Holmes Rolston, III, *Science and Religion: A Critical Survey*
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Chapter 1

Methods in Scientific and Religious Inquiry

To have a method is to have a disciplined mode of "following after" (μέθοδος) truth, and in science and religion alike one intends an orderly approach to understanding, to be a methodist, but procedures in the two fields may seem very different and even incompatible. In this overview we will broadly assess their operation so as to see whether and how far they are related or opposed. Lest the diversity in religion prove overwhelming, the plan here is to consult mainly Western theistic belief, itself diverse enough, as it has developed in interaction with the sciences, which have a diversity almost equal to that in theism. Despite the pluralism, these two great epistemic lines in the West are cousins, at once kindred and independent. What follows is partly a description characteristic of science and theology, but, so far as I choose good science and good religion for models, it is a prescription of how inquiry there ought to be done, perhaps not always, but at least in the present state of these arts.

The thesis that will emerge is that in generic logical form science and religion, when done well, are more alike than is often supposed, especially at their cores. An implication of this is that positivistic and scientistic views that exalt science and downgrade religion involve serious misunderstanding of the nature of both scientific and religious methods. At the same time, in material content, science and religion typically offer alternative interpretations of experience, the scientific interpretation being based on causality, the religious interpretation based on meaning. There are differing emphases in specific logical form in the rational modes of each. But both disciplines are rational, and both are susceptible to improvement over the centuries; both use governing theoretical paradigms as they confront experience. The conflicts between scientific and religious interpretations arise because the boundary between causality and meaning is semipermeable.

1. THEORIES, CREEDS, AND EXPERIENCE

The Hypothetico-deductive Method and Theory-laden Facts

Whether there exists an overall scientific method is open to question, since the procedures of electronics engineers, plant taxonomists, and social psychologists are

so diverse. In a generalized way science mixes observation, theory, and inference, but these ingredients with their blending are more complex than at first appears, and not until something of this complexity is appreciated can one appreciate a scientific method and then profitably ask how far religious inquiry differs from it. Let us begin by saying that a scientist attempts to operate out of theory in an if-then mode "over" the facts. A schematic of this would find a theory (the hypothesis) arising out of the facts, followed by deduction back down to further empirical-level expectations, those then being related back to observations to confirm or disconfirm the theory, more or less, and to generate revised theory, from which new conclusions are drawn, after which the facts are again consulted (Figure 1.1). This is sometimes called the hypothetico-deductive model, but we are using a more expanded version of it than that phrase usually implies, and also noticing already that a theory comes to have a developmental history.[1]

Such facts quickly become theory-laden. When the engineer reports that the current through the meter is ten amperes, or the zoologist discovers that the vertebrates are related to the tunicates, the larval notochord of the latter and the spinal chord of the former having evolved from a long-extinct hypothetical ancestor, their facts come within and are partially products of their theoretical frameworks. Fabricated concepts and laws are used to trace and to classify natural events, and the facts so obtained do not come nakedly but rather filtered through these constructs. In the more theoretical sciences, those likeliest to affect cosmic belief, there is often a tenuous combination of speculative abstraction with sense observation, linked by hundreds of intervening hypotheses, as in the experiments that verify the time dilation of relativity theory by measuring the supposed decay of muons at high velocity, all translated into streaks on photographic plates and meter readings. The geneticist maps a gene by back inference from statistical phenotypic expressions. The biochemist decodes the amino acid sequence in a protein by observing certain colored stains or layers of material in an ultracentrifuge. Molecular biochemistry contains highly theoretical construction of models of unobservable entities and processes—for instance, the lac-operon genetic sequence—to account for observed gross phenomena at great distance from the postulated microentities. Geology has become a unified science only in recent years, with the appearance of plate tectonics, but that supertheory stands at a great inferential distance from the immediate observation of fault lines, subsidence measurements, chart tracings that indicate oceanic ridges, and magnetome-

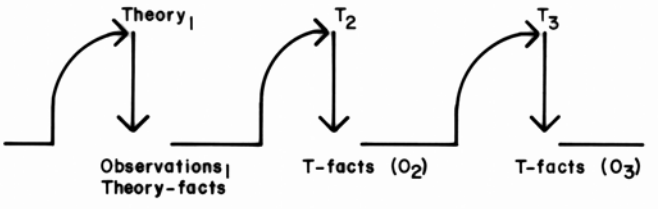

Figure 1.1 The developmental history of a theory

ter readings from which are inferred prehistoric reversals of Earth's magnetic field.

Even in the plainer bare world there are no centimeters, or calories, or lines of latitude and longitude; nor can it be Tuesday, 1:30 P.M. (EST), for these are all conceptual overlays on nature. The center of gravity in a rock is as much assigned as discovered. Still, one may reply, at least there are some evident natural kinds; there are tunicates and genes, there were trilobites in the Cambrian period, and Yosemite's Half Dome is made of quartz monzonite. But even these facts do not come unalloyed with the theories by which they were obtained. There is always some definition or decision about theoretical kinds in what counts as a tunicate, a gene, quartz monzonite, or the Cambrian period, as these are fitted into explanatory theories.

The whole numbers may seem natural enough until we add, divide, and multiply by zero and infinity, and with some artificial innovation must define what these operations will mean. The point in science is to mix theory and fact appropriately, and not to pretend that they can be insulated from each other. The naked fact is mostly a mythical entity; facts are contextual truths. To believe in pure facts is to believe "the dogma of the immaculate perception." The "facts" are always to some extent "artifacts" of the theory. The "facts" are preceded by "acts" that set up the facts. The facts are seldom, if ever, immediately given; they are arranged for, indeed, chased down on long hunts by those armed with powerful theories. Even where theoretical concepts can be cashed in for observations in a fairly straightforward way, the cash-in rules come out of the theory, not the observations, and such rules can change in the course of the development of the theory.

How such theories are originated, as distinct from their subsequent verification, has proved troublesome to analyze, and recently it has seemed that the context of discovery is more important, more interesting, than is the later context of justification. Given a certain set of observations, what theory will fit them? In cataloging natural types or in formulating simple regularities one is tempted to say that science works by induction, a logic that leads in toward a concluded general principle from premised particular occasions. Here the contribution of the scientist can seem minimal, even though the law vastly overprojects what can be verified. But the generating of theories is more complex; the scientist comes up with models and abstractions, such as "lines of force in an electromagnetic field," or "covalent bonding," or "black holes," concepts that no doubt come by mulling over the data, but in which he also contributes creative hypotheses that require the stroke of genius.

These initial ideas may come in the laboratory or at study but are sometimes reported to come in unusual circumstances. While dozing by the fire, August Kekulé dreamed a reverie of gamboling atoms and snakes, one biting its own tail, out of which the great chemist that night developed the chain-linked ring structure of benzene.[2] Fred Hoyle regarded as pivotal in triggering the steady-state theory of the universe a curious personal incident in which he lost a screw or nail and could never find it, as though it had forever vanished. He reversed the experience to conceive of the spontaneous creation of matter.[3] Albert Einstein reported that he initiated his relativity theory, partly at least, "in vision" late one night, and he greatly

emphasized the free play of the imagination, first and charismatic, only later to be put sternly to observational test.[4] Hans Adolf Krebs, on the other hand, reported a long and steady step-by-step deciphering of the citric acid cycle.[5] Both elements are present in Charles Darwin and difficult to separate.[6] But if eurekaism is one extreme, dull inductivism is another. There is much inspiration whenever a fertile hypothesis is born. The logic of such inception has proved elusive; it involves something beyond either induction or deduction, and there seems to be no recipe for cooking up theories. This is perhaps necessarily so proportionately as it is creative. Revolutionary science is more chaotic here than is normal science.

Verification and Falsification

Crucial though the question is of how one gains a novel theory, the real test comes with its verification. Given a theory (T), what observations (O) follow? Here deduction is in order, at least in a broad sense; logic leads out from premised general principles to particular conclusions. In the mathematical phases of science, where one has formal laws and initial conditions, this can be exact and necessary deduction, but elsewhere it is less so. Atomic theory is only partially metric, and what could be deduced from the atomic table about the properties of as yet unfound elements was suggestive and imprecise. Often a theory permits the deduction only of a range of possible alternatives, and we must sometimes deduce in a weak, nontight sense. Still, a fertile theory will suggest new observations that can be made to check it. Here we often presume that our logic is paralleling a causal chain, that a law causally produces an observed event, the narrower sense of the hypothetico-deductive or covering-law model. But the principle here is broader than this, including whatever particular events or observational structures follow from general theoretical models.

If T, then O
Given: O
Therefore: T

Alas, however, this procedure commits the logical fallacy of affirming the consequent, since some quite variant theory (T') might as well or better explain the observations in question, and the history of science is replete with examples of this. On the other hand, if the observations fail (not-O), then the theory is refuted, by *modus tollens,* an elementary principle of valid argument:

If T, then O
Given: not-O
Therefore: not T

Science then first appears to be caught in a rotten asymmetry: no amount of positive observations can prove a theory, while a single negative observation will destroy it. We can be definitely wrong, but only vaguely right! This asymmetry has led some scientists to concentrate on falsification, counting disconfirming instances as more weighty than confirming cases.[7]

What happens in actual science is that positive observations do in some way tend to establish the theory, although it is difficult logically to specify just how. Again,

it is tempting to say that positive observations by induction render the theory probable, while conceding that this is never hard proof even in science and recognizing that the rational status of induction is flawed, especially so far as future predictions from the theory involve a kind of backing into the future. Positive observations corroborate or strengthen the theory, although they cannot clinch it. We get no proofs; we get at best plausibility arguments.

On the other hand, on closer inspection, those negative observations that first appear to offer hard disproof also soften. Theories are not tested purely and simply but in conjunction with various presumed or unknown intermediate factors, called auxiliary hypotheses (A), such as those pertaining to instruments, to irrelevant or absent influences, etc., and one can typically adjust for upsetting circumstances so as to salvage the central theory:

If (T + A), then O
Given: not-O
Therefore: not-T and/or not-A

Something has been falsified, but what? Some variant auxiliary hypothesis (A') will allow deducing the obtained observations while retaining the theory. Thus, the auxiliary belt of surrounding hypotheses becomes a protective cushion. In most practical and theoretical science we are reduced to saying: if T, then probably O. But then not-O no longer refutes the theory, especially where this is an occasional not-O.

But it may be, of course, that the error is rather in the body of the theory itself. Newtonian theory predicted planetary movements reasonably well, except that the orbit of Uranus was irregular, and some astronomers suspected that the theory might be faulty. In a celebrated triumph of mathematical astronomy, John Couch Adams and Urbain Jean Joseph Leverrier introduced the auxiliary hypothesis of an unknown planet that was disturbing Uranus' orbit, and thus Neptune was found and Isaac Newton confirmed. Later, when aberrations in the perihelion of Mercury were found, Leverrier again suggested the auxiliary hypothesis of an innermost planet, Vulcan, whose influence was perturbing Mercury. But no such planet was found. Perhaps it was lost in the solar glare? Eventually the trouble proved to lie in Newtonian theory, and relativity theory came to replace it and to explain these discrepancies in Mercury's behavior. The problem is to know when to "put in some epicycles" to protect a theory and when to suspect the core theory itself.

Every theory is held in the face of certain anomalies, margins of error, and so on. For so simple a law as that for the distance *(S)* traveled in a specified time *(t)* under the acceleration due to gravity *(a)*, $S = 1/2at^2$, the observations never fit the theory exactly, since the theory specifies a perfect vacuum. We also have to assume that there is no magnetism present countering the gravity, but to check this one needs a theory of magnetism and a measuring device built on the theory. In genetics and biochemistry one is constantly invoking as yet unknown genetic codings, enzymes, or repression or induction effects to explain departures from the norm. The theoretical imbalance in corroboration and falsification abstracted above, by the time it is emplaced in the practice of science, loses much of its asymmetry.

At the same time, really stubborn disconfirmations are more unwelcome than

repeated confirmations are welcome. The structural asymmetry probably does mean, contrary to a certain sense of fair play, that in science (and in religion too, we shall soon maintain) you want to try to hit an opposing theory not where it is muscular but rather in the soft underbelly where it is weak; you ought to evaluate a theory (or a creed) more on its weaknesses than on its strengths.

In more complex and partly established theory there are large amounts of confirming and some disconfirming observations, and one has to decide just how good the evidence is. That decision is rational, perhaps progressively corroborated as science settles into a theory, but often it is more discretionary and less tidy than is admitted by those charmed by an ideal of absolute demonstration. Every comprehensive theory has got to argue away some of the evidence it faces. Sometimes we do not believe the theory because it is not confirmed by the facts; but sometimes we do not believe the "facts" because there is no theory that confirms or predicts them and they go against a well-established theory that we have. We could handle this exception, if we had a little more time to deal with it! Meanwhile, an anomaly makes a poor logical fit in what theory we do have. Then again, experiments can be quite repeatable and quite wrong, where the conceptual framework repeatedly gives you the wrong result. You can step on a bathroom scale and get 150 pounds every time, when your weight is really 160 pounds. Hidden faults and errors are repeatable. Theories cast light, but may also put some things in shadow.

Crucial experiments are infrequent, if indeed they exist at all. Hardly anywhere is there a simple verification or falsification, and the more massive the governing theory becomes, the less convenient these procedures are. The evidence for the big theories, which make any metaphysical difference, is never of the here-and-now, before-your-very-eyes sort. What counts for a good theory is its ability to draw together and make sense of the available experiential material, and in this the relationship between theory and observation is often indirect and interactional.

Testing Creeds in Experience

Religion too methodically mixes experience, theory, and inference. There are many disanalogies; often one finds notions of revelation and inspiration, and hence of normative authority, that cannot be easily reconciled with the procedures of science as just sketched. Creeds are not so provisional as scientific theories sometimes are, but more like settled operational assumptions (which scientific theories also can become). And there are many noncognitive elements in religion not present in science. Nevertheless, in a general way religious convictions develop in the face of certain experiences judged to be of ultimate importance, as of suffering or of joy, of sin and salvation, of the holy and the moral. On reflection by theologians there arise cognitive, theoretical notions suggesting certain universal spiritual laws or generalizations, leading to a positing of an underlying ultimate reality in and beyond the world that is sufficient to account for such experiences. God, Brahman, or *śūnyatā* (Emptiness) is then used to interpret ongoing experience, and here, as with science but more so, the subsequent experiences are produced by and come within that framework of convictions that these experiences first spawned.

The later religious experience provides a testing of dogmas, confirming or dis-

confirming them. The history of religion is strewn with abandoned beliefs, largely overcome by more commanding creeds or made implausible by new ranges of experience. To the contemporary religious mind, primitive fetishes and taboos, superstitions and sacrifices seem quite as quaint as (and perhaps a form of) primitive science. Only a handful of the myriad religious hypotheses of the human race have survived the sifting in experience that makes them classic (that is, verified in experience), and for that handful this durability increases their categorical element. Most earlier religions are extinct; a few are relict. Some will say that it is only modern science that wipes out old creeds, but this is not always the case. Sometimes new creeds wipe out old ones. Witchcraft and astrology were already prohibited in the Scriptures as unbecoming to monotheistic theory (although some belief in them persisted, *per nefas).* The Hebrews disenchanted the universe on the basis of monotheism long before science appeared—a finding that subsequently made science possible.

Even classical theism, though once medieval, has nowhere become modern without dramatic revisions. One central element in the creeds of the Reformation churches is that they are "always reforming" *(semper reformanda),* that is, steadily improving their creeds in the light of contemporary experience that brings a new perspective to the foundations of the tradition, retaining only so much of that classic faith as continues to prove adequate, and that often in a reinterpreted form. The Roman Catholic Church has claimed an irreformable core to its creeds, but in the second half of this century this classical infallibility claim has been found by many who once held it not really to square with experience, and the Roman church is now undergoing hardly less radical revision than those churches that confess to a continuing reformation. Religious belief has to weather a critical thinking out and testing out of the experiences that follow from its creeds, and theologies too are selected for their success over historic time.

Religion does use the if-then mode of deriving consequences from its creeds and testing them in experience. In this, however, religious convictions cannot usually be cast into empirically testable frameworks. Simple events, such as planetary motions or chemical reactions, adapt well to watching with objective instruments, but more complex events, such as guilt and forgiveness, quantify poorly and are difficult to make operational. The instruments for their recording are subjective selves, and the hunting down of those experiences that are found when armed with religious creeds is a matter indeed of experience, of "going through," and not merely of observation, "looking on." In physics and chemistry, material things instantiate laws in a rather tight way, but living things, even in biology, often show only generalizations or statistical trends, hardly rejected by occasional counterexamples. Personal beings, as unique, rational, affective agents, can test religious convictions only experientially, not experimentally; existentially, not operationally.

Low-level generalizations can sometimes be tested empirically, as with "The family that prays together stays together"[8] or "Persons become more religious in adverse times." (Even if verified statistically, the underlying explanatory theory might still be contested.) Intermediate religious generalizations need personal experiences mingled with observation. "Blessed is the man who walks in the law of the Lord" is the judgment that the moral life, as described biblically, yields the good

life, and a considerable number of persons have claimed to find this replicable and thus verified. The Buddhist claim that worldly life at its core is eventually unsatisfactory *(duhkha),* so far as life is driven by uncontrolled desires, is perhaps only part of larger cosmological claims in the first and second noble truths, but this relatively specific claim is at least in some degree subject to experiential verification.[9]

2. MODELS, PATTERNS, PARADIGMS

Scientific and Religious Paradigms

"Seeing" is universally "seeing as." We interpret what we see in order to see it. To tell what is going on, to see what is taking place, our observations are formed within gestalts. We see cows, not red patches, persons rather than bodies, love or hate rather than bare behavior. To notice this is not to deny that philosophically oriented observers can sometimes strip away the coordinating patterns and lay bare rudimentary data. But such naked facts are abstractions artificial to normal experience, which occurs within natural and conventional categories. Routinely in science and in religion alike an event makes sense not merely as our senses register it but as it is found to be intelligible within certain established patterns of expectation.[10] The understanding cannot see and the senses cannot think; cognizing and perceiving are wired up together. This interpretive seeing is sometimes thought to contrast with hypothetico-deductive science, but it is really in keeping with an earlier realization that observations are heavily theory-laden, that we come to see things as instances of types or universals. As these models become increasingly dominant, they become paradigms, and then we are able to give a better account of the revolutionary phases of theory overthrow while retaining our earlier hypothetico-deductive account for the evolutionary development of theories.[11] At times some theory replacements cut clean from previous theory (the heavenly spheres of medieval astronomy were abandoned in Newtonian astronomy); at other times much is conserved, if reinterpreted, in subsequent theory (Newton's laws are a special case within Einstein's relativity theory). Both clean cuts and conservation under radically new theories involve paradigm shifts.

Paradigms are governing models that, in some fairly broad range of experience, set the context of explanation and intelligibility. Their holders wish to conserve these basic referent theories so far as they can by using them to interpret new experience or, in the event of counterexperiences, by introducing subsidiary hypotheses that allow the theory's conservation by peripheral adjustments. Paradigms are abandoned reluctantly, because they have hitherto been highly successful in structuring the data of experience. It has proved difficult in some cases to specify just what qualifies as a paradigm; paradigms have sometimes broader, sometimes narrower scope, and there may be a hierarchical interweaving of major and minor paradigms. But the basic idea here of a controlling patterned seeing does seem to characterize the history of science and religion alike. Prominent examples of dominant or subordinate paradigms in science include the Copernican and Ptolemaic astronomies; the fixity

of species and the evolution of species; Newton's absolute space-time and Einstein's relativity; mechanism and teleology; determinism and indeterminism; natural selection and orthogenesis; theories of phlogiston and of the ether; the taxonomic sequence of phylum, class, order, family, genus, and species; geologic uniformitarianism and catastrophism; the Paleozoic, Mesozoic, and Cenozoic periods; the wave and particle theories of light; atomic theory.

Those familiar with the history of science will realize how much of its controversy and upheaval comes at periods of major paradigm shifts. Those engaged in its present practice will notice that many of these examples pervade their work as the assumptions that make it possible, while some of the overthrown paradigms now seem incredible. Notice too that one is not entirely oriented here by cognitive knowing; by following the techniques and methods of his predecessors and peers a scientist gets also a "know how" to do, as well as a "know that" something is so, so that there are tacit as well as explicit elements in our control by a paradigm. As Thomas S. Kuhn argues, a paradigm is a "disciplinary matrix" as well as a theoretical viewpoint.

Religious paradigms are found prominently in creedal affirmations—for example, that Jesus Christ is fully human, fully divine, one person; that God is love; that persons are made in the image of God (the divine character of the person); that an immortal soul resides in the body; that God predestines all; that Israel is a chosen people; that God (Allah) is, and Muhammad is his messenger; that the *ātman* (inmost self) is Brahman, the divine Absolute; that the conventional world *(samsāra)* is illusory *(māyā);* that the mundane world *(samsāra)* is the transmundane world *(nirvāna)* upon enlightenment; and that, short of enlightenment, a law of moral causation *(karma)* operates by which persons are reincarnated from life to life. Here again, a paradigm is not merely cognitive but carries a kind of skill at judgment, some tacit knowledge of how to work with it, from it. Some examples of paradigms in religion that have been entirely abandoned or seriously questioned by modern persons include animism and polytheism, the six-day creation, the fall of an original couple and the subsequent biological transmission of that original sin, the demon-possession theory of disease, the three-story universe (heaven above, earth, hell beneath), medieval accounts of purgation and indulgences, and (much revised if not abandoned) the verbal inerrancy of the Bible.

Pervasive and Persuasive Characteristics of Paradigms

A good paradigm has a maplike character in that reality is selected and represented through it so as to fit into a kind of basic picture: Newtonian mechanism portrays the world as a great machine; Darwinian evolutionary survival of the fittest portrays the world primarily as a jungle; behaviorism sees life-environment interactions as stimuli and responses; physics views protons, electrons, and photons as both waves and particles. God is a Father, Shepherd, and Creator. Jesus is the normative person. The Church is the body of Christ. Persons get "lost" and "saved." Life in the common world is driven by "thirst" *(tanhā);* essentially this world is a realm of "suffering" *(duhkha)* that is "empty" *(śūnya),* with one's fortunes in it the result of deeds *(karma)* in present or past lives. Imagery is present alike in science and in religion, and to become aware of the representational or symbolic character here is

to realize that these critical affirmations are maps rather than exact pictures of reality. Maps and models organize reality; they are never passive containers for experience, but they actively help us find organization in reality just because they abstract its structures. They tell us what to look for, what to discount, and what to make of what we find; and in this sense they are proposals as well as discoveries.

In this sense, while the outcome of an experiment does not depend on the mental states of those who conduct it, the setup of an experiment, what outcomes are arranged for, does depend on the mental states (the theories) of the experimenters. Arrangements can and should be made for outcomes that falsify or verify our theories, and there are surprises, outcomes that we do not expect or understand. All the same, only those sorts of outcomes can happen that we have advertently or inadvertently arranged for. We never catch black holes, DNA molecules, neurotransmitters, or tectonic plates unless there is, preceding the catch, a mental state that goes looking for them. We catch patterns with a frame of mind.

"If I hadn't believed it, I wouldn't have seen it." Physicists spent decades looking for the neutrino. After repeated failures, they prepared extremely elaborate experiments (sixteen tons of scintillating liquid, 144 photomultiplier tubes, electronic apparatus 120 feet long) finally to catch it—inferring it from rare flashes of certain kinds amidst thousands of other flashes, arranged for with hundreds of thousands of dollars' worth of equipment, all taken two miles underground in a South African gold mine.[12]

On the other hand, when physicists got a theory that suggested that they look for positrons, they looked back to discover that positrons had been appearing for years in cloud chamber photographs and ignored as an anomaly. One can't see what one isn't looking for, even though the evidence is amply present. Often, what we find ourselves looking *at* depends on what we are looking *for* and *with.*

As a paradigm proves to have high deployability it increasingly permeates all that we see, and thus a widely inclusive paradigm has a very low negotiability. We have faith in it. Like a creed, it has a categorical element in practice, although it is in principle a hypothesis. The belief that every event has a necessary and sufficient set of causes is virtually nondebatable, by some of its holders, as the basic assumption of all science. The precise status of this belief—whether it is an a priori claim, an empirical discovery, or a methodological hypothesis—is difficult to uncover. Recent physics has especially had to trouble over it, but scientists find it impossible to work without assuming that it is true sufficiently for the purposes of their research. The paradigm of evolution has rapidly become so entrenched that by its means biologists, geologists, anthropologists, and astronomers explain the origin of species, life, society, landscapes, Earth, matter, and even the universe. In biological phases of evolution, the principle of natural selection has so come to govern accounts of why things happened as they did that adduced counterexamples are likely to be reinterpreted with auxiliary hypotheses protecting the principle that only the fittest survive.

Gestalts, Anomalies, and "Bliks"

This pervasive and persuasive tenacity of a good paradigm raises the fear that they sometimes come to be held "no matter what" and thus degenerate into an ideology

or a "blik"—a presupposition with which we view experience, spectacles through which all data will be viewed, with adjustments only in ad hoc hypotheses that are rigged for the sole purpose of saving the theory from refractory facts, and that actually insulate the theory from experience.[13] This is perhaps allied with a law in gestalt theory by which viewers tend to complete a pattern regardless of whether it is completed in the observed reality. Hence, a source of error in theology and in science is a tendency to see causes and meanings, first in ranges of experience where they are readily found, and later to project them onto places where they are missing or incomplete. The theory that begins as a synthetic judgment about the world can get subtly transformed into an analytic prejudgment brought to the world, so that variant experience can no longer transform the theory but rather the theory transforms the experience. A blik is a theory grown arrogant, too hard to be softened by experience.

A humorous illustration is provided by the case of the deluded patient who complains to his physician, "Doctor, I'm dead." The doctor tries to assure him otherwise, with little success, and eventually exclaims in exasperation, "Well, dead men don't bleed, do they?" The patient agrees, "No, they don't." Whereupon the doctor jabs the patient's finger with a needle. As the blood trickles out, the patient sighs, "O.K. I was wrong! Dead men do bleed!" Actual instances of the power of a paradigm are more serious. After rejecting his earlier years in communism, Arthur Koestler reflected over its hold on him: "My Party education had equipped my mind with such elaborate shock-absorbing buffers and elastic defenses that everything seen and heard became automatically transformed to fit the preconceived pattern."[14] Reflecting on an earlier dominance of Freudian ideas in her psychoanalytic theory, Karen Horney recalled how "the system of theories which Freud has gradually developed is so consistent that when one is once entrenched in them it is difficult to make observations unbiased by his way of thinking."[15]

In the judgment of many critics this conversion of a paradigm into an ideological prejudgment happens notoriously in religious belief. Belief in God begins in experience, perhaps that of goodness in creation, or of the numinous, or of sin and salvation; but it thereafter becomes transformed into a blik, which is held by introducing ad hoc revisions so as to allow no evidence to contradict the theory. All good paradigms are self-serving, no doubt, but the trouble arises when they brainwash us. Still, in less fanatical religion criticism is as much encouraged as it is in science and often is as telling. In both fields doubts arise as a result of experience, and these doubts are the first steps toward revised and improved theories and creeds.

We do have an innate thirst to complete an explanation, and our tendency to hold on to available explanations and to press them as far as possible is as often fruitful as it is misleading. What one wants and expects in a fecund paradigmatic theory is massive explanatory power, a capacity to be deployed into ever-widening ranges of experience. A good paradigm can eat up and digest its competitors, and often absorbs and continues the explanatory power that opposing accounts once had. The paradox of a paradigm, whether in science or in religion, is that the better it is, the longer it survives, the more its resilience, the closer we probably are to the truth, and the more we ought to hang on to it, because it is to be expected that the nearer we are to the truth, the harder a theory will be to overthrow. The ultimate

theory will, of course, be unfalsifiable anywhere in practice, because it is entirely true! But just this element of trust that is well justified makes it harder to get a wedge of doubt in, to seek truth in unlikely directions, and to face up to an epistemic crisis. There is a sense in which one needs both to seek disconfirmations and to distrust them.

One does need ever to beware of an ideology, that is, having one's logic (*logos*) so controlled by a form (idea) as to be oblivious of empirical and experiential input, so that this input is neither supportive nor constitutive of the theory, nor any longer able to reform it. The first part of being reasonable is to hold on to whatever logic you have, conserving a tradition, entering a paradigm, appreciating the best sense that can be made of the phenomena to this point. One keeps an inherited truth so long as it yields clarity without arrogance. The second part, more chaotic and threatening, is to know when to give up the old, to launch into the new. One needs to be able to recognize the kind of exception to a rule that signals the end of the rule. This is the hardest part, because there is no precedent for it, so far as it is a genuinely creative step, although of course unprecedented steps have often been taken in the past.

The operation of paradigms is usefully, but oversimply, illustrated by the young lady-old hag reversible drawing (Figure 1.2). Viewers do not see, except by artificial straining, just black and white lines and patches, hard data, but they see now a young

Figure 1.2 Lady-Hag reversible drawing

lady and again an old hag; and whether a certain line is a necklace or a mouth, or another is a nose or a chin, depends upon the gestalt. The viewer does not just "see" particulars; she "sees as" these are governed by the gestalt. In physics an electron can be seen as a wave or a particle. In biochemistry the conduct of a hunting coyote can be interpreted mechanistically or teleologically. Behavioristic psychology sees the self in a stimulus-response pattern; humanistic psychology sees the inwardness of a centered, creative self. Sometimes these paradigms are complementary, as is suggested by the reversible drawing here, but sometimes they are not. When burning came to be seen as oxidation, the phlogiston theory had to be abandoned. When astronomers came to see the movements of the planets as Copernican theory does, those orbits could no longer be seen as Ptolemaic theory had seen them. On a broader scale, science and religion provide variant grids by which the world can be mapped, but how far they are complementary and how far incommensurable is not easily discovered.

Some of the subjectivity in the example considered here is offset by remembering that the acceptance of a paradigm is collective, not just individual, and that a paradigm is much argued over, sifted through, and tested out, depending not just on what one perceives but on one's capacity to persuade others and to retain community allegiance. A paradigm is intersubjective and must command a community. The example is also too static, in that drawings have no dynamism. Theories and creeds grow and mature, and these epistemic gestalts replace one another in historical succession, so that we have in reality not a frozen picture but a motion picture, a story, a living narrative alike in the development of science and religion. Older theory and creed are sometimes dissolved, judged incoherent, and forgotten, but they are sometimes reallocated and retained under a transformed gestalt. Thus, the past in science and in religion is partly discounted and partly recounted as an earlier, juvenile chapter in an ongoing narrative now become more sophisticated.

The major religious systems offer diverse creeds through which the significance of life in the world may be viewed. But in attempting to appreciate them there is often considerable, if not insurmountable, difficulty in making that gestalt switch which occurs so easily in the lady-hag drawing. This difference arises because the viewing sensitivities of beholders depend on their behavior, experience, and character. Further, these gestalts may overlap in part but be ultimately incommensurable. The Theravada Buddhist and the Christian concur in seeing life as something sacred and to be reverenced, but they disagree over whether to see the world as the creation of a personal Cod or as a fluid matrix of dependent origination.

The complexity of gaining and defending a religious view can be suggested by another drawing, that of a black-and-white Rorschach picture that contains hidden the figure of a bearded man somewhat like traditional pictures of Jesus (Figure 1.3). The viewer may have to study the picture to detect this pattern, and even then will puzzle over whether it is really there or just an illusion. Still, when one has seen it, the portrait tends to govern what one sees there afterward. Christians are able to see the mystical presence of Jesus hidden in certain ranges of experience, while unbelievers often cannot make sense of the same ranges of experience, or see them under some other paradigm. The gestalt with the hidden

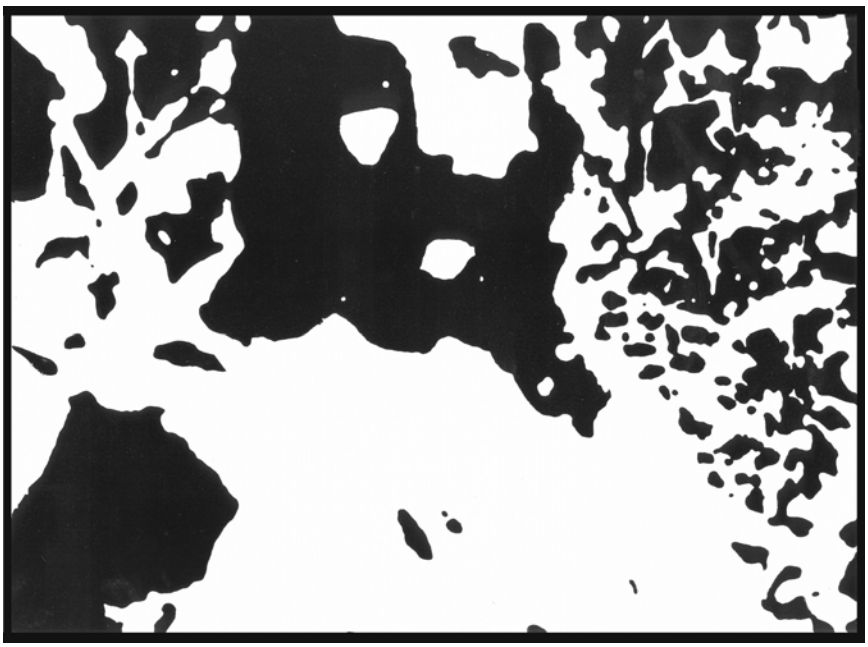

Figure 1.3 The Jesus gestalt

Christ figure here is ambiguous and easily dismissed, but in actual Christian life this hidden presence is often not so easily discounted. It is as though by moral and spiritual experience one's resolving power in the drawing could be sharpened, intense and sharper, so that the believer and unbeliever still could see the same gross shapes but attach different weights and intensities to them. Thus, the believer would find more confirmation, while the unbeliever might remain puzzled before equivocal experience. What one is willing to tolerate as static or noise—the meaningless blotches in the background—depends greatly on developed sensitivities. This points up the participatory nature of religion, increased over that in science, which later we have to examine.

In paleoanthropology many anthropoid skulls, which are often partial or in fragments requiring much construction, have been recovered. The brain capacity of these fossil skulls increases with geological time (Figure 1.4). This tends to support the prevailing view that human intelligence evolved out of prehuman forms, through several stages of *Australopithecus* (gracile, robust, and perhaps habiline), with a brain capacity of about 500 cc, reaching *Pithecanthropus,* about 1,000 cc, and later Neanderthal man, 1,500 cc, more or less. But there is one anomalous skull, known as ER-1470, which is removed from the rest, with much greater cranial capacity than the theory allows. What an anthropologist, using his best judgment across all the data, has to decide is what sort of flier, fluke, or hoax ER-1470 is and whether revision in the main theory is called for.

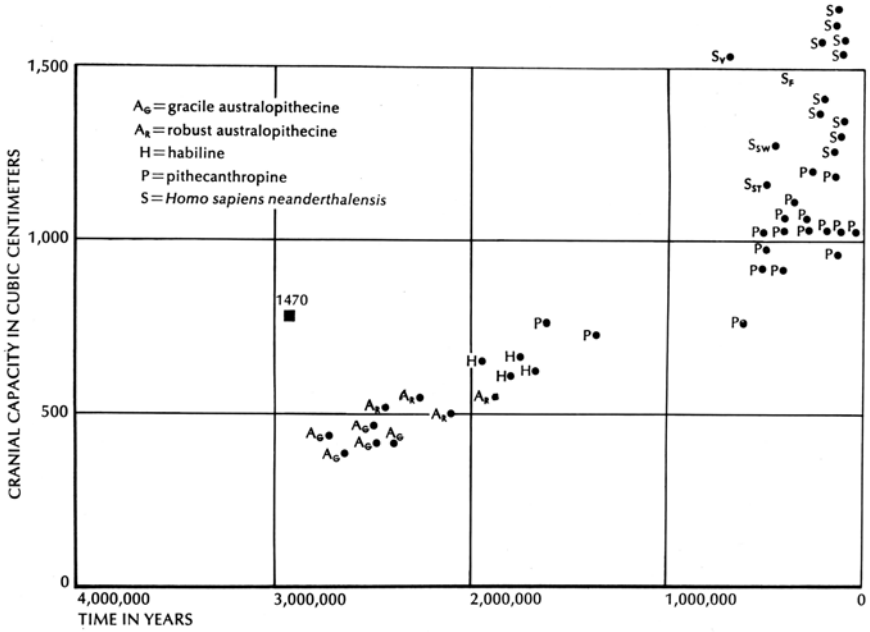

Figure 1.4 Evolution based on cranial capacities (Adapted from J. B. Birdsell, *Human Evolution,* 2d ed. [Chicago: Rand McNally & Co., 1975], p. 337)

In the gospel accounts hundreds of deeds and sayings of Jesus are preserved, written down some years afterward. To some extent these were reshaped by the mind of the early church; to some extent they faithfully portray the historical Jesus. In the Christian mind these portraits warrant viewing him as a perfect human, and Jesus has been a principal, if not the principal, ideal of moral and spiritual character in the Western world. There is also surviving in the gospels an odd story in which Jesus, traveling into Jerusalem while staying at nearby Bethany, sees from a distance a fig tree, precociously leafed out. He reaches it to find it barren, and, although it is not yet the season for figs, curses it for the lack of fruit. As he passes that way later, the blasted fig tree has withered.[16]

On the face of it, and magical elements aside, this conduct seems intemperate; and what the Christian, using her best judgment across all the gospel data, has to decide is whether the normative ideal is a paradigm read into, or out of, the actual historical character of Jesus, whether this account of cursing the fig tree calls merely for an auxiliary hypothesis (such as that Jesus used the tree as an object lesson to condemn the fruitlessness of Israel) or for revision of the main claim that Jesus lived an ideal life, the anomaly surviving as a relic of a churlish side of Jesus' character, glossed over in the prevailing paradigm. In science and in religion alike, one needs to attend to all the appropriate facts, but the sifting of these into the most credible paradigm is never easy. Sometimes it requires the wise neglect of awkward facts, and sometimes those awkward facts that are initially dismissed later prove so serious as to overthrow the theory.

3. OBJECTIVITY AND INVOLVEMENT

Science and religion both exist only as processes in persons. Although nature and God may be out there, science and religion alike are an informing of the subject—personal knowledge. Even if their respective theories and facts are in some degree objective knowledge, representing the real world, they are inescapably also subjective knowledge, information acquired, achieved, and processed by human subjects. The knower is never less present than is the known, since knowing is a relationship. A little reflection here will check the facile assumption that science is or ought to be entirely an objective discipline while religion is altogether a subjective one, an opinion usually ventured by persons flailing religion. It may also warn us to be cautious in divorcing the activity of scientists, who are persons as subject to involvements as anyone else, from the structure of their science, at least until one has seen how far the latter can be factored out of the former. A participatory element is always present in science, although it is true that this element significantly deepens as the nature of the inquiry becomes religious.

No discipline, certainly not science, can proceed without truth telling, and this at once introduces ethical demands. Not only must the investigator tell the truth, but also he depends on the honesty of colleagues and predecessors, since he can personally verify only the thousandth part of what he knows. Researchers occasionally forge or color their reports, and if such dishonesty is not soon detected it often proves seriously disruptive, as with the Piltdown hoax in anthropology. A scientist trusts in the integrity of a community of scholars, and a decision about truth here is rather rarely by replication of experiments but ordinarily comes by judgments about whom to trust. That the world is round, or that a hydrogen atom contains one electron and one proton, or that time dilates with increased velocity, or that the sporophytes of cryptogams are diploid—these are facts in principle verifiable by work with firsthand data, but, since time and talents are limited, they are routinely believed as communicated by the honesty of others.

Dedication and Universal Intent

We speak of a dedicated scientist as we do of a dedicated saint. Being a good scientist is not merely an occupation, it is a calling. Although conscientiousness in the two differs in important respects, which will appear later, there is in both a commitment to an inquiry as genuinely worthwhile and as profitable enough to warrant the sacrifices that are required to pursue it. The pure scientist operates at a level of involvement unreached by those with applied concerns; like the saint, she is so devoted as enormously to invest the self in her discipline. No major accomplishments in either science or religion have been made without commitment.

Einstein remarked that science is driven by "passion" no less than are the humanistic pursuits.[17] This passion ought to enhance the capacity for judgment rather than to prejudice it. It is a passion at a level of involvement advanced from those with applied concerns for human welfare; it is a passion for truth intrinsic in the subject matter. All good scholars so love their disciplines as to hate error in them, especially as contributed by partisan bias. Like a judge who is intensely interested

in justice and just so disinterested before disputants, every intellectual needs disinterest fed by concern.

Scientist and theologian alike seek what is called universal intent, a setting aside of private interests so as to promote the single-minded discovery of public truth, what is true at large and for all persons.[18] It is odd to speak of "my science," yet permissible to speak of "my religion," owing to ranges of involvement that we will soon trace. But both scientist and theologian are humans making their way around in the world, and their self-understanding is hooked into their disciplines. It is appropriate to speak of a professor of science, equally with a professor of religion, and mean by that one who values the integrity of his discipline and pledges his life against the truth witnessed to by it. The witness of either professor is personally backed but moves toward public truth. All of the classical faiths would find it deviant for "my religion" to mean a faith intended for myself alone. Their truth is preached for all. Good religion shares with science an interest in truth independent of one's personal stake in it. It is equally bad in either area to start so proving one's private beliefs to others that this defense becomes primary, for then the discovery of a better theory for myself and for others is thwarted. Such willingness to submerge one's own achievements in the advancing tide of knowledge requires a steady humility on the part of theologian and scientist alike. Any who ask which discipline is the most troubled by dogmatism will find the question difficult to answer, and perhaps will conclude only that arrogant self-confidence is becoming in neither. A bare self-interest has to be overcome, the self's concerns aligned with this ultimate truth, which is in this sense objective or universally intersubjective.

Science and theology alike are designed to correct anthropocentric error by inferring how things are in nature or in ultimate reality independently of the peculiarities of our sensory and cognitive faculties. Yet the knower always enters into her descriptions and cannot escape her framework. We cannot think without paradigms, and yet we hope to submit to the facts, do this what it may to our models. Just this willingness to set the compulsion of the truth above a compelling paradigm prevents the latter from becoming an ideology; it enables our paradigms, self-serving as they are, to be self-correcting. Only devotion to truth can accomplish this; and so a willingness not only to give of oneself but to give up one's preconceptions and illusions for the sake of the truth—a determination to hear the whole truth and nothing but the truth, come what may, cost what it may—is as characteristic of good theology as it is of good science. The reforming spirit in theology is just this insistence that a person must not get in the way of the truth, must not bias it, but hear it sensitively and entirely.

Informed Judgment and Decision

The foregoing virtues perhaps can be assigned to the climate in which the scientist works, and thus they are a part of his larger methodology shared with other scholars. But it might be contended that these have little to do with the content of his knowledge. Honesty, truth, commitment, selflessness, and humility in the scientist facilitate the inception and teaching of science, but they do not belong to the finished product that science delivers. They belong to the psychological matrix of

science but not to its logical structures. Even this makes them indispensable, but there are, we must notice, some areas where the immediate scientific judgments have an inescapable personal coefficient.

Like religion, science can be communicated only to those who are subjectively prepared, that is, willing and able, to receive its claims. It can be appreciated only by those who value it, and this requires a joining of and an education into a skilled community. Science has its logic, often an impressively rigorous one, but that logic is simply not available without sustained study, critical interaction, and this is both psychologically and logically costly. Science is not so much objectively as it is intersubjectively testable, replicable only by those who live and work into its particular fields with achievements adequate for judgments there. This is a matter not only of access to a field but also of ongoing functioning within it, of depending on a community that can understand and criticize one's work. Only occasionally can a scientist work individually; usually she needs collegial interaction and even closely coupled teamwork. In science and in religion this dependence on a community differs in ways we soon will specify (there are confessional elements in religion as well as professional ones), but there remains in common an element of personal qualification derived from a corporate education.

The criteria commonly given for assessing a theory are the extent of its agreement with experience, its internal consistency, its simplicity, its elegance, its deployability or interconnectedness with allied fields, its fruitfulness or productivity, its testability or predictive power, and the degree to which it provides a satisfying sense of explanation. In the application of these criteria a considerable degree of argument is appropriate, and in the metric sciences this may be of a computational kind. Some theories are eventually rather well settled into, but appraisal of even the simplest laws and theories always includes a scientist's larger judgment of what can safely be left out in evaluating a particular natural phenomenon. On the cutting edge of science when assessing rival theories, as well as at the philosophical frontier as these theories become more cosmic, perceptive judgment is required no less than conceptual clarity and factual accuracy.

Just how good is the evidence for natural selection as the sole editing factor in evolution? Is the big-bang theory of the origin of the universe now more credible than the steady-state theory? Why did dinosaurs become extinct? *Stegosaurus* had enormous bony plates along its back, and the theory demands some survival value for these. But were they for defense, to make the animal appear more fierce, or to protect against actual attack, or cooling fins, or used in courtship, or some combination of these, or by serendipity first one and then another? Are no acquired characters ever genetically transmitted, or is there enough evidence that they sometimes are, as Trofim Denisovich Lysenko has maintained? Does the evidence for extrasensory perception warrant further investment of research funds there? Just how simple is behaviorism, and is it too simple to be satisfying? Is Sigmund Freud right that monotheism is a projection of the father figure? Has science found causal connections often enough to demonstrate that the apparent randomness in nature is only apparent? Whatever psychological dimensions may operate in decisions here, there are also logical dimensions involved. Max Weber's thesis on the relationship between Protestantism and the rise of capitalism is a distinguished contribution to

social science, and it can be empirically supported, but its overall adequacy is very complex to assess.

The answers come as they do to a judge appraising justice, to an ethicist gauging morality, to a theologian testing a religious creed—by a mingling of argument, of weighting of facts, of notions of plausibility, and even by intuitions that yield an informed judgment. Science is decision-laden; one simply cannot do it without grading. Further, the grading is not algorithmic. It is judgmental, and in this respect often draws near to the sort of grading that goes on in religion, considerably exceeding mere observational checking and computing therefrom.

Observer Involvement in Science and Religion

Against the older notions of the researcher as a mere spectator, recent science recognizes the observer's active contribution. The scientist selects what to study and how to study it. Whenever he builds laboratories, sets up experiments, isolates phenomena, or brings theories to direct observations, he is constructing the nets with which he fishes, and his catch is partly a function of his net. In every controlled experiment we tamper with what we observe, even the controls. These factors can partly be compensated for, as with the rat's differing responses to stimuli in the cage and in the field, but they are never eliminated. The more rigorously we probe nature, the more we increase this distorting manipulation. Are we creating the bizarre array of elementary particles that come out of our high-energy accelerators? Do they exist naturally or only as artifacts? Organic molecules have been artificially synthesized in the laboratory by passing electric discharges through selected gases, but how nearly does this reproduce the environment on Earth under which life might have originated? This is how a certain biochemical reaction proceeds in vitro, but is this the whole story in vivo? Existing reptiles can be shown to be less intelligent than mammals, but were the dinosaurs less intelligent than those earliest mammals that replaced them?

To some it seems that astronomers only watch, but even the optical telescope selects the visible range of light as befits the eye or film, and so astronomers have invented instruments to discover other ranges of radiation. What they choose to investigate and how they interpret it in terms of their cosmological theories depends heavily on the manipulations accomplished in the laboratories of physics. What we "see" is a red shift of a spectral line (the Doppler effect), a sight already arranged for by a theory. What we conclude, on the basis of much further theory, is that the universe is expanding. Observation is always a relationship, and this does not cease to be true as science vastly enlarges the range of sentient experience. Whatever is known must come through to us in terms of perceptual equipment that we naturally own as this can be aided by an apparatus that we have created, in terms of cognitive capacities that we may think up within the parameters of our neurological structures. What we are looking for hooks around, often unbeknown to us, to become what we are looking with. So it is not merely the initial selection of a problem in which the scientist is involved; she remains involved in the reception of all information and in the ongoing construction of her instruments and theories of attack.

The simplistic notion that science ought to be entirely a neutral discipline,

contrasting with the involvements of religion, distorts what we must now try to see more accurately—how the two fields can be brought into contrast at vital points, which have to do with their essential paradigms, their particular logic, and their extremes. But at intermediate points and in underlying rationality these contrasts can dissolve into similarities, though never without some insoluble residues of difference. The natural sciences deal with a dimension of experience that can be characterized as empirical, while religion, beyond any account of the phenomenal world, deals further with a dimension that can be characterized as existential, moral, spiritual. Natural science can treat things as objects, while religion must reckon as well with subjectivity where it is present.

In this respect the human sciences are problematic. The controversies in psychology that surround a science of the mind, beyond behavioral science, show this tendency of science toward outwardness, and Émile Durkheim's first rule of sociological method is that we must consider social facts as things to be observed like natural facts. So far as these sciences are empirical, they can continue to treat human phenomena objectively. When a psychologist, sociologist, or anthropologist wishes to get into the mind-sets of those studied—for indeed humans cannot be otherwise fully understood—what is inward has somehow, by empathic appreciation, to be laid out for public access. Still the social scientist is an onlooker even where he is an in-looker; he converts his subjects into an object of study, but he does not, qua social scientist, ask of himself the inner questions of subjective experience.

Religion asks about good and evil, about guilt and redemption, about love, justice, and holiness, about the values of the subject in its objective world, and it judges these to be the ultimate or deepest ranges of experience, beside which the empirical explanations of the sciences are penultimate or even superficial. In the natural processes that the physical and biological sciences investigate, most of these issues do not ordinarily appear. So far as they do, as for instance when an evolutionist asks whether the elimination of the less fit is bad, the question cannot be solved with those tools with which the scientist does her empirical work, and so proves to be a nonscientific question. These issues can become, descriptively, subject matter for the social sciences, but when they do science becomes more participatory. The instruments of observation are empathetically constructed; a subject appraises another subject, whom she treats as an object; and the results of even a supposedly descriptive inquiry are increasingly loaded with interpretive categories that demand introspective feeling for their appreciation.

Here the scientist is a member of the class that she observes, at least generically. Yet a scientist proposes to work on an observable other, and to eliminate the consequences of her work for her own experiencing "I." This is sound methodology so far as it achieves universal intent by suppressing personal stakes. Though perhaps selecting for study what promises to be relevant and beneficial, the chemist can neutrally study covalent bonding, or the meteorologist cold fronts, for these are at much distance. But no human scientist has such remoteness from his object, for in the last analysis he is experimenting on himself. Psychology has psychiatry as its cousin; all the human sciences become helping sciences, broadly therapeutic. When physiology and psychology describe normal human conduct or functioning, they are not far from normative conduct, ethics. The line between an "is" and "ought" can

be drawn and ought to be drawn, but it proves semipermeable. Ethnology is never far from ethics; nor is human ecology. Like physicians, human scientists mix scientific detachment with a deep concern for the patient. So far as there comes with them any concern for human welfare, they not only describe the normal but also expect to have relevance in normative prescriptions. Thus, science may be value-free at the physical end of the spectrum, but at the humanistic end it courts values it cannot itself provide.

On any occasions where prescriptions are offered, some values must be superadded to empirical data, and science has moved over to the participatory level of religion. Reformatory elements begin to appear, and in religion reformation of the person is a primary goal. Religion is accordingly less hypothetical and more categorical than is some science, since the latter can have less nearness, be less imperative, and therefore be more negotiable. Religion is thus to be trusted in, while science is sometimes more lightly believed. But some sciences operate in areas where convictions are not tentatively held, as those find who investigate whether some races are lower in intelligence or who propose genetic experiments to enhance human genius.

Science stays hard, that is, objective, proportionately as it stays empirical, and in all the sciences—physical, biological, and social—one can isolate out elements of strict science. Are there special brain centers for the emotions, others for reasoning? But so far as the issues are observational, they are proportionately superficial, piecemeal bits of analysis that form technical science, technical because it is experimental and manipulatory. It does not demean this impressive technical element to see it for no more than it is and as but instrumental to deeper human concerns. In this technical domain scientific assertions can be put outwardly and impersonally, contrasting with the way that religious assertions require also inwardness and personality for their comprehension.

Science becomes soft, that is, participatory and subjective, as it nears the experiential beyond experimental dimensions. Are humans more emotionally driven than rationally guided? At length, religion is participatory in ways that science never reaches. How best do we use our emotional capacity to love? To what world view does it seem most worthwhile and reasonable to give my allegiance? Here science *has* a way of truth; religion *is* a way of truth. In science one knows "about" the object; religion removes that "about" to know with more intimacy.

Here the judge must be up to what she judges; that is, the character conditions are more demanding. Aesthetic achievement or sensitivity is required of the music or art critic in a way not needed in the chemist or even the sociologist. Moral experience is required in the counselor, a sense of justice of the judge. Spiritual qualification is required of the theologian, involving talent at levels not demanded of the physicist qua physicist. Only the pure in heart can see God. Every discipline requires its relevant sensitivity; and learning and thinking in the biophysical arid social sciences, so far as they operate empirically, are simpler morally, aesthetically, and spiritually, however complex a causal logic may be used, than these are in religion. Proportionately as truths become more significant, combining cosmic with personal importance, they require more sensitivity for their reception. One cannot verify merely by painstaking observation or imaginative construction what has been discovered and confirmed by passion, sacrifice, faith, and suffering. This relative

restriction of science to empirical levels and to descriptive, technical logic partly explains why, among those competent to judge, there can be broader intersubjective agreement in science than in religion. Sometimes it even seems that the elusiveness of an answer is in proportion to the importance of the question!

The danger of such sensitive involvement lies in slipping into a no-lose setup, where negative results prove the observer is out of tune with his object of study, while positive results prove that the observer is in tune with it, and right! One must carefully allow place for being both in tune and critical enough to hear falsity. Meanwhile, no one can judge with competence any enterprise with which she is not competently and seriously engaged, because the absolutely crucial thing about any scientific or theological inquiry is that it be controlled by the reality that it intends to study, and this demands adequate engagement with it, adequate receptivity and sensitivity. Religious thinkers too attempt to be "scientific," that is, systematically to scrutinize their beliefs for their consistency, simplicity, deployability, for adequately explanatory accounts, for practicality in and congruence with experience. Needless to say, this requires a specific method adequate to the subject matter, and this cannot always be scientific in the positivistic sense but may demand instead considerable existential involvement.

To be objective is not in most cases to be neutral or indifferent; nor does it prohibit the holding of previously gained, presently owned, presumed beliefs. Objectivity requires only that one be willing and anxious to test convictions against experience and logic, and to reform them accordingly. Those who are prepared to accept such criticisms do not hold convictions subjectively, that is, only from within a private subjectivity. They own no bliks, but they look to be informed and reformed from without; they seek external involvement in correcting their judgments. We began this section tracing how both science and religion are, in one sense, subjective knowledge; we can close it by noticing that they intend also to be, in a further sense, objective knowledge.

4. SCIENTIFIC AND RELIGIOUS LOGIC

Causes and Meanings

Science and religion share the conviction that the world is intelligible, susceptible to being logically understood, but they delineate this under different paradigms. In the cleanest cases we can say that science operates with the presumption that there are causes to things, religion with the presumption that there are meanings to things. Meanings and causes have in common a concept of order, but the type of order differs. "Cause" has proved a difficult notion to explicate. Some scientists have tried to reduce it to, or to substitute for it, bare functions between variables. But most scientists find it difficult to escape the conviction that the variables are efficaciously connected. In a stretched sense, or in loose everyday use, cause refers to any contributing factor in an explanation (as with Aristotle's four causes), and it may include deliberations, reasons, and even meanings. But in science cause is restricted

to outward, empirically observable constant conjunctions, attended by an elusive notion of necessary production of consequent results by the preceding spatiotemporal events. Where causes are known, prediction is possible, and an effect is commonly thought explained if its causes are known, especially if it is subsumed under a covering law (as with gravitation, thermodynamics, or natural selection), that law giving a certain logic to the process. It does little explanatory work to refer *x* to the class *X,* and to notice that *x* produces *y* because all x's regularly produce y's, when we do not understand those other productions either; we have only gotten used to them. So law alone, although it permits deductive prediction, provides only the beginning of illumination, which further requires some intelligibility past regularity in the relationship between cause and effect.

"Meaning" is the perceived inner significance of something, again a murky but crucial notion. Occasional apprehension of meanings does not constitute a religion, any more than occasional recognition of causes constitutes a science. But where meanings are methodically detected out of a covering model, which is thought to represent an ultimate structure in reality, one has some sort of religion or one of its metaphysical cousins in philosophy. Science holds that causality runs deep in the nature of things; religion holds that what is highest in value runs deepest in the nature of things. It may be objected that one can search for meanings without being religious. This has not often been true historically in any broad sense, for, until the twentieth century, cultures, so far as they were systems of meaning, have been everywhere interwoven with religion.

More recently, under the impact of science some humanists and existentialists have held that meaning is merely a human construct, nonreligiously selected, since the world itself neither offers nor bears any meaning structures. It remains to be seen, in view of the contemporary problem of meaninglessness, how viable these latter accounts are and whether any culture can be sustained on them; but here perhaps one has the anomaly of systematic nonreligious meaning. However, if meaning is thought to be given in the world structure, or to be had in dialectical relationship with the natural order, or to evolve as a sacred cultural emergent, then one has a religion, though perhaps a new immanentist or naturalistic one rather than a classical supernaturalistic or transcendentalist one. Relative to the distinction between cause and meaning, it may be said that science answers how questions and religion answers why questions; but these words, while suggestive, are not reliable indicators of syntax and the kind of explanation sought.

Social scientists and psychologists are disagreed as to whether their sciences are ever sciences of meanings, and the puzzle as to how far human subjects can be causally understood has left the human sciences unsettled. Rigorous behaviorists insist that psychology is entirely a causal science, while humanistic psychologists seek to understand personality as a function of meaning. Social scientists find that causes operate in human affairs; there are causes of inflation, war, revolution, depression, suicide, birth and death rates, environmental crises, etc., and these causes operate comprehensively, including overriding or negating what the members of a society may mean and intend. At the same time no society is entirely understood without appreciating its meaning structures as these interlock with the causal factors that constrain it. Meaning structures too can be understood in terms of a governing

model out of which conduct follows. Given a certain meaning model (M), a certain pattern of conduct (O) will be observed (if M, then O), and thus meaning models, no less than causal law, can be embraced under the sort of logical inquiry we have here been tracing. They too have their regular operations and predictable dynamics. We have already maintained that creeds and theologies can be studied in this way. Although social scientists or psychologists may inquire what meanings other persons have and how these function in their lives, they do not use—the majority will insist—their sciences to discover meanings for themselves. These sciences may describe the meanings that others have, but they do not prescribe what meanings scientists themselves ought to have. The scientist may find meanings in his subjects and make these his object of study, but he does not, with his science, find meanings in the world structure or cultural structure and make these life-orienting. Whenever one undertakes this latter task, one has passed over into the province of religion and its cognate fields—ethics, comparative religion, the humanities, philosophy. Thus, in the human sciences we find an overlap between science and religion, but so far as there is disputed ground this is because we know what the master paradigms in the two fields are—that science is a study of causes and religion is an inquiry into meanings.

Negotiability and Compatibility of Causes and Meanings

Each master paradigm is virtually nonnegotiable, a dogma within that discipline. These paradigms arise out of experience, for the scientist has found many causal connections, while the saint has discovered much of significance. Such realized causality and meaningfulness are universalized into the beliefs that everything is causally sequential and that all events are meaningfully interpretable, and with this they become presumptions brought to experience as well as derivations from it. In modern science this yields a universe of precise law, which persons can successfully study and profitably manipulate. In modern religion this yields a universe that has cumulative meaningfulness, coming to focus in God, the Absolute, or a divinity of the natural whole.

These dispositions to interpret things causally and also meaningfully are built into the deep structures of the mind, and we have to some degree an innate psychological drive to find things intelligible. But neither the causality found by science nor the significance found by religion is to be dismissed as merely psychological, for these also are present as logical structures in the mind. The mind has evolved as a natural fit in response to the environment in which life occurs. What an individual mind brings innately to the world recapitulates the edited genetic experience of this species.

There is some temptation to say here that causal relations are "really there," discovered, objective, but that meanings are invented, subjective, only "in us." A truth in this is that causal relations, after we have recognized how they are subject to our mental structures and constructions, may be outwardly reviewed for their constant conjunctions, while meanings appear as the subject is experientially related to her world. But, again subject to value structures provided by the mind, it would be anomalous if humans had evolved their enormous innate thirst for meaning in

life in a world where life is a natural event but where all these investings of life's relations with meaning in the world (for example, those of love and hate, fear and joy, birth and death, of beauty and fruitfulness, of work and parenting) were inappropriate and superficial. In this case all those appearances of language as it seems to lodge meanings in things and relationships would in fact be deceiving and refer in a hidden way only to the psychic state of the user of such language, a state that was disjoined from his biological origins. This might be so, but any argument strong enough to prove it is likely also to carry the implication, with Immanuel Kant, that causes as well as meanings are nothing but compositions of the mind. Until such argument prevails, it is simpler to hold that causes are experienced in the world and that meanings, however self-involving, are sometimes given, often relational, even if on occasion created *ex nihilo* in the mind.

It is perhaps true that disciplined science can abstract out bare causes, devoid of any meaning; but this is a very sophisticated, high-level analysis, only recently accomplished in the intellectual life of humankind. The real world of nature and culture in which we live is one in which we meet facts, values, disvalues in fusion; they come at us together. It seems natural to say that we meet and find both causes and meanings there. The gut nature of living on, surviving, makes the world a field of values and disvalues, never neutral to the pursuit of life; and at this point it becomes artificial to leave by analysis the causes objectively there and wrench the meanings out of it as a subjective appearance or fabrication. What is given, what is protocol, is not naked sense data, not bare constant conjunctions, but a milieu of events, with causes and meanings in-mixed, sought and found, made and coming at us, opportunities, a world we have to move through and to evaluate.

Can either discipline tolerate anomalies? Yes, but both will so minimize the exceptions that their respective gestalts still govern. A pathologist may search without success across decades for the causes of a baffling disease, but she will not conclude that the disease is uncaused; a psychiatrist is likewise likely to insist that every mental disease has in fact some cause. A monotheist may admit frankly that he finds some events meaningless, although he also may believe that even these have some divine purpose, which he cannot now find. Quantum mechanics has come to permit the possibility that there is some genuine indeterminacy in subatomic nature. So far as evil prevents the assignment of meanings, its presence has always troubled theism.

Randomness on the one hand and absurdity on the other do challenge these paradigms but are allowed only when effectively overridden by a statistical causality or a net meaningfulness that does not interrupt a larger intelligibility. By some accounts this reduces these paradigms to regulative maxims. The scientist proceeds in the effort to find all the causes she can; the theologian will pursue meanings as far as he can. Neither must then claim that her or his procedure will in every case be successful. But both are still prone to think of their procedures as appropriate because the world is constructed so as amply, if not universally, to bear relations of causality and of meaningfulness.

The warfare between science and theology is often a struggle to clarify to what extent causal explanations are compatible with or antagonistic to meaning explanations. Particular disputes may result in adjusted claims about the territory occupied

by each account. While no one denies that each field commands some territory of its own and that there is partial complementarity, are they always commensurable? Some kinds of causal accounts, for example, the competitive survival of the fittest, do seem to inhibit some kinds of meaning accounts, such as that every species was divinely designed at an initial, sudden creation. Some causal explanations show some meaning explanations to be inaccurate, inadequate, or irrelevant. But if these are really different tracks of explanation, how can they compete as they sometimes do? Science, by redescribing nature, places constraints on what concepts of God are credible, even though science by this redescription prescribes nothing about God's existence. It sets limits within which meaning accounts can work.

Does the presence of sacred meanings in the world require any tearing in the weft of causes and effects, any perforation of the natural by a supernatural order? Does the meaning account sometimes constrain the causal, as when the experience of autonomy and moral responsibility seems to demand that persons be something more than effects predetermined by antecedent causes and stimuli? If there is randomness that proves causally baffling, inexplicable by science, does this imperfection correlate with the absurd in religion? Or can an account be reached whereby such causal looseness provides just that novelty and unfinished openness to nature and to life that religion can enjoy? Experience that is counted puzzling under the one paradigm may prove intelligible under the other.

Differing Kinds of Logic

The causal paradigm favors a computational logic, whether inductive or deductive (at least for routine science, though perhaps not for revolutionary science), while the meaning paradigm involves an intelligibility that is more holistic. Causes go into linear networks, which often permit a quantifying theoretical overlay measuring with numbers such things as wavelengths and stimulus-response correlations, although we should not forget that those numbers, which look so accurate and objective, even with their margins of error, are in the case of scientific measurement always the product of a theoretical overlay on nature and never purely natural computations at all. The validity of such quantifying depends on the quality of the overlay.

Even nonmetric science is prone to taxonomic serial catalogs and phylogenetic chains, the steps of which can be isolated for analysis. This brings a particular occurrence or individual under a covering law or type. Such repeatability and parallelism are not always found or verified by either induction or deduction, and just what counts as patterns similar enough to warrant their inclusion under the same law is always a matter of some discretion. But the causal character presumed here sometimes permits to science a level of rationality and thus of testability different from that in religion, a step-by-step checking that can be summed up into near-compulsory argument.

Religious meanings are not integrative in this scalar way. When set in their gestalt, the particulars give rise to meaning. In detecting more sophisticated patterns, as when, despite her aging, we recognize the face of a friend whom we have not seen for decades, there is a subtle interplay of textural features by which the whole is constituted. This sort of logic is present in science when a geologist

recognizes the facies of rock strata, or when a dendrologist notices the differences between the bark of spruce and that of fir. But it looms much larger as one approaches the perception of meaning in a novel, such as *Gone with the Wind,* or in a historical career, as of Abraham Lincoln. One must join earlier and later significances in ways more qualitative than quantitative, more dramatic than linear. The sense of scenic scope is more crucial than that of incremental detail, hence the nonmetric character of religion.

Pattern statements differ from detail statements, alike in science and religion, but in some science it is easier to go from detail statements to pattern statements, owing to the metric-causal character. The holographic character of meaning models is not merely sequential with the chronology of life but requires more cross-play and interweaving, a logical network sometimes said to be more characteristic of the right than of the left cerebral hemisphere, more characteristic of the brain in general than of a computer. But this remains in the if-then mode, for even in the analysis of gestalts one says such things, to recall the reversible drawing, as "If that is a young woman, then this is a necklace and that an ear. But if it is a hag, then this is a mouth and that an eye."

The finding of meanings is not as simple as is identifying unvarying conjunctions. Those unique, nonrepeatable factors present in each occasion can often be integrated into its meaningfulness, while in subsuming an event under causal law these are irrelevant. The *Victory of Samothrace* instances certain universal forms of grace, strength, and flair, found also in other great sculptures. However, its aesthetic value is not constituted in abstracting these but rather just as these are indissolubly particularized in the individual integrity of one historical statue. There are recurrent religious meanings, as when persons rediscover the significance of forgiveness or of sacrificial love, but each occasion instantiating this will be cherished not only for its generality but also for its particularity.

There are various modes of interest of the human mind, not all of them either scientific or religious. Science and religion share a theoretical mode of interest. Both want to operate out of a model or theory, a plot or a pattern, that gives a universal intelligibility to what is observed in particular episodes. But science has little interest in particulars for their particularity after they have been included as instances of a universal type. It has little interest, for instance, in proper names as essential to its content. But religion retains its interest in particulars both for their constitutive power in enriching the universal model and as loci of value. It is thus full of proper names, no less than of creedal models.

Because of this inclusion of particulars in the composition of meanings, religion can tolerate the presence of surprise more than can science. The history of science is beset with surprises, of course. But real surprises are quite upsetting to prevailing theory, for scientific models must be specifically extensible in advance to all forthcoming phenomena, and any incapacity to predict is unnerving. Religion is less inclined to predict, less insistent on similarity of cases; rather, it waits to see, after the fact, whether its paradigm can extend to cover these surprises, whether if the theory is true then a novel observation can be seen by retrodiction to follow from it. Neither the causal flow nor the meaning flow is reversible in fact. Yet causal accounts are projectable in thought symmetrically forward and backward (remem-

bering, however, the logically troublesome status of induction). The admission of the singular existent implies that a meaning account cannot always, on the basis of recalled experience, limit its expectations as to what will and will not be absorbable into its creeds. In this sense a religious theory has an openness beside which a scientific theory is closed.

One does not always have to say in advance exactly what would refute one's theory, for that requires too much prophetic power; but one must *be* willing to examine each new bit of evidence as it comes along with widening ranges of human experience. A Christian judges Jesus, the Christ, to be the key to meaningful life in the world by perceiving in him the normative expression of a life style of agape. The claim follows that the agape life will always be found meaningful, but one is not able to say, in prospect, just what will count as a context for agape. Such contexts are too idiographic, although one can say, in retrospect, whether those meanings launched in Jesus have been continued as embodied in the historical particularity of each disciple's life. Here one has to judge the cumulative effect of severally inconclusive and partial verifications, which are woven not to prove but to corroborate a creed.

One can deduce only in a looser logic of weak connections. One can know out of his theory something of the possibilities that the future may hold, but he cannot make the watertight predictions that a positivist will insist that the hypothetico-deductive model requires. But to know, out of one's theory, something of the possibilities is already to know something, just as to know probabilities is already to know much, although it is not to know everything. Neither science nor religion arrives at certainties. They at best predict probabilities, but religion is looser here than is science and often can predict only a range of possibilities. Still, there is a logic to it, a model out of which one can derive the oncoming particulars and a symbolic system that functions as a regulatory model, albeit a noncausal one, into which the events of life are fitted (composing and recomposing this creed) and out of which they are interpreted.

Thus, the hypothetico-deductive method in religion does not employ the narrower sense of "deduce" that science sometimes uses. Although a new event cannot be entirely foreseen from the theory, that event, when it does occur, does follow and unfold from the theory, while some other events may not. From the first half of a play we cannot predict just how the second half will proceed, although as it proceeds we have a gathering sense of how the several events fit into an overall plot. We reason back down from the general to the particular, more broadly deriving from the paradigmatic plot what episodes may be allowed to constitute it. Thus, the dramatic plot is testable against unfolding experience. But this testability is not a stringent one. There is no single logically necessary deduction from what has gone before, although certain events can, and others cannot, be significantly emplaced in the scheme. Even in science this may occur, as in evolutionary theory, where later specific developments in their novelty cannot be unequivocably forecast, although after they occur they may be examined as to whether they are consistent with the theory.

Given that science remains causal, leaving off any assignment of meanings, it is a value-free enterprise, while religion is a valuational one. This is not a simple

matter, however, because there is a spectrum of meanings attached to value and to neutrality. Science, as we have noticed, shares certain pervasive values with religion, such as those of truth and critical inquiry. In science one makes judgments about good instruments or research. One operates on the presumption that science itself is good, either instrumentally or intrinsically or both. But where science is confined to causal accounts, it never prescribes life values, for these lie in the realm of meanings.

Science is not, as is sometimes thought, merely instrumental to value, for intrinsic science does redescribe the world for us. The descriptions here cannot be ignored, for such discoveries as the age and extent of the universe, the evolution of life and its biochemical nature, the human neurophysiological structures, or the electronic character of matter have forced theology to reform earlier accounts of meanings. Persons always shape their values in some correspondence with what they believe the world to be actually like. But these descriptions never constitute prescriptions, however much they may force a reconstituting of them. In this sense religion is fully operational, completely functional in joining theory with practice, as science is not, for religion has its own value setup, which permits the translation of principles into conduct, while any scientific system is parasitic on some value system before it can become operational in life. Religion, however, is not so operational that it can ignore what science reveals about the character of the world and of life.

An older form of this claim is that science seeks knowledge, but the spiritual quest is for wisdom.[19] Knowledge and wisdom are neither coextensive nor mutually exclusive, but they overlap. In part, but only in part, a person remains naive and unwise until she has integrated the best available knowledge from the current sciences into her world view. Still, such knowledge is not sufficient for wisdom, for no accumulation of causal explanations can ever produce the significance of a thing. The latter comes at another level of insight. In this sense, science explains but religion reveals; science informs, but religion reforms.

It is often said that science operates in an I-It mode, that of experience, while religion proceeds in dialogical encounter, the I-Thou mode. This distinction is founded on the biting difference, noticed daily, between dealing with persons and things.[20] This dichotomy recognizes the outward objectivity of science, where an "I" describes "things" in their causal relations and manipulates them as a result. In religion this "operational I" is replaced by a "relational I" that answers to the world and constitutes meanings in exchange with it. Demands flow to the "I" as well as proceed from it, for the existential "I" is called forth by that which is known. The subject has gone out to its object, which is no longer bare object, but is itself a subject, that is, a source of prescription to me. Wisdom appears in this intersubjective encounter, while the objective mode can provide only descriptive knowledge. So the notion of subjectivity loses some of its unwanted flavor, and the word "operational," often favorably linked with objectivity, becomes annoying so far as it is manipulative. The unilateral operator is ill fitted to hear the address of another or to respond to its worth.

Monotheism, moreover, detects the divine as a depth presence, an "Eternal Thou" in, with, and beyond the sacramental, superficial objectivity of the phenomenal world. This detection is comprehensively extended from the way in which we

detect other minds in the behavior of human bodies. That sense of divine address is more elusively present in Eastern religions, but what is present is a depth engagement of the sacred so gripping as to draw forth the entire person, a meeting of the world at its inciting ground such that the whole self is called to respond, nearer like my relation with a "Thou" than with an "It." Further, though, theism and monism aside, meanings may arise where we attach no "Thou-hood" to this gripping other, as in encounters with nature or in aesthetics.

Some accounts find religion to be less linguistic and thus less logical than science. This may be taken by critics as a vice, but it also may be taken by proponents as a virtue, that religion plunges to deeper levels than the conventional ones of science. This latter position is not without merit, for the religious object, God, if it exists, is incomparably greater than any routine scientific object, such as rocks, fish, or atoms. Logic and language may have evolved, and be evolving, best to fit the mundane, phenomenal world, and they may ill fit the transmundane, noumenal world. Sometimes in the West and often in the East, mystics cultivate noncognitive states supposed to transcend all logic and language.

We do not need entirely to dismiss such claims to recognize that nevertheless logic and language enter steadily and decisively into religion, just as fully as they do into science. Interpersonal Thou relationships are hardly less linguistic than experiences of an It; if anything, they are more so. The discovery of meanings, which humanizes us, requires language no less than the discovery of causes. If meanings are more resistant to language than are causes, if they have nonverbal dimensions, that may indicate that the intelligibility that religion seeks requires a richer logic than the scientific sort. If all created things derive an intelligibility from their Creator, then the phenomenal world is a product of the noumenal Logos and sacramentally points to it. The prescription of values takes more, not less, thinking than does the description of events. Possibly our religion outruns our rational capacities further than does science, but, whatever consequently is the place occupied by mystical moments, these do not constitute the whole of religion; nor can they stand alone. All the classical faiths have their speechless moments, but they all have their supporting scriptures, creeds, arguments, and education.

The immediate experience of God, Brahman, or *nirvāna* always proves on examination to be quite as theory-laden as are any of the protocol data of the sciences. This does not disparage the intensity or firsthand directness of such experience; it only insists that there is a logic that leads up to and unfolds out of it. In this sense "God," "Brahman," and *"nirvāna"* are postulates, inferential theoretical entities used to explain what underlies the world and certain marvelous encounters had within it. The personalness in religion does not prevent its being logical.

It is logically and empirically possible that religious knowledge would come by occasional interruption of an otherwise regular world order, by fluke and visitation, unprecedented, unrepeatable, not amenable to methodological study of even the theological sort, much less the scientific sort, proposed here. This could be not only in the context of discovery, which could well be nonpredictable, charismatic, mutational, revelational, but even in the context of verification. Revelation, miracles, oracles once confirmed could never again be reconfirmed, but would ever after have to be taken on sheer faith. But this would be an odd sort of knowledge, one that had no carry-forward features, with no way it could be shown to be true, reasonable,

probable, repeatable in experience. Such knowledge would be just true, inserted once for all into historical time. Whatever elements of this kind one can find in the classical religions, those faiths have also claimed that their truths could, in some measure, be verified in life, tested out in each new generation, seen to work again and again, despite the once-for-all character of the launching visitation.

Self-implicating Meanings

Meanings are always self-implicating. Values are by definition those things that make a difference. This might be thought to bias a person's capacities for logic in religion. One cannot think clearly about what one is wrapped up in. But the other side of this is that one will not think at all about that for which one does not care, or rightly think about that for which one does not rightly care. This caring becomes more self-reforming as the inquiry passes from the scientific to the humanistic to the religious. The task of religion is to examine that self in its relationships with the world, unmasking illusions and false cares, reforming it from self-centeredness, centering it on that which is of ultimate worth. This is worship, produced out of and returning to reflection. This worship, conceived as the self's disengagement from private concerns and engagement with the absolute, is precisely that universal intent that makes logic possible. Only such enthusiasm, or divine inspiriting, can get the self off-centered enough to reason aright.

The religious judgment is that the self must be reformed in order to eliminate its tendency toward rationalizing, and it is just this positive combination of worship and reflection that makes possible an unbiased rationality. Religion shares with science then a concern for objective rationality, only it knows far better than science that the path to true objectivity lies through subjective reformation. This passion makes for genius. Religion is the science of the spirit, where a rationality suited for objects is inadequate. Here the reflective scientist will not say that he comes to nature without assumptions, despising the theologian as being overcome with them. But he will see that, so far as his selection employs empirical causation as his fishing net, he has a different set of assumptions; and he may even wonder whether just these assumptions might prevent him from receiving the data of religion in an undistorted form.

Perhaps some will complain that the account here has dealt too much with religion as a means of *copying* reality, with correspondence in truth, and too little with religion as a means of *coping* with reality, with its instrumental functions in life. So we readily grant that religion is a means of coping. But that is just as true of science, which is driven by the need to cope with reality not less than to copy it. Like different sorts of maps, both help us to get around in the world (supply a "method") because each in its own way represents that world ("follows after it") more or less faithfully.

NOTES

1. Compare Carl G. Hempel, *Philosophy of Natural Science* (Englewood Cliffs, N.J.: Prentice-Hall, 1966).

2. See Richard Anschütz's account, "August Kekulé," in *Great Chemists,* ed. Eduard Farber (New York: Interscience Publishers, 1961), pp. 697-702.
3. Fred Hoyle, *Encounter with the Future* (New York: Trident Press, 1965), p. 93.
4. Dimitri Marianoff, *Einstein: An Intimate Study of a Great Man* (Garden City, N.Y.: Doubleday, Doran & Co., 1944), p. 68; Gerald Holton, "Constructing a Theory: Einstein's Model," *American Scholar* 48 (1979): 309-40).
5. Lubert Stryer, *Biochemistry* (San Francisco: W. H. Freeman & Co., 1975), pp. 327-28.
6. Stephen Jay Gould, "Darwin's Middle Road," *Natural History* 88, no. 10 (December 1979): 27-31.
7. Karl R. Popper, *The Logic of Scientific Discovery* (New York: Harper and Row, Harper Torchbooks, 1965).
8. Tested and statistically verified in research by Jack D. Jernigan and Steven L. Nock, reported in "Religiosity and Family Stability: Do Families That Pray Together Stay Together?", paper presented at the Society for the Scientific Study of Religion, Knoxville, Tenn., November 6, 1983.
9. Further claims involve the inconsistency and meaninglessness of this world *(samsāra),* and such a paradigm of world unintelligibility is difficult to test.
10. Norwood R. Hanson, *Patterns of Discovery* (Cambridge: Cambridge University Press, 1958); Michael Polanyi, *Personal Knowledge* (New York: Harper and Row, Harper Torchbooks, 1964).
11. Thomas S. Kuhn, *The Structure of Scientific Revolutions,* 2nd ed. (Chicago: University of Chicago Press, 1970). For the continuing and often unsettled debates about what constitutes scientific method and its logic, see also Imre Lakatos and Alan Musgrave, eds., *Criticism and the Growth of Knowledge* (Cambridge: Cambridge University Press, 1970); Stephen Toulmin, *Human Understanding,* vol. 1 (Princeton: Princeton University Press, 1972); Larry Laudan, *Progress and Its Problems* (Berkeley: University of California Press, 1977); Paul Feyerabend, *Against Method* (London: NLB Verso Editions, 1975). For the relevance of the debate about scientific explanation to religious explanation, see Ian G. Barbour, *Myths, Models, and Paradigms* (New York: Harper and Row, 1974), and his *Issues in Science and Religion* (New York: Harper and Row, 1971). Critical issues here include whether and how far new paradigms are continuous with or incommensurable with older paradigms, what are the criteria for paradigm choice, the degree to which standards of rationality are controlled by the paradigm, and whether paradigms are to be given a realist or an instrumentalist interpretation.
12. See the story in George Gale, *Theory of Science* (New York: McGraw-Hill, 1979), pp. 169-90, 278-85.
13. R. M. Hare, "Theology and Falsification," in *New Essays in Philosophical Theology,* ed. Antony Flew and Alasdair Maclntyre (New York: Macmillan, 1955), pp. 99-103.
14. Arthur Koestler et al., *The God that Failed,* ed. Richard Grossman (New York; Harper and Row, Harper Colophon Books, 1963), p. 60.
15. Karen Horney, *New Ways in Psychoanalysis* (New York. W. W. Norton & Co., 1939), pp. 7-8.
16. Mark 11:12-25; Matt. 21:18-22.
17. Albert Einstein, "On the Generalized Theory of Gravitation," *Scientific American* 182, no. 4 (April 1950): 13-17, citation on p. 13.
18. Polanyi, *Personal Knowledge,* p. 65.
19. Augustine, *The Trinity,* 12-13.
20. Following Martin Buber, *I and Thou,* trans. Walter Kaufmann (New York: Charles Scribner's Sons, 1970).