Chapter 7

Hermeneutics and science

Facts or interpretation?

The word science, from the Latin *scientia*, simply means ‘knowledge’, and thus describes every area of human knowing. Especially in the English language, however, science is associated with the natural or exact sciences, such as physics, biology, chemistry, and mathematics, in contrast to the humanities. It seems natural for us to distinguish between these two areas of human knowledge in terms of verifiability. Science seems to offer us the simple and certain facts of reality, while artistic, religious, and philosophical views about life are mere interpretations of the world. Science, we have learned in school, rests on strictly empirical observation, on accurate measurement, and on the exact verification of its results. In contrast to religion, art, and literature, scientific knowledge is independent of received opinion, personal bias, and the vagaries of language. In short, it would appear that all the elements we have outlined as intrinsic to hermeneutics do not apply to science. Scientists know facts, while philosophers, artists, and theologians peddle matters of personal taste. Scientists know; everyone else merely believes. This view of science, while no longer shared by most scientists, originated in the 18th and 19th centuries, and remains stubbornly lodged in our collective popular consciousness.

Scientific objectivism

‘Scientific objectivism’ is the view that science’s empirical method leads to the highest form of knowledge, namely objective truth as defined by scientific experimentation. There are, of course, good reasons for the origin of this view. Medieval natural philosophy had been strong on reason and logic, but conducted virtually no scientific experiments. Alchemy, the late medieval precursor to chemistry, did much to encourage experimental science, but also remained wedded to a metaphysical, and even magical, view of the world. Modern science, by contrast, earned its enormous reputation through medical and technological breakthroughs based on predicting the material causes and effects of natural phenomena.

Take medicine, for example: today we no longer treat fever by bloodletting to balance the body’s ‘humours’, but we take aspirin or acetaminophen because scientists managed to isolate the chemical process in our body that causes inflammation. Scientists at the forefront of this scientific revolution blamed the unscientific approach of their medieval and Renaissance predecessors for the slow advancement of research and technology. The British scientist Sir Francis Bacon (1561–1626), for example, complained that medieval scientists had started from certain axioms dictated by theology or natural philosophy, and then tried to figure out how empirical facts fit this framework. For instance, they endlessly discussed the possible existence of a vacuum by comparing Aristotle metaphysis with Christian notions about the nature of the universe. Instead of trying to interpret the world from philosophical texts, however, they should have conducted practical experiments. The typical researcher of his day, Bacon lamented, ‘flies from the senses and particulars to the most general axioms’, which he does not question but takes to be settled. True science, however, should be based on practical experimentation and proceed inductively. It should start ‘from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms last of all’.

Bacon’s inductive method, moving from particular facts to general principles, was characteristic of a new era in science that emphasized experimentation and verifiable results. In time, however, this corrective emphasis on induction became its own settled axiom that, ironically, obscured the way scientific knowledge actually works. The role of a framework for integrating facts, the personal involvement of the researcher in the process of scientific discovery, her imagination, passionate commitment, and faith in being on the right path to discovery—all these essential aspects of science were overlooked. In part, this distortion was due to the growing belief, arising in the 18th century, that the universe is a gigantic machine, governed by physical laws discoverable through impartial observation. For such a mechanistic conception of the world, science is purely descriptive. Knowledge is what happens to the detached observer, whose personality, disposition, and imagination contribute nothing to scientific discoveries. This systematic elimination of the knower from the process of knowing with a sole focus on the object of knowledge is called 'scientific objectivism'.

Scientific positivism

The French astronomer and mathematician Pierre-Simon Laplace (1749–1827) articulated a highly influential form of scientific objectivism called 'positivism'. Positivism claims to rely exclusively on established scientific facts for explaining the world. Laplace loved the idea that scientific facts would eventually reveal all general physical laws by which the world functioned, and thus render the world predictable. His dream was that 'all the forces by which nature is animated and the respective positions of the entities which compose it, [...] would embrace in the same formula the movements of the largest bodies of the universe and those of the lightest atom: nothing would be uncertain for it, and the future, like the past, would be present to its eyes'.

Scientific knowledge is thus modelled on a mechanic's understanding of a machine: know the parts and how they function in relation to each other, and you know how the whole mechanism works. To explain how a mechanism works, therefore, is also to understand it, but understanding no longer involves any personal relation to the knower, but concerns simply a functional grasp of a mechanism or instrument. Knowledge, in short, is simply a mass of information and therefore strictly objective insofar as it is devoid of any value or meaning. Factual knowledge comes *before* we form opinions about the meaning or purpose of such information. We can now see that a certain theory of science initiated the basic split between fact and value we have already observed earlier in Hirsch's interpretive theory and in legal positivism.

Laplace thus formulated the ideal of strictly objective knowledge that became deeply lodged in Western culture and still holds sway in many quarters: science has nothing to do with meaning but is all about observational accuracy, precision, and predictability. For this very reason, Laplace's ideal of science is really a delusion that equates information about particular facts with the meaning these facts have for us. This creates the illusion that human experience is reducible to the knowledge of the material conditions for such experience. Even in our day, this remains the temptation of reductive materialism, the idea that love is nothing but chemistry, and that morality finally comes down to genetic fine tuning.

Along with others, the French philosopher and sociologist August Comte (1798–1857) extended Laplace's mechanistic ideal of knowledge to our understanding of society as a whole. Comte added a historical dimension to scientific objectivism, by claiming that human knowledge in every field has to run through three developmental stages. The first is the theological or fictional stage in which theories about the world are dominated by the religious and poetic imagination. The second metaphysical or abstract stage is the disillusionment with the first stage, when gods are replaced by philosophical systems to explain human experience, and when old social orders are erased through revolutions. This negative movement is then followed by the third positive stage, when the now mature human spirit reforms society based on a factual understanding of the world.

Comte understood that facts only make sense within some kind of a theory, but in contrast to the theological and metaphysical stages, the positivist method will aim to generate its theories increasingly from established facts alone, and thus put education and social reformation on the secure empirical footing of the laws of nature. The true positive method, wrote Comte, ‘consists above all in seeing in order to foresee, in studying what is in order to conclude what shall be, according to the general dogma of the invariability of the natural laws’.

Thinkers like Comte are largely responsible for spreading scientific positivism (or objectivism) to non-scientific fields of knowledge, such as sociology and political theory. Researchers in the humanities were tempted by positivism’s lure of verifiable knowledge and sought to convert their disciplines into exact sciences. The school of analytic philosophy, for example, started when philosophers such as Rudolf Carnap (1891–1970) and Bertrand Russell (1872–1970) sought to verify truth statements by means of a logical rules. Today, scientific positivism, with its dream of scientific predictability, has long been discredited as illusory by many philosophers and modern scientists. The essential flaw of trying to shore up truth based on impersonal methods of verification is that judgements and insights require personal commitments—trust in a theory or belief in the basic rationality of the universe—that are not themselves subject to verification by rules. Put differently, there is no rule for how we apply rules.

Nonetheless, positivism’s desire for certainty is hard to eradicate from the popular imagination. Are we really immune to the tempting thought that human progress consists in controlling human nature and regulating social trends? Have we really outgrown the idea that true knowledge is guaranteed by scientific methods of verification?

Understanding as a basic mode of intelligent life

Scientific positivists were wrong to buy objectivity at the cost of eliminating the personal, subjective elements that characterize every human endeavour to know. As in any other area of human knowledge, science too is very much a matter of interpretation. As we have shown for other knowledge disciplines (philosophy, theology, and law), to acknowledge that all human knowing requires interpretation does not promote relativism, but actually helps us to affirm objective knowledge in a way that goes beyond the old divide between subjective belief and objective knowledge.

The philosopher of science Michael Polanyi (1871–1976) argued that understanding, defined as the integration of particular details into a meaningful whole, is a basic mode of learning common to all intelligent life. Polanyi showed that understanding is not a theoretical concept, but originates in the most basic impulse inherent in living species from the lowest animal to our own kind, namely to control and master one's environment.

Any attempt to make sense of one's situation, whether practically or mentally, is indeed an act of understanding. When, for example, a laboratory rat is taught to navigate a labyrinth and the setup is changed, she will first try to negotiate the novel arrangement based on the internalized understanding of the original, first maze. Trial and error eventually result in a new understanding, and each new adjustment will occur more quickly. Similarly, in experiments with chimpanzees, scientists have observed the same basic elements of mental activity exhibited by humans in seeking solutions to problems. Apes faced with the problem of obtaining food placed well out of reach outside their cage, for example, first recognized the problem, ruminated about it, came up with a stratagem, and then sought to verify their idea by putting it into practice. They also showed elation when obtaining their goal.

Contrary to the 19th-century ideal of the scientist as independent, detached observer, who accumulates facts until a general pattern or law of nature emerges, we have to realize that scientific research and discovery follow the intensely engaged interpretive pattern we have just described. Scientific research and discovery do not require detachment, but are based on personal involvement focused on a better understanding of reality.

Personal knowledge

Scientific knowledge shares with every form of human knowing involved commitment, whether we co-ordinate our eye muscles to focus on a distant object, or bring to bear our education and cultural background on the meaning of a text. In both cases, we are integrating a number of subsidiary elements to focus our task. Gadamer called this focal awareness the 'applicatory' dimension of hermeneutics. Polanyi called it the *from–to* pattern of knowledge. We think *from* and through our received knowledge and prior experiences *towards* our goal, bringing this know-how to bear on a certain task. In pursuing this goal, we do not, in fact we cannot, stop to verify our received knowledge. To do so would disrupt its subsidiary instrumental function.

Think, for example, about the various subtle counterbalancing movements required to ride a bike. Were we to focus on these instead of our goal of moving ahead, we'd surely fall down. In the same way, a scientist straining to understand something inhabits and uses scientific axioms without constantly doubting or verifying their truthfulness while he is working on a problem. Polanyi called this subsidiary element 'the tacit dimension' of knowledge. The scientist too participates in these structures, and wields them in striving for a new understanding of a phenomenon, the same way we wield a hammer to drive in a nail. We are aware of the handle and its vibrations in our hand, and we keep adjusting our aim and blows to focus on hitting the nail. Should we divert our attention from the nail to the hammer itself, we'd most likely merely hit our fingers.

Polanyi's concept of tacit knowing makes essentially the same point as Heidegger's 'in-order-to' structure of knowing: trying to understand the world around requires an engaged rather than a detached self. Gadamer made the same point by emphasizing the role of tradition as the tacit background that we inhabit and that guides our perception. All human knowledge, including science, follows this skilful pattern of inhabiting an activity whereby we integrate our intellectual movements and passions to focus on a goal. Indeed, even empirical observation (as demonstrated by the muscle coordination needed to focus the eyes) rests ultimately on the integration of such subsidiary elements to a focal centre. Knowledge is thus always the action of integrating particulars into a coherent whole. And this integration does not happen all by itself but requires personal engagement. As in any area of human knowledge, this integrative work depends on the training, personal convictions, and imaginative power of the scientist.

Scientific knowledge, as much as artistic knowledge, depends on this personal dimension for success.

Science as art

The no-nonsense, take-it-or-leave it reputation of science rests on the belief that science delivers simply facts, allowing for the exact prediction of results based on impersonal computation. Adherents to this still popular image of science, however, overlook a crucial personal element on which the natural sciences depend: the scientists interpret facts based on experience in order to make predictions. This personal element becomes clear when we compare scientists' interpretation of data to reading a map. A map represents a part of the earth's surface in a similar way to how experimental science represents our experience of reality. Now, we all know that we cannot read a map simply by reading a book about map-reading, or by memorizing rules about map reading. Rather, reading a map depends on our personal judgement and our skill as map readers. We first have to link our actual position in the landscape with a point on the map, then on the map we must find the way towards our destination, and, finally, we have to identify this path with the help of physical landmarks.

And just as the correspondence between the map and the actual landscape depends on our judgement, itself based on personal skill and experience, so any exact science requires a trained eye and personal judgement for correlating instrumental readings or mathematical computations with the reality of actual experience. The reading of gauges and dials, as well as the compensating for marginal deviations of calculations are interpreted by scientists within the context of their respective field and their intuitive understanding based on years of training. Thus scientific observation, just like map reading, is not an exact impersonal numbers game, but requires the personal judgement of the scientist. Scientific prediction depends on an art, namely the art of establishing—by means of the scientist's trained eye, ear, and touch—the correspondence between the explicit predictions of science and the actual experience of our senses to which these predictions apply.

Another telling example for the need of personal experience and judgement in scientific knowledge is a doctor's use of anatomy in making a diagnosis. A medical student, who has freshly memorized all the anatomic schemas of the human body from her science textbook together with descriptions of every illness, is not therefore automatically equipped to diagnose illnesses. Even extensive training on dead bodies in the pathology laboratory is no substitute for the experience acquired by a doctor or surgeon that allows him to see the body as a living, functional unit. Good knowledge of anatomy is of course necessary and immensely helpful, but, as with the reading of maps, integrating this information within the context of the living body as known from decades of practice sets apart the experienced medical practitioner or surgeon. Thus, insofar as scientific knowledge requires the artful integration of details into a coherent whole through an act of the imagination based on personal experience, science too relies on interpretation.

The hermeneutics of scientific discovery

Philosophers of science have long questioned the ideal of science as an impersonal and strictly rule-governed process. Norwood Russell Hanson (1924–67) and Paul Fyerabend (1924–94), for example, affirmed that scientific observation is not unbiased but always 'theory-laden'. Scientific theories are like lenses through which the researcher interprets findings. They thus confirm for science the contextual quality of observation Heidegger had called 'seeing-as'. Still, in the popular imagination, scientific discovery happens gradually, simply through controlled experimentation. According to this portrayal of scientific progress, carefully building on previous findings, the scientist would never affirm anything that has not been tested and verified by experience, and would drop a theory the moment an observation turns up which conflicts with it. In reality, however, scientific discovery is much more dynamic and much less predictable.

First, science relies on tradition insofar as scientists hold to a certain vision of reality or world picture as currently accepted by science. No one scientist actually knows and, least of all, constantly verifies every detail of this reality. Moreover, scientists are inducted into the world of science and its experimental methods as an apprentice learns from a master craftsman, *trusting* his authority and superior experience. Indeed, the general public shares in the cultural transmission of such knowledge though acquiring a general understanding of the world, which includes evolution, relativity, quantum mechanics, and so on, without necessarily grasping the details of such concepts. Philosophers of science refer to this accepted scientific description of the world as a 'paradigm', which guides the scientist in distinguishing between facts and groundless assumptions. In contrast to the general public, the professional scientist appropriates this scientific tradition, learning to own it and validate it based on personal experience. So-called scientific facts, thus, are never simply 'given', but derive their significance from being integral parts of a certain holistic interpretation of the world.

Second, the scientist is not an independent observer, but inhabits the current paradigm and upholds it by her commitment. This commitment is by no means arbitrary, but derives from the pleasure of possessing a satisfactory understanding of the world we inhabit. Science thereby takes its place beside other explanations of our world, such as those found through art, religion, and literature. As in these humanistic disciplines, commitment to science derives from the basic satisfaction of knowing one's way around and achieving intellectual control over problems that arise. Another word for commitment is *faith*. Because an accepted paradigm is a reasonable, but never total, explanation of our world, scientists are personally invested and have faith in this world picture.

We have to dispel the illusion that scientists drop any theory about physics, astronomy, biology, or any other scientific subject that is not fully verifiable. The fact is that no paradigm manages to offer a total explanation of the world, and the scientist has to live with anomalies, that is, with experiences that do not fit the theory and threaten to undermine it. Their personal faith in the stability of a paradigm allows scientists to shelve anomalies in the hope of resolving them later through an expansion of the theory, and this indeed sometimes happens. At other times, however, persistent anomalies can lead to overthrowing an entire theory and opening a new way of understanding the world.

The physicist and historian of science Thomas Kuhn (1922–96) showed that the process of scientific discovery is not an orderly, rule-governed affair, but rather resembles a paradigm change Kuhn called 'scientific revolution'. Such revolutions occur when an older theory fails to explain new phenomena. To think of a scientist cheerfully trying this or that experiment, calmly changing course at each failure, distorts the dynamic and creative process of science, and occludes the scientist's deep commitment to a possible new theoretical framework. Often, this passionate commitment to an established paradigm will result in resistance to new theories. At other times, a researcher may be already committed to a new paradigm, but will not fully understand it until some additional discovery vindicates the new vision as a better account.

Scientific discovery depends heavily on the personal intuition of a scientist whose deep familiarity with a prior theory and the relevant facts, together with the hitherto stubbornly unexplained anomalies, allows him to *intuit* a better way of integrating all these particulars into a new coherent framework. This intuitive vision, while based on experience, cannot be reduced to logic, but constitutes an intellectual leap from one existing interpretive framework to another.

As the history of discovery from Copernicus to Einstein shows us, scientific discovery begins with intellectual visions by trained scientists, visions that were inspired by the beauty and elegance of a rational universe. We have said that the desire to understand and hence a basic curiosity are common to animals and humans. Yet we are also symbolic animals who are able to transmit, manipulate, and recombine information abstractly through signs, and thus capable of incomparable feats of the imagination. Science, too, relies on this capability, and indeed major discoveries depend on the use of deeply rooted pictures or metaphors about reality.

Let us not forget that one of the main inspirations of the astronomer Galileo, aside from his dislike of Aristotle's hold on the minds of theologians, was his belief that the Bible and nature were two books by the same author, God, and thus could not ultimately contradict each other. Thus, if science showed the earth to orbit the sun, there must be a better theological reading of the Genesis account than the traditional geocentric one championed by the current ecclesial establishment. What remains obscured by a still-popular myth in scientific circles is that Galileo's proof for a heliocentric universe did not undermine Christianity. In fact, many Christian scientists and interested theologians were thrilled to discover that the earth was not, as Aristotelian metaphysics had demanded, at the centre of the universe, where all matter had to go due to its base corporality, while noble and spiritual things soared upward. Galileo had shown to the contrary that our planet was liberated from this shameful position and joined the dance of the stars.

As we can see from this example, both in science and in theology, facts are important, but what ultimately matters is the theory or world picture by which we integrate the individual parts of what we know into a meaningful whole. Even experimental verification by itself is no guarantee for arriving at the correct interpretation of reality, as demonstrated by the well-known controversy on alcoholic fermentation.

In the 1830s, for example, a number of chemists found that fermentation was not a mere chemical reaction but due to the living function of yeast cells, that is, of living cellular organisms. These findings, however, went against the dominant intellectual vision of contemporary scientists, who had synthesized yeast from inorganic materials, and took such results as proof for their cherished project of a chemical approach to all living matter. Consequently, they mocked the other findings as a regressive lapse into a vitalism (the view that nature is an intelligent, living organism) they believed themselves to have overcome. For a long time, this controversy remained unresolved, and the great French chemist Louis Pasteur (1822–95), who sided with the organic camp, recognized that each side integrated the facts differently based on 'an order of ideas which, strictly speaking, cannot be irrefutably demonstrated'. Eventually, the discovery of intracellular enzymes showed that both sides had been correct: the catalyst of the fermenting reaction was indeed a chemical enzyme, which also proved to be a vital part of living yeast cells. In this case, two theories were transformed into a more comprehensive paradigm.

Science as a distinct mode of knowledge

The fermentation controversy demonstrates that scientific knowledge does not progress through gradual accumulation of verified experimental results nor through rigorous, impersonal observation and application of rules. Such mechanical operations remain an important part of scientific activity, but do not explain the actual nature of scientific knowledge or discovery. Instead, striving for coherence through the integration of particulars into a meaningful whole, science proceeds hermeneutically. Every supposedly neutral observation is theory-laden; that is, facts are selected and recognized according to a certain interpretive framework. A theory is like a lens through which the scientist sees something *as* something of value for science, just as the trained artist or historian recognizes techniques or compositions as valuable. In turn, every new scientific theory is a visionary act of the imagination that is inspired by observation of facts and grounded in received scientific practices. Scientific knowledge thus moves in a hermeneutic circle, moving between parts and whole, clarifying and often transforming one another.

We have seen that science depends as much on tradition, personal involvement, commitment, and intuitive insight as does any other mode of knowing. The creative and visionary side of science also aligns scientific activity with the creative arts, poetry, and literature. At the same time, however, science remains a distinct mode of knowing. As with every other knowledge discipline, natural science is an articulate explanatory system of human experience that is accepted and sustained by personal commitment.

Unlike religion or the arts, however, or unlike more abstract sciences such as pure mathematics, the natural sciences deal in their own particular way with the facts of experience. When a scientist envisions a new atomic model, we assume that something like atoms actually exist. When we read literary texts such as Tolkien's *The Lord of the Rings*, we don't expect to meet Hobbits in the British countryside. And yet the truth of fiction, too, corresponds to human experience. Fantasy literature tells us that life can be enchanted, and consists of more than mere matter in motion. These sentiments correspond to our experience, but the *validation* of literary truths by our experience is not exactly the same as the experimental *verification* required by science. Perhaps one way of putting this difference is that while both science and the arts proceed basically from faith (a tacit personal commitment to a world picture or interpretive framework) to understanding, the faith element in the arts is deeper, more emotionally intense and intellectually complex. Nevertheless, both scientific verification and aesthetic validation of experience testify to the same personal and interpretive quality of all human knowledge. To know is to interpret.

The future of hermeneutics

What is the future of hermeneutics? In our introduction we said that hermeneutics stands for interpretation in general but also for a philosophical discipline. In the general sense of interpretation, hermeneutics remains relevant as long as we seek to understand ourselves and our world. As a philosophical discipline, hermeneutics is a minor field in the academy, which is dominated by more analytic approaches to philosophy concerned with truth statements and their verification. Hermeneutics, by contrast, enquires into the conditions of understanding, and that is more important than ever, especially in light of our changing culture. Computing technology and virtually universal access to information are rapidly altering the way we perceive the world and we need to reflect on the impact of computing technology on the nature of understanding. Induction into language and culture was formerly a more communal enterprise, controlled by parents and teachers. Now, for the first time in human history, a whole generation is growing up in many parts of the globe for whom the world is predominantly mediated through computers, tablets, and smartphones. They are 'born digital', and one of the most important questions to address in the future will be how this technical revolution affects their interpretation of world and self.

Hermeneutics has a future insofar as it may help us assess the impact of digital technology on the conditions we have outlined in this book as essential for human understanding. We have learnt that understanding requires an engaged rather than a detached self. How we understand ourselves and the world depends on the practical relation we have to things and on the interpretive lens we acquire through our cultural upbringing. Does today's digital culture encourage detached or engaged selves? We have also seen that understanding requires the patience of sustained familiarity with a problem and an educated imagination through which we can imagine things differently. Does our digital culture increase or decrease our attention span? Does digital technology encourage the deep familiarity with one's tradition, whether secular or religious, necessary for intelligent dialogue with other traditions? Are digital natives habituated to the long-term indwelling of a topic essential to scientific innovations, social visions, and creative artistic works?

Finally, hermeneutic philosophy provides an important antidote to fundamentalism. Secular and religious fundamentalists still defend the modernist illusion of timeless, certain knowledge. Their shrill voices and defensive, sometimes even violent, stances toward others are driven by the fear of relativism. In contrast, by insisting on the interpretive nature of all human knowledge without falling into relativism, hermeneutics encourages the interpretive humility essential to any dialogue. Acknowledging the profound mediation of even our deepest beliefs through history, tradition, and language should induce us to admit that we could be wrong and are thus open to correction. The awareness that our own interpretive framework can benefit from another's encourages conversation in order to learn. By contrast, the belief that truth is something self-evident only an obstinate fool would reject fosters a basic stance of confrontation. Insofar as hermeneutic philosophy encourages conversation among those of different faiths and cultures, hermeneutics will remain an essential part of our future.