered the causal antecedents of later events (Ricoeur, 1984).

Here, then, is the basic outline of the quest for absolute certainty according to modernity's story of scientific methodology: Step 1, reduce to the objective (interpretation-free) observable foundation; Step 2, find the causes; Step 3, induce the law. As noted, variations appear throughout history. In fact, it would be misleading not to acknowledge that *probability* has replaced *certainty* as the favored lexical item in the story as it is told today. Indeed, induction is itself statistical and probabilistic in nature. However, this change represents much more style than substance, as the aim remains to move toward 100% probability, thereby arriving at certainty or its closest approximation. This type of fallibilistic stance continues to pit doubt against certainty as competing alternatives, rather than understanding doubt and certainty as a dialectic, framed by the concept of plausibility.

More generally, all of the variations that have been introduced since the origin of Newtonian explanation—including those formulated under the methodological banners of neopositivism, instrumentalism, conventionalism, and functionalism—have in no way changed the basic themes. To a significant degree, we remain prisoners of the mechanical language game.

Recognizing that we remain prisoners of neopositivism's language game does not mean that there has been any lack of critics of this narrative. The movement from Leibniz to Kant to Hegel—the whole German Enlightenment—along with the later neo-Kantian revival can be seen as an attempt to heal the Cartesian splitting found in foundationalism, materialism, and objectivism. This critical effort sought to heal fundamental splits by recasting the dichotomous bifurcations found, for example, in subject versus object, mind versus body, cause versus reason, and interpretation versus observation, as dialectic complementary reflections of the same underlying identity. However, until the 1950s these and other critiques—including Dewey's (1929/1960) attack on certainty in his work entitled *The Quest for Certainty*—

had little influence in the natural sciences or in the line of psychology that locates itself in the natural sciences.

Hermeneutic Understanding

Historically, a contrasting language game was developed parallel to and as a reaction against neopositivism's quest for reductionistic causal explanation. This alternative picture arose within the hermeneutic tradition and it championed understanding, in contrast to explanation, as the methodology of science, or at least as the scientific methodology for the behavioral and social sciences, including the humanities.

Interpretation. Broadly, *hermeneutics* is the theory or philosophy of the interpretation of meaning. Hermeneutics elevates to a heroic role the very concept that mechanical explanation casts as demon error: interpretation. For our purposes, we can pass by the periods of classical, biblical, and romantic hermeneutics and even pass by Vico's historical hermeneutics. Our brief focus here is on the effort that Dilthey (1972) promoted at the turn of the present century to construct a methodology for the social sciences. This was termed the methodology of understanding. Within this methodology, *understanding* operates as an epistemological rather than a psychological concept and, most importantly, interpretation operates as the methodology that results in understanding.

Action Theory. As a methodology of the social and behavioral sciences, understanding is closely related to action theory. Action theory, which, lest we forget, characterizes Piaget's (1952, 1954, 1962) work, is a person-centered approach to inquiry into processes and operations of the living embodied agent (Overton, 1999). Action theory stands in contrast to variable-centered approaches to human behavior, which are externalist and event-oriented in their focus. Ricoeur (1991) clearly outlined—in the context of Wittgenstein's (1958/1953) language games—the distinction between variable-centered events and person-centered actions and in this outline suggested the distinction between explanation and understanding:

It is not in the same language game that we speak of events [variables] occurring in nature or of actions performed by people. For, to speak of events [variables], we enter a language game including notions like cause, law, fact, explanation and so on. . . . It is . . . in another language game and in another conceptual network that we can speak of human action [i.e., a person-centered frame]. For, if we have begun to speak in terms of action, we shall continue to speak in terms of projects, intentions, motives, reasons for acting, agents [interpretation, understanding], and so forth. (Ricoeur, 1991, pp. 132–133)

Within this dichotomous situation, *Verstehen*, or understanding, was conceived of as a competing alternative account of human functioning to that found in the natural sciences of the inorganic world. This account relies heavily on the intentional quality of action. To intend, is to do something "for the sake of." Intention thus implies order and direction and a methodology designed to account for action must entail inferences about patterns of action and, more generally, teleology. Note here, however, that this focus on action patterns, action organization, or the form of the object of inquiry is little different from Aristotle's formal and final explanations as they were designed to make the object of inquiry intelligible and gave reasons for the nature and functioning of the object.

At this point, a dichotomy of two competing alternative accounts of human functioning and human development thus stood as guardians against Cartesian anxiety, the natural science game of Aristotelian (some would say Galilean) efficient and material cause, and the human science game of Aristotelian formal and final understanding. Efficient and material causal explanation stands squarely committed to a materialist foundationalism. Formal and final pattern understanding, although more ambiguous about foundationalism, was sufficiently identified with an absolute idealism to assuage those who might fear a fall into the terror of relativism.

TRANSITION TOWARDS A NEW METHODOLOGY: THE 1950S

The concepts of *cause* and *interpretation* became the central battlegrounds in this struggle between explanation and understanding. Into the early 1950s it seemed increasingly clear that, at least as far as psychology was concerned, the reductionistic causal explanation of neopositivism-conventionalism-instrumentalism-functionalism had won the day as the methodology of choice. In fact, this increasingly anachronistic methodology, even today, continues to be used as virtually the exclusive doctoral training paradigm in most domains of psychology, including developmental psychology.

However, despite popular stories about the balanced culture and political climate of the 1950s, these years marked the beginning of an explosion of new ideas concerning scientific methodology and the implications of these ideas have yet to work themselves completely to fruition. These ideas arose from diverse narrative streams including analytic philosophy, the history and philosophy of the natural sciences, the philosophy of behavioral and social sciences, and hermeneutics. Despite their often complementary and reciprocally supportive nature, these narratives have frequently failed to connect or enter into a common dialogue, yet their cumulative effect has been to forge at least the outline of an integrated story of scientific method-

ology that moves beyond the split Cartesian dichotomies of natural science versus social science and explanation versus understanding. This language game, which might be called the *amodern* (Latour, 1993) story of scientific methodology, articulates and elaborates a relational perspective in which these antinomies are coordinated as distinct moments of an identical underlying activity termed empirical science.

Let me briefly point to some of the central characters in the 1950s revolution. First, representing analytic philosophy, there was the later Wittgenstein, whose seminal book *Philosophical Investigations* was originally published in 1953, and following from this point there was Wittgenstein's pupil Georg Henrik von Wright (e.g., 1971) as well as Hilary Putnam (e.g., 1987). Representing hermeneutics, there was Hans-Georg Gadamer, whose *Truth and Method* was first published in 1960, and later Jürgen Habermas (e.g., 1984), Richard Bernstein (e.g., 1983), and Paul Ricoeur (e.g., 1984). Representing the natural sciences were Steven Toulmin, whose *Philosophy of Science* was published in 1953, and N. R. Hanson, whose *Patterns of Discovery* was published in 1958. These were later followed by Thomas Kuhn (1962), Imre Lakatos (e.g., 1970), Larry Laudan (e.g., 1977), and, most recently, Bruno Latour (e.g., 1993). Representing the social sciences, Elizabeth Anscombe's *Intention* was published in 1957, as were William Dray's *Laws and Explanation in History* (1957), and Charles Frankel's *Explanation and Interpretation in History* (1957). These were followed by Peter Winch, whose *The Idea of a Social Science and Its Relation to Philosophy* was published in 1958, and later Charles Taylor (e.g., 1964).

RELATIONAL SCIENTIFIC METHODOLOGY

The story of this outline of an integrated relational methodology of the sciences is obviously detailed and complex (see Overton, 1998). Here I will outline the outline by focusing on a few central figures and their contributions. These include Wittgenstein's *Philosophical Investigations* (1958), Gadamer's *Truth and Method* (1989), Hanson's *Patterns of Discovery* (1958), von Wright's *Explanation and Understanding* (1971), Ricoeur's *Time and Narrative* (1984), and Latour's *We Have Never Been Modern* (1993).

Wittgenstein (1958) and Gadamer (1989) provided the basic scaffolding for the construction of this relational methodology. Wittgenstein's fundamental contribution entailed opening the door to the recognition that it is a profound error to treat the activities of science as providing veridical descriptions of a foundational Real. More positively, Wittgenstein's contribution lies in his suggestion that science is the product of some of the same human actions that underlie the conceptual constructions of our form of life, or *Lebenswelt*. Gadamer's contribution was a systematic demonstration

that this move beyond objectivism and foundationalism did not necessitate a slide into relativism and Cartesian anxiety.

Hanson's (1958) analysis of the history of the physical sciences was significantly influenced by Toulmin (1953) and by the later Wittgenstein (1958). In this work, Hanson drew three conclusions about the actual practice of the physical sciences as distinct from the classical language game in which they are described. These conclusions themselves provided a blueprint for the new relational methodology. The conclusions were that: (a) there is no absolute demarcation in the physical sciences between interpretative theory and observation or between interpretative theory and facts or data, a notion that was captured in his now-famous aphorism, "all data are theory laden"; (b) scientific explanation consists of the discovery of patterns, as well as the discovery of causes (see also Toulmin, 1953, 1961); and (c) the logic of science is neither a split-off deductive logic nor a split-off inductive logic, but is rather abductive (retroductive) in nature.

Interpretation and Observation

Hanson's (1958) first conclusion, that "all data are theory laden," became the core principle of the new relational methodology. The idea here of a reciprocal complementarity—a dialectic—between interpretation and observation heals the Cartesian split and thereby destroys any possibility of foundationalism or reductionism. Interpretation and observation, along with other fundamental bipolar concepts, cease being competing alternatives or exclusive dichotomies. Interpretation and observation are relational concepts, not the names for split-off natural entities. They are relational concepts in the same sense that Hegel's (1807) master-slave dialectic entails relational concepts, where it is impossible to define freedom without reference to constraints or to define constraints without reference to freedom.

Interpretation and observation are relational concepts in exactly the sense that Escher's famous sketch "Drawing Hands" is relational, as shown in Fig. 2.1. Here, as I have discussed elsewhere (Overton, 1998, 1999), at any moment the relational stance operates in a fashion roughly analogous to the sketch, in which a left and a right hand are shown in a posture such that each hand is simultaneously drawing and being drawn by the other. The hands are identical to each other in the sense that each is drawing and each is being drawn. At the same time, each hand preserves its own identity in the sense that there are distinctly both a left and a right hand. In this relation, neither is foundational and yet each maintains a distinct identity. Having taken this stance, there can be no question about which of a pair of bipolar concepts is more basic or which of the two is foundational for the other. At the same time, the relational stance allows the investigator to take the point of view from the pole of a focus on either interpretational features

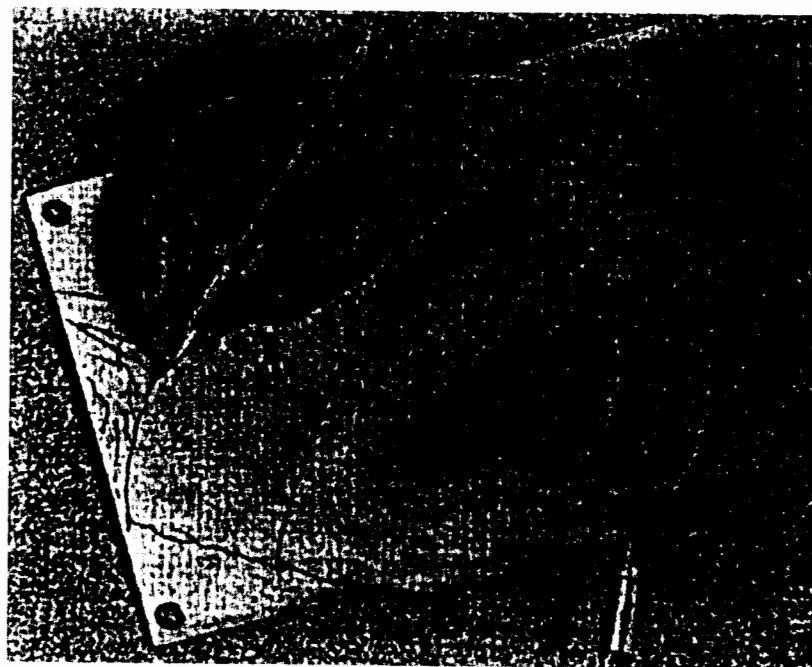


FIG. 2.1. M. C. Escher's "Drawing Hands" © 2002 Cordon Art B.V. Baarn-Holland. All rights reserved.

(e.g., Escher's left hand) or observational features (e.g., Escher's right hand). The *or* in this latter case is the inclusive *or* rather than the exclusive *or* of the either-or dichotomy. In other words, the inclusive *or* implies that, given the unity of the system under examination, one line of sight is as valid as any other line of sight. Taking one or another point of view constitutes a starting point that will eventually and necessarily implicate the others. To ask which hand is causing the drawing or is the mechanism of drawing and which hand is being drawn is senseless. Similarly, to ask whether the right or left is more Real, more foundational, is senseless. Hegel (1807, 1830) referred to this flow of categories where rigid either-or splits are broken down as the identity of opposites. Left hand and right hand are opposites and yet each defines the other. We can explore their oppositeness by taking a particular point of view—by standing at the left hand or standing at the right hand—but a point of view or standpoint is understood in the context of the acceptance that there is no ontological split. Disconnected items represent an abstraction that may prove useful for certain human purposes of inquiry, but such points of view in no way deny the underlying holism.

This feature of the new relational methodology was further supported and extended by two features of Gadamer's (1989) philosophical hermeneu-

tics. The first was his insistence that the alternating to-and-fro motion exhibited in play presents a favorable ontological alternative to Cartesian foundationalism. It is this ontological theme of to-and-fro movement that grounds and sustains the relational methodology. As a consequence, scientific activity, regardless of whether that activity is in the natural or the behavioral and social sciences, becomes grounded in the to-and-fro (left hand-right hand) movement of interpretation-observation.

Gadamer's (1989) second contribution consists of his articulation, following Heidegger (1962), of the hermeneutic circle. In this articulation, the hermeneutic circle comes to describe the basic form of how interpretation and observation move to and fro, that is, the circle describes the basic structure of the new scientific methodology.

Inquiry moves in a circular movement from phenomenological, common-sense understanding of an object of inquiry to the highly reflective and organized knowledge that constitutes scientific knowledge. The whole, the general field of inquiry, such as human development, is initially approached with the meanings, or prejudices, that constitute both common-sense observations and background presuppositions. These are the initial meanings of what hermeneutics terms the *pre-understanding*. These anticipatory meanings, called "the horizon of a particular present" by Gadamer (1989, p. 306), are projected onto the phenomenon of inquiry. As a consequence, they form an early stage in inquiry. However, the object of inquiry is not merely a figment of projection. The object of inquiry is itself an internally coherent whole and, consequently, it reciprocally operates as a corrective source of further projections of meaning. In this circle, interpretation identifies what will and what will not ultimately count as observations and observations determine what will and will not count as interpretation. Interpretation without observation is empty; observation without interpretation is blind.

Through this circle of projection (interpretation) and correction (observation, i.e., Escherian left hand-right hand), inquiry advances. Importantly, the notion of an advance or progress in knowledge is appropriate here because the hermeneutic circle is never a closed circle. The hermeneutic circle represents (following Hegel's [1807, 1830] dialectic) the open cycle whose action creates a continuing directional spirality to knowing. As Gadamer (1989) stated, "The circle is constantly expanding, since the concept of the whole is relative, and being integrated in ever larger contexts always affects the understanding of the individual part" (p. 190).

It was the dialectic cycle of interpretation and observation that later grounded and sustained Thomas Kuhn's (1962) notion of interpretative paradigms in the natural sciences and Lakatos' (1970) and Laudan's (1977) later discussions of the centrality of ontological and epistemological background presuppositions in any research program or tradition. It is the failure to play this cycle game that accounts for the joy among later postmodern

deconstructionists in their belief that the overthrow of interpretation-free observational science meant the nihilistic freedom of absolute relativism. It is the failure to play the cycle game that also accounts for the Cartesian terror, followed by dogmatic reactionary criticisms, among many natural scientists who came to fear that the radical postmodernists might be right.

Causality and Action Patterns

Hanson's (1958) second conclusion—that pattern and cause have always operated as explanations in the physical sciences—subverts the split stories of a clear-cut line of demarcation between the natural and social sciences. If natural science inquiry has, throughout the modern period, centrally involved both pattern and causal explanations, then understanding and explanation need not be dichotomous, competing, alternative language games. Pattern or action-pattern explanation, which entails intention and reasons, and causal explanation, which entails necessary and sufficient conditions, here become—as with Aristotle—relational concepts (Escherian left and right hands). Explanation then, defined as "intelligible ordering" (Hanson, 1958), becomes the superordinate concept that joins dynamic patterns and cause.

The challenge within this relational methodology is to establish a justifiable coordination of the two modes of explanation. Von Wright (1971) presented a richly detailed and complex effort in this direction and Ricoeur (1984) later built upon and expanded this effort. Both focused on explanation in the behavioral and social sciences.

Von Wright (1971) and Ricoeur (1984) each suggested that the coordination be made along the lines of an internal-external dimension. *Internal* here refers to the domain of the psychological person-agent or psychological action system. *External* refers to movements or states. Following from a critical distinction made earlier by Anscombe (1957), any given behavior can be considered internal under one description and external under another description. Thus, any specific behavior may be, to quote von Wright, "intentionalistically understood as being an action or otherwise aiming at an achievement, or . . . as a 'purely natural' event, i.e., in the last resort muscular activity" (p. 128).

Within this framework, causal explanations, understood as Humean causes defined by the logical independence or contingency relationship between cause and effect, account for external movements and states. Action-pattern explanation (i.e., action, action systems, intention, reason) accounts for the meaning of an act.

The situation here is actually quite clear if one reflects on it for a moment. Imagine the following behavior for two figures, A and B. Figure A moves across a space and a part of Figure A comes into contact with Figure B. In this case, there are states and movements and causal explanation is

quite appropriate. The intervening states that identify the movement can readily be considered a series of sufficient and necessary conditions leading to the last state in the series. This can even be demonstrated in a true experimental design.

Although this explanation might be satisfactory if the figures were inorganic objects, the situation changes when the figures are identified as people. In this latter case, it is unlikely that one will be satisfied with the causal explanation because no real psychological sense of the meaning of these movements has been provided. If, however, the figures are identified as people and I further indicate that the movement of Figure A to B is the action of a man who walks across the room and caresses his wife's cheek, explanation begins to operate in the context of action, intention, reasons, and, broadly speaking, meaning. The two moments of explanation—causal explanation on the one hand and action-pattern explanation on the other—explain different phenomena. They have distinct referents: movement and states in causal explanation and meaning in action-pattern explanation. Because they have different referents, different *explananda*, they are compatible. However, they do not replace each other. That is, speaking of reductionism, one cannot be reduced to the other. Action is not a cause of movement, but rather a part of movement. Cause cannot explain action, but action is required to initiate movement (von Wright, 1971).

There are a number of implications that can be drawn from this analysis of the coordination of explanatory types. One is that it demonstrates that, in principle, it is not possible to explain phenomena of consciousness via brain or neurobiological explanations. Consciousness is internal as defined above; consciousness is about psychological meaning and must be explained by action-pattern explanation. The brain is external; it is about states and movements, not psychological meaning. Neurobiological causal explanation complements action-pattern explanation, but can never present the mechanism of consciousness.

A second important implication is that, when one considers the distinction between person-centered and variable inquiry (Overton, 1999), it becomes clear that action-pattern explanations are the focus of the former and causal explanations the focus of the latter. Piaget's (1952, 1954, 1962) theory, for example, is a person-centered theory. Person (child-adult), agent (system, i.e., the epistemological subject), action, embodiment, and intention are core concepts that identify Piaget's focus on development. Piaget, indeed, at least implicitly recognized the coordination of explanatory types and appropriately focused his efforts on explanation via formal action pattern (schemes, operations) and final action pattern (the equilibration process, reflective abstraction). Many, if not all, of the misunderstandings of Piagetian theory that Lourenço and Machado (1996) articulated are derived from the fact that attacks on Piagetian theory have invariably come

from those who remain locked into the positivist story of exclusive causal explanation.

There are other implications to be drawn from a relational coordination of explanatory types, but another important question needs to be addressed here. This is the question of how exactly one would go about creating action-pattern explanation. Universally, students are instructed in how to work with causal explanation at least from the time they enter Psychology 101: Learn experimental research design, do an experiment! When it can be shown, under controlled conditions, that an added stimulus (antecedent, independent variable) invariably leads to the behavior of interest (consequent, dependent variable), this demonstrates that the stimulus is the sufficient cause of the event. This provides the rationale for training and enrichment experiments. On the other hand, when it can be shown, under controlled conditions, that, when a stimulus is subtracted or removed and the event does not occur, this demonstrates that the stimulus is the necessary cause of the event. This provides the rationale for deprivation experiments. Correlations are also discussed in this context and, although it is made explicit that correlation is not causation, the same message treats correlation as a step in the direction of causal explanation.

However, what are inductees into scientific method told about how to work with action-pattern forms of explaining? Generally, nothing. Sometimes, especially if the instructor values the story of modernity, students are told that it is a bad thing and to stay away from it because it involves interpretation and interpretation is a lot like speculation and speculation leads to mystery, miracles, spiritualism, and subjectivist relativism. Yet the student is virtually never told how to deal with action-pattern explanation if they choose to. I provide instruction in action-pattern explanation here, but to articulate the specifics of action-pattern explanation, but it is first necessary to turn to Hanson's (1958) third conclusion about the actual operation of science.

Abduction/Transcendental Argument

Hanson (1958) concluded that neither split-off induction nor split-off deduction constitutes the logic of science. Each of these enters the operation of science, but Hanson argued that the overarching logic of scientific activity is abduction. Abduction (also called *retroduction*) was originally described by the pragmatist philosopher Charles Sanders Pierce (1992). In a contemporary version, this logic is defined as "inference to the best explanation" (Fumerton, 1993; Harman, 1965).

Abduction operates by arranging the observation under consideration and all background ideas (including all metatheoretical assumptions and theoretical models) as two Escherian hands (Fig. 2.1). The possible coordi-

nation of the two is explored by asking what, given the background ideas, must necessarily be assumed in order to have that observation. The inference to, or interpretation of, what must, in the context of background ideas, necessarily be assumed then constitutes the explanation of the phenomenon. This explanation can then be assessed empirically to ensure its empirical validity (i.e., its support and scope of application). An important relational feature of this logic is that it assumes the form of the familiar hermeneutic circle by moving from the phenomenological level (the common-sense object) to explanation and back in an ever-widening cycle. The difference between this and the previously described hypothetical-deductive explanation is that in abduction, all background ideas, including metatheoretical assumptions, form a necessary feature of the process and the abductive explanations themselves become a part of the ever-widening corpus of background ideas, as shown in Fig. 2.2.

The basic logic of abduction operates as follows: (a) Step 1 entails the description of some highly reliable phenomenological observation (i.e., O is the case); (b) for Step 2, with O as the explanandum, an inference or interpretation is made to an action-pattern explanation (E) resulting in the conditional proposition "If E is the case, then O is expected"; (c) Step 3 entails the conclusion that E is indeed the case. Thus, the logical form of the argument is:

1. O (Phenomenological observation) is the case.
2. If E (action-pattern explanation) is the case, then O is expected.
3. Therefore, E is the case.

Examples of this action-pattern explanation or, more specifically, the one I describe next, are found throughout any work that takes a person-centered approach to developmental inquiry. Piaget's (e.g., 1965) work is particularly rich in abductive explanation. Consider the following example: There is the phenomenal observation (O) that it is the case that certain persons (i.e., children generally beyond the approximate age of 7 years) understand that concepts remain quantitatively invariant despite changes in qualitative appearances (conservation). Piaget then inferred a certain type of action system (E) having specified features including reversibility (concrete operations), thus, the conditional "If concrete operations (E), then conservation (O) is what would be expected." The conclusion, given the O, is: "Therefore, concrete operations explains the understanding of conservation."

In fact, many of Piaget's synchronous explanations are of this type, but so too is his main diachronic (i.e., developmental) explanation. Here, given the phenomenological observation that novel acts appear across time, Piaget inferred a principle, reflective abstraction-equilibration, that demonstrates how this transformed or emergent action is possible.

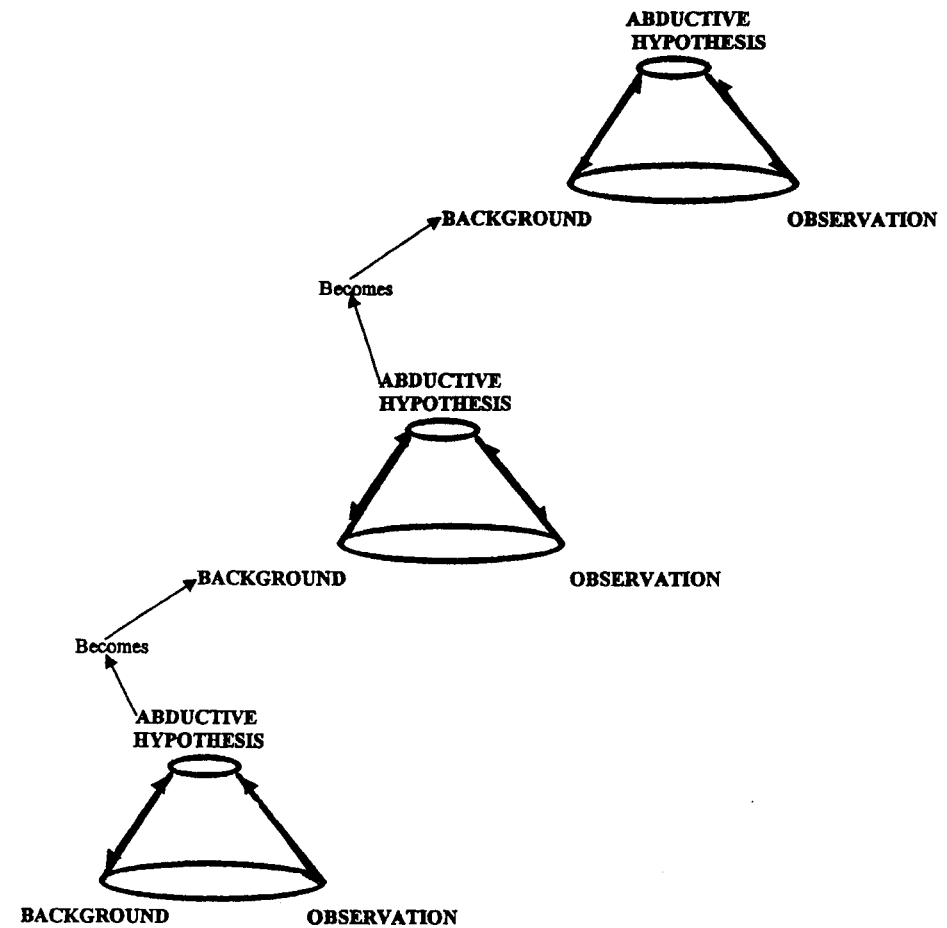


FIG. 2.2. The abductive process.

As Fumerton (1993) pointed out, it is obvious that, if the conditional in Step 2 is read as material implication, the argument would be hopeless because it would then describe the fallacy of the affirmed consequent (i.e., it would be viciously circular). Quite correctly, Fumerton recognized that the "If . . . then" relation asserts some other sort of connection. Specifically, the connection is one of meaning relevance between E and O, where relevance is defined in terms of the intelligibility of the relation between E and O (Overton, 1990).

It is also the case that there must be criteria established that would allow us to choose among alternative Es, the best E. This is no major hurdle, however, because many of the criteria for theory or explanation selection

that have been available under the traditional science language game can, with profit, be used here. These criteria include the scope of the explanation, the explanation's depth, coherence, and logical consistency, the extent to which the explanation reduces the proportion of unsolved to solved conceptual or empirical problems in a domain (Laudan, 1977), and, last but not least, the explanation's empirical support and empirical fruitfulness. Note here that scope, empirical support, and fruitfulness themselves bring the circle back to the observational world and thus keep the cycle open. Action-pattern explanation or theory, in fact, determines what will count as further observations and the empirical task is to go into the world to discover whether these observations can be found. Thus, the cycle continually moves from common-sense observations and background presuppositions to action-pattern explanations, returning then to more highly refined observations and back again to explanation.

A form of abduction was brought to prominence by Kant (1781) and has recently been elaborated by Charles Taylor (1995; see also Grayling, 1993; Hundert, 1989) and used in the arena of cognitive development by Russell (1996). This is the transcendental argument and its form is:

1. (We) have a (reliable) phenomenological experience with characteristic *a*.
2. (We) could not have an experience with characteristic *a* unless (our) consciousness had feature *b*.
3. Therefore, (our) consciousness necessarily has feature *b*.

The transcendental argument is designed to answer "How possible?" questions (von Wright, 1971) with respect to consciousness or psyche. In other words, given some highly reliable phenomenological observation or phenomenological experience such as conservation, what must we necessarily assume (i.e., what kind of action-pattern explanation) about the nature of our consciousness? What are the necessary conditions of intelligibility? Here, again, we begin with the explanandum, make a regressive argument to the effect that a stronger conclusion must be so if the observation about experience is to be possible (and being so, it must be possible). This then leads to the stronger conclusion.

This, then, is the answer to the question of how one does pattern explanation in the behavioral and social sciences. The procedure for action-pattern explanation is found in abduction and the rules of the transcendental argument, and in the criteria that establish a particular abductive transcendental explanation as the best or most plausible of alternative explanations. Rozeboom (1997) provided a richly detailed operational analysis of this process, along with practical advice on statistical and research strategies associated with the process.

In conclusion, let me note that there is much more to the story of the new relational methodology and much of this is given in the detailed elaboration of research methods and measurement models as the specific techniques for designing, conducting, and evaluating the empirical inquiry that adjudicates best explanation. Within this relational context, where interpretation and observation function as a complementary identity of opposites, the broad question of the validity of our scientific observations becomes a central issue. Validity has always been a concern of scientific methodology, but in the story of empirical science as narrated through the imagery of modernity, validity had nothing to do with interpreted meaning. In that story, validity became a content issue dependent to a great degree on the outcome of experimental design. In the relational story, the validity of our scientific observations, or what Messick (1995) called "score validity," becomes a complementary process involving, on the one Escherian hand, the distinctive features of construct validity as it involves interpretative meaning and, on the other Escherian hand, content validity as it involves denotative meaning. This elaboration, however, takes us away from the primary purpose of this essay.

I hope that the relational themes of the hermeneutic cycle of interpretation-observation, the dialectic of causal and action-pattern explanation, and the procedural cycle of the transcendental argument suggest the possibility of producing a relatively stable organized body of empirical scientific knowledge that avoids both the constriction of absolute certainty and the Cartesian terror of absolute relativism. Latour (1993), in his analyses of scientific activity, concluded that the language games of both modernity and postmodernism distort the meaning of the practice of science. Latour maintained that scientific activity, like other activities, most adequately resides in a stable, changing world of relative relativism and this is the world of the relational methodology.

AUTHOR NOTE

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