

EVOLUTION, THEOLOGY, AND METHOD PART 1: OUTLINE AND LIMITS OF SCIENTIFIC METHODOLOGY

FERNANDO CANALE
Andrews University

Introduction

During the last 150 years, evolutionary theory has become the standard theoretical explanation for the origins of life and the center of a new cosmology that other sciences dogmatically assume when developing research methods and interpretations of reality. Christian theology, as a scientific enterprise, is no exception to this rule. Evolution dismisses divine creation as nonscientific myth. To avoid this charge, theologians have proposed various versions of theistic evolution and harmonization. Thus, the challenge theologians must contend with is whether the only choices available to them are mythological faith or scientific truth. Further, it is necessary to consider whether a belief in creation necessarily entails a sacrifice of the intellect.

The creation-evolution debate, including the theological attempt at harmonization, generally takes place at the level of conclusion without taking into account the nature of the processes through which theologians and scientists arrive at their respective beliefs. This indicates that the problem is not about faith (i.e., religious experience) and science, but about the differences between two scientific enterprises—Christian theology and the empirical sciences. The process through which science arrives at its conclusions is complex. This article will attempt to present a brief discussion of the main structures and characteristics of science and theology in order to facilitate interdisciplinary dialogue and to help the church gain a realistic perspective of the present intellectual situation.

Therefore, this article will not be an analysis of the teachings of evolution and creation, but rather the rational processes that led to their formulations.¹ My goals in part 1 of this series are to examine how human beings arrive at conclusions and at truth and to examine in what way the Bible serves as the foundation of truth.² This will be done by providing

¹This approach belongs to philosophical research in the area of epistemology and hermeneutics.

²These questions were suggested to me by the organizing committee of the *International Faith and Science Conference* sponsored by the General Conference of Seventh-day Adventists, Ogden, Utah, August 23-29, 2002.

an introduction to the complex matrix of human rationality and the scientific method involved in the conception and formulation of theological and scientific teachings.

I will assess the relationship between evolution and theology from a methodological perspective by outlining the rational basis and structure of the scientific method. This will be done in several steps. First, in part 1, we will examine the pattern through which knowledge is generated and the general structure of method. On this basis, we will reflect on the need to demythologize science. Next, we will analyze the basic outline of the empirical scientific method and consider its outcomes. Finally, we will examine some postmodern criticisms to scientific methodology. In part 2, I will explore the role that the scientific method plays in the construction of evolutionary theory. Part 3 will address the relationship between evolution and theology.

Relational Pattern in Knowledge Formation

We will begin by analyzing the process through which theological and scientific ideas are formed. Thus, we must examine how human reason functions.³ We are used to thinking about concrete objects that we see or imagine through constructive models. However, there is another element in the process of thought—what we do when we think, i.e., how we come to understand something. Scientific and theological methods are founded on particular approaches to and definitions of understanding. Thus, it is necessary to understand how scientists and theologians come to a particular methodological approach to knowledge (reason).

Reason as Subject-Object Relationship

All cognitive activities spring from the subject-object relationship, which functions as the foundational cognitive unit. Because knowledge always takes place as a subject-object relationship, this structural unit is at the heart of experience formation.⁴ Experience, then, takes place between a cognitive subject (human being) and a cognitive object (whatever falls within the intentional consciousness of human beings). Because both theological and scientific knowledge fall within the realm of experience, they take place within this unit. Further, these types of knowledge are formalized, i.e., carefully organized, which helps to differentiate these

³I use the term “reason” in a wide sense to include all human cognitive activities.

⁴Nicolai Hartmann, *Grundzüge einer Metaphysik der Erkenntnis* (Berlin: De Gruyter, 1941), 1.5.a.1; 5.1.1.a; see also Fernando Luis Canale, *A Criticism of Theological Reason: Time and Timelessness as Primordial Presuppositions*, Andrews University Seminary Doctoral Dissertation Series, vol. 10 (Berrien Springs: Andrews University Press, 1983), 27-34.

types of knowledge from common knowledge. The process of knowledge, then, takes place when the human mind directs itself to an object.

The Levels of Operation of Reason

In the generation of human knowledge, the subject-object pattern of reason operates in three distinct but interdependent levels: sensory perception, the intellect, and reasoning.⁵ Sensory perception allows for information to be received from realities outside the human mind. The intellect then forms from this information general concepts that allow humans to be able to communicate. Reasoning searches for unity and coherence among all information received and conceptualizations produced by the previous two operations. The scientific method builds on these basic rational operations, which are the basis of observation, testability (sensory perception), generalizations, hypothesis, law (intellect), and theory (reasoning).

Immanuel Kant described the organizing drive of human reason (third operation). He argued that notions and concepts are organized around three guiding centers or ideas. From lesser to greater reach, they are human nature, the world, and God.⁶ Kant describes the function of these ideas as “regulative.”⁷ These “regulative” ideas arrange cognitions “into a system, that is to say, to give them connection according to a principle. This unity presupposes an idea—the idea of the form of a whole (of cognition), preceding the determinate cognition of the parts, and containing the conditions which determine à priori to every part its place and relation to the other parts of the whole system.”⁸

What Kant called “regulative” ideas, i.e., the ideas of human being, world, and God, I designate macro-hermeneutical presuppositions.⁹ Kant

⁵Aristotle and Kant recognized these levels, but interpreted them in different ways. Aristotle’s views are known as intellectualism and were used by classical philosophers and theologians; see *Posterior Analytics*, II, 19; and *Metaphysics* I, 9. Kant’s views, known as transcendental idealism, became influential in modern times. He believed that “all our knowledge begins with sense, proceeds thence to understanding, and ends with reason, beyond which nothing higher can be discovered in the human mind for elaborating the matter of intuition and subjecting it to the highest unity of thought” (*Critique of Pure Reason*, trans. J. M. D. Meiklejohn [Buffalo, NY: Prometheus, 1990], 189).

⁶Kant, 209, states: “It follows that all transcendental ideas arrange themselves in three classes, the first of which contains the absolute (unconditioned) unity of the thinking subject, the second the absolute unity of the series of the conditions of a phenomenon, the third the absolute unity of the condition of all objects of thought in general.”

⁷Ibid., 360.

⁸Ibid., 361.

⁹Hans Küng divides the field of theological interpretation into three separate categories: macro- (the study and classification of philosophical issues”), meso- (issue or doctrinal

was correct in his identification of the ideas and their unifying and systematic roles in human reasoning. Due to his modern context, however, Kant was not able to perceive that these ideas can be interpreted in different ways and therefore can render different results when applied as regulative principles. In other words, different interpretations of these ideas will produce different rational arrangements of the systematic whole of human knowledge.

Modernity and Objective Reason

Throughout history, philosophers have debated about how the relative function of the subject and object should be understood. Classical and modern scientific thinking gave priority to the object by assuming that the subject passively receives input from its objects. This emphasis defined the notion of scientific objectivity as excluding all contributions from the cognitive subject.

Richard Rorty describes the classical and modern interpretations of the functioning of scientific knowledge as foundationalism, the notion that the truth of our propositions is determined by "privileged relations to objects those propositions are about." Thus, truth is solely determined by "compulsion from the object known."¹⁰ The myth of science, as rendering absolute certain knowledge, builds on the foundationalist understanding of knowledge.¹¹ On the other hand, German idealism went to the other side, giving maximum priority to the thinking subject, who is supposed to create its own objects of thinking.

However, postmodernity has brought significant changes in definition to the subject-object relation. During the twentieth century, developments in philosophical hermeneutics¹² and the philosophy of science showed that all

interpretation"), and micro- (textual interpretation) models (*Theology for the Third Millennium: An Ecumenical View*, trans. Peter Heinegg [New York: Doubleday, 1988], 134).

¹⁰Richard Rorty, *The Mirror of Nature*, 2d ed. (Princeton: Princeton University Press, 1979), 159.

¹¹For the "myth" of science, see "Demythologizing Science" below.

¹²"Philosophical Hermeneutics" is the term for the philosophical discipline which studies the human phenomenon of interpretation. Hermeneutics is closely related to epistemology in that both study the way human knowledge (reason) functions. The disciplinary difference between the two seems to be related to their objects. The former studies how we understand historical phenomena. The latter studies how we understand natural phenomena. For an introduction to the historical development of philosophical hermeneutics, see Raúl Kerbs, "Sobre el desarrollo de la hermenéutica," *Analogía Filosófica*, 2 (1999): 3-33. For an introduction to the issues studied by philosophical hermeneutics, see Josef Bleicher, *Contemporary Hermeneutics: Hermeneutics as Method, Philosophy and Critique* (Boston: Routledge & Kegan Paul, 1980); and Hans-Georg Gadamer, *Philosophical*

knowledge results from contributions made by both the object and the subject,¹³ both of which perform active and passive roles.

The debate between classical-modern and hermeneutical approaches over the action of the subject and object is particularly notable in regard to the creation-evolution debate. Those who continue to assume the classical-modern notion of objectivity have been profoundly challenged by the development of postmodern philosophical hermeneutics.

Postmodernity and Hermeneutical Reason

Hermeneutical reason can be summarized as “to know is to interpret.”¹⁴ Contrary to common belief, this does not mean total relativism, but only the reinterpretation of the meaning of objectivity. Even though hermeneutical reason recognizes the input from the subject’s prior experience in the formation of knowledge, it also recognizes the decisive contribution of the real object to which the subject’s mind is addressed.

In correspondence with the subject-object relation discussed above, classical-modern objectivism assumes the existence of an “absolute universal truth” independent from the subject’s contribution. The hermeneutical approach, by way of contrast, allows for conflicting interpretations of knowledge. Therefore, because human reason produces conflicting interpretations, the hermeneutical approach is better able to deal with the problem of the subject-object pattern of knowledge formation than the classical-modern approach.

Conflict of Rational Interpretations

By making the rationality of conflicting interpretations possible, this epoch-making shift does not solve the creation-evolution debate, but

Hermeneutics, trans. David E. Linge (Berkeley: University of California Press, 1976).

¹³See, for instance, Hans-Georg Gadamer, *Truth and Method*, trans. Joel Weinsheimer and Donald G. Marshall, 2d rev. ed. (New York: Continuum, 1989); and Paul Feyerabend, *Against Method*, 3d ed. (London: Verso, 1993), 51.

¹⁴David Tracy explains the universality of interpretation in the following way: “Interpretation seems a minor matter, but it is not. Every time we act, deliberate, judge, understand, or even experience, we are interpreting. To understand at all is to interpret. To act well is to interpret a situation demanding some action and to interpret a correct strategy for that action. To experience in other than a purely passive sense (a sense less than human) is to interpret; and to be ‘experienced’ is to have become a good interpreter. Interpretation is thus a question as unavoidable, finally, as experience, understanding, deliberation, judgment, decision, and action. To be human is to act reflectively, to decide deliberately, to understand intelligently, to experience fully. Whether we know it or not, to be human is to be a skilled interpreter” (*Plurality and Ambiguity: Hermeneutics, Religion, Hope* [San Francisco: Harper & Row, 1987], 9).

places it on different footing. The classical-modern view of reason excludes the possibility of conflicting rational interpretations; only one rational explanation is possible. Classical and modern guidelines, which are generally assumed in the creation-evolution debate, force contenders to dismiss the opposing view as rationally impossible. This is because, as discussed above, the postmodern hermeneutical view of knowledge formation allows for the existence of more than one rational explanation of the same issue thereby creating a conflict of interpretations not preempted by rational demands. This does not, however, imply that both conclusions are "true." Thus, objectivity still reigns in postmodern hermeneutical reason. While conflicting interpretations are not ruled out as "irrational," the assumption is that only one can be true. Recognizing the limitations and historical dynamic of the process of knowledge formation, hermeneutical reason admits that it is not always possible to identify the "true" interpretation. Postmodern hermeneutics does not force contenders to dismiss opposing views as rationally impossible. Thus, theologians are not forced to seek harmonization between creation and evolution on rational grounds. Therefore, method might be able to achieve what cognitive capabilities cannot. It may be possible that the correct scientific approach will produce enough certitude to help theologians decide between creation and evolution.

What is Method?

Before turning to theological and scientific methodology, an acquaintance with the inner structure of method in general is needed.¹⁵ This will help to organize our thoughts on theological and scientific methodologies and to retrieve relevant information from studies in the fields of epistemology,¹⁶ the philosophy of science,¹⁷ and theological prolegomena relevant to the creation-evolution debate. These studies assume the existence of science and attempt to describe its function and to evaluate its grounds and claims.¹⁸

José Ferrater Mora suggests that method "follow[s] a certain 'way,'

¹⁵For a brief introduction to the notion of method, see my "Interdisciplinary Method in Christian Theology? In Search of a Working Proposal," *Neue Zeitschrift für Systematische Theologie und Religionsphilosophie* 43 (2001): 366-389.

¹⁶"Epistemology" is the name of the discipline that studies the foundations on which scientific knowledge builds. For an introduction to epistemology, see Rorty.

¹⁷"Philosophy of Science" is the name of the philosophical discipline that studies the disciplinary matrix of scientific activities. This discipline includes a general approach to science, as well as specific approaches to each discipline.

¹⁸This approach was pioneered by Immanuel Kant late in the eighteenth century. In his *Critique of Pure Reason*, he studied the claims of mathematics, physics, and metaphysics.

ὁδός, in order to reach a certain goal.”¹⁹ This general and simple description uncovers one of the most distinctive characteristics of method: action. If method is the path we follow in order to reach a goal, its essential characteristic is activity.²⁰ As activity, method is repetitive and has conditions. Thus, repetition is essential to the notion of method and repeated experimentation using the same method should render similar results. Less recognized, however, is the fact that conditions are also essential to the notion of method. Thus, methodic activity is conditioned by the concrete goal(s) it attempts to reach, the data it requires, and the ideas it assumes in processing the data and reaching its goals. The goals of method are its teleological condition, the data its material condition, and the ideas it assumes are its hermeneutical condition. The concrete profiles of theological and scientific methods become shaped by the interaction of all the conditions.

In this way, method includes in its essence the major epistemological issues that need to be considered when asking how theologians and scientists arrive at their conclusions. Familiarity with issues such as the origin of reliable information (from the perspective of the object), interpretation of the data (from the perspective of the subject), and the validity of conclusions and the truth of a belief (from both the perspective of the object and the subject), will help us to better understand and evaluate the debate between creation and evolution.

Any analysis of concrete philosophical, scientific, or theological methodologies should account for the conditions on which they build their conclusions. In the case of evolution, the reliability of its conclusions is specifically connected to the assumed trustworthiness of its method. The importance of method in theology is also paramount because it defines the overall direction, content, and teachings of particular theological schools and religious communities in a decisive manner.

Seventh-day Adventists, for instance, address the creation-evolution

¹⁹José Ferrater Mora, *Diccionario de Filosofía*, 5th ed., 2 vols. (Buenos Aires: Editorial Sudamericana, 1965), s.v. “method.”

²⁰Bernard Lonergan correctly describes method as “a normative pattern of recurrent and related operations yielding cumulative and progressive results” (*Method in Theology* [New York: Crossroad, 1979], 5). “There is method, then,” explains Lonergan, 4, “where there are distinct operations, where each operation is related to the others, where the set of relations forms a pattern, where the pattern is described as the right way of doing the job, where operations in accord with the pattern may be repeated indefinitely, and where the fruits of such repetition are not repetitious, but cumulative and progressive.” Consequently, Lonergan, 6-25, organizes his discourse on method as an identification and explanation of the operations involved in the task of doing theology. John Macquarrie agrees with Lonergan’s definition of method, but goes on to apply it in a different way to the task of theology (*Principles of Christian Theology*, 2d ed. [New York: Scribner’s, 1966], 33).

debate from personal conclusions that in many ways are dependent on studies that other theologians and scientists have made. For this reason, it is very important to consider the epistemological basis on which others have built the views we come to share or reject. The focus of this article is on the process by which theological conclusions and scientific method serve as the basis for the construction of the theory of evolution. This analysis becomes indispensable when theologians are called to think as representatives of the community of faith. It may also help to clarify the theories involved, bring an assessment of personal views on creation and evolution, and lead to understanding the way in which these relate to the entire body of Christian beliefs.

The Legend

For at least two centuries, the empirical sciences have enjoyed the unlimited prestige and authority that previously belonged to the medieval church. Due to the need for answers to perennial questions and a dissatisfaction with traditional philosophical or theological explanations, theologians have turned to science for answers. Moreover, empirical science seems to be closer to the facts than philosophy and theology; thus modern and postmodern cultures confer to it a higher reliability and authority. Popular culture willingly and uncritically accepts as true the pronouncements of a small community. Scientists have become prophets; scientific methodology has become divine inspiration. For the common man to say that something is "scientific" means that it is "true."²¹

What the general public seems to assume is that the achievements they read about in the educational pages of their newspapers and the threads they seem to perceive come from a single source and are produced by a uniform procedure. They know that biology is different from physics, which is different from geology. But these disciplines, it is assumed, arise when "the scientific way" is applied to different topics; the scientific way itself, however, remains the same.²²

The notion that science could be wrong, that it is not absolute, or that it provides alternative interpretations of the world escapes most, including many scientists and theologians.

According to Philip Kitcher, the most detailed articulation of the legend built around science has been provided "not by the practitioners but by their amanuenses in history of science, philosophy of science, and

²¹Philip Kitcher, *The Advancement of Science: Science without Legend, Objectivity without Illusions* (Oxford: Oxford University Press, 1993), 3.

²²Feyerabend, 246-247.

sociology of science.”²³ However, things have radically changed in the last fifty years or so. “Since the late 1950’s [sic] the mists have begun to fall. Legend’s luster is dimmed. While it may continue to figure in textbooks and journalistic expositions, numerous intelligent critics now view Legend as smug, uninformed, unhistorical, and analytically shallow.”²⁴

The brief description of science provided in the previous section clearly dispels the myth of scientific method. According to Laudan, however, this description of science is foundationalist, in need of criticism, and is itself a part of the legend and myth of science. It affects not only the general public, pop culture, philosophers, and theologians, but scientists themselves.²⁵ Thus, it is necessary to probe further into the operation of scientific methodology not by way of a general description, but by looking at what scientists really do when constructing their theories.

Method in the Empirical Sciences

The way in which the so-called empirical sciences arrive at their conclusions and the discovery of truth is by way of the empirical or experimental method. To say that something is “scientific” means that results are achieved through the application of the scientific method. It is necessary, then, to gain a working knowledge of the “scientific” method through which evolutionary theory has been produced. The scientific method applied in the construction of evolutionary theory is a subclass or application of the general empirical method of scientific research. Consequently, the next three sections will address the structure, conditions, outcomes, and postmodern criticism produced by philosophers of science. On this basis, we will consider how the scientific method is applied in the construction of evolutionary theory.

In the area of empirical research, philosophers of science have done a remarkable and detailed job. Particularly enlightening is the analytical

²³Kitcher, 4. A staunch defender of evolution, he speaks of “legend” rather than “myth” (4-10).

²⁴Ibid., 5.

²⁵Kitcher, 219, notes that “at the heart of Legend is an epistemology articulating the simple idea that scientific knowledge rests ultimately on observation and experiment. Much of twentieth-century philosophy, including the versions of logical empiricism that provide detailed articulations of Legend, adopts a static model of human knowledge. Abstracting from the complexities of human belief formation one conceives of an idealized knower, in possession of a body of evidence statements that represent the contribution of experience, and the project is to identify the relations that must hold among statements if some are to justify others, and thereby show how the evidential corpus warrants claims of theoretical science that may both be universal in scope and also purport to describe entities remote from sensory experience.”

and lengthy description of scientific research developed by Mario Bunge.²⁶ Because the purpose is not to describe the steps involved in scientific research but to outline the main epistemological structure on which scientific methodology operates, I will not follow Bunge's order of presentation. Instead, the analysis will be organized according to the formal conditions or components that all methodologies must include in their concrete undertakings. In so doing, I will only underline the main characteristics of empirical methodology as a preamble to understanding the "rational" status and scientific methodology of the theory of evolution. This will help to highlight the disciplinary differences that lead Christian theologians to propose the doctrine of creation and evolutionary scientists to propose the doctrine of evolution.

Both theology and science are rational scientific enterprises. The basic difference between them is not that one is rational and scientific while the other is not, but rather that both use rationality and scientific methodology from different data and both use different interpretations of the macro-hermeneutical presuppositions.

Brief Description of Scientific Methodology

As argued above, method, at its core, is an orderly activity aimed at reaching specific goals. Bunge sees method as "a procedure for handling a set of problems."²⁷ Specific sciences and problems may require different methods or procedures. When scientists speak of "scientific method" as a general designation, they usually refer not to specific disciplinary methods or procedures, but "to the whole cycle of investigation into every problem of knowledge."²⁸ Thus, the main pattern of scientific methodology may be summarized in the following activities: ask well-formulated and likely fruitful questions, devise hypotheses that are grounded and testable to answer the questions, derive logical consequences of the assumptions, design techniques to test assumptions, test the techniques for relevance and reliability, execute the tests and interpret their results, evaluate the truth claims of the assumptions and the fidelity of the techniques, determine the domains in which the assumptions and the techniques hold, and state the new problems raised by the research.²⁹

These steps take place within an established body of knowledge, from

²⁶Mario Bunge, *Scientific Research I: The Search for System* (Berlin: Springer-Verlag, 1967); and idem, *Scientific Research II: The Search for Truth* (Berlin: Springer-Verlag, 1967).

²⁷Bunge, *Scientific Research I*, 8.

²⁸Ibid.

²⁹Ibid., 9.

which scientists generate problems that require solutions. These solutions will eventually modify and/or enrich the established body of scientific knowledge, from which scientific research starts. This description points toward the need to demythologize popular notions of science, which revolve around the idea that science affirms only facts that are susceptible to the most rigorous experimentation. Although testability, e.g., experimentation, observation, remains a cornerstone of scientific methodology, it is only one of its steps. To better understand the complex nature of scientific research and the reliability and authority of its results, the conditions of research need to be briefly considered.

The Teleological Condition

The teleological condition involves the goal and subject-matter of science. The “goal” of science relates to the kind of knowledge scientific research seeks to achieve through its methodology. The “subject-matter” refers to the reality or realities scientists attempt to understand. The latter refers to content and scope; the former to form and method.

According to Bunge, “what factual science seeks is to map the patterns, i.e., laws, of various domains of fact.” In other words, scientists do not attempt to merely describe reality, but to discover its inner workings. This specific objective shows that empirical science is not a cosmography, i.e., detailed mapping of its events, but “a cosmology, i.e., a reconstruction of the objective patterns of events, both actual and possible, whereby their understanding and forecast—hence their technological control—is made possible.”³⁰ Kitcher explains that “scientific investigation aims to disclose the general principles that govern the workings of the universe. These principles are not intended just to summarize what select groups of humans have witnessed. Natural science is not just natural history. It is vastly more ambitious. Science offers us laws that are supposed to hold universally, and it advances claims about things that are beyond our power to observe.”³¹ Bunge summarizes: “In short, there is no science proper unless the scientific method is applied to the attainment of the goal of science: the building of theoretical images of reality, and essentially of its web of laws. Scientific research is, in short, the search for pattern.”³²

The beginnings of science can be traced back to Greek philosophy. In modern times, with the advent of empiricism and modernity, the empirical

³⁰Ibid., 28.

³¹Philip Kitcher, *Abusing Science: The Case against Creationism* (Cambridge: MIT Press, 1982), 33.

³²Bunge, *Scientific Research I*, 28.

sciences began a steady process of independence from philosophy. However, independence has never been complete. Science still depends on philosophical ideas and produces philosophical constructions. This becomes clearer when we consider the hermeneutical condition of method and when we reflect on the teleological condition or aim of science. As discussed earlier, the ultimate end of empirical science is to build a cosmology (or worldview). This was exactly the way in which Greek philosophy began and what still forms the goal of metaphysics and ontology. The difference between philosophy and science, then, is one of method rather than aim. This is important to bear in mind as we deal with the conflict of interpretations between creation and evolution.

By way of its method, science attempts to “reconstruct” reality. Through the influence of the Enlightenment, the myth of scientific rationality developed. Scientific method was supposed to produce what traditional philosophy could not, i.e., the absolute universal truth about reality. What becomes evident in a study of scientific methodology is that even modern philosophers of science who defend its rationality and are staunch defenders of the theory of evolution concede that scientific method does not produce absolute, infallible truth, but rather partial approximations.

Through its method, science proceeds to build progressively truer (albeit partial, problematic, and improvable) reconstructions of reality.³³ “Hence, science cannot have an ultimate goal, such as building a complete and flawless cosmology. The goal of science is rather the ceaseless perfecting of its chief products (theories) and means (techniques), as well as the subjection of more and more territory to its sway.”³⁴

What empirical science seeks to understand by way of its rigorous research methodology, and the identification of the specific areas of knowledge in which scientific methodology is applied, brings the need to consider the content and scope of science. Empirical science can be applied to any theory that can be tested empirically. As with Greek classicism, ontological investigation began with the study of nature and *expanded later* to the humanities. This remains true among the branches of the empirical sciences—the sciences of nature, e.g., physics, chemistry, biology, and individual psychology, and of the spirit, e.g., sociological psychology, sociology, economics, political science, material history, and history of ideas.³⁵

³³Ibid., 29.

³⁴Ibid., 30.

³⁵I am using Bunge’s preliminary suggestion as an illustration of the general reach of scientific methodology (ibid., 23-24). The modern application of scientific methodology in the humanities has been seriously challenged by, for instance, Hans-Georg Gadamer (*Truth and Method*). Gadamer’s challenge, 4-5, to the application of scientific methodology in the humanities came from the teleological condition of method. Because this challenge uncovered ideas that led to postmodernity, it also affected the understanding of reason, and through it, the

In this study, we are concerned with the application of scientific methodology in the natural sciences, particularly in geology, paleontology, and biology. We will consider the “products” of science below. But first, we turn our attention to the material condition of science.

The Material Condition

The question of where scientists obtain their information may be the most publicized feature of scientific methodology. Scientists arrive at “truth” because they build their conclusions on data they receive through sensory perception. This empirical (Greek *empeiria*, “experience”) condition is so important that it is used to label the method and the sciences that employ it.

The selection of sensory perception as the source of scientific knowledge is required by the teleological and hermeneutical conditions of method. We have already considered the teleological condition that the empirical sciences use to study the whole of natural phenomena. Consequently, the choice of sensory perception or experience as a source of data is necessary in order to access reality, i.e., what is real. It is through sensory perception that natural and historical entities are revealed to human reason.

Scientists, therefore, believe that their information originates from “real” rather than “imaginary” things. They take for granted that real things are only those that can be accessed through sensory perception and/or technological enhancement. As will be seen in the next section, scientists implicitly presuppose an understanding of what “real” means, i.e., they assume ontological ideas.³⁶ In other words, ideas come into science from the side of the hermeneutical conditions of scientific methodology.

The material condition of scientific methodology takes place in two modes: tradition and testing, i.e., observation. Thus, scientists obtain information from two sources of empirical data. Our brief description of scientific methodology made clear that scientific research starts by identifying a problem, which has been suggested from the results of previous studies. This is an “empirical” source of data because scientists access it through sensory perception; but it is not experience or the material condition that grounds the truth scientific methodology is supposed to grant. The empirical source of information that grounds scientific truth comes toward the end of the method when scientists test

scientific method in the natural sciences.

³⁶The ontological assumption of realism is general, without many philosophical subtleties. Karl Popper’s positivist account of scientific thought extends to realism’s overcoming the modern turn to the subject (*The Logic of Scientific Discovery* [London: Hutchinson, 1968], 93-94).

their hypotheses.³⁷ This order is required by the goal of science, as discussed in the previous section.

The realization that the conception, formulation, and advancement of hypotheses take place before, i.e., a priori, empirical testing helps us to discover the pivotal role that tradition plays in scientific methodology. After all, scientists construct their hypotheses from questions arising from previous scientific teachings. In so doing, they work not from “facts” produced by nature, but from “facts” produced by the human spirit, i.e., reason. From the viewpoint of content, this characteristic of the scientific method appears as the progressive accumulation of scientific knowledge; from the perspective of formal communication of content, it appears as tradition. Thus, science takes place within an “orthodox” tradition. Tradition subsumes all that the researcher brings to the scientific method and reveals the existence and operation of the hermeneutical condition.

Before considering the hermeneutical condition, I would like to underline that the basic difference between theological and scientific methodologies takes place at the level of the material condition. Undoubtedly, it is here that the greatest discrepancy between the theological and empirical sciences occurs. Following a tradition initiated in modern times by Descartes, Locke, and Hume, scientists dismiss supernatural revelation as a source of information on which to build their views. This conviction directly flows from the macro-hermeneutical notion that only things or events that present themselves to us in space and time exist and can be taken as evidence on which to build scientific knowledge. Consequently, the existence of God and his revelation in Scripture are dismissed as fantasy.³⁸ This summary dismissal flows from the foundationalist³⁹ role scientists confer to empirical testing. In other words, science confers “revelatory” status primarily to natural phenomena and to historical phenomena only in a subordinate sense.⁴⁰ This is due to the fact that testing hypotheses—the ultimate ground of scientific truth—renders its best results when applied to the repetitive cycles of nature.⁴¹ Coupled to the empiricist foundationalism of science, we have the “spiritual” foundationalism of Christian theology. Following Plato’s

³⁷Testing includes, for instance, observations, measurements, experiments (Bunge, *Scientific Research I*, 222).

³⁸Ibid., 29.

³⁹For an introduction to the notion of “Foundationalism,” see Rorty, 155-164.

⁴⁰As we will see below, the subordinate position of historical data affects the scientific nature and reliability of evolutionary science when compared with the scientific nature and reliability of the physical sciences.

⁴¹Popper, 252.

cosmology, Christian theology has conceived its area of study—God and the realm of supernature—as a timeless and spaceless reality, i.e., spiritual realm. Modern theology and the empirical sciences agree that religion belongs to the realm of timelessness, and science to the realm of space and time. By their very nature, the methods of theology and empirical science do not conflict because they are mutually exclusive of one another. We should not be surprised, then, when scientists dismiss religious experience from the realm of empirical science or when theologians see no contradiction between the theory of evolution and Christianity. Platonic dualistic cosmology continues to survive today because it is able to subsume evolutionary cosmology as a valid explanation in the spatiotemporal realm. And it does so while retaining a deeper parallel timeless-spaceless level for spiritual, i.e., supernatural, realities. Theistic evolutionary schemes flourish in this soil.⁴² Of course, as we will see later, Scripture directly opposes Platonic cosmology by not accepting the generalized notion that God and religion belong to a timeless, spaceless realm. Conflict between evolution and creation can only take place if both theories are understood to refer to the same field of reality, i.e., to the temporal-spatial realm of creation.⁴³ In short, acceptance of the Platonic cosmological framework defuses the conflict between creation and evolution. We will come back to this issue later when studying the way in which Christian theologies relate to evolutionary theory.

The Hermeneutical Condition

The hermeneutical condition refers to all the presuppositions required for the proper operation of the scientific method. Bunge explains that “in general, every problem is posed against a certain *background* constituted by the antecedent knowledge and, in particular, by the specific presuppositions of the problem” (emphasis original).⁴⁴ These presuppositions constitute the a priori, i.e., the preontological state, of scientific methodology.

Presuppositions may be thought to include the sum total of life experience. Under the influence of classical philosophy, the modern age understood scientific knowledge to be “objective” because it was thought

⁴²See for instance, Alfred North Whitehead, *Process and Reality: An Essay in Cosmology* (New York: Macmillan, 1929); and Pierre Teilhard de Chardin, *The Phenomenon of Man* (New York: Harper & Row, 1959).

⁴³On this, see arguments against conventional thinking on science, presented by Larry Laudan, *Beyond Positivism and Relativism: Theory, Method, and Evidence* (Boulder: Westview Press, 1996), 223-230.

⁴⁴Bunge, *Scientific Research I*, 171.

to be totally determined by the object. To ensure objectivity, modern scientists were supposed to divest or purify themselves from all previous experience. Personal experience was considered to be subjective bias or prejudice. However, when human beings use scientific methodology, they make concrete contributions which decidedly shape the outcome of both reason and scientific method. This does not mean that science should include personal biases or prejudices. It only indicates, as we shall see, that not all prejudices that are brought to science are negative. The scientific method requires the use of hermeneutical presuppositions. For this reason, we need to recognize and identify them as a condition of method.

In speaking of scientific paradigms, Thomas Kuhn brings the condition of method to the attention of the scientific community. In so doing, Kuhn does not create a new condition of scientific methodology. On the contrary, he only identifies and explains the role that the scientific a priori has always played in scientific method. We should not forget that the scientific a priori is required to get the method started. It is only from the a priori that a problem can be defined and a hypothesis may be advanced. The scientific a priori does not originate, as Kant suggested, in the cognitive structure of humanity. Rather, scientists acquire these presuppositions by belonging to the scientific tradition.⁴⁵

The only way to become a scientist is by engaging in formal scientific education. According to Kuhn, the part that education plays in developing an "ordinary" citizen into a scientist is that it inculcates in students a scientific paradigm or disciplinary matrix. Kuhn suggests that takes place by ways of "exemplars," i.e., "concrete problem-solutions that students encounter from the start of their scientific education, whether in laboratories, on examinations, or at the ends of chapters in science texts."⁴⁶ Through the study of exemplars, the student is taught to view "the situations that confront him as a scientist in the same gestalt as other members of his specialists' [*sic*] group. For him they are no longer the same situations he had encountered when his training began. He has meanwhile assimilated a time-tested and group-licensed way of seeing."⁴⁷ Thus, "by doing science rather than by acquiring rules for doing it" students learn "tacit knowledge."⁴⁸

⁴⁵Thomas Kuhn explains that science is "research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice" (*The Structure of Scientific Revolutions*, 2d ed. [Chicago: University of Chicago Press, 1970], 10). It is through tradition, then, that scientists get their a priori hermeneutical presuppositions.

⁴⁶Ibid., 187.

⁴⁷Ibid., 189.

⁴⁸Ibid., 191.

Among the contents implicit in the “tacit knowledge” students incorporate into their scientific a priori as a disciplinary matrix are an “entire constellation of beliefs, values, techniques, and so on shared by the members of a given community.”⁴⁹ This constellation of beliefs includes, for instance, symbolic generalizations,⁵⁰ particular models,⁵¹ values,⁵² law, theory, application, and instrumentation.⁵³

This tacit, implicit knowledge that scientists bring to method includes various levels of inclusiveness. Because tacit knowledge contributes in the generation of the meaning of scientific problems, hypotheses, laws, and theories, i.e., the outcomes of science, we can detect macro-, meso-, and micro-levels of hermeneutical presuppositions working in empirical science. The macro-hermeneutical presuppositions in empirical science include the philosophical presuppositions discussed in this subsection. Meso-hermeneutical presuppositions might include the disciplinary matrix or paradigm of which Kuhn speaks. Micro-hermeneutical presuppositions are the specific theories, laws, and problems that generate concrete hypotheses in concrete scientific disciplines.⁵⁴

In regard to philosophical presuppositions in the method of empirical sciences,⁵⁵ Bunge correctly remarks that “philosophy may not be found in the finished scientific buildings (although this is controversial) but it is part of the scaffolding employed in their construction.”⁵⁶ Earlier, I argued that Christian theology includes in its formation an interconnected ensemble of macro-hermeneutical presuppositions. Among other things,

⁴⁹Ibid., 175.

⁵⁰Ibid., 182-184.

⁵¹Ibid., 184.

⁵²Values, such as accuracy, simplicity, consistency, plausibility, or preference of quantitative over qualitative procedures, are used to judge theories (ibid., 184-186).

⁵³Ibid., 10.

⁵⁴This categorization in progressive levels of specificity is only an incomplete suggestion. In “Paradigm, System and Theological Pluralism,” I refer to what I call “system,” which I identify here as macro-hermeneutical presuppositions. The “system” designation properly describes the inner coherence between the various macro-hermeneutical presuppositions operating respectively in theology and empirical science (*Evangelical Quarterly* 70 [1998]: 195-218).

⁵⁵Due to their generality and inclusiveness, these are macro-hermeneutical presuppositions that correspond to the macro-hermeneutical presupposition level operative in Christian theology. Since I am not a scientist, I leave others to distinguish between what Kuhn calls paradigm or disciplinary matrix and the levels of meso- and micro-hermeneutical presuppositions.

⁵⁶Bunge, *Scientific Research I*, 291.

they deal with God, human beings, the world, the one and the many (the whole), and reason. Scientists assume interpretations on these issues as well. Many of the "scientific" interpretations of these issues are drawn from philosophy or are created by the philosophical reach of an overarching scientific theory. For instance, the evolutionary theory becomes the cosmological macro-hermeneutical presupposition of empirical scientific methodology.

Perhaps the broadest philosophical presupposition of science is that the entities it studies are real, i.e., have existence outside of the human mind (empirical realism). Their reality is presupposed in the grounding notion of fact, which is the referent of scientific teaching and especially the source of its testing procedures.⁵⁷ Moreover, empirical realism presupposes a spatiotemporal understanding of reality. In this, empirical realism radically departs from classical Aristotelian realism.⁵⁸ Not surprisingly, this macro-hermeneutical presupposition requires the rejection of classical ontology, including the notions of God and the soul. The macro-hermeneutical role that God played in classical philosophy and theology is now to be played by nature and history. Thus, the immutability grounded by the classical notion of timeless realities, e.g., God, soul, essence, ideas, is replaced by ontological determinism.

Ontological determinism must be presupposed because the aim of science is to discover the recurrent patterns of nature in order to predict events. For scientific laws to be predictable, natural phenomena must be themselves ordered by law. This is assumed on philosophical rather than scientific ground. Popper refers to the nonscientific ground of science by saying that the belief in the ontological lawfulness of nature is "a question which obviously cannot be answered by any falsifiable theory and which is therefore 'metaphysical': how is it that we are so often lucky in the theories we construct—how is it that there are 'natural laws?'"⁵⁹ Popper answers his question by noting that "regularities which are directly testable by experiment do not change. Admittedly, it is conceivable, or logically possible, that they might change; but this possibility is disregarded by empirical science and does not affect its methods. On the contrary, scientific method presupposes the immutability of natural process, or the 'principle of the uniformity of nature.'"⁶⁰

⁵⁷Ibid., 291-292.

⁵⁸Aristotelian realism centers around the notion of first substance, which is a composite of spatiotemporal (matter) and timeless (form) realities.

⁵⁹Popper, 107.

⁶⁰Ibid., 252. Bunge notes that ontological determinism has been seriously challenged by the quantum theory "which acknowledges objective chance not only as a trait of complex

The articulation of the whole as a complex of many parts is ordered in a multilayered pyramid in which the "higher levels are rooted in the lower ones both historically and contemporaneously."⁶¹ The main levels from bottom to top are the physical, biological, psychological, and sociocultural. This presupposition, for instance, requires that evolution should be extended from its original biological level to the higher levels that it supports, i.e., culture and history.

The macro-hermeneutical presupposition regarding the nature of scientific knowledge has changed through the years and is presently under serious scrutiny. This is due to philosophical changes in the interpretation of reason, which were brought about during the twentieth century by the rise of hermeneutical philosophy and which were popularized by the advent of postmodernity. According to Bunge, until the second part of the nineteenth century scientists assumed that in principle it was possible "to exhaustively know the present, past and future states of any object in such a way that no uncertainty about it remains."⁶² This mythical assumption was replaced by a limited knowability, according to which "science presupposes that its objects are knowable to some extent, and it acknowledges that some of the limits to knowledge are set by the objects themselves, whereas others are temporary."⁶³ Until the end of the twentieth century, scientists were theoretical objectivists following the modern interpretation of objective knowledge. That is to say, they assumed their knowledge was generated only by the objects they studied. In practice, however, their use of philosophical and scientific presuppositions in the operation of the scientific method anticipated postmodernity.

Postmodernity revolves around the philosophical-hermeneutical discovery that human reason works from historically generated principles of interpretation. Because they are historically generated they may change. Change in the principles of interpretation, especially at the macro-hermeneutical level, may result in a change of paradigm that subsequently generates a scientific revolution.⁶⁴ The notion that scientific teachings depend on changing rules has caused great upheaval in scientific circles. Larry Laudan characterizes the current situation in scientific epistemology

systems but even at the level of 'elementary' particles, which obey stochastic laws. Whether such a randomness is final or will eventually be analyzed as the outcome of lower level fields, it is premature to decide" (*Scientific Research I*, 295).

⁶¹Bunge, *Scientific Research I.*, 293.

⁶²Ibid., 296.

⁶³Ibid., 298.

⁶⁴Thomas Kuhn deals in detail with these issues in *The Structure of Scientific Revolutions*.

as a conflict between traditional positivism and relativism.⁶⁵ The fact remains that scientific method uses hermeneutical presuppositions to generate its problems, formulate its hypotheses, and test their consequences. Even when interpretation, i.e., contribution from the subject, is present in every step of scientific methodology, scientists have not yet incorporated the hermeneutical turn in their methodology and adjusted to its epistemological consequences.

Outcomes of the Scientific Method

Following the brief description of the main steps involved in the scientific method and a description of the conditions involved in its operation, we now turn to the outcomes of method. Scientists produce hypotheses, laws, and theories. This consideration is important because it helps us to understand the epistemological status of the evolutionary "theory." The conditions of method work as presuppositions that directly or indirectly, explicitly or implicitly, shape the concrete contents and epistemological status of scientific outcomes. Let us consider them briefly.

Hypotheses

After defining a problem, scientists attempt to solve it by constructing and testing hypotheses. An empirical hypothesis may be described as a conjecture about certain unexperienced or unexperientiable facts which are "corrigible in view of fresh knowledge."⁶⁶ Thus, hypotheses are assumptions about reality we construct in order to explain it. Therefore, we may see them as interpretive schemes. Scientists construct their hypotheses by drawing, implicitly or explicitly, from the interpretive guidance of macro- (philosophical), meso- (disciplinary matrix), and micro- (concrete disciplinary context) hermeneutical presuppositions. Thus, hypothesis formation is a complex interpretive act because it builds on three antecedent levels of interpretive acts and constructions.

A hypothesis is not a datum; but it should not be equated with fiction either. Data and hypotheses share similarities: both result from interpretation and are corrigible. Their basic difference is that data are actual empirical experiences, while hypotheses are propositions about nonexperienced realities. Bunge provides a useful example that may help us to visualize the difference between data and hypotheses.

The information that the needle of a given meter is pointing to the 110 volt mark is a singular empirical datum: it may be tested by mere ocular

⁶⁵Laudan, 3-25.

⁶⁶Bunge, *Scientific Research I*, 222.

inspection. (In general[,] experiences, either single or in bundles, are necessary to corroborate singular empirical data. They are not sufficient, though: some theoretical element will always be needed.) That this datum refers to an electric current in the meter is no longer a datum but a hypothesis. In fact (i) electric currents are inferable but not observable and (ii) the hypothesis may turn out to be false, as the meter may be out of order, so that its indications may be wrong.

Finally, hypotheses always say more than the data they attempt to explain. This “plus” value of hypothetical thinking tends to build as scientific constructions become more complex and involved, particularly in the case of such all-embracing theories as evolution.

Once formulated, scientific hypotheses play a hermeneutical role in guiding the researcher in the design of testing approaches and techniques that will corroborate or falsify a particular hypothesis. These techniques also result from the interpretive constructions of scientists. (At this point, the reader should bear in mind that in this section I am drawing mainly from Bunge, who is not a postmodern relativist.) If interpretative construction is present in the reception of data, the formulation of hypotheses, the construction of testing techniques, and their evaluation, one wonders why some scientists are so opposed to the postmodern conviction that to know is to interpret.

Laws

A scientific law is a confirmed hypothesis that is supposed to depict an objective pattern. According to Bunge, “laws summarize our knowledge of actuals and possibles.”⁶⁷ It would be incorrect, however, to assume that scientists arrive at laws by simply testing hypotheses. The process through which scientists arrive at laws is more complex. To understand this process we need to bear in mind that the search for scientific law is the search for sameness in an ever-changing reality.⁶⁸

But how do we arrive at a universal law from changing realities in which no two individuals are exactly alike? Plato invented a timeless, ontological realm that supposedly grounded knowledge in a changing reality.⁶⁹ With the advent of modern empiricism, Plato’s ontological foundation of knowledge was rejected. According to the macro-hermeneutical presuppositions operating in empirical scientific methodology, only concrete, changing, diverse,

⁶⁷Ibid., 23.

⁶⁸Empirical science is the last link in a long scientific tradition that originated with the Greek philosophers. While Heraclitus understood the real to be in constant flux as an ever-changing river, Parmenides conceived it to be an immutable sphere.

⁶⁹In this way Plato became a very influential foundationalist.

spatiotemporal entities are recognized as objects and referents of scientific knowledge. Popper concludes that there are insurmountable difficulties in inducing or inferring universal statements from singular ones.⁷⁰ If induction has problems, perhaps definite techniques for summarizing and generalizing data would lead to universal laws. Unfortunately, laws are not the result of simple generalization and summary. In the conception and formulation of laws, scientists follow a hypothetico-deductive procedure. In other words, they progressively invent, imagine, and construct new hypothetical generalizations until, through a process of trial and error, they arrive at a universal law.⁷¹ We should bear in mind that the invention of universal, all-inclusive hypotheses are attempts to explain and understand a multitude of lower-level hypotheses that scientific research produces over time. These attempts are motivated and made possible by the organizing drive of human reason described by Kant. Bunge characterizes this drive of human reason behind the formulation of universal laws and theories as the “nervous system of science.”⁷² It is important to bear in mind that in *inventing* a universal hypothesis, human reason selects only a *few traces* of a multifarious and complex reality.⁷³

To say that a law is a confirmed hypothesis does not mean that any or all hypotheses become laws after they are tested and confirmed. Only confirmed universal hypotheses can become laws. In order to confirm a law we must descend from its “high” level of abstraction and universality and through deduction “specify the circumstances under which” its “use or test takes place.”⁷⁴

Theories

“The work of the scientist consists in putting forward and testing theories.”⁷⁵ In this subsection, we will consider briefly the nature, need, formation, and limits of theory. In the next subsection, we will deal with the testability of theory. According to Popper, “theories are nets cast to

⁷⁰Popper, 21-29. Bunge is of the opinion that such techniques produce “low level” laws because they render only empirical generalizations (*Scientific Research I*, 323).

⁷¹Bunge, *Scientific Research I*, 323, explains that “there are no known rules for inventing either high level concepts or the law statements that tie them up: unlike the finding of empirical generalizations, the creation of theoretical concepts and laws is not a rule-directed activity” (see also 346).

⁷²Ibid., 380-382.

⁷³Ibid., 347-348.

⁷⁴Ibid., 351.

⁷⁵Popper, 31.

catch what we call 'the world': *to rationalize, to explain, and to master it*" (emphasis supplied).⁷⁶ Bunge describes the process through which scientists arrive at theories in the following way:

As research develops, relations among the previously isolated hypotheses are discovered or invented and entirely new, stronger hypotheses are introduced which not only include the old hypotheses but yield unexpected generalizations: as a result one or more *systems of hypotheses* are constituted. These systems are syntheses encompassing what is known, what is suspected, and what can be predicted concerning a given subject matter. Such syntheses, characterized by the relations of deducibility holding among some of its formulas, are called hypothetico-deductive systems, models, or simply theories (emphasis original).⁷⁷

One can argue that the difference between laws and theories resides in their referents. Laws are hypotheses about an objective, recurrent pattern in nature, while theories are hypotheses about broader chunks of reality. Theories are not about recurrent patterns, but about complex portions of reality whose explanation requires the putting together of existing laws and theories.⁷⁸

Scientists go beyond the discovery of natural laws to construct theories about large portions of reality. This is because reason compels them to do so. Reason understands the need to connect isolated parts into progressively more inclusive wholes. Bunge explains that in science "a factual proposition can acquire full meaning only within a context and by virtue of its logical relations with other items."⁷⁹ It is not surprising, then, that scientists build theories.

Theories should not be thought of as only the end result of scientific reasoning, but also as presuppositions required for the proper operation of the scientific method. "One cannot know whether a datum is significant until one is able to interpret it, and data interpretation requires theories."⁸⁰ Besides, the formulation of a problem (the first step in the application of the scientific method) requires the application of theories.⁸¹

⁷⁶Ibid., 59.

⁷⁷Ibid., 381.

⁷⁸Ibid. He states: "'Theory' designates a system of hypotheses, among which law formulas are conspicuous—so much so that the core of a theory is a system of law formulas."

⁷⁹Ibid., 382. Bunge, 382, explains further that these logical connections involve the systematization or interconnectivity of hypotheses. "In short, systematization renders the meaning of hypotheses more precise and enhances their testability. In addition, it explains most of the hypotheses by subsuming them under stronger assumptions (axioms) and intermediate level theories."

⁸⁰Ibid.

⁸¹As presuppositions, theories guide research and suggest new lines of investigation.

Scientists arrive at theories by constructing explanations and by putting things together. To say that theories are “constructions” means that they do not portray “literally a real thing, event, or process.”⁸² They are not snapshots or summaries of things. Instead, they are sketchy and symbolic reconstructions of real systems.⁸³ Theories are creations beyond reality which are necessary to explain reality.⁸⁴ That theories are explanations means that they are the result of invention and interpretation. “Invention is the kernel of theory construction”⁸⁵ and means that there are no preset rules for theory construction. Theories are original creations⁸⁶ that proceed by interpreting, rather than describing or summarizing observed realities.⁸⁷ That theory construction results from interpretation means that it “does not proceed in a vacuum but in a preexistent matrix.”⁸⁸

Finally, theory construction necessarily involves idealization, simplification, selectivity, hypothesizing, and the search for discrepancies and deliberate departures from truth. Bunge describes the limitations of scientific theories in the following words:

Every scientific theory is built, from the start, as an idealization of real systems or situations. That is, the very building of a scientific theory involves *simplifications* both in the selection of relevant variables and in the hypothesizing of relations (e. g., law statements) among them. Such simplifications are made whether or not we realize that they amount to errors—not mistakes but just discrepancies with actual fact. Moreover, this is not a mere descriptive statement concerning actual habits of theory construction: it is a rule of theory construction that as many simplifications as needed are to be made at the start, relaxing them gradually and only according as they are shown to constitute too brutal amputations. Such simplifications are, of course, deliberate departures from truth.⁸⁹

It is important to notice that theory construction is a speculative enterprise that searches for understanding, coherence, and explanation at the level of ideas rather than at the level of concrete facts.⁹⁰ This applies

⁸²Bunge, *Scientific Research I*, 385.

⁸³Ibid., 386.

⁸⁴Ibid., 455.

⁸⁵Ibid., 459

⁸⁶Ibid., 455.

⁸⁷Popper, 280.

⁸⁸Bunge, *Scientific Research I*, 449.

⁸⁹Ibid., 388.

⁹⁰Ibid., 455, where he states: “In the processing of experience and in the invention of

particularly to far-reaching theories like evolution. Theories are grand hypotheses because they include and connect other lower-level theories, hypotheses, and laws. In this process, the search for understanding necessarily involves distortion and the possibility of wrong representations of the world. Thus, scientific theories, as scientific laws, exist at a high level of generalization that is far removed from the realities and processes they attempt to explain.

According to Bunge, “we should know a priori, from an analysis of the very process of theory construction, that every factual theory is at best approximately true, just because it involves too many simplifications and some inventions that are bound to be inadequate to some extent because they cannot be fully controlled either by experience or by logic.”⁹¹

The way in which theories connect with reality requires a move from the process through which scientists arrive at conclusions to the process through which they arrive at truth. Let us consider, then, the testing and corroboration of scientific theories.

Testing, Corroboration, and Scientific Truth

Scientific theories are not a summary of what scientists discover and prove through experimentation. The pathway of scientific method “is not from data to theory but data to problem, from problem to hypotheses, from hypotheses to theory, and back from theory and evidence to a projection that can be checked by another piece of evidence—with the help of further theories.”⁹² Through the process of theory construction, scientists create a coherent explanation of the data available to them, which is invented with the help of a particular perspective or heuristic idea.⁹³ Scientists, however, want more than merely coherent explanations. Metaphysics provides coherent explanations. What distinguishes a metaphysical from a scientific explanation of the world is that the former cannot be tested, while the latter can. By testing through experiment or observation, scientists attempt to falsify or corroborate their hunches, i.e., hypotheses

ideas, most particulars are *discarded* and the rest are *disfigured* rather than carefully collected and packaged. Precepts, which anyhow are products of analysis rather than raw experiences, are mostly discarded in the process of selecting relevant items. And those that are picked out become transmuted into ideas, which are in turn anything but faithful reproduction of the given. A posteriori we discriminate and sort out the ideas and come to realize that some of their component unites—concepts—have no experiential counterpart, this being why they have a chance of participating in the explanation of experience.”

⁹¹Ibid., 549.

⁹²Ibid., 455.

⁹³Ibid., 450.

and theories. Scientific methodology, then, finds its distinctive foundation through empirical testing.

Scientists test their hypotheses and theories, which are abstract generalizations far removed from concrete existing realities in space and time and that can be neither verified or falsified directly, by deducing from the theory a consequence that can be tested by observation and experiment. In other words, scientists apply their theoretical construction to reality in search of a recurrent reality (event) that can be tested through experimentation. Testing, then, is applied to "statements asserting that an observable event is occurring in a certain individual region of space and time."⁹⁴ The results of testing determine whether a theory is falsified or corroborated.⁹⁵

For a theory to be falsified, it must first be falsifiable. According to Popper, a theory is falsifiable when it rules out at least one typical recurrent event in space and time.⁹⁶ Actual testing, then, takes place by observation of a spatiotemporal body.⁹⁷ If a theory is falsified, it must either be modified or rejected and replaced by a better one. However, according to Popper, theories cannot be verified, but only corroborated in various degrees.⁹⁸ The degree to which theories may be corroborated is not determined by the number of corroborations, but by the severity of tests to which hypotheses have been subjected.⁹⁹ Testing, however, is not beyond interpretation. On the contrary, not only the construction of problems, hypotheses, laws, and theories, but also testing, experimentation, and the instruments used in them are conditioned by theory and the teleological, material, and hermeneutical conditions of method.¹⁰⁰

The result of this conditionality is significant. It shows, for instance, that corroboration of theories should not be confused with truth.¹⁰¹ This is so because one expects scientists to explain why their theories are supposed to be held as truth. Truth is not claimed for corroborated scientific theories. The epistemological analysis of scientific methodology, however, reveals that the myth of science as objective, absolute truth does not match the reality of what scientists and human reason are able to

⁹⁴Popper, 103.

⁹⁵Ibid., 109.

⁹⁶Ibid., 86, 88, 90.

⁹⁷Ibid., 102-103.

⁹⁸Ibid., 267-268.

⁹⁹Ibid.

¹⁰⁰Ibid., 107.

¹⁰¹Ibid., 275-276.

perform. On the contrary, it shows that “no theory is unambiguously determined by experience.”¹⁰² Popper helps us to see how limited is the corroboration of scientific theories by comparing testability and experimentation to structural piles that sustain the edifice of scientific theories over the swamp of everyday opinion:

The empirical basis of objective science has thus nothing “absolute” about it. Science does not rest upon solid bedrock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles [testing]. The piles are driven down from above into the swamp, but not down to any natural or “given” base; and if we stop driving the piles deeper, it is not because we have reached firm ground. We simply stop when we are satisfied that the piles are firm enough to carry the structure, at least for the time being.¹⁰³

The piles in Popper’s metaphor relate to the empirical base or the testing on which hypothesis, laws, and, especially, theories rest. What Popper seems to indicate is that empirical testing and corroboration of a theory is never final or absolute. Moreover, testing is pursued only until the researcher or the community is satisfied.

Postmodern Criticism of Scientific Method

By the end of the twentieth century, a select group of philosophers of science became increasingly dissatisfied with the general description of science (see discussion above). “Prominent among their ranks are Kuhn, Feyerabend, the later Quine, the later Goodman, Rorty, and dozens of lesser lights.”¹⁰⁴ They submitted the generally accepted view of science to criticism, which is not kindly received by many in the scientific community.¹⁰⁵ The following quotation will give us the general idea of the notion of science these philosophers of science are criticizing:

According to Legend, science has been very successful in attaining these goals [attainment of truth about the world]. Successive generations of scientists have filled in more and more parts of the COMPLETE TRUE STORY OF THE WORLD (or, perhaps, of the COMPLETE TRUE STORY OF THE OBSERVABLE PART OF THE WORLD). Champions of Legend acknowledged that there have been mistakes and false steps here and there, but they saw an overall trend toward accumulation of truth, or, at the very least, of better and better approximations to truth. Moreover, they offered

¹⁰² Ibid., 144.

¹⁰³ Ibid., 111.

¹⁰⁴ Laudan, 4.

¹⁰⁵ For instance, Laudan, 5, sees them as “postpositivists” endorsing “a thoroughgoing epistemological relativism about science.”

an explanation both for the occasional mistakes and for the dominant progressive trend: scientists have achieved so much through the use of SCIENTIFIC METHOD (emphasis original).¹⁰⁶

Thus universal, unrestricted, sole authority is given to science over all other human approaches to truth about the universe. Not surprisingly, the big bang and evolutionary theories have become dogmatically affirmed by scientists and accepted by theologians without much discussion.

The criticism produced by this new line of philosophers is far-reaching and goes beyond the limits of this paper. Their criticism of science, however, challenges the universality of scientific results.

Not Playing by the Rules

Feyerabend contends that when one takes time to review all that is involved in the actual methodological procedures used by scientists in arriving at their interpretive constructions, one discovers that these constructions are not built by playing "by the book," i.e., by generally accepted rules of scientific investigation. The "perfect" narrative enunciation of a scientific theory hides a lot of cut-corners, pushes problems between theory and fact, and makes ad hoc approximations¹⁰⁷ that "conceal, and even eliminate, qualitative difficulties. They create a false impression of the excellence of our science."¹⁰⁸ Moreover, in their drive to find explanations for the astonishing complexity and variety in nature, scientists never follow the rules for evaluating proposed theories and even use falsified theories.¹⁰⁹ It would seem that what guides them to accept theories is the feeling of power they receive when attempting to

¹⁰⁶Kitcher, *The Advancement of Science*, 3.

¹⁰⁷Feyerabend, 49, states: "Wherever we look, whenever we have a little patience and select our evidence in an unprejudiced manner, we find that theories fail adequately to reproduce certain *quantitative results*, and that they are *qualitatively incompetent* to a surprising degree. Science gives us theories of great beauty and sophistication. Modern science has developed mathematical structures which exceed anything that has existed so far in coherence generality and empirical success. But in order to achieve this miracle all the existing troubles had to be pushed into the *relation* between theory and fact, and had to be concealed by *ad hoc* hypotheses, *ad hoc* approximations and other procedures."

¹⁰⁸Ibid.

¹⁰⁹In our description of scientific methodology we saw that, according to Popper, theories must be either falsified or corroborated. However, Feyerabend, 50, remarks that "methodologists may point to the importance of falsifications—but they blithely use falsified theories, they may sermonize how important it is to consider all the relevant evidence, and never mention those big and drastic facts which show that the theories they admire and accept may be as badly off as the older theories which they reject. In practice they slavishly repeat the most recent pronouncements of the top dogs in physics, though in doing so they must violate some very basic rules of their trade."

explain the facts of nature. However, Feyerabend also reports that “according to our present results, hardly any theory is *consistent with* the facts. The demand to admit only those theories which are consistent with the available and accepted facts again leaves us without any theory. (I repeat: *without any theory*, for there is not a single theory that is not in some trouble or other)” (emphasis original).¹¹⁰

Creating Our Own Rules

In practice, the circular nature of scientific methodology discourages critical thinking and fosters dogmatism. Feyerabend denounces the existence of scientific dogmatism that prevents challenges to the reigning theory. “In cosmology a firm belief in the Big Bang now tends to devalue observations that clash with it.”¹¹¹ Scientific journals give the round-about to those who want to publish ideas contrary to the accepted theory, including evolution.¹¹² The reason for this dogmatism is a built-in circularity of reason and scientific methodology. Scientific research starts by defining a problem, and problems assume the existence of theories. Conversely, when a theory is formulated and accepted it generates and influences research.

The scientific method is a hermeneutically and theoretically guided process. Challenges to wide-reaching theories are not welcome because they not only disturb the theory, but the entire constellation of other theories, laws, and hypotheses that depend on it for their existence. It is much easier to accept challenges to less inclusive or influential theories. This shows how difficult it is to maintain the critical nature of scientific research. Unfortunately, “there is no alternative to the project of using what we think we know to appraise the methods which we take to be reliable.”¹¹³

As Kuhn explains, we become scientists by belonging to a scientific tradition that passes the rules of the game from one generation to another.¹¹⁴ There is no alternative because reason’s operation, the heart and engine of the scientific method, requires the application of a priori

¹¹⁰Ibid., 50. Feyerabend, 39, states: “Considering how the invention, elaboration and the use of the theories which are inconsistent, not just with other theories, but even with *experiments, facts, observations*, we may start by pointing out that *no single theory ever agrees with all the known facts in its domain*. And the trouble is not created by rumors, or by the result of sloppy procedure. It is created by experiments and measurements of the highest precision and reliability” (emphasis original).

¹¹¹Ibid., 241.

¹¹²Verne Grant, *The Evolutionary Process: A Critical Review of Evolutionary Process* (New York: Columbia University Press, 1985), 14.

¹¹³Ibid., 299.

¹¹⁴Kuhn, 11-22; see also Feyerabend, 214-237.

ideas to the objects it attempts to understand and explain. The term "a priori" may be interpreted in various ways. Kant defines it as forms, categories, and regulative ideas. Others define it to be hermeneutical presuppositions, categories, schemata, patterns, theories, rules of the game. Change in the interpretation of the a priori leads to paradigm changes both in reason and science. This brings us to the impact of postmodernity on the understanding of scientific methodology.

Universal Rules?

Scientific results depend on the application of a priori rules, which include macro- (philosophical assumptions), meso- (methodological matrices involving an entire constellation of scientific rules and procedures), and micro- (theories, laws, and procedures that apply to specific fields of research) hermeneutical presuppositions. These hermeneutical presuppositions involve complex sets of theories and procedures of various kinds that are not derived from data or facts, but which are variously interpreted by philosophers and scientists.

Scientific rationality is about using the "right" criteria, rules, or categories to process the data, information, reasoning, and experiments required in the operation of scientific research. In classical and modern times, it was generally assumed on metaphysical grounds that all human beings, especially scientific researchers, worked under the same universal rules. Various metaphysical and epistemological theories told "us why our criteria of successful inquiry are not just our criteria but also the right criteria, nature's criteria, the criteria which will lead us to the truth."¹¹⁵ Thus, modern science was born when philosophers still assumed that the a priori rules of reason (epistemology) were universally given to all human beings (foundationalism).

The demise of classical ontology precipitated by empiricist criticism made the modern sciences possible, but, unfortunately, left them without the foundations on which claims for universal truth had been grounded. Postmodernity is the recognition of this fact.¹¹⁶ The myth of science, briefly put, consists in the illusion that empirical data is a foundation that produces the "true," absolute, universal, and totally certain results that the old classical metaphysics claimed to reach, but never did because it was too speculative and removed from reality. That many scientists still think along these general lines

¹¹⁵Rorty, 299.

¹¹⁶Jean-Francois Lyotard explains that postmodernity has an "incredulity toward metanarratives" (*The Postmodern Condition: A Report on Knowledge*, trans. Geoff Bennington and Brian Massumi [Minneapolis: University of Minnesota Press, 1979], xxiv). He, xxiv, states: "The obsolescence of the metanarrative apparatus of legitimation corresponds, most notably, to the crisis of metaphysical philosophy and of the university institution which in the past relied on it."

becomes apparent in the controversy about the underdetermination of scientific theories. In simple terms, can a body of empirical evidence render only one rationally acceptable and valid explanation or many? Positivists (modernists) argue in the affirmative; postpositivists (postmodernists or relativists) argue in the negative. The controversy started by Hume continues unabated into the twenty-first century.¹¹⁷

From scientific practice, as described by Feyerabend, and from philosophical reflection, as developed by Heidegger and Gadamer, postmodernity has made clear that there are no universal principles on which the rational search for truth can be grounded. The principles and rules of science are themselves the product of involved and complex rational interpretations that change with the passage of time.¹¹⁸ Thus, absolute reason was replaced by hermeneutical reason.¹¹⁹ Scientists can no longer assume a rational approach and or that the application of the “right” rules of the game will render one single, possible explanation of reality, especially when the issue is so complex and inclusive as in the question of origins. The more complex the facts are the more likely various possible rational explanations will emerge.¹²⁰

Conflict of Interpretations or Universal Truth?

Can we decide between conflicting theories? Modernist positivist philosophers of science say, yes, by a correct application of scientific methodology, rationality, and with the progress and accumulation of scientific knowledge. Postmodernist (postpositivist) philosophers of science say no. This debate takes place under the label “commensurability of scientific discourses or theories.” Thus, this is not a debate about scientific method, but about reason in general. Rorty describes commensurability as the ability “to be brought under a set of rules which will tell us how rational agreement can be reached on what would settle the issue on every point where statements seem to conflict. These rules tell us how to construct an ideal situation, in

¹¹⁷For an introduction to the debate on underdetermination, see Laudan, 29-54.

¹¹⁸Feyerabend, 51, states: “The material which a scientist *actually* has at his disposal, his laws, his experimental results, his mathematical techniques, his epistemological prejudices, his attitude towards the absurd consequences of the theories which he accepts, is indeterminate in many ways, ambiguous, and *never fully separated from the historical background*. It is contaminated by principles which he does not know and which, if known, would be extremely hard to test. Questionable views on cognition, such as the view that our senses, used in normal circumstances, give reliable information about the world, may invade the observation language itself, constituting the observational terms as well as the distinction between veridical and illusory appearance” (emphasis original).

¹¹⁹This seems to be suggested by Rorty, 315-356.

¹²⁰For an introduction to the notion of simplicity and its role in science, see Popper, 136-145.

which all residual disagreements will be seen to be ‘noncognitive’ or merely verbal, or else merely temporary—capable of being resolved by doing something further.”¹²¹

Those who believe in the commensurability of theories assume that the rules to bring about rational agreement exist and are accepted by all merely because humans are rational beings. In this scenario, only one theory is rational. The rest are “irrational,” or as Rorty says, “noncognitive.” To agree is to be rational; to disagree with the consensus is to be “irrational.” I think most scientists and theologians believe that there is only one rational explanation for every problem. It is from this meso-hermeneutical presupposition that the relation between evolution and creation is addressed. Since there can be only one possible rational explanation, any possible answer must, therefore, be false or true. Scientific methodology, being rational, is able to decide whether an explanation is true or false. The decision is made on the basis of universal, rational rules of the rational-scientific game. In our case, scientists advancing evolutionary theory dismiss creation as nonrational.¹²² Since creation is based on supernatural revelation, it infringes upon the material condition of method and, therefore, cannot be rational. If it is not rational, then it is not true either.

Those who believe in the incommensurability of theories assume as evident that there are no general rules of rationality binding all human nature.¹²³ They are convinced that rational rules are determined by conventional consensus among human beings and are transmitted through tradition and education. Since there are no general rules that bind all human beings together, there is no rational agreement between traditions that work under different sets of rational rules. So neither creation nor evolution can be considered irrational; both are rational, but work under different rules of rationality and method. Neither can be dismissed as “irrational” or “unscientific.” In the case of conflict between theories, postmodern philosophy asserts that reason cannot help us to decide between them. This is because reason has no parameters or rules that may serve as guides in the decision-making process. Reason can only help us to

¹²¹Rorty, 316.

¹²²In contrast to the methods of science, “the methods and claims of creationists are not subject to experimentation, prediction, revision, or falsification. To them, these pursuits are irrelevant, because they believe they possess the ‘truth’ as set forth in the Bible” (Berra, 4).

¹²³Laudan, 6-14, deals with incommensurability at a linguistic level which challenges the translation and comparison of contents of rival theories. He correctly argues in favor of translation and comparison. The ultimate problem, however, is how to decide between conflicting theories once we have compared them. The problem between creationism and evolutionism is not about translation or comparison, but about truth. Can the truth be decided on the basis of reasoning and interpretation?

interpret reality, but it may not decide between the interpretations it helped us to produce.

In many cases, theories are incommensurable. However, this does not mean that we cannot decide which theory is true. It means only that we cannot decide on a rational basis. There are other ways besides reason that we can take to decide between theories. Postmodernity only reveals rational incommensurability. We cannot decide the truth about theory from a set of scientific rules of interpretation and make decisions about what is truth. Yet, scientific method has more than merely rational rules of interpretation. Rules of interpretation are, simply, the contributions from the side of the subject in the subject-object relationship. But knowledge and scientific method also have contributions from the side of the object. So, scientific theories are *incommensurable* from the side of the subject (rational rules), but *commensurable* from the side of the object, which reason attempts to interpret. Thus, creation and evolution are incommensurable from the side of the rules of the game they operate under (the conditions of method), but are commensurable from the perspective of the reality they attempt to interpret, e.g., the origin of the universe and life on earth. The decision to adopt one theory over another, then, does not flow from the rational rules of the game, but from the relation of theory and reality. In this way, we come back to the complex issues of verifiability, corroboration, and the testing of scientific theories.¹²⁴

Reason and science can only produce conflicting interpretations, not universal truths that all human beings are bound to accept merely because humans are rational beings. Moreover, reason cannot help us to decide between conflicting interpretations. But a choice must be made, otherwise theory-oriented scientific method cannot operate. Use of a theory implicitly implies a belief in its truthfulness. Since we do not choose on the basis of universal, rational truth, choices always involve faith. With the passage of time, choices become immovable scientific dogmas, especially when used to understand other aspects of reality. This happens in science, particularly in the case of the interpretation of the origins of the universe and life. Changes in all-inclusive issues impact the entire field of scientific studies.

The general description of scientific methodology provided above clearly dispels the popular myth of science as an infallible instrument for

¹²⁴This is a very complex issue. Since scientific testing does not take place outside of theory but from theory and reason, it is not clear whether an "impartial" decision can be consistently reached, especially in macro-hermeneutical issues. According to Kuhn, one of the "bad boys" in the philosophy of science, changes in macro-hermeneutical issues are possible, but take long periods of time and occur within the dynamics of hermeneutics and history. They do not result from the unprejudiced use of reason or scientific methodology (Kuhn, 10-11).

discovering absolute truth. Postmodernism has brought down the myth of reason as the absolute arbiter of what truth is. Recent criticism of scientific methodology has shown the historical-hermeneutical component of scientific methodology and its dependence on tradition and authority. In Feyerabend's words, "science is not sacrosanct."¹²⁵ However in Western society, the myth persists, probably due to the need to find answers to perennial questions and the willingness to accept as final the theories of science rather than traditional philosophical or theological explanations. Because empirical science seems to be closer to the facts than philosophy and theology, our culture confers to it a higher reliability and authority.

For theology, these philosophical developments mean that a theology based on the principle of *sola Scriptura* is not irrational. The counterpart to what scientists call speculation or guess in creating and building a comprehensive evolutionary worldview, is what Scripture calls divine inspiration. Evolution stands as the rational explanation produced by the scientific community in the Western world, while biblical inspiration stands as the rational explanation of the community of faith received from God by way of divine revelation and inspiration. Certainly, from a rational perspective, these two theories are incommensurable. From the perspective of the reality they explain, however, they are commensurable. Because they explain the same reality in opposite ways, they stand in conflict. And we are compelled to choose between them because the functioning of reason and scientific methodology requires we assume a specific cosmology. Yet, because reason has no universal rules, choices of cosmology stand on faith, not only in theology, but also in empirical science. Thus, reason does not force Adventism, for instance, to adapt the biblical account of creation to an evolutionary explanation in order to safeguard its rationality.

Conclusion

We have so far described the major components involved in the method on which the prestige of science and the authority of the evolutionary theory is built. As the church considers how to relate to evolution, it is important to have in mind a general picture of science. The description presented in this article has been based primarily on Bunge's description and Popper's focused analysis. I would like to conclude this discussion of the scientific method with Popper's conclusions.

The analysis of scientific methodology as a general research model reveals some important characteristics that should be considered when approaching the science-theology relation and the question of origins.

(1) *Science does not produce absolute truth.* The application of the

¹²⁵Feyerabend, 214.

scientific method does not produce absolute final discovery of truth, but helps us to wrestle with the constant task of interpreting reality. "Science is not a system of certain, or well-established, statements; nor is it a system which steadily advances towards a state of finality. Our science is not knowledge (*episteme*): it can never claim to have attained truth, or even to be a substitute for it, such as probability. . . . *We do not know: we can only guess.* And our guesses are guided by the unscientific, the metaphysical (though biologically explicable) faith in laws, in regularities which we can uncover—discover" (emphasis original).¹²⁶

(2) *Science is not dogmatic.* The dogmatic use of scientific conclusions, therefore, goes against the method and spirit of science.

Once put forward, none of our "anticipations" are dogmatically upheld. Our method of research is not to defend them, in order to prove how right we were. On the contrary, we try to overthrow them. Using all the weapons of our logical, mathematical, and technical armory, we try to prove that our anticipations were false—in order to put forward, in their stead, new unjustified and unjustifiable anticipations, new "rash and premature prejudices", as Bacon derisively called them.¹²⁷

(3) *To do science is to interpret.* Scientific method does not proceed by way of discovering absolute truth in empirical facts, but by way of interpretation, construction of explanations, bold ideas, and speculation. "Out of uninterpreted sense-experiences science cannot be distilled, no matter how industriously we gather and sort them. Bold ideas, unjustified anticipations, and speculative thought, are our only means for interpreting nature: our only organon, our only instrument for grasping her."¹²⁸

(4) *Science as interpretation requires scientific a priories.* This becomes apparent when we deal with the hermeneutical condition of method. "Even the careful and sober testing of our ideas by experience is in its turn inspired by ideas: experiment is planned action in which every step is guided by theory."¹²⁹

(5) *Science cannot produce absolutely certain, only tentative, results.* This is a most important characteristic of science because it anticipates postmodernity. "The old scientific idea of *episteme*—of absolutely certain, demonstrable knowledge—has proved to be an idol. The demand for scientific objectivity makes it inevitable that every scientific statement must remain *tentative forever*. It may indeed be corroborated, but every corroboration is relative to other statements which, again, are tentative.

¹²⁶ Popper, 278.

¹²⁷ *Ibid.*, 279.

¹²⁸ *Ibid.*, 280.

¹²⁹ *Ibid.*

Only in our subjective experience of conviction in our subjective faith, can we be 'absolutely certain'" (emphasis original).¹³⁰ "The wrong view of science betrays itself in the craving to be right; for it is not his possession of knowledge, of irrefutable truth, that makes the man of science, but his persistent and recklessly critical quest for truth."¹³¹

¹³⁰Ibid.

¹³¹Ibid., 281.