Articles

ALBERT EINSTEIN AND BERNARD LONERGAN ON EMPIRICAL METHOD

by Donna Teevan

Abstract. In the science-and-theology dialogue, it becomes imperative that theologians develop sophistication in empirical method. Albert Einstein stated that to understand what physicists do we should not listen to what they say but watch what they do. Still, he wrote incisively about method in physics. Theologian and philosopher Bernard Lonergan developed a methodical approach to theology that was influenced by the natural sciences. I present Einstein's thought on epistemology and the relationship between sense experience and theory. I then turn to Lonergan's understanding of empirical method in the natural sciences, generalized empirical method, and his treatment of Einstein's work.

Keywords: Albert Einstein; empirical; epistemology; Bernard Lonergan; scientific method; theological method.

As theology increasingly employs empirical studies and enters into cross-disciplinary dialogue, especially with the social and natural sciences, it becomes imperative that theologians develop sophistication in empirical method. An empirical approach to theology is in some senses nothing new, but scientific and epistemological developments in the mid-twentieth century illustrate the challenge in taking an approach that is empirical

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without being empiricist. To sort through some of the issues, I address a few ideas offered by the physicist Albert Einstein (1879–1955) and the Jesuit theologian and philosopher Bernard Lonergan (1904–1984). Einstein recommended that to understand what physicists do we not listen to what they say but watch what they do (Einstein 1982, 270). Nonetheless, Einstein himself wrote quite incisively about epistemology and method in physics. Lonergan wrote extensively on epistemological matters and developed a generalized empirical method for theology that he based on his understanding of scientific method. In this article I present Einstein's approach to science, emphasizing his understanding of the relationship between sense experience and theoretical construction. I then turn to Lonergan's notion of empirical method, giving particular attention to his treatment of Einstein himself and to the topics that Einstein takes up in presenting his own understanding of scientific method.

Einstein's Approach to Scientific Method

Einstein's remarks on scientific method are sometimes specific to theoretical physics and at other times intended to be applied more broadly. In one of these wider applications, he states that "the whole of science is nothing more than a refinement of everyday thinking" (Einstein 1982, 290). This conviction underlies his own explorations of the nature of thinking beyond the bounds of science. In analyzing Einstein's written reflections on epistemology, philosophers have found his position difficult to categorize under traditional headings. Henry Margenau contributed an essay entitled "Einstein's Conception of Reality" to the volume on Einstein's thought in The Library of Living Philosophers series, a collection in which the philosopher is invited to respond to the essays analyzing his or her work. He argues that Einstein's view "contains features of rationalism and extreme empiricism, but not in logical isolation" (Margenau 1949, 247). In his response to the authors of this volume examining his philosophy, Einstein endorses Margenau's appraisal, explaining that the physicist's need to connect experience and concepts, which we shall see takes anything but a direct path, makes a "wavering between these extremes [rationalism and empiricism] . . . unavoidable" (Einstein 1949, 680). Keeping at bay any desire to squeeze Einstein's thought into a single philosophical category, let us consider his own statements about the scientific enterprise.

The Limitations of Induction. Einstein asserts that science is not "a purely empirical enterprise" (1961, 142) in that it is not simply a matter of induction: "There is no inductive method which could lead to the fundamental concepts of physics" (1982, 307). Physics is a logical system of thought, one that cannot be "distilled, as it were, from experience by an inductive method" (1982, 322; see also 301). He criticizes "even the great Newton" and the scientists that followed, especially in the nineteenth century, for attempting to derive the fundamental concepts of physics inductively (1982, 301, 307).

One angle from which to read Einstein's strong repudiation of a strictly inductive approach might be his position's complex relationship to Ernst Mach's positivism. As Philipp Frank explains it (1949, 274), Mach insisted that the fundamental laws of physics should contain only concepts that could be defined by direct observations or at least by a short chain of thoughts connected with direct observation. Although Einstein acknowledged his abiding appreciation for Mach, he did depart from Mach's positivism in certain respects (Frank 1949, 271–75). In brief, Einstein eschewed the easy move from direct observation to conceptualization. Some have argued that even Mach would concur that such a move would be an oversimplification, one perhaps more characteristic of nineteenth-century positivism than of twentieth-century positivism (or logical empiricism, as it is occasionally designated). Those espousing the latter recognize that there are concepts not deducible from sense data. Still, Mach maintained his preference for treating concepts as the result of direct deduction from sensory experience (Frank 1949, 281–82). For Einstein the process is more complex.

It may be helpful to look at how Einstein himself explains the relationship between science and epistemology. He describes science without epistemology as "primitive and muddled" (Einstein 1949, 684). Still, he claims that the scientist cannot adhere too rigidly to an epistemological system. In fact, Einstein suggests that, to the systematic epistemologist, the scientist must appear to be an

> unscrupulous opportunist: he appears as *realist* insofar as he seeks to describe a world independent of the acts of perception; as *idealist* insofar as he looks upon the concepts and theories as the free inventions of the human spirit (not logically derivable from what is empirically given); as *positivist* insofar as he considers his concepts and theories justified *only* to the extent to which they furnish a logical representation of relations to sensory experiences. He may even appear as *Platonist* or *Pythagorean* insofar as he considers the viewpoint of logical simplicity as an indispensable and effective tool of his research. (Einstein 1949, 684)

This quotation furnishes a neat summary of Einstein's approach to epistemology and serves as a warning to anyone who would pin a ready-made label on his approach to scientific method.

Einstein's Understanding of the Real. Given this epistemological mix as well as the fact that Einstein was a physicist rather than a philosopher, we do not have a clear and precise statement of his conception of reality. From his own autobiographical reflections we know that he was influenced by Mach and Immanuel Kant. Nonetheless, his writings as a whole suggest that he is not simply a logical positivist or an idealist. Having just noted his differences with Mach and in regard to Kant, I should stress that for Einstein the "categories" are not some form of Kantian a priori but conceptions that are freely invented and are to be judged by their usefulness, their ability to advance the intelligibility of the world which is independent of the observer. As he sees it, the difference between his own thinking and Kant's is on just this point: Einstein understands the categories as "free conventions" rather than as "unalterable (conditioned by the nature of the understanding)" (Einstein 1949, 674). Einstein asserts that "'the real' in physics is to be taken as a type of program, to which we are, however, not forced to cling *a priori*" (1949, 674).

To summarize as concisely as possible, let me offer Margenau's key points before proceeding to Einstein's response. (1) Einstein's thought contains features of rationalism and extreme empiricism. (2) His thought implies a threefold distinction between an *external world*, the *observer's perception* of that external world, and our *notions* of it. (3) Einstein opposes the view that theory copies reality. (4) Objectivity in his thought becomes equivalent to the invariance of physical laws, not physical phenomena or observations; this invariance is expressed in the form of differential equations. (5) Simplicity is a criterion of the real. (6) The fact that classical continuity of properties is contradicted by quantum physics raises questions about the future of physics; Einstein's preference at this impasse is to explore field theories, thus retaining in some form a classical approach, one that describes reality "in terms of systems defined by stable properties having significance at all times" (Margenau 1949).

In his reply to Margenau's essay, Einstein begins with clarifications and explanations of points with which he fundamentally concurs. He agrees that his position fluctuates between rationalism and empiricism, which he characterizes as inevitable in the physicist's engagement with both the conceptual and the empirical. Clarifying his interest in Kant as a later development in his thought, he offers his agreement with Kant's idea that the real is not given to us but put to us. Einstein then registers strong disagreement with Margenau's analysis of his approach to objectivity, especially with its focus on differential equations. He argues that "we are far from being able to judge whether differential laws of the type to be considered have any solutions at all which are everywhere singularity-free; and if so whether there are too many such solutions" (Einstein 1949, 681). On technical grounds he also criticizes Margenau's presentation of "orthodox" quantum theory, which undermines Margenau's discussion of Einstein's relation to this development.

Unfortunately, Einstein's response to this essay on his conception of reality leaves us with very little to construct a clear idea of his thinking on this subject. His brief discussion of rationalism and empiricism is more of a functional description of the work of a physicist than a truly philosophical self-reflection. We can turn to his silences for some ideas that he might have assessed as accurate. He does not take issue with Margenau's assertion that he accepts the existence of a world largely independent of the human observer. Nor does he disagree with the essay's emphasis on simplicity as a guide to identifying the real. Although we cannot take Einstein's silence on these points as a sure indication of agreement, his writings do support Margenau's analysis on these points. Einstein's notion of the real and its relation to empirical method will come into a little greater focus as we move on to his understanding of the nature of principles and theories in science.

Scientific Principles and Theories. Fundamental principles are described by Einstein as "free inventions of the human intellect" (Einstein 1982, 272). Principles nonetheless are closely related to empirical observations. As Einstein puts it, "the scientist has to worm these general principles out of nature by perceiving in comprehensive complexes of empirical facts certain general features which permit of precise formulation" (1982, 221). These principles, not "isolated general laws abstracted from experience" or "separate results of empirical research," provide the basis of deductive reasoning.

Theories (and, one might presume, the search for principles as well) arise from what Einstein describes as our "passion for comprehension," which he compares with the passion for music (1982, 342). Einstein identifies two types of theories in physics. One he calls *principle* theories, which have as their starting point empirically discovered rather than hypothetically constructed elements, which give rise to mathematically formulated criteria that must be satisfied. The theory of relativity, which waited twenty-five years for direct experimental evidence to support it, is an example of this type of theory. The advantages of principle theories, in his assessment, are "logical perfection and security of foundations" (1982, 228). The other category is that of *constructive* theories, which begin with a relatively simple formal scheme and create a picture of the interrelationships among complex phenomena. Einstein explains that "when we say we have succeeded in understanding a group of natural processes, we invariably mean that a constructive theory has been found which covers the processes in question." The benefits of this kind of theory are "completeness, adaptability, and clearness" (1982, 228).

The difference between a principle and a theory is not as clear as it might first appear. Einstein tends to treat principles as heuristics that assist in the formulation of a theory. At first he insisted that what is now known as his relativity theory be called the relativity *principle*. Max Planck was the first to use the term *theory* to describe it. Eventually, Einstein gave in to this increasingly widespread usage, though for a while he placed it in quotation marks to signify his discomfort with the terminology (Folsing 1998, 209).

Experience. Einstein holds that "all knowledge of reality starts from experience and ends in it" (1982, 271). If the fundamental concepts of physics cannot be "distilled" from experience, what is the role of experience in Einstein's approach to physics? His clearest answer to this question is found in his 1949 *Autobiographical Notes*. Here he asserts that theories are tested by experience, not constructed by it ([1949] 1996, 85). In other writings Einstein develops this idea more fully. Experience constitutes the sole criterion of the "physical utility of a mathematical construction" (1982, 274). Most important, experience can serve to disprove a theory, because a valid theory should not contradict empirical facts. To put it another way, the adequacy of the theory to experience provides its justification, and thus theories that employ concepts that are "close to experience" are less likely to be disproved (1982, 349; see also 247).

Einstein admits, however, that the theory of general relativity relinquishes "'closeness to experience' of fundamental concepts in order to attain logical simplicity" (1982, 349). In a 1914 paper he offers the theory of relativity as an example of a conclusion that is not presently accessible to experience and will require many years of empirical research to ascertain whether its theoretical principles correspond with reality (1982, 222). Writing several years later, he maintains that the theory of relativity did not originate in speculation but in "the desire to make physical theory fit observed fact as well as possible" (1982, 246). Thus, although the desire for logical simplicity may outweigh adequacy to experience in the construction of a theory, both are necessary.

A theory is more impressive, in Einstein's view, according to (1) "the greater simplicity of the premises," (2) "the more different kinds of things it relates," and (3) "the more extended its area of applicability" ([1949] 1996, 31). A theory is not to contradict empirical facts, of course; but, given the choice among theories that fit the observations, Einstein's preference is for those whose premises exemplify logical simplicity (1996, 23), that use a minimum of primary concepts and relations (1982, 293). Margenau points out (1949, 255) that for Einstein the principle of simplicity functions not only to assess the value of one theory in relation to another but to guide the construction of new theories.

The Role of Intuition in the Formulation of Concepts. Einstein describes the connection between concepts and sense experience as "purely intuitive, not itself of a logical nature" ([1949] 1996, 11). An understanding of empirical science as a continuous process of induction does not, in his judgment, do justice to the role of intuition and deductive thought in scientific process (1961, 142). He contends that "pure logical thinking cannot yield us any knowledge of the empirical world" in that knowledge is grounded in experience (1982, 271). He describes the task of the physicist as the attempt to arrive at universal laws through a process of deduction and goes on to state that "only intuition, resting on a sympathetic understanding of experience, can reach them" (1982, 226).

Einstein, strongly influenced by Kant but rejecting Kantian categories, argues that "nothing can be said *a priori*" about how we form concepts, connect them to each other, and coordinate them with sense experiences (1982, 292). On one hand, the concept's connection with sense experiences is crucial, for without it we have only "empty concepts" and not science (1982, 293). On the other hand, even concepts closest to experience "are from the point of view of logic freely chosen posits" ([1949] 1996, 13). Einstein stresses the work of the imagination in forming concepts, claiming that they are arrived at by "free invention" (1982, 322).

Summary of Einstein's Approach to Empirical Method. Although Einstein describes himself as an occasional empiricist, so to speak, his thinking is not truly empiricist. To borrow a definition from one of Einstein's commentators, "empiricism as applied to natural science is that concepts and natural laws are abstracted from experience" (Lenzen 1949, 360). Clearly Einstein rejects that approach and thus, in my view, is operating empirically without being an empiricist. He asserts that scientific knowledge has two components, one given empirically and the other imaginatively and theoretically, with neither one simply derived from the other (Northrop 1949, 390). The connection or correlation between the two is intuitive, although not in the Humean sense. The act of intuition that brings together the empirical and the theoretical arises from the creativity of the scientist's imagination. The connection "does not arise apart from and independent of experience; nor can it be derived from experience by a purely logical procedure. It is produced by a creative act" (Einstein 1982, 343). The justification of a theory involves its fit with the observations, logical simplicity, and explanatory power.

Lonergan on Method

I want to begin my discussion of Lonergan's approach to empirical method with a few words about his presentation of method in his *Method in Theology* (1972). For him, method is "a normative pattern of recurrent and related operations yielding cumulative and progressive results" (p. 4). Lonergan contrasts this vision of method as a framework for collaborative creativity with two other methodological perspectives. The first of these is to see method as an art that is learned by imitating a master. The second alternative is to set up a successful science, such as the natural sciences, as the methodological standard. Lonergan certainly does not conceive of method as artistic imitation, nor does he adhere strictly to the model of the natural sciences. He sees himself as offering a third way, an approach to method that examines the natural sciences for insight into the basic terms and relations of human cognition, but he does not promote the natural sciences as offering the definitive method for all disciplines.

Still, the method of modern science has a significant role in Lonergan's thought. I will explain shortly its role as an illustration of human intelligence, but here I wish to make the historical note that one of Lonergan's aims as a theologian was to bring Roman Catholic theology into dialogue with the modern world—with contemporary developments in history, philosophy, and the natural sciences. This goal was rooted in his conviction that he was in the midst of a profound transition from classical to modern controls of meaning that must be understood for the well-being of humanity. Of course, today we tend to articulate the major intellectual shift as one from modernity to postmodernity, but in Lonergan's time Catholicism was grappling with the implications of modernity for theological thought and religious living. In Lonergan's view, the problem of modernity was that it had not fully matured and the classical culture it was replacing was breaking down. In a 1967 article, "Dimensions of Meaning," he argues that the "clearest and neatest illustration of the breakdown of classical culture lies in the field of science" (Lonergan [1967] 1988b, 238). After summarizing the Aristotelian conception of science with its emphasis on the necessary, essential, and universal at the neglect of the contingent, accidental, and particular, Lonergan offers a further contrast between this classical approach and modern science:

> [In the modern scientific approach] we do not put theory and practice in separate compartments; on the contrary, our practice is the fruit of our theory, and our theory is orientated to practical achievement. We distinguish pure science and applied science and technology, technology and industry; but the distinctions are not separations, and however great the differences between basic research and industrial activity, the two are linked by intermediate zones of investigation, discovery, and invention. ([1967] 1988b, 239–40)

A comparison between Lonergan and Einstein on issues of social responsibility is beyond the scope of this study; but certainly, for both of them, no matter how abstractly they describe it, the empirical method of the sciences operates in a fully historical context.

Having said that, it remains that the most detailed presentation of empirical method in Lonergan's writing is found not in his remarks about Western cultural transitions but in his study of the operations of human intelligence. The cognitional theory that underpins Lonergan's approach to theological method was developed in his major philosophical work *Insight*, which was published in the late 1950s. Lonergan's project in this volume is "to reach the act of organizing intelligence that brings within a single perspective the insights of mathematicians, scientists, and men of common sense" ([1957] 1992, 4). He begins his study of insight with an investigation into the workings of human intelligence in mathematics and science, because these fields offer illustrations of cognitional operations with clarity and precision. He believes that these same basic operations also occur in the functioning of intelligence operating in the commonsense world of everyday experience; in the commonsense mode, however, human beings lack that theoretical precision about what they are doing when they are knowing. Regardless of the subject matter or the specialized methods employed, human knowing is a compound of experience, understanding, and judgment, which then may be followed by decision or action.

To put it in other terms from Lonergan, there are four levels of human consciousness. On the level of experience, we sense, feel, and move. On the level of understanding, we inquire and formulate. On the level of judgment, we reflect, marshal the evidence, and pass judgment on truth and falsity. Finally, on the fourth level, that of decision, we deliberate, evaluate, and decide. For Lonergan, knowledge consists in three of these activities: the compound of experiencing, understanding, and judging. The process of knowing, then, is not to be imagined in optical metaphors, as "taking a good look" at "the already out there now," but as the result of these operations. This is the fundamental process of every human inquiry, including both theology and science.

In a sense, Lonergan's idea that all fields of inquiry have a common base in the operations of human intelligence is similar to Einstein's claim that science is a refinement of everyday thinking. Another similarity between these two ideas can be found in Lonergan's discussion of belief. He asserts that both common sense and scientific knowledge rely heavily on belief, knowledge based on the testimony and work of others, rather than on personally acquired knowledge. Here he is not using "belief" in a religious sense. Lonergan points out that human knowing is a group enterprise and therefore that much of what we know comes from believing others. Scientists rely on mathematical tables, for example, and build on the work of others rather than repeat endlessly the experiments of their predecessors. Their knowledge may be described as personally acquired as they make original contributions. For all of us, scientists and nonscientists alike, our beliefs and personally acquired knowledge intermingle. The difference between scientific and commonsense knowledge is the control of belief (Lonergan 1974a, 88). Science is precise in a way that common sense is not and demands kinds of verification that go beyond commonsense thinking. Science also requires an ability to move into theoretical ways of thinking that may be described as explanatory rather than as simply descriptive. Einstein, however, does not employ these distinctions and presents the process of scientific inquiry as sometimes what Lonergan would call both descriptive and explanatory, while at other times, for example in the case of relativity theory, as simply explanatory.

The empirical method employed by scientists, according to Lonergan, determines patterns that unite data in an explanatory fashion, that is, in relation to one another. He states that empirical science seeks not the relations of things to our senses but their relations to one another (Lonergan [1957] 1992, 65). He uses the term *description* to designate the relation of things to our senses and presents this type of knowing as characteristic of common sense. Although he regards scientific thought as primarily explanatory, he adds that it needs "descriptions that determine the data which explanations must satisfy" ([1957] 1992, 273). Indeed, he asserts that our explanations are valid only insofar as our descriptions are exact ([1957] 1992, 370). Description and explanation are also closely related in that they are concerned with the same objects, albeit from different perspectives. Fundamentally, scientific thought moves from description to explanation.

The Heuristic Structures of Empirical Method. Lonergan likens the process of empirical method to the action of a pair of scissors. The lower blade includes research results and scholarly techniques: scientific experiments, working hypotheses, precise measurements, and empirical correlations ([1957] 1992, 600–601). Lonergan describes these as "insights," which require an upper blade to constitute anything more than that ([1960] 1996, 61). The empirical sciences do more than proceed from data. The upper blade of the scissors consists in a heuristic structure, a set of generalities that is at once universal and concrete.

A heuristic structure is an aid to discovery, a way of moving toward the unknown. It anticipates findings of a certain kind. Empirical method employs two types of heuristic structure, classical and statistical, that guide us in exploring world process, which Lonergan understands as both systematic and nonsystematic. Classical heuristic structures seek to discover the functional relationships between measurable aspects of data; they head toward systematization. Statistical heuristic structures focus on frequencies, setting aside theoretical constructions. They anticipate the discovery of probabilities from which relative actual frequencies may diverge at random ([1957] 1992, 91). Lonergan presents Einstein, along with Galileo and Newton, as representative of classical empirical method. In fact, most of the references that Lonergan makes to Einstein occur in his discussions of classical heuristic structure. Lonergan cites Einstein as a scientist who operates within a classical framework yet moves scientific method forward. Nonetheless, Lonergan advocates the complementary value of statistical heuristic structures, arguing strongly that both are necessary.

The Canons of Empirical Method in the Sciences. In *Insight* ([1957] 1992) Lonergan follows his discussion of classical and statistical heuristic structures with a chapter on six rules, or canons, of empirical method. His purpose in elaborating these canons is consistent with the overall aim of his project, thus he seeks to provide further "insight into insight" by presenting the principles that govern its fruitful unfolding in empirical investigations. We must keep in mind that he examines the workings of the natural sciences not to present a detailed analysis of their particular methods but to illustrate the workings of human intelligence.

The first of these canons (which he once called "principles"), the canon of selection, restricts the subject matter of empirical inquiry to the data of sense experience. As I explain further on, Lonergan contends that in its essentials empirical method can be applied to the data of consciousness as well as the data of sense. At this point, however, he is concerned with the commonly accepted understanding of empirical method.

The second principle, the canon of operations, asserts that the accumulation of insights relevant to empirical investigation includes both mathematical observations and insights associated with observations, experiments, and practical operations. This canon concerns the ongoing process by which theories point inquiry in a certain direction, resulting in discoveries that sometimes call for the creation of more adequate theories. These first two canons emphasize the importance of attention to data.

The third principle, the canon of relevance, distinguishes between the aims of pure and applied science. It holds that the same data can be regarded from the perspectives of different types of insight. The first concern of empirical investigation is the intelligibility of the data, but once an understanding of the data is established, other questions arise regarding the potential uses of this knowledge and the technologies that may be developed from it. Still, the canon of relevance asserts that these purposes must remain distinct; understanding for the sake of understanding has its place.

The fourth principle, the canon of parsimony, requires that the findings of empirical inquiry consist in what can be verified in the data and not in the unverified imaginings of the investigators. To put it another way, "the canon of parsimony in its most elementary form excludes from scientific affirmation all statements that are unverified, and still more so all that are unverifiable" (Lonergan [1957] 1992, 102).

The fifth canon, that of complete explanation, asserts that the goal of empirical method is the complete explanation of all phenomena or data that accord with the canon of selection. Lonergan argues that this fifth canon, seemingly redundant in light of the canon of selection, is necessary to reinforce a contemporary correction to Galileo's understanding of scientific method. Galileo regarded scientific progress as the reduction of secondary qualities (e.g., color as seen, sounds as heard, heat as felt) to their real and objective source in primary qualities, the mathematical dimensions of the real. Lonergan, in contrast, contends that progress in science is the movement from experiential to pure conjugates. Experiential conjugates are correlatives understood in relation to our experience; colors, for example, "will be experiential conjugates when defined by appealing to visual experience" ([1957] 1992, 102). Pure or explanatory conjugates "are correlatives defined implicitly by empirically established correlations, functions, laws, theories, systems" (p. 103). Both experiential and pure conjugates are verifiable. The key difference between his position and Galileo's, according to Lonergan, regards space and time. For Galileo they were primary qualities, whereas for Lonergan they can be understood as experiential conjugates in regard to familiar elements of our experience and as pure conjugates "defined implicitly by the postulate that the principles and laws of physics are invariant under inertial or, generally, under continuous transformations" (p. 108). A complete explanation requires attention to both conjugates. Lonergan contends that in its incompleteness Galileo's understanding violates the canon of complete explanation, and in its failure to base his affirmation of primary qualities on the claim that they were verified or verifiable it does not meet the requirement of the canon of parsimony. In this regard, Lonergan states that Galileo "would have to settle an account with Einstein, who has made various proposals regarding the space-time of physics and has some grounds for supposing his line of thought verifiable and, to some extent, verified" (p. 109). Lonergan's approach allows for both the affirmation of everyday experience as real and for the affirmation of Einstein's theory of relativity, which goes beyond the human imagination.

The types of laws appropriate for the explanation of all data will be both classical and statistical, giving rise to the sixth and final principle, the canon of statistical residues (pp. 93–125). Investigations employing classical methods yield an empirical residue that calls for statistical methods of inquiry. Classical laws shed light on the abstract relations between concrete relations, but they do not fully account for the concrete, for particular cases. After classical methods have been applied, statistical methods come into play to investigate the empirical residue. There are many intricate dimensions to Lonergan's discussion of this canon, but I focus on the one most germane to this article. Lonergan distinguishes his discussion of the need for statistical investigation from a description of quantum mechanics. He also recasts the relationship between Einstein's determinism and indeterminacy in terms of his own distinction between the abstract and particular cases: "Einstein's differential equations are not statements about positions and velocities in defiance of Heisenberg's principle; they are statements of the abstractness and so invariance of classical laws. The proper answer to the old determinism is an affirmation, not of an indeterminism on the same imaginative level, but of the indeterminacy of the abstract" (p. 124). In short, the canon of statistical residues attempts to deal with the relationship between the abstract and particular cases, maintaining that classical and statistical modes of inquiry are complementary.

I have noted places where Lonergan makes specific references to Einstein in his presentation of the canons of empirical method. To conclude this section, I simply add that Einstein might concur with all of them except, perhaps, the last. Einstein did not frame his relationship with the Heisenberg Principle or with quantum mechanics in the terms proposed by Lonergan, and the relationship between his position and theirs is more complex than Lonergan could have done justice to within the purview of his inquiry into the activity of human intelligence. Lonergan's acceptance of the canon of empirical residue and his sympathy with quantum mechanics mark a difference between his thinking and Einstein's.

Lonergan's "Generalized Empirical Method." Lonergan extends the scope of empirical method by introducing the notion of a "generalized empirical method." The method is empirical, he asserts, because it "stands to the data of consciousness as empirical method stands to the data of sense" (Lonergan [1957] 1992, 268). In more specifically theological contexts Lonergan also relates his decision to describe his approach as a generalized empirical method to his commitment to begin his theological work from data. He tends to use the term *empirical* as a way to contrast his data-rooted theological method with a deductivist theological approach that begins with premises (which in a Catholic deductivist theology are drawn from scripture and tradition) and proceeds to logical conclusions that follow from the premises. Lonergan's generalized empirical method begins not from premises but with data interpreted from a historically conscious perspective (Lonergan 1974c, 58).

In addition to the comprehensive approach of generalized empirical method, Lonergan advocates the need for "special methods" that are adapted to the demands of a specific field of inquiry, such as those employed in the natural sciences and in historical research. Generalized empirical method does not replace these; rather, it highlights their common underpinning in the activities of human intelligence, in the occurrence of insight.

Insight. I believe that what Einstein describes as the act of intuition is what Lonergan calls insight. Lonergan uses the term *insight* for "a distinct activity of organizing intelligence that places the full set of clues in a unique explanatory perspective" ([1957] 1992, 3). In a direct insight the person grasps the intelligible unity of the data. In an inverse insight the person discovers that the anticipated intelligibility is not there. Lonergan states that both types of insights are present in Einstein's work on relativity. General relativity "invokes a direct insight into the significance of measurements," and special relativity invokes "an inverse insight into the insignificance of constant velocity" ([1957] 1992, 66).

I would like to add another thought on the relation of Lonergan's notion of insight to Einstein's approach to scientific method. Despite his emphasis on the function of intuition in scientific thinking, Einstein would not, in my view, substantially disagree with philosopher Michael McCarthy's statement that "the development of understanding is a gradual discursive process rather than an ecstatic intuitive event" (McCarthy 1990, 265). It may be that what some call "intuition" is really a "gradual discursive process" characterized by subtlety and highly connective thinking. Elizabeth Morelli, for example, has argued that "women's intuition" is not irrational but really a matter of insights coalescing (Morelli 1994). In this vein, I would suggest that what Einstein is stressing in his use of the term *intuition* is that there simply is not a straight line from data to conclusions, nor are there any conclusions without the play of human creativity. Reaching conclusions in science requires not staring blankly at data but engaging one's intelligence and judgment. When Einstein highlights the role of the scientist's imagination, he is, in Lonerganian terms, stressing the fact that experience, without understanding and judgment, does not suffice for knowledge.

Critical Realism. Epistemologically, Lonergan is a critical realist. He distinguishes between two quite distinct types of realism: naive and critical. Naive realism essentially equates knowing with looking. Critical realism, by contrast, maintains that human knowing consists in the operations of experience, understanding, and judging. It contends that taking a good look at something may provide data for these operations, but it does not constitute knowing. Lonergan's critical realism commends idealism (against empiricism) for acknowledging that human knowing includes understanding as well as experiencing, but repudiates idealism for its conclusion that the world it knows is ideal rather than real (1972, 238–39). He argues that by our senses and by our consciousness we receive not appearances but data ([1967] 1988a, 218). In short, he contends that through intelligent grasp and reasonable affirmation we know not just the world of appearances but the real.

In my discussion of Einstein's epistemology, I noted the difficulty of assigning his views to any one philosophical category, and I affirm that judgment here. Still, I must point out the common ground that Einstein shares with Lonergan's understanding of critical realism. In *Insight* Lonergan observes that Einstein's notion of space and time goes beyond that which can be imagined. Lonergan goes on to remark that contemporary scientists, unlike their predecessors, cannot regard knowledge as a matter of taking a good look but as a compound of experiencing, understanding, and judging. The real, for the scientist, is not the already-out-there-now, but what can be verified in this process of knowing ([1957] 1992, 449–50). Einstein's notion of the real is far more elusive and less systematically presented. Nonetheless, I propose that there is some similarity to Lonergan's position in Einstein's contentions that (1) knowledge of reality begins from experience (experience); (2) theories are constructed by the creativity of human intelligence (understanding); and (3) theories must be justified by their congruence with the observations, simplicity, and explanatory power (judgment).

How Einstein would respond to Lonergan's notion of objectivity is more difficult to assess. Lonergan attempts to overcome the longstanding split between subject and object with his idea that objectivity is "the consequence of authentic subjectivity, of genuine attention, genuine intelligence, genuine reasonableness, genuine responsibility" (Lonergan 1972, 265). In other words, the real is what is known in true judgment, and objectivity is what is attained in true judgment. Looking for interdisciplinary common ground, he contends that "mathematics, science, philosophy, ethics, theology differ in many manners; but they have the common feature that their objectivity is the fruit of attentiveness, intelligence, reasonableness, and responsibility" (1972, 265). Einstein might not disagree with Lonergan's contention in a general sense, but whether he would regard it as adequate is purely a matter of speculation. His own thinking on the matter of objectivity is none too clear.

Conclusion

First, in this comparison of Einstein and Lonergan, we should keep in mind that Lonergan's "generalized" empirical method goes beyond Einstein's conception of scientific method. As applied to the data of consciousness rather than simply the data of sense, Lonergan's generalized empirical method seeks to determine patterns of experience, which he identifies as biological, artistic, dramatic, and intellectual. Mathematics and scientific thought illustrate one of these patterns—the intellectual. Thus, Lonergan's generalized empirical method is concerned with the full range of experience, including the aesthetic and the interpersonal, and his emphasis on the empirical should not be read as a devaluing of these other dimensions of human experience. Lest Einstein's thought be construed narrowly, however, we should not forget his appreciation of the aesthetic, particularly in the form of mathematical beauty. In Einstein's thought mathematics, especially elegant mathematics, serves as a heuristic as well as the formal element of a scientific argument.

Second, both Einstein and Lonergan understand scientific method to be constituted by sense experience and the creative and intelligent activity of the human inquirer. Scientists are far more than "gawkers." Lonergan commends Einstein for having an "upper blade" to his method. Here I need to point out that Lonergan's notion of the upper blade is rather complicated. As stated earlier, the upper blade of empirical method consists in a heuristic structure, which in Einstein's case is classical. Lonergan writes in some detail about the upper blade in *Insight*. There he associates it with "differential and operator equations" and "postulates of invariance and equivalence" ([1957] 1992, 337). In *Method in Theology* he presents the scissorlike movement more simply as consisting of an upper blade that is self-appropriation and a lower blade that is data. In any case, it seems clear that Lonergan believed Einstein to operate effectively with an upper and a lower blade that generated scientific success.

My third point is a suggestion that Lonergan's notion of insight is a more precise and helpful way of speaking about the process Einstein describes as intuition. Both thinkers are addressing what is necessary to come to an explanatory perspective. Both agree that scientific concepts—or in Lonergan's terms, insights—must be rooted in experience. If concepts and experience are not connected—that is, if concepts are simply connected to each other—what you have in Lonergan's vocabulary is "closed conceptualism" and in Einstein's words "empty talk." Lonergan's definition of the closed conceptualism he rejects is quite similar to the inductive view of science that Einstein so forcefully condemns:

> What is a closed conceptualism? Well, conclusions result from principles. In turn, principles result from their component terms. But whence come the terms? The conceptualist view is that they are had by an unconscious process of abstraction from sensible data. It follows that all science is a matter of comparing terms, discovering necessary nexus, and setting to work the cerebral logic machine to grind out all the possible conclusions. (Lonergan [1967] 1988c, 85)

Lonergan also writes of a conceptualist extrinsicism sometimes operative in theology that ignores the reality that theologies develop in history and are formulated by human beings (1974b, 30). He contrasts closed conceptualism with the approach he espouses, that of an "open intellectualism," which conceives the movement toward conclusions as the result of a series of acts of understanding.

The implications of this position for theology are significant. Lonergan's approach to theological method stresses the need for theology to begin from data. A contemporary theology that follows this path will pursue dialogue with the social and natural sciences. What Einstein's thinking on scientific method offers is a caution that there is no direct route from data to theory. Such a warning might well inform our thinking in the current discussions about the difference between natural theology and a theology of nature. Ian Barbour has repeatedly distinguished natural theology from what he advocates as "a theology of nature." The latter starts from a religious tradition, from historical revelatory experience, rather than from science itself. It aims to reformulate doctrines in the light of scientific developments, but it does not build theological doctrines directly upon scientific findings (Barbour 1997, 100). In accord with this perspective, Lonergan's conviction that theology must begin from the data of both sense and consciousness marks data as a starting point, not a conclusion. In Lonergan's methodological scheme, the first phase of theology consists of listening to the past and then moving into a second phase of direct discourse, grounded in the present with a view toward the future. Thus, for Lonergan as for Barbour, theological reflection is rooted in the life of a historical religious community. To maintain the integrity and vitality of the life of a religious community or tradition, it is necessary to reexamine continuously the relationship between new advances in human knowledge and religious faith. Certainly, hermeneutics, critical theory, and liberationist thought have made us attentive to the complexity of data selection and interpretation. Lonergan and Einstein show us the further challenge of moving beyond the description of data into an explanation of the relations of data to each other.

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